The Report of the Commissioner of Agriculture, for 1897, consists of three volumes, as follows:

Volume I. Fifth Annual Report of the regular work of the Department of Agriculture, as required by section 5 of chapter 338 of the Laws of 1893.

Volume II. Ninth Annual Report of the State Weather Bureau, and Tenth Annual Report of the Cornell University Agricultural Experiment Station, made to the Commissioner of Agriculture in compliance with the provisions of section 87 of chapter 338 of the Laws of 1893.

Volume III. Sixteenth Annual Report of the New York Agricultural Experiment Station, made to the Commissioner of Agriculture in accordance with the provisions of section 85 of chapter 338 of the Laws of 1893.

State of New York—Department of Agriculture.

# SIXTEENTH ANNUAL REPORT

OF THE

## BOARD OF CONTROL

OF THE

# NEW YORK
# Agricultural Experiment Station,

(GENEVA, ONTARIO COUNTY.)

## FOR THE YEAR 1897,

### With Reports of Director and Other Officers.

TRANSMITTED TO THE LEGISLATURE JANUARY 14, 1898.


WYNKOOP HALLENBECK CRAWFORD CO.,
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1898.

# STATE OF NEW YORK.

No. 22.

# IN ASSEMBLY

JANUARY 14, 1898.

## SIXTEENTH ANNUAL REPORT

OF THE

## Board of Control of the New York Agricultural Experiment Station.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,
ALBANY, JANUARY 14, 1898.

*To the Assembly of the State of New York:*

I have the honor to herewith submit the Sixteenth Annual Report of the Director and Board of Managers of the New York Agricultural Experiment Station at Geneva, N. Y., in pursuance of the provisions of the Agricultural Law.

I am, respectfully yours,

CHARLES A. WIETING,
*Commissioner of Agriculture.*

# 1897.

# ORGANIZATION OF THE STATION.

## BOARD OF CONTROL.

GOVERNOR BLACK........................... Albany.
WILLIAM C. BARRY........................ Rochester, Monroe County.
S. H. HAMMOND .......................... Geneva, Ontario County.
MARTIN V. B. IVES....................... Potsdam, St. Lawrence County.
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LYMAN P. HAVILAND ...................... Camden, Oneida County.
G. HOWARD DAVISON....................... Millbrook, Dutchess County.

## OFFICERS OF THE BOARD.

MARTIN V. B. IVES.................................. *President.*
W. O'HANLON ....................................... *Secretary and Treasurer.*

S. H. HAMMOND,
W. C. BARRY,
F. O. CHAMBERLAIN,
F. C. SCHRAUB,
LYMAN P. HAVILAND,
G. HOWARD DAVISON,
} ............................ *Executive Committee.*

## STATION STAFF.

W. H. JORDAN, SC. D........................ Director.
L. L. VAN SLYKE, PH. D..................... Chemist.
WM. P. WHEELER............................. First Assistant.
S. A. BEACH, M. S.......................... Horticulturist.
VICTOR H. LOWE, B. S....................... Entomologist.
* F. A. SIRRINE, M. S...................... Entomologist.
* F. C. STEWART, M. S...................... Mycologist.
FRANK H. HALL, B. S........................ Editor and Librarian.
GEO. W. CHURCHILL.......................... Agriculturist and Sup't of Labor.
C. G. JENTER, PH. C........................ Assistant Chemist.
WENDELL PADDOCK, B. S...................... Assistant Horticulturist.
† W. H. ANDREWS, B. S...................... Assistant Chemist.
J. A. LECLERC, B. S........................ Assistant Chemist.
† A. D. COOK, PH. C........................ Assistant Chemist.
C. P. CLOSE, M. S.......................... Assistant Horticulturist.
FRED D. FULLER, B. S....................... Assistant Chemist.
† E. B. HART, B. S......................... Assistant Chemist.
F. THOMPSON, B. S.......................... Assistant Chemist.
FRANK E. NEWTON ........................... Clerk and Stenographer.

Address all correspondence, not to individual members of the staff, but to the NEW YORK AGRICULTURAL EXPERIMENT STATION, GENEVA, N. Y.

The Bulletins published by the Station will be sent free to any farmer applying for them.

* Connected with Second Judicial Department Branch Station.
† Connected with Fertilizer Control.

# TABLE OF CONTENTS.

# Sixteenth Annual Report

OF THE

# Board of Control of the New York State Agricultural Experiment Station.

## TREASURER'S REPORT.

GENEVA, N. Y., *October* 1, 1897.

*To the Board of Control of the New York Agricultural Experiment Station:*

As treasurer of the Board of Control, I respectfully submit the following report for the fiscal year ending September 30, 1897:

### Maintenance Account.

*Receipts.*

| | | |
|---|---|---|
| 1896. | | |
| Oct. | 1. To balance on hand | $8,611 75 |
| | To amount received for produce sold | 1,592 12 |
| | To amount received from Comptroller | 37,500 00 |
| | | $47,703 87 |

*Expenditures.*

| | |
|---|---|
| By building and repairs | $3,823 80 |
| By chemical supplies | 620 52 |
| By contingent expenses | 1,651 01 |
| By feeding stuffs | 1,428 60 |
| By fertilizers | 224 32 |
| By freight and express | 449 86 |
| By furniture and fixtures | 871 01 |
| By heat, light and water | 1,858 76 |

| | | | |
|---|---|---|---|
| | | By labor | $13,637 46 |
| | | By library | 719 41 |
| | | By live stock | 121 20 |
| | | By postage and stationery | 376 02 |
| | | By publications | 2,440 63 |
| | | By salaries | 14,615 97 |
| | | By scientific apparatus | 986 00 |
| | | By seeds, plants and sundry supplies | 1,213 10 |
| | | By tools, implements and machinery | 504 63 |
| | | By traveling expenses | 1,483 16 |
| 1897. | | | |
| Oct. | 1. | By balance | 678 41 |
| | | | $47,703 87 |

EXPENSE OF BULLETINS AND ENFORCING PROVISIONS OF CHAPTER 955 OF THE LAWS OF 1896.

*Receipts.*

| | | | |
|---|---|---|---|
| 1896. | | | |
| Oct. | 1. | To balance on hand | $922 77 |
| | | To amount received from Comptroller | 10,000 00 |
| 1897. | | | |
| Oct. | 1. | Account overdrawn | 1,101 19 |
| | | | $12,023 96 |

*Expenditures.*

| | |
|---|---|
| By chemical supplies | $692 24 |
| By heat, light and water | 826 84 |
| By postage and stationery | 41 25 |
| By publications | 2,431 62 |
| By salaries | 6,609 75 |
| By scientific apparatus | 32 00 |
| By traveling expenses | 1,390 26 |
| | $12,023 96 |

## Second Judicial Department, Chapter 675 of the Laws of 1894.

| | | |
|---|---|---|
| 1896. | *Receipts.* | |
| Oct. | 1. To balance on hand.................... | $45 88 |
| | To amount received from Comptroller... | 8,451 17 |
| | | $8,497 05 |
| | *Expenditures.* | |
| | By chemical supplies .................. | $44 00 |
| | By contingent expenses ............... | 181 23 |
| | By fertilizers ......................... | 111 55 |
| | By freight and express................. | 36 04 |
| | By furniture and fixtures ............. | 17 20 |
| | By heat, light and water.............. | 47 15 |
| | By labor ............................ | 520 09 |
| | By library .......................... | 127 55 |
| | By postage and stationery............. | 62 68 |
| | By publications ...................... | 1,342 69 |
| | By salaries ......................... | 4,122 22 |
| | By scientific apparatus ............... | 123 20 |
| | By seeds, plants and sundry supplies.... | 224 44 |
| | By tools, implements and machinery.... | 12 |
| | By traveling expenses ................ | 728 50 |
| | By rents ............................ | 762 05 |
| 1897. | | |
| Oct. | 1. By balance ........................ | 46 34 |
| | | $8,497 05 |

## Postage Account, Special Appropriation.

| | | |
|---|---|---|
| 1896. | *Receipts.* | |
| | To amount received from Comptroller... | $500 00 |
| | *Expenditures.* | |
| | By postage and stationery............. | $218 00 |
| | By balance on hand.................. | 282 00 |
| | | $500 00 |

## SPECIAL APPROPRIATION FOR REPAIRS TO BUILDINGS.

*Receipts.*

| | |
|---|---|
| To amount received from Comptroller... | $1,200 00 |

*Expenditures.*

| | |
|---|---|
| By repairs ............................ | $1,198 46 |
| By balance ............................ | 1 54 |
| | $1,200 00 |

All expenditures are supported by vouchers, approved by the auditing committee of the Board of Control, and have been furnished the Comptroller of the State of New York.

## UNITED STATES APPROPRIATION UNDER ACT OF CONGRESS APPROVED MARCH 2, 1887.

*Dr.*

| | | |
|---|---|---|
| 1897. | | |
| July | 1. To receipts from Treasurer of United States, as per appropriation for fiscal year ending June 30, 1897, as per act of Congress, approved March 2, 1887.. | $1,500 00 |

*Cr.*

| | |
|---|---|
| By postage and stationery............ | $0 05 |
| By publications ...................... | 155 68 |
| By salaries .......................... | 1,264 99 |
| By scientific apparatus ............... | 8 85 |
| By seeds, plants and sundry supplies.... | 30 27 |
| By traveling expenses ................. | 40 16 |
| | $1,500 00 |

WILLIAM O'HANLON,

*Treasurer.*

# DIRECTOR'S REPORT.*

*To the Honorable Board of Control of the New York Agricultural Experiment Station:*

*Gentlemen:*— I have the honor to present herewith the report of the New York Agricultural Experiment Station for 1897.

A statement of the efforts and progress of the past year can be no more fittingly prefaced than by an acknowledgment of the earnest support and wise direction which you have given me as your executive officer. I am sensible also of the loyal co-operation of the members of the Station staff in the prosecution of the work which we have undertaken. Moreover, the press of the State and the leaders of agricultural thought and practice have given us most hearty and efficient assistance in securing the means necessary to the development of our equipment; and I am conscious that the intelligent agricultural masses have stood in such an attitude of sympathy towards this institution as to constitute a strong stimulus to vigorous effort in their behalf. This combination of favorable conditions has conspired to make the record of the Station for the year 1897 one which it is pleasant to review.

In my report for 1896, attention was directed to the need of strengthening the work of the Station at several important points. The recommendations which I then made have met with your approval and much has already been accomplished towards re-enforcing old lines of effort and establishing those which are new.

### Addition to the Station Staff.

*Editor and Librarian.*—This most important position has been filled by the selection of Frank H. Hall, B. S., formerly connected with the Office of Experiment Stations in the United States Department of Agriculture.

*Reprint of Bulletin No. 142.

Mr. Hall is a native of Michigan, and graduated from the Michigan Agricultural College in 1888.

After graduation he was elected to an instructorship in mathematics in his alma mater, from which he resigned to accept a position on the United States Geological Survey.

In 1893, Mr. Hall became connected with the Office of Experiment Stations as librarian and proof reader and when he resigned on April 1, 1897, to enter upon his present duties he was connected with the editorial staff of the Experiment Station Record as editor of the department of field crops. His fitness for the peculiar work which he has undertaken in this institution is already shown by the favor with which his popular expositions of the Station bulletins have been received and by the way in which he is proceeding to bring the Station library into a condition of efficiency and availability.

*Bacteriologist.*—Mr. H. E. Harding, B. S., of the University of Wisconsin, has been elected to the position of bacteriologist. He is to enter upon his duties on January 1, 1899.

Mr. Harding is a graduate of the University of Wisconsin in the class of 1896. For nearly three years he has been pursuing special studies in bacteriology with Dr. H. L. Russell, chiefly with reference to the bacteria of the farm. He has had an intimate knowledge of, and considerable connection with the detailed investigations which resulted in the recent important discoveries of Babcock and Russell concerning the curing of cheese. In June Mr. Harding will go to Europe for study until he takes up his work here.

*Dairy Expert.*—It was felt that this position should be filled by some one not only entirely familiar with the best methods of the manufacture of butter and cheese, but also with the difficulties and problems which confront New York dairymen. The qualifications of the gentleman selected for this work meet both of these requirements. Mr. George A. Smith is well known in the State of New York not only as the efficient Director of Farmers' Institutes for three years, but also as one of the dairy experts of the New York State Department of Agriculture. Mr. Smith is an accomplished cheese-maker, and through his intimate and long continued contact with the farmers of the State, he has become well acquainted with the peculiar needs of New York dairying. It is felt that the confidence which the farmers of the State have in Mr. Smith will strengthen the Station with its constituency.

*Botanist.*—A Station botanist has not yet been chosen. He will be selected with reference to his fitness to take up investigations in plant pathology which, in consideration of the large fruit and vegetable growing interests of the State of New York, is a most extensive and important field of effort.

*Other changes.*—During the year Mr. W. W. Parker and Mr. E. C. Worden, assistant chemists, have closed their connection with the Station, and Mr. E. B. Hart and Mr. Firman Thompson have been elected to take their places.

Mr. F. C. Stewart, mycologist at the Second Department Branch Station, has been granted a year's leave of absence for further study.

## Building Equipment.

*Biological and dairy building.*—In accordance with the unanimous decision of your Board, the Legislature of 1897 was asked to appropriate $41,000 for the erection of a new building to be devoted to biological and dairy research. This request was granted, there being no apparent opposition. Leading dairymen and horticulturists all over the State contributed to this result by expressing to their representatives in the Legislature their belief that this appropriation would advance the agricultural interests of the State. It must be conceded, moreover, that there is at the present time a tendency on the part of both the National and State Legislatures to recognize generously any just demand coming from farmers.

The money for the erection of this building became available early in April, but the plans and specifications were not placed in the hands of your building committee until nearly the middle of August. Such a delay was exceedingly unfortunate because it has obliged the contractor to proceed with his work during cold weather.

The contract for the erection of the building was awarded to Mr. A. B. Morrison, of Geneva, N. Y., on very satisfactory terms, and its construction has proceeded with expedition so that the walls and roof are practically completed. It is hoped that the building may be available for our use by midsummer.

The following is a summary of the facilities that this building will afford, a somewhat detailed description of which will appear in a subsequent report:

1. Dairy Department. This includes a milk-receiving room, pasteurizing room, cheese-making room, butter-making room, cold-storage room, six cheese-curing rooms and dairyman's office.

The first four rooms are wainscoted in glazed brick with vitrified tile floors and are to be equipped with the very best apparatus for investigation work.

The cheese-curing rooms are to exhibit some unique features in the way of control of temperature and moisture.

2. Bacteriological Department. This includes a laboratory, incubator room, culture room, general work room and office. The temperature of the incubator and culture rooms will be under automatic control, and their use will be shared with the Station botanist.

These rooms will be supplied with compressed air, steam at high pressure, hot and cold water, fuel and lighting gas, and with the most modern apparatus for bacteriological investigations.

3. Botanical Department. The rooms in this department will be a laboratory office and museum, with a joint use of the incubator and culture rooms. The equipment of compressed air, steam, water and gas will be the same as in the bacteriological department, and the equipment of apparatus will be no less efficient.

4. Horticultural Department. The space for this department will include the horticulturist's laboratory, horticulturist's office, assistant horticulturists' office, and two large museum rooms. In many respects these rooms will be equipped similarly to those of the other departments mentioned.

5. Entomological Department. This will contain an office large enough to afford laboratory facilities and a museum room.

The heat for this building will be supplied from twin boilers of twenty-five horse-power each, which will carry a pressure of from sixty to seventy-five pounds, the pressure on the radiators being reduced to five pounds. These boilers will furnish steam for a twenty horse-power engine, which will supply power for running the dairy machinery, the compressor of the refrigerating plant, an automatic compressed air pump, a water pump and other apparatus.

The building is to be equipped with one of the most approved forms of refrigerating apparatus which will be used to secure a low temperature in the cold storage room and such temperatures as are desired in the cheese-curing, bacteriological, cheese and dairy rooms.

The temperature of the building will be automatically controlled by a pneumatic system of temperature regulation. In the offices, laboratories and working-rooms of the dairy department, this control will be applied directly to the valves of the radiators. In the cheese-curing rooms, and to a partial extent in the culture and incubator rooms, the temperature will be regulated through the operation of dampers opening or closing hot and cold air tubes.

*New forcing house.*—A new building has been added to the forcing house plant, the dimensions of which are 100 by 20 feet. This is to be utilized for investigations in plant nutrition.

*Poultry house.*—The facilities for poultry investigation have been increased by the erection of a new house. The special features of this building are an incubator cellar where uniformity of temperature can be secured, a series of brooders warmed by hot water, breeding pens of the most approved plan, storage for a large variety of foods, a room for the poultryman and a cooking room.

*General repairs.*—During the past eighteen months the buildings of the Station have been put in thoroughly good condition. The two houses occupied by Mr. Beach and Mr. Wheeler have been enlarged and renovated throughout, and have been equipped with bathrooms and new heating apparatuses. The chemical laboratory, the three barns and other outbuildings have also received exterior coats of paint.

*Further needs.*—I desire to recommend the erection in the near future of a tool shed which shall accommodate all of the machinery which is used on the farm. It will also be wise to build potting sheds with accommodations for various mixtures of forcing house soils in the immediate vicinity of the forcing houses.

## LIBRARY.

The three rooms on the west side of the Director's house have been set apart for a library. They have recently been repainted and repapered and are now in a very attractive condition. The largest one is supplied with the tables and chairs necessary in a general reading room. The number of books in the library has been largely increased during the past year by the purchase of complete sets of the journals giving the records of investigation and of such other literature as is useful in an institution of this kind. It has been found possible, also, to practically complete the sets of bulletins and reports of other American stations and of the United States Department of Agriculture. These have been attractively bound and form an important part of our reference library.

In view of the fact that the members of the staff should keep in touch with the current literature of investigation, it has been decided that one-half day of each week shall be set aside as library day. It may be desirable to keep the library open evenings in order that as much time as possible may be available for consulting the journals and other serial publications, the file of which will soon number about one hundred.

## PUBLICATIONS.

Reference was made in my last report to the desirability of modifying in some respects the character of the publications from this Station. It was there proposed that the bulletins written by the members of the staff, to be called the Complete Bulletins, should be full in detail and as scientific in discussion as appeared desirable to the writers. It was also suggested that instead of issuing these bulletins to the entire number of persons whose names are on our mailing list, popular bulletins should be written on the basis of the more complete form which should convey to the agricultural public the results of our work in more simple and less technical language. This plan has been put into execution, and if we may judge from the expressions of approval which have come to us from farmers and from those engaged in work at other Stations, this departure is likely to prove both popular and successful. It is decided, in addition, that the annual reports shall consist only of such matter as is published in the complete bulletins. There seems to be no good reason for printing any great amount of matter in the annual report which does not appear in the bulletins. If any fact or conclusion is worth publishing at all it is proper to give to it the fullest possible circulation among those for whom it has special value.

The Station editor also prepares press reviews, which are sent with the bulletins to all newspapers on our mailing list. It is a matter of gratification that these reviews are very fully and widely printed. This plan not only secures a more widespread attention to our bulletins but also insures accuracy of statement in regard to our conclusions.

## Mailing List.

The mailing list of this Station includes several divisions: (1) The officers of the United States Department of Agriculture and of all other experiment stations; (2) the newspapers of this State and a few outside; (3) those persons who desire to receive our complete bulletins; (4) the main list, or those who receive the popular bulletins. The latter list now numbers about thirty thousand names. In two years our mailing list has increased about ten thousand names.

WORK IN THE SECOND JUDICIAL DEPARTMENT.

The expenditure of the appropriation for work in this department has been along much the same lines as in the past years. The needs of the farmers and market gardeners in this section of the State clearly indicate the directions in which they should receive help. The concentration of vegetable and fruit growing, both out of doors and under glass, in the vicinity of New York for so many years has brought about a corresponding concentration of injurious fungi and insects. The aid, therefore, which this Station is able to give to the agriculture of Eastern New York is chiefly in studying new diseases and insects and in illustrating how these pests may be held in check. There seems to be no question but that the policy which has heretofore prevailed in the management of this special work should be materially changed. An attempt has been made to carry on at Jamaica, where this branch effort has its headquarters, more or less scientific research. Such research necessitates an equipment of apparatus and a reference library, and if it is successfully maintained under the present plan, apparatus and library facilities must be duplicated, a policy which is certainly unwise and wasteful. There is no question but that the concentration of the scientific work in the laboratories of the Station at Geneva will be in the interests of economy and efficiency. In this way much more varied and extensive experiments, illustrative and otherwise, can be conducted in different parts of the Second Judicial Department. It is gratifying to know that one of the most intelligent and active agricultural societies in this department has already, by unanimous resolution, approved this change of policy. A very encouraging feature of this action by such a body of farmers was the accompanying declaration that one special line of experiments had already saved to the agriculture of one section of Long Island at least $75,000. In view of the considerations here presented, I shall recommend that this special fund be expended chiefly in maintaining experiments in the field and in forcing houses, which shall be an attempt to illustrate the application to practical agriculture of the facts discovered in our laboratory research.

It now appears probable that in 1898 attention can be most profitably given to the potato and pickle interests of Long Island. With this in view, arrangements are already being made to locate experiments at at least eight different points, chiefly with reference to the use of fertilizers in potato growing and to the application of a spraying mixture in controlling the diseases which prey upon cucumbers.

Experience teaches that it is not enough merely to discover a fact and point out its relations to practical agriculture. The extreme conservatism of the agricultural class seems to render it necessary to go even farther, and by illustration and by precept upon precept to overcome indifference and skepticism. It is true that such instructional efforts as this are outside of the proper function of the Experiment Station, but conditions seem to require them.

## CHEMICAL DEPARTMENT.

*Fertilizer analysis.*—The demands upon this Station for the inspection of commercial fertilizers are steadily and rapidly increasing. The records show that in no other state are the requirements for this work so heavy as is the case in New York. During the year 1897, 184 manufactures have filed in this office the required statements concerning 1,728 brands of fertilizers. Not all the registered brands are actually sold in the State, but the real number is unnecessarily and even absurdly large. There is not a single good reason for this multiplication of names in the fertilizer trade, but many reasons why such a state of things should not exist. It is a cause of confusion and of unnecessary expense and should hasten a change to a more economical system of buying and selling plant food.

During the season of 1897 three traveling agents were employed by the Station for the collection of samples of fertilizers in different parts of the State. These agents were at work during about four and one-half months, and they collected 1,005 samples, representing 748 different brands. This is less than the entire number of brands sold. It is impossible with the funds now at the command of the Station for fertilizer inspection to search out and sample in any one year every brand that is sold or offered for sale within the boundaries of the State. As a matter of fact, the work of this kind that is now done is really costing the Station more than the sum appropriated for this purpose. It is entirely safe to say that the appropriation for fertilizer inspection in New York is less in proportion to the necessary work than is the case in any other state. The situation is somewhat perplexing. It would be desirable if some means could be devised to check this useless multiplication of brands, at least so long as it is necessary for the State to inspect them. This could be done, possibly, by imposing an analysis fee upon each brand sold or offered for sale. There are reasons why it would be just to do this. For instance, one company registered in 1897 two hundred and forty-two brands and the effort required for the inspection of these, provided they were all sampled, is a large proportion of the work for the year. This company imposes upon the State an expense which is greatly disproportionate to its sales as compared with other companies offering a greatly less number of brands. It is very certain that if the fertilizer trade continues its present development, either an analysis fee must be imposed or else the State appropriation must be considerably increased. As the matter now stands, a large share of the time of the chemist-in-chief and of four assistant chemists, besides a good deal of attention on the part of the Director of the Station, is devoted to fertilizer inspection. The result is that the efforts of certain Station officers in the direction of investigation are unfortunately limited by this burden of routine work to an extent not justifiable from any point of view. I commend this matter to the attention of your Board as one worthy of serious and careful consideration.

*Sugar beets.*—Considerable attention has been devoted to sugar beet analysis. This was made necessary by the present active and wide spread discussion of sugar beet production in New York.

About one hundred and fifty samples of beets were analyzed and a general summary of the results is given in Bulletin 135, showing that the average percentage of sugar in the beets was 15.3 per cent. The present indications are that this work will be largely increased in 1898.

*Plant nutrition.*—Investigations are in progress concerning the plant-food needs of fruits and vegetables and the effect of certain compounds in fertilizers upon the quality of fruits.

*The composition of cider and vinegar.*—A study of the composition of cider and cider vinegar is now going on with a view to discovering some means of distinguishing between real and artificial or adulterated cider vinegar.

## Department of Horticulture.

Of the nine horticultural bulletins issued by the Station in 1897 five discuss plant diseases and the methods of treating them, and one relates to apparatus used in treating insects and diseases which are injurious to plants. It should not be inferred from this that subjects relating to plant pathology occupy two-thirds of the time of the horticultural staff, although it is true that much attention is devoted to work of this kind.

*Plum leaf spot.*—For several years questions pertaining to the treatment of the leaf spot of plum and cherry have been under investigation. The work which Mr. Fairchild started in 1891 to determine the best means of preventing injury to plum and cherry nursery stock was followed until a satisfactory line of treatment could be confidently recommended. Investigations were then undertaken with the same disease in the orchard. A report of the progress of this work in 1895 was given in Bulletin 98 and the Annual Report for that year. The experiments were continued in 1896 to determine whether the disease may be controlled by two treatments with Bordeaux mixture, 1-to-11 formula, and if so when these treatments should be made. The results, as set forth in Bulletin 117, show that two timely and thorough treatments with this mixture may control the disease on plums in some seasons, but three treatments generally give best results. The Italian prunes, which were given this treatment, showed an average gain of 24½ pounds of fruit per tree at an extra cost of less than one cent per pound.

*Cherry leaf spot.*—Cherries ripen so early in the season that it has not yet been found practicable to give them the thorough treatment which is necessary to control the leaf spot, without spotting the fruit with the spray so as to injure its appearance when ripe. This question is still under investigation.

*Raspberry anthracnose.*—In Bulletin 124 Mr. Paddock gives the results of three seasons' work with the raspberry anthracnose. He finds that it is best to set none but healthy plants and practice a short rotation of crops. The spread of the disease in infested fields was successfully prevented by treatment, but the yield of fruit was not increased enough to make the spraying profitable.

*Oat smut.*—The treatment of oat smut can hardly be called a horticultural operation, but the general importance of the subject to the agriculture of the State and the need of a bulletin to furnish correspondents with instructions for treating this disease made it desirable that some investigations concerning it should be undertaken. In Bulletin 131 Mr. Close sets forth clearly the results of investigations which were conducted in 1897, partly at the Station and partly on the farm of Messrs. King and Robinson, Trumansburg, Tompkins County. Lysol, a fungicide which has not heretofore been tried against grain smuts, gave excellent results. The most inexpensive treatment, soaking with 0.2 per cent formalin solution, cost for the material 1.4 cents per bushel of seed treated.

*Gooseberry mildew.*—We have long wished to know something definite as to the comparative value of potassium sulphide and Bordeaux mixture for preventing gooseberry mildew. Mr. Close's investigations on this point are published in Bulletin 133. The best results were obtained when the treatment was begun early in the season, and potassium sulphide proved superior to Bordeaux mixture, lysol and formalin for preventing the disease.

*Spray pumps and mixtures.*—The constant demand for elementary instruction concerning the use of spray mixtures and spray pumps made it necessary to make further tests of apparatus and revise former instructions so as to include the most recent developments in this line. This has been done by Mr. Paddock and the results are given in Bulletin 121 on Spray Pumps and Spraying.

*Effect of wood ashes upon apple scab.*—For five years one of the apple orchards at the Station has been devoted to an investigation of the question whether fertilizing the soil liberally with wood ashes may make the apples more resistant to the scab. The results in this investigation are set forth in a bulletin on this subject in which it is shown that, with the conditions under which this investigation was made, immunity from apple scab is not at all increased by liberal applications of hard wood ashes to the soil.

*Forcing tomatoes.*—Methods of training and benching tomatoes in the forcing house are discussed in Bulletin 125. The conclusion is reached that, at least in this climate, single stem training is clearly superior to three stem training in forcing tomatoes. Plunging small pots containing the young tomato plants in the soil of the bench to see whether confining the roots thus would bring the plants into bearing earlier or increase their productiveness, showed that practically nothing was gained by this treatment and when used with three stem training it was a detriment.

*Varieties of fruit at the Station.*—But two bulletins have been prepared in 1897 on the varieties of fruit which are growing at this Station. These are Bulletins 127 on Strawberries and 128 on Raspberries, Blackberries and Dewberries, both by Mr. Paddock.

The following shows the number of varieties of commonly cultivated fruits in the Station collection at the close of 1897, not including plants which were received in the fall of 1897 nor those currants and gooseberries which are grown here simply to illustrate the species to which they belong:

| | Number of Station seedlings now growing. | Number of varieties added in fall of '96 and spring of '97. | Total number of varieties now growing at the Station. |
|---|---|---|---|
| Pomaceous fruits: | | | |
| Apples | 50 | 108 | 671 |
| Crab apples | ........... | 1 | 22 |
| Pears | 39 | 19 | 240 |
| Quinces | ........... | 2 | 11 |
| Stone fruits: | | | |
| Apricots | ........... | 11 | 36 |
| Cherries | 1 | 21 | 75 |
| Peaches | ........... | 17 | 147 |
| Plums | 18 | 43 | 243 |
| Small fruits: | | | |
| Grapes | 446 | 6 | 675 |
| Currants | 53 | 10 | 102 |
| Gooseberries | 256 | 5 | 479 |
| Blackberries | 1 | 3 | 34 |
| Dewberries | 43 | ........... | 49 |
| Raspberries | 23 | 6 | 123 |
| Strawberries | 53 | 27 | 113 |
| Total | 983 | 306 | 3,020 |

## DEPARTMENT OF PLANT PATHOLOGY.

*A new disease of sweet corn.*—Mr. Stewart has given considerable time to the study of a new disease of sweet corn to which the early varieties of this crop are much subject in the market gardens of Long Island. He has demonstrated that this disease is bacterial in its nature, which is the first step necessary to a discovery of methods of prevention. The subject needs further study, and no remedial measures can now be recommended. Prevention may perhaps be secured by care in the selection of seed and by the planting of resistant varieties.

*Potato scab.*—The ploughing in of a crop of green rye had no effect in preventing potato scab. The disease appeared to be aggravated rather than checked.

*Potato stem blight.*—This was not communicated by planting diseased tubers, neither were peppers, tomatoes, egg plants or plants of other species infected by contact with diseased potato tubers.

*Carnation rust.*—The application of a solution of common salt neither prevented the rust nor benefited the growth of the carnation plants.

*Downy mildew on cucumbers.*—The early cucumber and pickle industry of Long Island has been in danger of destruction from the ravages of this disease. The experiments of Mr. Stewart in 1896 resulted in materially checking its development by spraying with Bordeaux mixture.

These experiments were repeated at two points in 1897 with similar results. On a small plat of early cucumbers at Floral Park, spraying caused an increased yield of over 30,000 fruits per acre.

On the farm of Mr. Robert Colyer an acre of late cucumbers was sprayed under the direction of Mr. Stewart. The resulting crop was about 102,000 fruits, the average yield with growers who took no pains to control the mildew being not over 20,000 fruits per acre. It is probable that other growers can produce equally large crops when the spraying is done with equal intelligence and thoroughness.

## DEPARTMENT OF ENTOMOLOGY.

*Insectary.*—A portion of one of the large greenhouses is being remodeled for use as an insectary. Among other important features it will contain breeding cages of necessary sizes and shapes in which various species of injurious insects can be isolated and their habits studied, root cages for studying insects which attack the roots of plants, and fumigating boxes to be used in testing the effects of various gases upon insects in different stages of development. A dark room also forms an important part of the equipment of the insectary.

*The collection of insects.*—About 200 species have been added to the Station collection of insects besides valuable biological material illustrating the life histories, habits and injurious work of some of the species already in the collection. The collection now numbers nearly 2,600 species.

*Illustrations.*—An important part of the work during the past season has been the making of illustrations, photographs and drawings, showing the structure, life histories and habits of injurious insects and their natural enemies. A large number of these illustrations have been made during the past summer. They are kept on file for use in bulletins as needed.

*Inspection of nursery stock.*—Nursery stock inspection has been continued again this season, but to a less extent than the season previous. About fifteen nurseries have been visited, with the result than ten species of insects, all more or less injurious, have been found on young trees about to be shipped, showing that these insects are distributed by means of nursery stock. The species referred to are as follows: The woolly aphis, peach tree borer, the pistol-case bearer, oyster-shell bark-louse, scurfy bark-louse, plant lice of various species, the bud moth, the New York plum Lecanium, the oak scale and *Aspidiotus ancylus.* The San José scale has also been found in a small nursery in Western New York. Infested stock has possibly been shipped from this nursery for six or eight years past. The present owner is going out of the business and is clearing the land for fruit.

*Experiments in dipping young nursery trees infested with plant lice.*— Young nursery trees infested with plant lice cannot be sprayed to advantage, as the lice cause the leaves to curl. The lice congregate in great numbers on the under sides of the leaves at and near the tips of the young trees. By dipping these infested tips the insects may be killed. The object of the experiment was to determine the proper strength of the solution (a solution of whale-oil soap) to use. The expense of treating the trees was so slight that no record of it was kept. It was shown that whale-oil soap will kill the lice and may be safely used for this purpose at a strength of one pound to seven gallons of water, but that a stronger solution, one pound to three gallons, will injure the foliage. The weaker solution kills the lice as effectually as the stronger.

*Experiments in spraying young nursery trees.*— One-year-old apple grafts were sprayed with green arsenite (Scheele's green) one pound to 100 gallons. The trees were badly infested with the canker-worm. This application was made late in June and was so effectual in destroying the canker-worms that another application was not necessary.

Young cut-leaf birch trees, badly infested with thrips, were sprayed three times with a whale-oil soap in solution, to which was added one ounce of flowers of sulphur to one gallon of the soap solution. This combination proved highly successful, showing that this serious pest can be controlled.

*Experiments in fumigating nursery stock with hydrocyanic acid gas.*—These experiments are not yet completed, but the indications now are that nursery stock can be successfully fumigated in large frost-proof cellars where the trees are ordinarily stored over winter, without going to the expense of building houses for this purpose where stock can be fumigated in small lots only.

*Spraying experiments with green arsenite.*—These experiments form a part of a series of experiments with green arsenite begun in 1896, their object being to test the value of green arsenite as compared with Paris green.

Fourteen large trees owned by O. L. Jackson, at Rushville, were used for the experiments and were sprayed three times. Examinations made soon after the first application showed that only the young worms, those about one-fourth inch long, had been killed by the spray. After the third application the trees were practically free from worms, the older ones having finally succumbed.

This indicates that green arsenite may be slow in its action but where the trees were sprayed three times it was effectual.

*Investigations and experiments with plant lice.*—Four species of plant lice have been under observation during the past season, two infesting the plum and two infesting the currant. The work of studying out the complete life histories of these species is not yet complete. The best progress has been made with *Hyalopterus pruni*. All stages but one have been observed and drawings made. In all the other species studied, with the probable exception of *Myzus*, new facts concerning their life histories have been brought to light, and their various forms figured for the first time. Nine species of the natural enemies of these insects have also been studied and illustrations made showing the different stages in their development.

Experiments in spraying currant bushes and plum trees showed that these lice may be destroyed if a whale oil soap solution, one pound to seven gallons of water, is properly used.

*The cotton-wood leaf beetle.*—The investigations and experiments with this insect were finished during the past season.

The field used the previous year was sprayed with green arsenite, former experiments having shown that this insecticide would probably prove the most effectual of any tried. Three applications were made, with the result that the plat was kept almost entirely free from the insects.

In comparing the cost of spraying and running the "bug machines," or "drags," it was found that the spraying could be done at about two-thirds the expense of the other method. It was also found, however, that under ordinary circumstances the best results would be obtained by using the "machine" for a few days soon after the last application of the poison.

## DEPARTMENT OF ANIMAL INDUSTRY.

*Feeding experiments with chicks and capons.*—From an extended test of the relative efficiency of whole and ground grains in feeding chicks and capons it was learned that more food was eaten and a more rapid and profitable gain was made when the ground grain was fed.

*Source of milk fat.*—An extended and somewhat elaborate investigation concerning the source of milk fat was begun early in the year and the results so far as reached were published in Bulletin 132.

The data show clearly that food fats are not essential to the formation of milk fat, and that the milk fat was not derived wholly from the metabolism of protein; but that probably its origin was partially in the carbohydrates of the food, as has been demonstrated to be the case with body fat.

## PRODUCTION OF FIELD CROPS.

An important series of experiments has been begun on the Station farm for the purpose of studying the relative economy of certain systems of maintaining soil fertility.

## EDUCATION IN ROAD BUILDING.

The U. S. Department of Agriculture, among other efforts, is endeavoring to disseminate information concerning the construction and economy of good roads. To this end a bureau known as the Office of Road Inquiry has been established.

As one means of accomplishing its purposes this Office is coöperating with the Land Grant Colleges and the Experiment Stations in building in proximity to these institutions samples of roads which shall be an object lesson, especially to rural communities.

The first of these roads was built at New Brunswick, N. J., and the second at Geneva. The latter was built by the united efforts of the Office of Road Inquiry, private citizens, the village of Geneva and the Experiment Station, and is located on North and Castle streets. It extends about twelve hundred feet along the northern boundary of the Station property and runs the entire length of Castle street, the whole distance being about one and a quarter miles.

The manner of construction is what is known as MacAdam, the covering of the road bed consisting of broken stones to the depth of eight inches. On North street the road is eight feet wide and on Castle street the width is fourteen feet for the greater part of the distance, the remainder being twenty feet.

The lower five inches of the covering was obtained from common field stone, and this was surfaced with three inches of broken Hudson River trap rock.

The cost, details of construction and other related facts will be given in the report of the Department of Agriculture. As this road was completed only last October it is too early to draw conclusions as to its quality and durability. It is satisfactory so far and has changed the streets between the Experiment Station and the city from a condition which at times was almost unbearable and prohibitive of travel to one of convenience and comfort.

## BULLETINS PUBLISHED IN 1897.

The following is a list of the bulletins issued by the Station for the year 1897. All of these are included in this report excepting Nos. 114, 115, 116, 120, 122, which were presented in the report for 1896.

No. 114—January.—Gooseberries. S. A. Beach. Pages 48.

No. 115—January.—Director's report for 1896. W. H. Jordan, Pages 26.

No. 116—January.—Report of analyses of commercial fertilizers for the fall of 1896. L. L. Van Slyke. Pages 57.

No. 117—March.—Treatment of leaf spot in plum and cherry orchards in 1896. S. A. Beach. Pages 9.

No. 118—March.—Alfalfa. W. P. Wheeler. Pages 10.

No. 119—March.—The downy mildew of the cucumber: What it is and how to prevent it. F. C. Stewart. Pages 30.

No. 120—March.—A practical method of fighting cutworms in onion fields. F. A. Sirrine. Pages 14.

No. 121—March.—Spray pumps and spraying. Wendell Paddock. Pages 23.

No. 122—April.—The pistol-case bearer. V. H. Lowe. Pages 12.

No. 123—April.—Spraying potatoes on Long Island in the season of 1896. F. C. Stewart. Pages 27.

No. 124—April.—Anthracnose of the black raspberry. Wendell Paddock. Pages 14.

No. 125—July.—Forcing tomatoes: Comparison of methods of training and benching. Note on a tomato disease. S. A. Beach. Pages 32.

No. 126—November.—Feeding experiments with chicks and capons: The relative efficiency of whole and ground grains as commonly fed. W. P. Wheeler. Pages 19.

No. 127—November.—Strawberries in 1897. Wendell Paddock. Pages 12.

No. 128—November.—Variety tests with raspberries, blackberries and dewberries. Wendell Paddock. Pages 11.

No. 129—November.—Report of analyses of commercial fertilizers for the spring of 1897. L. L. Van Slyke. Pages 71.

No. 130—December.—A bacterial disease of sweet corn. F. C. Stewart. Pages 17.

No. 131—December.—Results with oat smut in 1897. C. P. Close. Pages 14.

No. 132—December.—The source of milk fat. W. H. Jordan and C. G. Jenter. Pages 34.

No. 133—December.—Spraying in 1897 to prevent gooseberry mildew. C. P. Close. Pages 12.

No. 134—December.—Report of analyses of commercial fertilizers for the fall of 1897. L. L. Van Slyke. Pages 39.

No. 135—December.—The composition and production of sugar beets. L. L. Van Slyke, W. H. Jordan and G. W. Churchill. Pages 30.

No. 136—December.—Inspection of nurseries and treatment of infested nursery stock. V. H. Lowe. Pages 30.

No. 137—December.—Commercial fertilizers for potatoes. W. H. Jordan. Pages 22.

No. 138—December.—Experiments and observations on some diseases of plants. F. C. Stewart. Pages 18.

No. 139—December.—Plant lice: Descriptions, enemies and treatment. V. H. Lowe. Pages 20.

No. 140—December.—Wood ashes and apple scab. S. A. Beach. Pages 27.

No. 141—December.—Digestion and feeding experiments. W. H. Jordan and C. G. Jenter. Pages 30.

No. 142—December.—Director's report for 1897. W. H. Jordan. Pages 20.

W. H. JORDAN,

*Director.*

N. Y. Agr'l Exp't Station, Geneva, N. Y., Dec. 31, 1897.

## NEWSPAPERS AND PERIODICALS PRESENTED TO THE STATION.

Acker & Gartenbau Zeitung, Milwaukee, Wis.

Agricultural Epitomist, Indianapolis, Ind.

Agricultural Gazette of New South Wales, Sydney, N. S. W.

Agricultural Student, Columbus, Ohio.

Agricultural Students' Gazette, Cirencester, Eng.

Albany Weekly Journal, Albany, N. Y.

Allegan Gazette, Allegan, Mich.

American Agriculturist, New York, N. Y.

American Cultivator, Boston, Mass.

American Grange Bulletin and Scientific Farmer, Cincinnati, Ohio.

American Philosophical Society, Proceedings, Philadelphia, Pa.

American Stock Keeper, Boston, Mass.

Angelica Every Week, Angelica, N. Y.

Baltimore Weekly Sun, Baltimore, Md.

Canadian Horticulturist, Toronto, Canada.

Church and Farm, Salt Lake City, Utah.

Cincinnati Society of Natural History, Journal, Cincinnati, Ohio.

Commercial Gazette, New York, N. Y.

Cotton Planters' Journal, Memphis, Tenn.

Dairy World, London, Eng.

Detroit Free Press, Detroit, Mich.

DeRuyter Gleaner, DeRuyter, N. Y.

Elgin Dairy Report, Elgin, Ill.

Farm and Fireside, Philadelphia, Pa.

Farm and Home, Springfield, Mass.

Farm Journal, Philadelphia, Pa.

Farm News, Springfield, Ohio.

Farm Poultry Semi-Monthly, Boston, Mass.

Farm, Stock and Home, Minneapolis, Minn.

Farmers' Advocate, London, Canada.
Farmers' Guide, Huntington, Ind.
Farmers' Home, Dayton, Ohio.
Farmers' Magazine, Springfield, Ill.
Farmers' Voice, Chicago, Ill,
Forester, Washington, D. C.
Geneva Gazette, Geneva, N. Y.
Gentleman Farmer, Chicago, Ill.
Gleanings in Bee Culture, Medina, Ohio.
Green's Fruit Grower, Rochester, N. Y.
Herd Register, Peterboro, N. H.
Hoard's Dairyman, Fort Atkinson, Wis.
Homestead, Des Moines, Iowa.
Horticultural Gleaner, Austin, Tex.
Indiana Farmer, Indianapolis, Ind.
Industrial American, Lexington, Ky.
Iowa Weather and Crop Service Review, Des Moines, Iowa.
Irrigation Age, Chicago, Ill.
Ithaca Democrat, Ithaca, N. Y.
Jersey Bulletin, Indianapolis, Ind.
Journal and Herald, Springville, N. Y.
Long Island Farmer, Jamaica, N. Y.
Louisiana Planter and Sugar Manufacturer, New Orleans, La.
Market Garden, Minneapolis, Minn.
Mirror and Farmer, Manchester, N. H.
Montana Fruit Grower, Missoula, Mont.
Monthly Weather Review, Washington, D. C.
National Nurseryman, Rochester, N. Y.
National Stockman and Farmer, Pittsburg, Pa.
Nebraska Bee-Keeper, York, Neb.
Nebraska Farmer, Lincoln, Neb.
New England Farmer, Boston, Mass.
New England Florist, Boston, Mass.
New York Edition, Farm and Fireside, Springfield, Ill.
New York Farmer, Port Jervis, N. Y.
New York Produce Review, New York, N. Y.

Northwest Pacific Farmer, Portland, Ore.
Olean Herald, Olean, N. Y.
Oregon Agriculturist, Portland, Oregon.
Pacific Coast Dairyman, Tacoma, Wash.
Pomona Herald, Pascoag and Providence, R. I.
Poultry Monthly, Albany, N. Y.
Practical Farmer, Philadelphia, Pa.
Prairie Farmer, Chicago, Ill.
Prattsburgh News, Prattsburgh, N. Y.
Progressive South, Richmond, Va.
Queensland Agricultural Journal, Brisbane, Queensland.
Salt Lake Herald, Salt Lake City, Utah.
Sanitary Inspector, Augusta, Me.
Southern Cultivator, Atlanta, Ga.
Southern Planter, Richmond, Va.
Southern States Farm Magazine, Baltimore, Md.
Southwestern Farmer and American Horticulturist.
State Board of Health Bulletin, Memphis, Tenn.
Suffolk Bulletin, Huntington, N. Y.
Sugar Beet, Philadelphia, Pa.
Vermont Farmers' Advocate, Burlington, Vt.
Wallace's Farmer, Des Moines, Iowa.
Watkins Review, Watkins, N. Y.
West Virginia Farm Reporter.
Western Plowman, Moline, Ill
Woman's Home Companion, Philadelphia, Pa.
Wool Record, New York, N. Y.

# REPORT

OF THE

# CHEMICAL DEPARTMENT.


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*Connected with Fertilizer Control.

# REPORT OF THE CHEMIST.

L. L. VAN SLYKE.

## I. REPORT OF ANALYSES OF COMMERCIAL FERTILIZERS FOR THE SPRING OF 1897.*

### SUMMARY.

(1) Samples collected. During the spring of 1897, the Station collected 735 samples of commercial fertilizers, representing 500 different brands. Of these different brands, 400 were complete fertilizers; of the others, 32 contained phosphoric acid and potash without nitrogen; 33 contained nitrogen and phosphoric acid without potash; 1 contained nitrogen and potash without phosphoric acid; 31 contained phosphoric acid alone; and 3 contained potash salts only.

(2) Nitrogen. The 400 brands of complete fertilizers contained nitrogen varying in amount from 0.30 to 8.08 per cent, and averaging 2.23 per cent. The average amount of nitrogen found by the Station analysis exceeded the average guaranteed amount by 0.14 per cent, the guaranteed average being 2.09 per cent and the average found being 2.23 per cent.

In 293 brands of complete fertilizers, the amount of nitrogen found was equal to or above the guaranteed amount, the excess varying from 0.01 to 2.73 per cent, and averaging 0.30 per cent.

In 107 brands, the nitrogen was below the guaranteed amount, the deficiency varying from 0.01 to 2.25 per cent and averaging 0.29 per cent. In 87 cases, the deficiency was less than 0.5 per cent.

The amount of water-soluble nitrogen varied from 0.01 to 6.25 per cent and averaged 0.95 per cent.

*Reprint of Bulletin No. 129.

(3) Available phosphoric acid. The 400 brands of complete fertilizers contained available phosphoric acid varying in amount from 0.83 to 19.68 per cent and averaging 8.44 per cent. The average amount of available phosphoric acid found by the Station analysis exceeded the average guaranteed amount by 0.81 per cent, the guaranteed average being 7.63 per cent and the average found being 8.44 per cent.

In 326 brands of complete fertilizers, the amount of available phosphoric acid found was above the amount guaranteed, the excess varying from 0.01 to 10.68 per cent and averaging 1.14 per cent.

In 74 brands, the available phosphoric acid was below the guaranteed amount, the deficiency varying from 0.01 to 3.06 per cent and averaging 0.58 per cent. In 49 cases the deficiency was below 0.5 per cent.

The amount of water-soluble phosphoric acid varied from 0 to 12.47 per cent and averaged 4.97 per cent.

(4) Potash. The complete fertilizers contained potash varying in amount from 0.08 to 15.58 per cent, and averaging 4.57 per cent. The average amount of potash found by the Station analysis exceeded the average guaranteed amount by 0.27 per cent, the guaranteed average being 4.30 per cent and the average found being 4.57 per cent.

In 297 brands of complete fertilizers, the amount of potash found was above the guaranteed amount, the excess varying from 0.01 to 4.41 per cent and averaging 0.53 per cent.

In 103 brands, the potash was below the guaranteed amount, the deficiency varying from 0.01 to 8.32 per cent and averaging 0.47 per cent. In 85 of these cases, the deficiency was less than 0.5 per cent.

In 88 cases among the 400 brands of complete fertilizers the potash was contained in the form of sulphate free from an excess of chlorides.

(5) The retail selling price of the complete fertilizers varied from $15 to $60 a ton and averaged $28.92. The retail cost of the separate ingredients unmixed varied from $1.80 to $34.25 and averaged $20.17, or $8.75 less than the selling price.

## INTRODUCTION.

### NUMBER AND KINDS OF FERTILIZERS COLLECTED.

During the spring of 1897, we collected 735 samples of commercial fertilizers, representing 500 different brands. The tabulated statement below indicates the different classes included in the collection.

CLASSES OF FERTILIZERS COLLECTED.

| Brands containing only phosphoric acid. | Brands containing only potash. | Brands containing nitrogen and phosphoric acid without potash. | Brands containing nitrogen and potash without phosphoric acid. | Brands containing phosphoric acid and potash without nitrogen. | Brands of complete fertilizers |
|---|---|---|---|---|---|
| 31 | 3 | 33 | 1 | 32 | 400 |

From these figures it can be seen that 80 per cent of the commercial fertilizers offered for sale during the spring consisted of complete fertilizers. The remaining 20 per cent was distributed in nearly equal proportions between acid phosphates, bone and mixtures containing acid phosphate and potash.

### COMPOSITION OF FERTILIZERS COLLECTED.

The tabulated statement below shows the average composition of the complete fertilizers collected during the spring, together with a comparison of the guaranteed composition and that found by analysis.

AVERAGE COMPOSITION OF COMPLETE FERTILIZERS COLLECTED.

| | PER CENT GUARANTEED. | | | PER CENT FOUND. | | | Average per cent found above guarantee. |
|---|---|---|---|---|---|---|---|
| | Lowest. | Highest. | Average. | Lowest. | Highest. | Average. | |
| Nitrogen | 0.40 | 8.78 | 2.09 | 0.30 | 8.08 | 2.23 | 0.14 |
| Available phosphoric acid | 1.93 | 11.00 | 7.63 | 0.83 | 19.68 | 8.44 | 0.81 |
| Insoluble phosphoric acid | ...... | ...... | ........ | 0.10 | 8.06 | 2.19 | ........ |
| Potash | 0.14 | 19.00 | 4.30 | 0.08 | 15.58 | 4.57 | 0.27 |
| Water-soluble nitrogen | ...... | ...... | ........ | 0.01 | 6.25 | 0.95 | ........ |
| Water-soluble phosphoric acid | ...... | ...... | ........ | 0.20 | 12.47 | 4.97 | ........ |

## Comparison of Selling Price and Commercial Valuation.

Giving to the different constituents the values assigned in the schedule on page 356 for mixed fertilizers, 14 cents a pound for nitrogen, 5½ cents a pound for water-soluble phosphoric acid, 5 cents a pound for citrate-soluble phosphoric acid, 2 cents a pound for insoluble phosphoric acid, and 4½ cents a pound for potash, we can calculate the commercial valuation, or the price, at which the separate unmixed materials contained in one ton of fertilizer, having the composition indicated in the preceding table, could be purchased for cash at retail at the seaboard. Knowing the retail prices at which these goods were offered for sale, we can also readily estimate the difference between the actual selling price of the mixed goods and the retail cash cost of the unmixed materials; the difference covers the cost of mixing, freight, profits, etc. We present these data in the following table, including only complete fertilizers.

### Commercial Valuation and Selling Price of Fertilizers.

| Commercial Valuation of Complete Fertilizers. | | | Selling Price of One Ton of Complete Fertilizer. | | | Average increased cost of mixed materials over unmixed materials for one ton. |
|---|---|---|---|---|---|---|
| Lowest | Highest. | Average. | Lowest. | Highest. | Average. | |
| $1 80 | $34 25 | $20 17 | $15 00 | $60 00 | $28 92 | $8 75 |

## Cost of One Pound of Plant-Food in Mixed Fertilizers as Purchased by Consumers.

In the table following we present figures showing the lowest, highest and average cost to the purchaser of one pound of plant-food in different forms.

Cost of One Pound of Plant-Food to Consumers.

| In complete fertilizers. | Lowest. | Highest. | Average. |
|---|---|---|---|
| | Cents. | Cents. | Cents. |
| Nitrogen | 11.7 | 187 | 20.1 |
| Available phosphoric acid | 4.4 | 69.7 | 7.5 |
| Potash | 3.75 | 60 | 6.5 |

From the foregoing figures, it is seen that, to some farmers who purchased a very low-grade fertilizer at a high price, the cost of nitrogen was $1.87 a pound; the available phosphoric acid, 69.7 cents; and the potash, 60 cents. On the other hand, to those farmers who purchased plant-food most cheaply, each pound of nitrogen cost 11.7 cents; of available phosphoric acid, 4.4 cents; and of potash, 3¾ cents. Taking an average of all the mixed fertilizers, farmers paid 20.1 cents a pound for nitrogen, 7½ cents a pound for available phosphoric acid and 6½ cents a pound for potash.

These figures indicate that farmers should invariably avoid purchasing low-grade fertilizers, unless they are sure that the price is proportionately low, a condition which rarely accompanies the sale of such fertilizers. It also appears that, on an average, in purchasing mixed fertilizers, farmers are paying much more for their plant-food than they can secure it for in unmixed forms direct from manufacturers. Thus, while the average cost of one pound of nitrogen to the farmer is 20.1 cents in mixed goods, it can be purchased for 12 to 15 cents a pound. While available phosphoric acid is costing 7½ cents a pound in mixed goods, it can be purchased at less than 5 cents, and the same is true of potash.

## Trade-values of Plant-food in Raw Materials and Chemicals, Adopted by Experiment Stations.

The trade-values in the following schedule represent the average prices at which, in the six months preceding March, the respective ingredients, in the form of unmixed raw materials, could be bought at retail for cash in our large markets, Boston, New York and Philadelphia. These prices also correspond to the average wholesale prices for the six months preceding March, plus about 20 per cent, in case of goods for which there are wholesale quotations.

TRADE-VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS, ADOPTED BY EXPERIMENT STATIONS.

| | 1897. Cts. per pound. |
|---|---|
| Nitrogen in ammonia salts | 13½ |
| Nitrogen in nitrates | 14 |
| Organic nitrogen in dry and fine-ground fish, meat and blood, and in high-grade mixed fertilizers | 14 |
| Organic nitrogen in cotton-seed meal and castor-pomace | 12 |
| Organic nitrogen in fine-ground bone and tankage | 13½ |
| Organic nitrogen in fine-ground medium bone and tankage | 11 |
| Organic nitrogen in medium bone and tankage | 8 |
| Organic nitrogen in coarser bone and tankage | 3 |
| Organic nitrogen in hair, horn-shavings and coarse fish-scraps | 3 |
| Phosphoric acid, soluble in water | 5½ |
| Phosphoric acid, soluble in ammonium citrate | 5 |
| Phosphoric acid in fine bone and tankage | 5 |
| Phosphoric acid in fine medium bone and tankage | 4 |
| Phosphoric acid in medium bone and tankage | 2½ |
| Phosphoric acid in coarser bone and tankage | 2 |
| Phosphoric acid in fine-ground fish, cotton-seed meal, castor-pomace and wood ashes | 4½ |
| Phosphoric acid, insoluble in ammonium citrate, in mixed fertilizers | 2 |
| Potash as high-grade sulphate, in forms free from muriates (chlorides), in ashes, etc | 5 |
| Potash in muriate | 4½ |

## COMMERCIAL VALUATION OF FERTILIZERS.

The commercial valuation of a fertilizer consists in estimating the approximate value or money-cost of the essential fertilizing constituents (nitrogen, phosphoric acid and potash) in one ton of fertilizer. This does not take into consideration cost of mixing, of transportation, storage, commissions to agents and dealers, etc., but only the one item of retail cash cost, in the market, of unmixed raw materials.

## SIMPLE RULE FOR CALCULATING THE APPROXIMATE COMMERCIAL VALUATION OF A FERTILIZER FROM THE RESULTS OF ANALYSIS.

*Multiply the per cent of nitrogen by three and to the product add the per cent of available phosphoric acid and the per cent of potash.* The total sum will express in dollars and cents the approximate commercial valuation of one ton (2,000 pounds) of the fertilizer.

Example.—A fertilizer contains 3.44 per cent of nitrogen, 6.15 per cent of available phosphoric acid and 9.89 per cent of potash.

| | |
|---|---|
| 3.44 (per cent nitrogen) multiplied by three equals | $10 32 |
| 6.15 (per cent available phosphoric acid) equals | 6 15 |
| 9.89 (per cent potash) equals | 9 89 |
| Total | $26 36 |

## LIST OF MANUFACTURERS WHO HAVE FILED STATEMENTS REQUIRED BY LAW.

Manufacturers to the number of 184 have filed with this Station the statement required by law. Of these there are 61 whose factories are located outside of New York State. These 184 manufacturers put on the market 1,728 different brands. Many of these brands are manufactured for special parties in other states, so that the number of different brands actually sold in this state is short of the total given above. Within the past two years it has become very common to have special goods made for local dealers which have a limited sale in the dealer's immediate locality. This method is becoming more and more common, and, of course, increases largely the number of brands made and sold.

| Names and Addresses of Manufacturers. | Number of brands reported. |
|---|---|
| Acme Fertilizer Co., 62 William Street, New York City | 7 |
| American Reduction Co., 1516 Second Avenue, Pittsburg, Pa | 4 |
| Armour Fertilizer Works, 205 La Salle Street, Chicago, Ill | 7 |
| Edward J. Attwood, Andover, N. Y | 7 |
| Bachman & Co., Chester, Orange Co., N. Y | 1 |
| A. M. Baker & Son, Mt. Morris, N. Y | 6 |
| H. J. Baker & Bro., 93 William Street, New York City | 43 |
| Addison Baldridge, MacDougall, N. Y | 1 |
| J. A. Bingham, Marlborough, N. Y | 5 |
| Bowker Fertilizer Co., 43 Chatham Street, Boston, Mass | 40 |
| Bradley Fertilizer Co., 92 State Street, Boston, Mass | 39 |
| The Bradley Fertilizer Co., Philadelphia, Pa | 13 |
| Brisbin & Douglas, Clyde, N. Y | 2 |
| Charles Brown, Mt. Morris, N. Y | 1 |
| Brumfield & Foster, Colora, Md | 9 |
| J. P. Butts, Oneonta, N. Y | 4 |
| Chandler, Russell & Chandler, Newark, N. J | 9 |
| E. B. Chapin, Rochester, N. Y | 3 |
| R. F. Chappius, Dryden, N. Y | 1 |
| Chemical Co. of Canton, Baltimore, Md | 11 |
| Chesapeake Guano Co., Baltimore, Md | 3 |
| Clark & Powers, Fabius, N. Y | 1 |
| Clark's Cove Fertilizer Co., 40 Exchange Place, New York City | 15 |
| The Cleveland Dryer Co., 92 State Street, Boston, Mass | 8 |
| Club and Grange Fertilizer Co., Syracuse, N. Y | 6 |
| E. Frank Coe Co., 135 Front street, New York city | 28 |
| Colgrove & Vann, Willow Creek, N. Y | 2 |
| Peter Cooper's Glue Factory, 13 Burling slip, New York City | 1 |
| A. S. Core Fertilizer Works, White Plains, N. Y | 14 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y | 242 |
| E. A. Cross, Hilton, N. Y | 3 |
| Cuba Fertilizer Co., Cuba, N. Y | 9 |
| Cumberland Bone Phosphate Co., Portland, Me | 12 |
| Cuyler & Carr, Milford, N. Y | 4 |
| L. B. Darling Fertilizer Co., Pawtucket, R. I | 10 |
| Detrick Fertilizer and Chemical Co., Baltimore, Md | 27 |
| Louis F. Detrick, Baltimore, Md | 9 |
| C. A. Dryer, South Lima, N. Y | 3 |
| P. P. Dunan, 310 Equitable Building, Baltimore, Md | 8 |
| Edward Dwyer, Livonia, N. Y | 3 |
| Eastern Farm Supply Association, Montclair, N. J | 12 |
| Robert D. Eaton, Norwich, N. Y | 6 |

| NAMES AND ADDRESSES OF MANUFACTURERS. | Number of brands reported. |
|---|---|
| The Elixir Fertilizer Co., 107 W. 14th Street, New York City | 1 |
| Erie City Fertilizer Works, Erie, Pa | 4 |
| Essex Fertilizer Co., Newark, N. J | 2 |
| Geo. S. Ewart, North Sparta, N. Y | 1 |
| Farmers' Fertilizer Co., Syracuse, N. Y | 14 |
| Farmers' and Builders' Supply Co., Owego, N. Y | 7 |
| W. S. Farmer & Co., Baltimore, Md | 6 |
| John Finster, Rome, N. Y | 1 |
| Henry Fitchard, Minetto, N. Y | 1 |
| Geo. B. Forrester, 169 Front Street, New York City | 19 |
| Thos. P. Gaines, Sherburne, N. Y | 3 |
| Geneva Coal Co., Geneva, N. Y | 15 |
| A. C. Geslain, 131 Rutledge Street, Brooklyn, N. Y | 2 |
| G. W. Goddard, Mt. Upton, N. Y | 3 |
| Great Eastern Fertilizer Co., Rutland, Vt | 16 |
| Griffith & Boyd, 9 South Gay Street, Baltimore, Md | 9 |
| John Haefele, Delaware Avenue, Albany, N. Y | 1 |
| H. O. Hale, Norwich, N. Y | 3 |
| Ira C. Hall, Farmer, N. Y | 5 |
| The Hallock and Duryee Fertilizer Co., Mattituck, N. Y | 5 |
| Hammond's Paint and Slug-Shot Works, Fishkill, N. Y | 1 |
| John Hardiman, New Hartford, N. Y | 2 |
| Geo. L. Harding, 205 Water Street, Binghamton, N. Y | 1 |
| Hathaway & Reynolds, Oriskany Falls, N. Y | 5 |
| Isaac C. Hendrickson, Jamaica, N. Y | 2 |
| S. M. Hess & Bro., 4th and Chestnut Streets, Philadelphia, Pa | 9 |
| J. S. Hewitt & Sons, Locke, N. Y | 8 |
| C. C. Hicks, Penn Yan, N. Y | 9 |
| Hubbard & Co., 10 Light Street, Baltimore, Md | 9 |
| Humphrey & Holdridge, Honeoye Falls, N. Y | 6 |
| Imperial Fertilizer Co., 5 Hanover Street, New York City | 2 |
| International Seed Co., Rochester, N. Y | 3 |
| Geo. A. Ives, Bainbridge, N. Y | 2 |
| F. N. Isham, Avon, N. Y | 1 |
| The Jarecki Chemical Co., Sandusky, Ohio | 8 |
| The Jones Fertilizer Co., Cincinnati, Ohio | 9 |
| F. W. Jones, Jonesburg, N. Y | 4 |
| Kinne Bros. & Howell, Ovid, N. Y | 1 |
| Lackawanna Fertilizer and Chemical Co., Moosic, Pa | 4 |
| F. R. Lalor, Dunnville, Ontario, Can | 1 |
| Lazaretto Guano Co., Baltimore, Md | 45 |

| NAMES AND ADDRESSES OF MANUFACTURERS. | Number of brands reported. |
|---|---|
| Liebig Manufacturing Co., 26 Broadway, New York City | 10 |
| Lister Agricultural Chemical Works, Newark, N. J | 27 |
| Joseph Lister, 1158 Elston Avenue, Chicago, Ill | 1 |
| Locke Fertilizer Co., Locke, N. Y | 8 |
| Lonergan & Livingston, Albany, N. Y | 2 |
| Long Island Agricultural Chemical Co., Long Island City, N. Y | 6 |
| George F. Lowe, LeRoy, N. Y | 1 |
| Lowell Fertilizer Co., Lowell, Mass | 11 |
| Frederick Ludlam, 108 Water Street, New York City | 8 |
| Mapes Formula and Peruvian Guano Co., 143 Liberty Street, New York City | 18 |
| Maryland Fertilizing and Manufacturing Co., 30 South Halliday Street, Baltimore, Md | 19 |
| Maxson & Starin, Cortland, N. Y | 12 |
| W. B. McDowell, Middletown, N. Y | 2 |
| Michigan Carbon Works, Detroit, Mich | 9 |
| Miller Fertilizer Co., 411 East Pratt Street, Baltimore, Md | 7 |
| Milsom Rendering and Fertilizer Co., East Buffalo, N. Y | 20 |
| Minot & Decker, Brockport, N. Y | 4 |
| Mitchell Fertilizer Co., Tremley, N. J | 3 |
| L. Mittenmaier & Son, Rome, N. Y | 4 |
| Moller & Co., Maspeth, N. Y | 2 |
| Francis P. Murray, Macedon, N. Y | 2 |
| National Fertilizer Co., Bridgeport, N. Y | 6 |
| Geo. A. Newcomb, Cottage, N. Y | 1 |
| Wm. Newton, Henrietta, N. Y | 1 |
| New York Fertilizer Co., 203 Broadway, New York City | 1 |
| Niagara Fertilizer Works, Buffalo, N. Y | 38 |
| Northwestern Fertilizing Co., Chicago, Ill | 18 |
| Oakfield Fertilizer Co., Buffalo, N. Y | 8 |
| Oneonta Fertilizer and Chemical Co., Oneonta, N. Y | 18 |
| Overton & Co., Reading Center, N. Y | 1 |
| Pacific Guano Co., 27 William Street, New York City | 23 |
| Packers' Union Fertilizer Co., New York City | 7 |
| Chas. D. Parks, Danbury, Conn | 3 |
| Patapsco Guano Co., Baltimore, Md | 21 |
| G. A. Pearsall, Williamson, N. Y | 5 |
| E. E. Pease, Mapleton, N. Y | 1 |
| Penfield Milling Co., Delhi, N. Y | 2 |
| A. W. Perkins & Co., Rutland, Vt | 1 |
| A. Peterson, Penfield, N. Y | 5 |

| Names and Addresses of Manufacturers. | Number of brands reported. |
|---|---|
| J. E. Phelps, Jamaica, N. Y. | 7 |
| Moro Phillips Chemical Co., 131 South 3d Street, Philadelphia, Pa. | 17 |
| Wm. W. Phipps, Albion, N. Y. | 4 |
| H. A. Pierce & Co., Armor, N. Y. | 2 |
| B. J. Pine, East Williston, N. Y. | 1 |
| L. S. Pitkin, Lorraine, N. Y. | 1 |
| Powers, Gibbs & Co., Wilmington, N. C. | 10 |
| Preston Fertilizer Co., Long Island City, N. Y. | 16 |
| Queen City Fertilizer Co., Buffalo, N. Y. | 15 |
| Quinnipiac Co., 83 Fulton Street, New York City | 38 |
| Rasin Fertilizer Co., Baltimore, Md. | 9 |
| Read Fertilizer Co., 88 Wall Street, New York City | 35 |
| John S. Reese & Co., Baltimore, Md. | 20 |
| J. L. Reynolds & Co., Mt. Vernon, N. Y. | 3 |
| C. A. Rice, Ellington, N. Y. | 1 |
| J. L. Richer, New Berlin, N. Y. | 2 |
| Riverside Acid Works, Warren, Pa. | 4 |
| Rochester Fertilizer Works, Rochester, N. Y. | 17 |
| Rogers & Hubbard Co., Middletown, Conn. | 10 |
| Sessions & Leonard, Palmyra, N. Y. | 4 |
| Shappee Bros., Horseheads, N. Y. | 1 |
| Sharpless & Carpenter, 24 South Delaware Avenue, Philadelphia, Pa. | 13 |
| G. W. Sharretts & Co., 8th Street and 2d Avenue, Baltimore, Md. | 6 |
| Chas. A. Sickler & Bro., Wilkesbarre, Pa. | 5 |
| Isaac Smith, Columbiaville, N. Y. | 7 |
| Spaulding & Conde, Lyndonville, N. Y. | 1 |
| W. W. Sprague Co., Union Stock Yards, Chicago, Ill. | 1 |
| W. H. Stamp, Warsaw, N. Y. | 6 |
| H. Stappenbeck, Utica, N. Y. | 3 |
| Standard Fertilizer Co., Boston, Mass. | 18 |
| Sterling Oil Co., Greenport, N. Y. | 1 |
| G. W. Stoddard, Mt. Upton, N. Y. | 3 |
| W. B. Stewart, South Plymouth, N. Y. | 3 |
| Swift & Co., Chicago, Ill. | 6 |
| C. R. Sworts, Dundee, N. Y. | 7 |
| F. W. Tassell, Williamson, N. Y. | 2 |
| I. P. Thomas & Son, 2 South Delaware Avenue, Philadelphia, Pa. | 13 |
| Edward D. Tolles, Attica, N. Y. | 8 |
| Henry F. Tucker Co., Boston, Mass. | 3 |
| Geo. O. P. Turner, Churchville, N. Y. | 8 |
| Ellsworth Tuthill & Co., Promised Land, N. Y. | 6 |

| Names and Addresses of Manufacturers. | Number of brands reported. |
|---|---|
| George F. Tuthill & Co., Greenport, N. Y. | 1 |
| J. E. Tygert & Co., 42 South Delaware Avenue, Philadelphia, Pa. | 8 |
| Tygert-Allen Fertilizer Co., 2 Chestnut Street, Philadelphia, Pa. | 9 |
| F. G. Underwood, Oneida, N. Y. | 3 |
| J. E. Van Benthuysen, Lishaskill, N. Y. | 4 |
| J. W. VanCott & Son, Unadilla, N. Y. | 3 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | 16 |
| Walker, Stratman & Co., Pittsburg, Pa. | 8 |
| F. E. Webster, Sennett, N. Y. | 1 |
| Robt. West, Hamilton, Ontario, Can. | 2 |
| W. E. Whann, William Penn, Pa. | 8 |
| M. E. Wheeler & Co., Rutland, Vt. | 10 |
| Wickwire & Sheldon, Hamilton, N. Y. | 4 |
| Willoughby & Fletcher, Oxford, N. Y. | 2 |
| Wilkinson & Co., 29 South William Street, New York City | 2 |
| Williams & Clark Fertilizer Co., 27 William Street, New York City | 25 |
| M. J. Wilson, Rushford, N. Y. | 1 |
| Wooster & Mott, Union Hill, N. Y. | 7 |
| C. K. Yates, Farmer, N. Y. | 1 |
| York Chemical Works, York, Pa. | 5 |
| Zell Guano Co., Baltimore, Md. | 45 |

## TERMS USED IN STATING RESULTS OF ANALYSIS.

In the tables following, the terms used to express the results of analysis are self-explanatory for the most part. Attention is called, however, to two additional determinations which we have not usually published heretofore.

One of these is "water-soluble" phosphoric acid. While manufacturers are required to guarantee only the amount of available phosphoric acid (water-soluble plus reverted or citrate-soluble), yet it seems desirable that consumers should know what proportion of the available is water-soluble. The available phosphoric acid being equal, one would choose by preference a fertilizer containing the larger amount of water-soluble phosphoric acid.

The amount of water-soluble phosphoric acid varied from 0 to 12.47 per cent and averaged 4.97 per cent. This constituted nearly 60 per cent of the available phosphoric acid present.

The water-soluble nitrogen includes nitrogen present in the form of ammonia salts and nitrates together with that present in small amounts of soluble organic matter. The amount of water-soluble nitrogen varied from 0.01 to 6.25 per cent and averaged 0.95 per cent. This constituted 42.6 per cent of the total nitrogen present.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| W. W. Acheson, Belleview, Fla. | Animal food for vegetable, field and fruit crops. | Albany. | 3447 |
| Acme Fertilizer Co., Maspeth, N. Y. | Acme fertilizer No. 1. | Jamaica. | 3074 |
| Acme Fertilizer Co., Maspeth, N. Y. | Acme fertilizer No. 2. | Jamaica. | 3067 |
| Acme Fertilizer Co., Maspeth, N. Y. | High grade special. | Jamaica. | 3075 |
| Acme Fertilizer Co., Maspeth, N. Y. | Superior superphosphate. | Bridgehampton. | 3142 |
| Allison & Co., New York City. | Canada hard wood ashes. | East Marion. | 3114 |
| American Reduction Co., Pittsburg, Pa. | Powter's brand. | Otto. | 3283 |
| American Reduction Co., Pittsburg, Pa. | Powter's general phosphate. | Otto. | 3281 |
| American Reduction Co., Pittsburg, Pa. | Special potato. | Otto. | 3282 |
| The Armour Fertilizer Works, Chicago, Ill. | All soluble. | Bliss. | 3367 |
| The Armour Fertilizer Works, Chicago, Ill. | Blood and bone. | Bliss. | 3366 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | —— | —— | 13.50 | 0.50 | —— | —— |
| Found | | | 19.60 | 0.04 | | |
| Below guarantee | | | | 0.46 | | |
| Guaranteed | 3.70 | 8 | —— | 9 | —— | —— |
| Found | 3.45 | 6.60 | 8.68 | 8.77* | 2.63 | 1.93 |
| Below guarantee | 0.25 | 1.40 | | 0.23 | | |
| Guaranteed | 4.95 | 8 | —— | 5 | —— | —— |
| Found | 4.59 | 7.03 | 9.11 | 4.92 | 2.71 | 1.99 |
| Below guarantee | 0.36 | 0.97 | | | | |
| Guaranteed | 7.40 | 7 | —— | 4 | —— | —— |
| Found | 6.18 | 5.97 | 8.54 | 4.63 | 4.35 | 2.14 |
| Below guarantee | 1.22 | 1.03 | | | | |
| Guaranteed | 1.23 | 6 | —— | 4 | —— | —— |
| Found | 1.58 | 8.97 | 12.01 | 5.01* | 0.68 | 2.37 |
| Guaranteed | —— | —— | 1.50 | 5 | —— | —— |
| Found | | | 0.47 | 3.70 | | |
| Below guarantee | | | 1.03 | 1.30 | | |
| Guaranteed | 1.20 | 8 | —— | 1.50 | —— | —— |
| Found | 1.80 | 5.41 | 8.73 | 2.29* | 0.49 | 2.37 |
| Below guarantee | | 2.59 | | | | |
| Guaranteed | 1.60 | 8 | —— | 2 | —— | —— |
| Found | 2.18 | 4.94 | 8.99 | 2.14* | 0.63 | 2.47 |
| Below guarantee | | 3.02 | | | | |
| Guaranteed | 2.50 | —— | 2 | 7 | —— | —— |
| Found | 1.99 | 1.09 | 1.37 | 9.88* | 0.29 | 0.33 |
| Below guarantee | 0.51 | | 0.63 | | | |
| Guaranteed | 2.88 | 8 | 10 | 4 | —— | —— |
| Found | 2.88 | 7.05 | 9.96 | 5.95* | 1.76 | 2.55 |
| Below guarantee | | 0.95 | | | | |
| Guaranteed | 5.76 | —— | 10 | —— | —— | —— |
| Found | 6.78 | | 10.26 | | 5.52 | |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| The Armour Fertilizer Works, Chicago, Ill. | Bone, blood and potash. | Batavia. | 3347 |
| The Armour Fertilizer Works, Chicago, Ill. | Grain grower. | Batavia. | 3346 |
| E. J. Attwood, Andover, N. Y. | New York standard No. 2. | Andover. | 3384 |
| Bachman & Co., Chester, N. Y. | Success. | Chester. | 3194 |
| A. M. Baker & Son, Mt. Morris, N. Y. | Ontario. | Mt. Morris. | 3386 |
| H. J. Baker & Bro., New York City. | Complete cabbage manure. | Jamaica. | 3072 |
| H. J. Baker & Bro., New York City. | Complete nitrogenized manure. | Jamaica. | 3073 |
| H. J. Baker & Bro., New York City. | Complete potato manure. | Jamaica.<br>Poughkeepsie. | 3071<br>3173 |
| H. J. Baker & Bro., New York City. | Harvest home. | Poughkeepsie. | 3172 |
| H. J. Baker & Bro., New York City. | Lawn dressing. | White Plains. | 3160 |
| H. J. Baker & Bro., New York City. | Standard UNXLD. | Poughkeepsie.<br>Glens Falls. | 3171<br>3394 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 4.11 | 8 | 10 | 7 | ——— | ——— |
| Found | 4.41 | 9.17 | 13.12 | 7.11* | 1.02 | 6.03 |
| Guaranteed | 1.64 | 8 | 10 | 2 | ——— | ——— |
| Found | 2.37 | 8.33 | 13.49 | 2.02 | 0.52 | 5.31 |
| Guaranteed | 1.23 | 10 | ——— | 3 | ——— | ——— |
| Found | 1.26 | 9.97 | 11.19 | 3.07 | 0.71 | 7.34 |
| Guaranteed | 1.15 | 1.93 | 6.78 | 0.14 | ——— | ——— |
| Found | 0.30 | 0.83 | 0.96 | 0.08 | 0.04 | |
| Below guarantee | 0.85 | 1.10 | | | | |
| Guaranteed | 1.03 | 10 | ——— | 4 | ——— | ——— |
| Found | 1.37 | 10.22 | 13.44 | 4.29 | 0.29 | 6.94 |
| Guaranteed | 4.75 | 5 | 6 | 7 | ——— | ——— |
| Found | 4.87 | 6.30 | 6.66 | 6.96* | 3.05 | 4.80 |
| Guaranteed | 8 | 5 | 6 | 3 | ——— | ——— |
| Found | 7.70 | 6.22 | 6.61 | 4.06* | 3.93 | 4.23 |
| Below guarantee | 0.30 | | | | | |
| Guaranteed | 3.30 | 5.75 | 6.75 | 10 | ——— | ——— |
| Found | 3.78 | 6.56 | 6.93 | 10.17* | 1.86 | 5.38 |
| Guaranteed | 1.25 | 8 | ——— | 2 | ——— | ——— |
| Found | 1.55 | 8.87 | 10.37 | 2.68 | 0.54 | 5.44 |
| Guaranteed | 3.70 | 5 | 6 | 7.50 | ——— | ——— |
| Found | 3.66 | 6.30 | 6.87 | 7.49 | 2.34 | 3.77 |
| Guaranteed | 1.85 | 8 | 9 | 2.25 | ——— | ——— |
| Found | 2.38 | 10 | 11.18 | 3.41 | 1.01 | 3.56 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| H. J. Baker & Bro., New York City. | Vegetable, vine and potato manure. | Kingston. | 3209 |
| H. J. Baker & Bro., New York City. | Victor. | Cutchogue. | 3128 |
| Becker Bros., Gowanda, N. Y. | Erie County special. | Gowanda. | 3324 |
| Becker Bros., Gowanda, N. Y. | Ohio Valley. | Gowanda. | 3325 |
| Becker Bros., Gowanda, N. Y. | Potato special. | Gowanda. | 3326 |
| Bowker Fertilizer Co., Boston, Mass. | Ammoniated dissolved bone. | Jamaica.<br>Silver Creek.<br>Lansingburgh. | 3100<br>3255<br>3424 |
| Bowker Fertilizer Co., Boston, Mass. | C. A. D. special No. 2. | South Lima. | 3583 |
| Bowker Fertilizer Co., Boston, Mass. | C. A. D. special No. 3. | South Lima. | 3582 |
| Bowker Fertilizer Co., Boston, Mass. | Corn phosphate. | Lishaskill. | 3475 |
| Bowker Fertilizer Co., Boston, Mass. | Dissolved bone phosphate. | Brocton. | 3245 |
| Bowker Fertilizer Co., Boston, Mass. | Empire State bone and potash. | Collins. | 3323 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.65 | 5 | 6 | 12 | —— | —— |
| Found | 1.96 | 6.56 | 6.68 | 11.28 | 0.81 | 5.30 |
| Below guarantee | | | | 0.72 | | |
| Guaranteed | 3 | 10 | —— | 8 | —— | —— |
| Found | 3.40 | 10.33 | 11.32 | 8.34 | 1.90 | 7.87 |
| Guaranteed | 1.64 | 7 | —— | 2 | —— | —— |
| Found | 1.65 | 8.34 | 11.19 | 1.37 | 0.09 | 5.44 |
| Below guarantee | | | | 0.63 | | |
| Guaranteed | 1.64 | 8 | —— | 2 | —— | —— |
| Found | 2.10 | 8.16 | 10.80 | 2.05 | 0.09 | 4.94 |
| Guaranteed | 3.28 | 9 | —— | 5 | —— | —— |
| Found | 3.15 | 10.37 | 11.55 | 5.14 | 0.36 | 8.51 |
| Guaranteed | 1.50 | 8 | 10 | 2 | —— | —— |
| Found | 1.64 | 8.10 | 12.19 | 2.23 | 0.43 | 4.96 |
| Guaranteed | 0.75 | 7 | 8 | 12 | —— | —— |
| Found | 0.79 | 9.71 | 11.66 | 10.20 | 0.53 | 5.54 |
| Below guarantee | | | | 1.80 | | |
| Guaranteed | 2.25 | 8 | 9 | 15 | —— | —— |
| Found | 2.51 | 7.04 | 10.18 | 15.58 | 1.35 | 1.88 |
| Below guarantee | | 0.96 | | | | |
| Guaranteed | 1.50 | 9 | 11 | 2 | —— | —— |
| Found | 1.84 | 8.76 | 12.02 | 2.23 | 0.51 | 3.94 |
| Below guarantee | | 0.24 | | | | |
| Guaranteed | —— | 11 | 13 | —— | —— | —— |
| Found | | 10.88 | 15.28 | | | 5.67 |
| Guaranteed | —— | 8 | 10 | 3 | —— | —— |
| Found | | 8.74 | 12.41 | 3.76 | | 4.82 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Bowker Fertilizer Co., Boston, Mass. | Farm and garden phosphate. | Gloversville.<br>Camden. | 3503<br>3753 |
| Bowker Fertilizer Co., Boston, Mass. | Fine dry ground fish. | Jamaica. | 3099 |
| Bowker Fertilizer Co., Boston, Mass. | Fresh ground bone. | Lansingburgh.<br>Oswego. | 3423<br>3701 |
| Bowker Fertilizer Co., Boston, Mass. | Fresh milled kainit. | Lishaskill. | 3476 |
| Bowker Fertilizer Co., Boston, Mass. | Grape belt and fruit special with extra potash. | North Collins. | 3333 |
| Bowker Fertilizer Co., Boston, Mass. | Harvest bone dissolved. | Warsaw. | 3370 |
| Bowker Fertilizer Co., Boston, Mass. | Hill and drill. | Orient.<br>Silver Creek.<br>Glens Falls. | 3115<br>3253<br>3395 |
| Bowker Fertilizer Co., Boston, Mass. | Hop and potato phosphate with extra potash. | Glens Falls.<br>North Collins.<br>Cortland. | 3397<br>3332<br>3634 |
| Bowker Fertilizer Co., Boston, Mass. | Lawn and garden. | West Troy.<br>Binghamton. | 3440<br>3594 |
| Bowker Fertilizer Co., Boston, Mass. | Market bone. | Southampton.<br>Cooperstown. | 3156<br>3574 |
| Bowker Fertilizer Co., Boston, Mass. | Market garden fertilizer. | Orient. | 3116 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.50 | 8 | 10 | 2 | — | — |
| Found | 1.87 | 9.45 | 11.66 | 2.25 | 0.80 | 6.55 |
| Guaranteed | 6.60 | — | 6 | — | — | — |
| Found | 6.21 | | 5.89 | | 0.40 | 0.57 |
| Below guarantee | 0.39 | | | | | |
| Guaranteed | 2.50 | 5 | 18 | — | — | — |
| Found | 2.53 | 10.44 | 20.64 | | 0.91 | 0.78 |
| Guaranteed | — | — | — | 11 | — | — |
| Found | | | | 11.49 | | |
| Guaranteed | 0.80 | 7 | — | 5 | — | — |
| Found | 0.73 | 8.60 | 11.43 | 8.40 | 0.01 | 4.47 |
| Guaranteed | — | 12 | — | — | — | — |
| Found | | 14.37 | 17.14 | | | 7.42 |
| Guaranteed | 2.25 | 9 | 12 | 2 | — | — |
| Found | 2.81 | 9.15 | 12.13 | 2.44 | 1.61 | 5.28 |
| Guaranteed | 0.82 | 8 | 10 | 5 | — | — |
| Found | 1.06 | 8.29 | 11.77 | 5.82 | 0.53 | 3.05 |
| Guaranteed | 3.25 | 6 | 8 | 5 | — | — |
| Found | 4.71 | 6.90 | 10.22 | 4.91 | 3.81 | 0.27 |
| Guaranteed | 1.50 | — | 16 | — | — | — |
| Found | 1.94 | | 23.86 | | 0.70 | 0.89 |
| Guaranteed | 2.25 | 6 | 8 | 10 | — | — |
| Found | 2.72 | 8.21 | 10.37 | 10.15 | 0.98 | 5.23 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Bowker Fertilizer Co., Boston, Mass. | Potash bone. | Brocton. | 3244 |
| Bowker Fertilizer Co., Boston, Mass. | Potash phosphate. | Lishaskill.<br>Collins.<br>Camden. | 3477<br>3322<br>3752 |
| Bowker Fertilizer Co., Boston, Mass. | Potato manure. | Southampton. | 3155 |
| Bowker Fertilizer Co., Boston, Mass. | Potato phosphate. | Brocton.<br>West Troy.<br>Gloversville. | 3243<br>3438<br>3504 |
| Bowker Fertilizer Co., Boston, Mass. | Special formula. | Fenton. | 3338 |
| Bowker Fertilizer Co., Boston, Mass. | Staple phosphate. | Springville.<br>Oswego. | 3317<br>3702 |
| Bowker Fertilizer Co., Boston, Mass. | Stockbridge cabbage and cauliflower manure. | West Troy. | 3439 |
| Bowker Fertilizer Co., Boston, Mass. | Stockbridge celery special. | West Troy. | 3441 |
| Bowker Fertilizer Co., Boston, Mass. | Stockbridge corn, grain, etc. | Albany. | 3445 |
| Bowker Fertilizer Co., Boston, Mass. | Stockbridge manure. | Glens Falls. | 3396 |
| Bowker Fertilizer Co., Boston, Mass. | Stockbridge onion special. | West Troy. | 3442 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.75 | 5 | 7 | 2 | —— | —— |
| Found | 1.14 | 9.46 | 12.01 | 2.74 | 0.55 | 6.22 |
| Guaranteed | 0.75 | 8 | 10 | 3 | —— | —— |
| Found | 1.01 | 8.23 | 11.93 | 3.88 | 0.46 | 2.82 |
| Guaranteed | 2.25 | 8 | 10 | 4 | —— | —— |
| Found | 2.78 | 9.37 | 11.45 | 4.24 | 0.78 | 6.25 |
| Guaranteed | 1.50 | 8 | 10 | 2 | —— | —— |
| Found | 1.71 | 9.08 | 11.98 | 2.25 | 0.58 | 1.31 |
| Guaranteed | 2 | 10 | —— | 8 | —— | —— |
| Found | 1.37 | 11.57 | 12.19 | 6.57* | | 8.89 |
| Below guarantee | 0.63 | | | 1.43 | | |
| Guaranteed | 0.75 | 8 | —— | 3 | —— | —— |
| Found | 0.89 | 10.22 | 12.33 | 3.35 | 0.25 | 5.09 |
| Guaranteed | 4 | 5 | 6 | 6 | —— | —— |
| Found | 5.03 | 5.08 | 8.08 | 6.71 | 3.66 | 2.77 |
| Guaranteed | 4.10 | 4 | 5 | 5.50 | —— | —— |
| Found | 5 | 6.64 | 8.44 | 7.04 | 3.01 | 5.45 |
| Guaranteed | 3.25 | 8 | 10 | 4 | —— | —— |
| Found | 3.27 | 9.53 | 11.58 | 4.63 | 1.38 | 7.32 |
| Guaranteed | 3.25 | 5 | 8 | 10 | —— | —— |
| Found | 3 | 4.56 | 10.45 | 9.99 | 1.55 | 1.13 |
| Below guarantee | 0.25 | 0.44 | | | | |
| Guaranteed | 4.50 | 6 | 8 | 5 | —— | —— |
| Found | 4.30 | 7.95 | 9.70 | 7.33 | 2.27 | 5.50 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Bowker Fertilizer Co., Boston, Mass. | Stockbridge potato and vegetable manure. | Southampton. | 3154 |
| Bowker Fertilizer Co., Boston, Mass. | Stockbridge vegetable and potato manure. | Troy. | 3427 |
| Bowker Fertilizer Co., Boston, Mass. | Stockbridge top dressing. | Southampton. | 3153 |
| Bowker Fertilizer Co., Boston, Mass. | Superphosphate. | Lishaskill.<br>Oswego. | 3474<br>3703 |
| Bowker Fertilizer Co., Boston, Mass. | Superphosphate with potash. | Cattaraugus.<br>Lansingburgh.<br>Cortland. | 3280<br>3426<br>3633 |
| Bowker Fertilizer Co., Boston, Mass. | Sure crop. | Silver Creek.<br>Lansingburgh.<br>Seneca Hill. | 3254<br>3425<br>3698 |
| Bowker Fertilizer Co., Boston, Mass. | Tobacco grower. | Syracuse. | 3674 |
| Bowker Fertilizer Co., Boston, Mass. | Tobacco phosphate. | Syracuse. | 3675 |
| Bowker Fertilizer Co., Boston, Mass. | Wells & Hudson's high-grade. | Riverhead. | 3132 |
| Bradley Fertilizer Co., Boston, Mass. | Ammoniated dissolved bones. | Glens Falls.<br>Tully. | 3407<br>3649 |
| Bradley Fertilizer Co., Boston, Mass. | Bean and potato phosphate. | Glens Falls.<br>Tully. | 3405<br>3650 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 3.25 | 5 | 8 | 10 | ——— | ——— |
| Found | 3.38 | 7.28 | 8.77 | 10.52 | 1.25 | 3.58 |
| Guaranteed | 3.25 | 6 | 8 | 7 | ——— | ——— |
| Found | 3.28 | 9.37 | 12.25 | 6.46 | 1.79 | 5.78 |
| Below guarantee | | | | 0.54 | | |
| Guaranteed | 5 | 4 | 6 | 6 | ——— | ——— |
| Found | 5.20 | 7.84 | 8.92 | 7.34 | 3.37 | 4.61 |
| Guaranteed | ——— | 13 | 15 | ——— | ——— | ——— |
| Found | | 11.88 | 16.04 | | | 7.11 |
| Below guarantee | | 1.12 | | | | |
| Guaranteed | ——— | 10 | 12 | 1 | ——— | ——— |
| Found | | 14.96 | 16.93 | 1.47 | | 10.40 |
| Guaranteed | 0.75 | 8 | ——— | 1 | ——— | ——— |
| Found | 1.19 | 9.29 | 11.77 | 1.70 | 1.52 | 5.59 |
| Guaranteed | 2.25 | 7 | ——— | 4 | ——— | ——— |
| Found | 2.63 | 9.63 | 10.61 | 3.93 | 1.74 | 5.20 |
| Guaranteed | 1.25 | 8.50 | ——— | 1.08 | ——— | ——— |
| Found | 1.45 | 9.64 | 11.42 | 1.18 | 0.48 | 7.09 |
| Guaranteed | 3.30 | 7 | 9 | 7 | ——— | ——— |
| Found | 3.42 | 8.51 | 10.95 | 7.54 | 1 | 5.44 |
| Guaranteed | 1.65 | 7 | 8 | 1 | ——— | ——— |
| Found | 2.23 | 7.91 | 11.09 | 1.67 | 0.81 | 3.86 |
| Guaranteed | 0.82 | 8 | 10 | 3.25 | ——— | ——— |
| Found | 1.44 | 7.31 | 9.94 | 3.32 | 0.41 | 5.21 |
| Below guarantee | | 0.69 | | | | |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Bradley Fertilizer Co., Boston, Mass. | B D sea fowl guano. | Attica.<br>Amsterdam.<br>Canton. | 3352<br>3484<br>3781 |
| Bradley Fertilizer Co., Boston, Mass. | Complete manure for potatoes and vegetables. | Jamaica.<br>Troy. | 3079<br>3443 |
| Bradley Fertilizer Co., Boston, Mass. | Farmers' new method. | Cornwall.<br>Evans.<br>Albany. | 3189<br>3277<br>3448 |
| Bradley Fertilizer Co., Boston, Mass. | Hop fertilizer. | Solsville. | 3546 |
| Bradley Fertilizer Co., Boston, Mass. | Niagara phosphate. | Evans.<br>Glens Falls.<br>Tully. | 3276<br>3406<br>3651 |
| Bradley Fertilizer Co., Boston, Mass. | Patent superphosphate. | Troy.<br>Tully. | 3436<br>3646 |
| Bradley Fertilizer Co., Boston, Mass. | Potato fertilizer. | Cornwall.<br>Troy.<br>Tully | 3188<br>3435<br>3647 |
| Brumfield & Foster, Colora, Md. | Hard-times ammoniated phosphate. | Sherburne. | 3531 |
| Brumfield & Foster, Colora, Md. | High-grade acid phosphate. | Sherburne. | 3530 |
| J. P. Butts, Oneonta, N. Y. | Hustler. | Oneonta. | 3567 |
| Cuyler E. Carr, Milford, N. Y. | Potato and hop fertilizer. | Milford. | 3576 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer.[1] | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pound of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.06 | 8 | 10 | 1.50 | ——— | ——— |
| Found | 2.29 | 8.45 | 10.25 | 2.12 | 0.66 | 6.19 |
| Guaranteed | 3.71 | 8.50 | 10 | 7 | ——— | ——— |
| Found | 3.63 | 8.91 | 10.66 | 7.44 | 1 | 4.82 |
| Guaranteed | 0.82 | 8 | 10 | 2.15 | ——— | ——— |
| Found | 1.30 | 8.28 | 10.37 | 2.13 | 0.36 | 4.45 |
| Guaranteed | 1.65 | 8 | 9 | 4.32 | ——— | ——— |
| Found | 2.06 | 9.34 | 11.71 | 4.70 | 0.64 | 5.13 |
| Guaranteed | 0.82 | 7 | 8 | 1.08 | ——— | ——— |
| Found | 1.20 | 8.19 | 9.95 | 1.60 | 0.33 | 5.91 |
| Guaranteed | 2.06 | 8 | 10 | 1.50 | ——— | ——— |
| Found | 2.29 | 9.81 | 12.57 | 1.57 | 0.72 | 4.69 |
| Guaranteed | 2.06 | 9 | 11 | 3.25 | ——— | ——— |
| Found | 3 | 9.59 | 12.28 | 3.47 | 1.12 | 4.00 |
| Guaranteed | 0.80 | 10 | 11 | 1 | ——— | ——— |
| Found | 1.31 | 12.84 | 14.03 | 0.88 | 0.74 | 0.84 |
| Guaranteed | ——— | 14 | ——— | ——— | ——— | ——— |
| Found | | 16.05 | 17.04 | | | 8.22 |
| Guaranteed | 0.82 | 8 | ——— | 4 | ——— | ——— |
| Found | 0.87 | 9.01 | 10.60 | 3.92 | 0.53 | 6.39 |
| Guaranteed | 0.82 | 8 | ——— | 4 | ——— | ——— |
| Found | 0.91 | 8.81 | 10.30 | 3.77 | 0.43 | 6.43 |
| Below guarantee | | | | 0.23 | | |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Chandler, Russell & Chandler, Newark, N. J. | Potato manure. | Jamaica. | 3066 |
| E. B. Chapin, Rochester, N. Y. | Monroe chief. | Rochester. | 3787 |
| E. B. Chapin, Rochester, N. Y. | Potato fertilizer. | Rochester. | 3788 |
| E. B. Chapin, Rochester, N. Y. | Standard. | Rochester. | 3588 |
| Chesapeake Guano Co., Baltimore, Md. | Ammoniated bone superphosphate. | North Collins. | 3335 |
| Chesapeake Guano Co., Baltimore, Md. | New York special No. 2. | North Collins. | 3334 |
| Clark's Cove Fertilizer Co., New York City. | Bay State fertilizer. | Gloversville. | 3505 |
| Clark's Cove Fertilizer Co., New York City. | Defiance complete manure. | Lishaskill.<br>Pulaski. | 3473<br>3724 |
| Clark's Cove Fertilizer Co., New York City. | Good acre hop and tobacco grower. | Lishaskill. | 3471 |
| Clark's Cove Fertilizer Co., New York City. | King Philip alkaline guano. | Lishaskill.<br>Pulaski. | 3469<br>3725 |
| Clark's Cove Fertilizer Co., New York City. | Potato phosphate. | Lishaskill. | 3470 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 3.70 | 7.50 | ——— | 7 | ——— | ——— |
| Found | 3.51 | 8.64 | 9.63 | 7.44 | 2.47 | 5.47 |
| Guaranteed | 1.25 | 6 | ——— | 4 | ——— | ——— |
| Found | 1.35 | 6.21 | 8.89 | 4.40* | 0.45 | 2.39 |
| Guaranteed | 1.25 | 7 | ——— | 6 | ——— | ——— |
| Found | 1.03 | 5.74 | 7.80 | 5.59 | 0.29 | 2.70 |
| Below guarantee | 0.22 | 1.26 | | 0.41 | | |
| Guaranteed | 1.75 | 7 | ——— | 3 | ——— | ——— |
| Found | 1.52 | 6.49 | 9.41 | 4.23* | 0.39 | 2.52 |
| Below guarantee | 0.23 | 0.51 | | | | |
| Guaranteed | 0.82 | 8 | 9 | 1 | ——— | ——— |
| Found | 1.33 | 9.15 | 12.85 | 1.15 | 0.81 | 3 |
| Guaranteed | 1.65 | 8 | ——— | 2 | ——— | ——— |
| Found | 1.86 | 8.21 | 10.08 | 2.18 | 1.13 | 6.25 |
| Guaranteed | 2.47 | 9 | ——— | 2 | ——— | ——— |
| Found | 1.30 | 7.44 | 10.80 | 3.24 | 0.45 | 1.66 |
| Below guarantee | 1.17 | 1.56 | | | | |
| Guaranteed | 0.82 | 6 | 8 | 2 | ——— | ——— |
| Found | 1.50 | 8.71 | 11.77 | 2.09 | 0.51 | 2.38 |
| Guaranteed | 2.10 | 8 | 9 | 3 | ——— | ——— |
| Found | 2.15 | 9.81 | 13.44 | 3.09 | 0.45 | 3.16 |
| Guaranteed | 1.25 | 6 | 7 | 3 | ——— | ——— |
| Found | 1.50 | 6.38 | 9.34 | 2.96 | 0.39 | 1.97 |
| Guaranteed | 2.47 | 6 | 7 | 5 | ——— | ——— |
| Found | 2.78 | 7.27 | 9.05 | 5.17 | 0.75 | 4.70 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Clark's Cove Fertilizer Co., New York City. | Soverign acid phosphate. | Altamont. | 3581 |
| Clark's Cove Fertilizer Co., New York City. | Sunflower bone meal. | Lishaskill. | 3478 |
| Clark's Cove Fertilizer Co., New York City. | Sweepstakes potato manure. | Lishaskill. | 3472 |
| Cleveland Dryer Co., Cleveland, Ohio. | Buckeye ammoniated bone superphosphate. | Jamestown. | 3222 |
| Cleveland Dryer Co., Cleveland, Ohio. | Horsehead phosphate. | Jamestown. | 3220 |
| Cleveland Dryer Co., Cleveland, Ohio. | Phospho bone. | Jamestown. | 3221 |
| Cleveland Dryer Co., Cleveland, Ohio. | Superior bone. | North Collins. | 3337 |
| Club & Grange Fertilizer Co., Syracuse, N. Y. | No. 1. | Sidney.<br>E. Syracuse. | 3550<br>3673 |
| Club & Grange Fertilizer Co., Syracuse, N. Y. | No. 2. | E. Syracuse. | 3672 |
| E. Frank Coe Co., New York City. | Ammoniated bone superphosphate. | Redwood. | 3773 |
| E. Frank Coe Co., New York City. | Buckwheat fertilizer. | Ellicottville.<br>De Ruyter. | 3299<br>3636 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 12 | 13 | —— | —— | —— |
| Found | | 14.92 | 15.84 | | | 11.64 |
| Guaranteed | 1.65 | —— | 14 | —— | —— | —— |
| Found | 2.22 | | 19.92 | | 0.43 | |
| Guaranteed | 2.88 | 7 | 8 | 7.50 | —— | —— |
| Found | 2.96 | 7.18 | 10.16 | 7.49 | 1.49 | 1.59 |
| Guaranteed | 2.47 | 9 | 11 | 1 | —— | —— |
| Found | 1.64 | 9.64 | 13.52 | 0.35* | 0.91 | 5.69 |
| Below guarantee | 0.83 | | | 0.65 | | |
| Guaranteed | —— | 10 | 12 | —— | —— | —— |
| Found | | 12.56 | 14.18 | | | 8.66 |
| Guaranteed | 2.60 | 10 | —— | 1.08 | —— | —— |
| Found | 0.90 | 8.35 | 12.51 | 0.73* | 0.18 | 4.50 |
| Below guarantee | 1.70 | 1.65 | | 0.35 | | |
| Guaranteed | 3.29 | —— | 22 | —— | —— | —— |
| Found | 3.14 | | 20.75 | | 0.85 | |
| Below guarantee | | | 1.25 | | | |
| Guaranteed | —— | 8 | 10 | 3 | —— | —— |
| Found | | 9.43 | 10.43 | 2.90 | | 3.15 |
| Guaranteed | 1.65 | 8 | 9 | 2 | —— | —— |
| Found | 0.90 | 8.11 | 10.51 | 1.69* | 0.08 | 3.41 |
| Below guarantee | 0.75 | | | 0.31 | | |
| Guaranteed | 2 | 9 | —— | 1.35 | —— | —— |
| Found | 1.99 | 9.43 | 12.32 | 1.8 * | 0.70 | 6.09 |
| Guaranteed | 0.40 | 9.50 | 11 | 1 | —— | —— |
| Found | 0.61 | 9.37 | 13.41 | 1.07* | 0.11 | 6.11 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| E. Frank Coe Co., New York City. | Celebrated special potato fertilizer. | Newburg.<br>Troy. | 3182<br>3428 |
| E. Frank Coe Co., New York City. | Columbian brand ammoniated bone superphosphate. | Poughkeepsie. | 3174 |
| E. Frank Coe Co., New York City. | Columbian corn fertilizer. | Ellicottville.<br>De Ruyter.<br>Redwood. | 3303<br>3637<br>3775 |
| E. Frank Coe Co., New York City. | Columbian potato fertilizer. | Poughkeepsie.<br>De Ruyter. | 3175<br>3635 |
| E. Frank Coe Co., New York City. | Dissolved bone potash | Varysburg. | 3372 |
| E. Frank Coe Co., New York City. | Excelsior guano. | Jamaica. | 3081 |
| E. Frank Coe Co., New York City. | Gold brand. | Homer. | 3640 |
| E. Frank Coe Co., New York City. | Grain fertilizer. | De Ruyter. | 3638 |
| E. Frank Coe Co., New York City. | High grade soluble bone. | Ellicottville.<br>Nelson. | 3302<br>3742 |
| E. Frank Coe Co., New York City. | High grade special corn fertilizer. | Newburg. | 3183 |
| E. Frank Coe Co., New York City. | Matchless grain fertilizer. | Newburg.<br>Ellicottville. | 3184<br>3304 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.65 | 9 | 11 | 3.50 | —— | —— |
| Found | 1.74 | 9.48 | 12.59 | 3.59* | 0.88 | 6.88 |
| Guaranteed | 1 | 9 | 11 | 1.85 | —— | —— |
| Found | 1.76 | 9.29 | 12.44 | 2.01* | 0.81 | 7 |
| Guaranteed | 1 | 9 | 11 | 1.85 | —— | —— |
| Found | 1.61 | 8.92 | 12.58 | 2* | 0.73 | 7.06 |
| Guaranteed | 1 | 9 | 11 | 1.85 | —— | —— |
| Found | 1.40 | 9.55 | 12.97 | 1.91* | 0.64 | 7.06 |
| Guaranteed | —— | 12 | —— | 2.75 | —— | —— |
| Found | | 11.44 | 14.19 | 2.28* | | 8.78 |
| Below guarantee | | 0.56 | | 0.45 | | |
| Guaranteed | 3.50 | 9 | 10 | 3.40 | —— | —— |
| Found | 3.40 | 8.53 | 10.98 | 4.34* | 2.22 | 6.80 |
| Below guarantee | | 0.47 | | | | |
| Guaranteed | 2.50 | 8 | 9 | 6 | —— | —— |
| Found | 2.45 | 8.35 | 10.30 | 5.66* | 1.52 | 5.99 |
| Below guarantee | | | | 0.34 | | |
| Guaranteed | 0.80 | 9 | 11 | 1.08 | —— | —— |
| Found | 0.87 | 11.20 | 14.88 | 1.21* | 0.08 | 8.08 |
| Guaranteed | —— | 13 | 15 | —— | —— | —— |
| Found | | 13.68 | 16.78 | | | 5.29 |
| Guaranteed | 1.75 | 9 | 10 | 3 | —— | —— |
| Found | 1.68 | 9.75 | 13.21 | 3.50* | 0.94 | 7.33 |
| Guaranteed | 0.65 | 11 | 12 | 1 | —— | —— |
| Found | 1.01 | 11.64 | 14.41 | 1.31* | 0.15 | 7.82 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| E. Frank Coe Co., New York City. | Prize brand grain and grass fertilizer. | Springville. | 3318 |
| E. Frank Coe Co., New York City. | Prize brand rye fertilizer. | Troy. | 3429 |
| E. Frank Coe Co., New York City. | Ralston's Knickerbocker. | Ellicottville. | 3301 |
| E. Frank Coe Co., New York City. | Red brand. | Jamaica. | 3080 |
| E. Frank Coe Co., New York City. | Special potato fertilizer. | Redwood. | 3774 |
| E. Frank Coe Co., New York City. | XXV phosphate. | Ellicottville.<br>Homer. | 3300<br>3641 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Ammoniated bone superphosphate. | Ellicottville.<br>Oneonta.<br>Parish. | 3309<br>3566<br>3730 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Ammoniated wheat and corn phosphate. | Angola.<br>Saratoga.<br>Phœnix. | 3273<br>3393<br>3691 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Chautauqua County special. | Dunkirk. | 3268 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Crocker's phosphate. | Cooperstown. | 3571 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Erie. | Ellicottville. | 3307 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.40 | 11 | —— | 1 | —— | —— |
| Found | 0.72 | 11.34 | 14.36 | 1.08* | 0.14 | 8.21 |
| Guaranteed | 0.43 | 9.30 | 11 | 1 | —— | —— |
| Found | 1.06 | 10.97 | 14.35 | 1.51* | 0.23 | 7.11 |
| Guaranteed | 1.65 | 8 | —— | 1.25 | —— | —— |
| Found | 2.06 | 10.60 | 14.09 | 1.89* | 1.29 | 6.75 |
| Guaranteed | 3.50 | 9 | 10 | 6 | —— | —— |
| Found | 3.44 | 8.36 | 10.40 | 6.31* | 2.10 | 6.36 |
| Below guarantee | | 0.64 | | | | |
| Guaranteed | 1.65 | 9 | 11 | 3.50 | —— | —— |
| Found | 1.86 | 10.31 | 12.67 | 3.01* | 0.66 | 8.03 |
| Below guarantee | | | | 0.49 | | |
| Guaranteed | 1 | 8 | 9 | 1 | —— | —— |
| Found | 1.40 | 10.53 | 13.81 | 1.42* | 0.19 | 7.41 |
| Guaranteed | 2.90 | 10 | 11 | 1.08 | —— | —— |
| Found | 3.20 | 10.56 | 10.97 | 1.35 | 1.13 | 8.95 |
| Guaranteed | 2 | 10 | 11 | 1.60 | —— | —— |
| Found | 2.26 | 10.16 | 11.89 | 1.94 | 0.79 | 7.25 |
| Guaranteed | 1.64 | 10 | —— | 2 | —— | —— |
| Found | 1.78 | 10.94 | 13.80 | 2.26 | 0.78 | 7.90 |
| Guaranteed | 1.20 | 10 | 11 | 1.50 | —— | —— |
| Found | 1.02 | 10.60 | 11.84 | 1.62 | 0.54 | 5.67 |
| Guaranteed | —— | 11 | —— | —— | —— | —— |
| Found | | 11.56 | 13.56 | | | 3.39 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | General crop phosphate. | Norwich.<br>Oswego. | 3540<br>3611 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Market garden special. | Bayside. | 3091 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | New rival ammoniated superphosphate. | Chester.<br>Angola.<br>Owego. | 3190<br>3272<br>3608 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Niagara phosphate. | Owego. | 3610 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Potato, hop and tobacco phosphate. | Ellicottville.<br>Saratoga.<br>Owego. | 3308<br>3392<br>3612 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Practical ammoniated bone superphosphate. | Angola.<br>Phœnix. | 3271<br>3692 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Special manure. | Boonville. | 3785 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Universal grain grower. | Westfield.<br>Milford.<br>Owego. | 3258<br>3575<br>3609 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Vernon's onion special. | Florida. | 3198 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | Wheat, oats and corn fertilizer. | Homer. | 3639 |
| Crocker Fertilizer and Chemical Co., Buffalo, N. Y. | W. & H. high grade potato manure. | Riverhead. | 3131 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.82 | 7 | 8 | 1.08 | ——— | ——— |
| Found | 0.97 | 7.14 | 8.27 | 1.22 | 0.11 | 2.75 |
| Guaranteed | 3.70 | 8 | 9 | 8 | ——— | ——— |
| Found | 3.90 | 8.27 | 9.45 | 8.93 | 0.47 | 7.37 |
| Guaranteed | 1.23 | 10 | 11 | 1.60 | ——— | ——— |
| Found | 1.21 | 9.97 | 11.62 | 1.75 | 0.51 | 5.50 |
| Guaranteed | ——— | 11.50 | 12.50 | ——— | ——— | ——— |
| Found | | 11.96 | 12.72 | | | 3.79 |
| Guaranteed | 2 | 10 | 11 | 3.25 | ——— | ——— |
| Found | 2.12 | 10.13 | 11.71 | 3.88 | 1.40 | 4.88 |
| Guaranteed | 0.82 | 8 | 9 | 1.08 | ——— | ——— |
| Found | 1.00 | 8.45 | 10.05 | 1.32 | 0.41 | 4.67 |
| Guaranteed | 4.50 | 8 | 9 | 5.40 | ——— | ——— |
| Found | 4.19 | 7.60 | 9.30 | 5.70 | | 5.22 |
| Below guarantee | 0.31 | 0.40 | | | | |
| Guaranteed | 0.82 | 7 | 8 | 2.70 | ——— | ——— |
| Found | 1.20 | 7.35 | 9.73 | 2.84 | 0.62 | 4.83 |
| Guaranteed | 2 | 9 | 10 | 3.10 | ——— | ——— |
| Found | 2.01 | 9.43 | 12.58 | 3.47 | 0.33 | 6.91 |
| Guaranteed | 1 | 8 | 9 | 1.60 | ——— | ——— |
| Found | 1.19 | 8.12 | 11.28 | 1.87 | 0.26 | 5.49 |
| Guaranteed | 3.28 | 10 | 11 | 8 | ——— | ——— |
| Found | 3.13 | 11.09 | 11.23 | 9.22 | 0.67 | 8.76 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number |
|---|---|---|---|
| Cuba Fertilizer Co., Cuba, N. Y. | Buckwheat special. | Cuba. | 3290 |
| Cuba Fertilizer Co., Cuba, N. Y. | Competition. | Fredonia. | 3232 |
| Cuba Fertilizer Co., Cuba, N. Y. | Dissolved bone and potash. | Cuba. | 3288 |
| Cuba Fertilizer Co., Cuba, N. Y. | Hustler. | Fredonia. | 3231 |
| Cuba Fertilizer Co., Cuba, N. Y. | Potato and corn manure. | Cuba. | 3289 |
| Cuba Fertilizer Co., Cuba, N. Y. | Standard. | Cuba. | 3291 |
| Cumberland Bone Phosphate Co., Portland, Me. | Ammoniated dissolved bone. | Demster. | 3711 |
| Cumberland Bone Phosphate Co., Portland, Me. | Bone and potash. | Westfield.<br>Schenectady. | 3261<br>3464 |
| Cumberland Bone Phosphate Co., Portland, Me. | Concentrated phosphate. | Schenectady.<br>Demster. | 3463<br>3712 |
| Cumberland Bone Phosphate Co., Portland, Me. | Dissolved bone phosphate. | Schenectady. | 3465 |
| Cumberland Bone Phosphate Co., Portland, Me. | Fruit and vine. | Schenectady.<br>Demster. | 3468<br>3710 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 14 | 15 | —— | —— | —— |
| Found | | 14.17 | 15.30 | | | 10.11 |
| Guaranteed | 0.83 | 8 | —— | 1 | —— | —— |
| Found | 0.97 | 8.69 | 10.31 | 1.17 | 0.56 | 6.12 |
| Guaranteed | —— | 10 | —— | 4 | —— | —— |
| Found | | 11.23 | 11.80 | 4.22 | | 7.41 |
| Guaranteed | 0.83 | 8 | —— | 4 | —— | —— |
| Found | 0.96 | 8.51 | 10.24 | 4.22 | 0.53 | 6.52 |
| Guaranteed | 2.47 | 7 | —— | 8 | —— | —— |
| Found | 2.38 | 7.46 | 9.39 | 8.08 | 1.09 | 4.61 |
| Guaranteed | 1.23 | 10 | —— | 3 | —— | —— |
| Found | 1.39 | 9.75 | 10.95 | 3.14 | 0.82 | 7.07 |
| Below guarantee | | 0.25 | | | | |
| Guaranteed | 1.65 | 9 | 10 | 2 | —— | —— |
| Found | 2.39 | 9.66 | 11.03 | 2.36 | 0.64 | 5.91 |
| Guaranteed | —— | 8 | 12 | 2.50 | —— | —— |
| Found | | 10.01 | 14.29 | 3.02* | | 0.99 |
| Guaranteed | 3 | 8 | 10 | 7 | —— | —— |
| Found | 3.10 | 8.02 | 11.46 | 7.35 | 1.44 | 1.71 |
| Guaranteed | —— | 10 | 13 | —— | —— | —— |
| Found | | 10.92 | 15.81 | | | 1.86 |
| Guaranteed | 0.82 | 4 | 10 | 8 | —— | —— |
| Found | 1.82 | 6.52 | 10.64 | 9.44* | 0.48 | 1.72 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Cumberland Bone Phosphate Co., Portland, Me. | Guano. | Westfield.<br>Schenectady.<br>Mt. Pleasant. | 3263<br>3467<br>3697 |
| Cumberland Bone Phosphate Co., Portland, Me. | Hawkeye. | Westfield. | 3262 |
| Cumberland Bone Phosphate Co., Portland, Me. | Potato fertilizer. | Gloversville.<br>Mt. Pleasant. | 3506<br>3695 |
| Cumberland Bone Phosphate Co., Portland, Me. | Seeding down fertilizer. | Schenectady.<br>Mt. Pleasant. | 3466<br>3696 |
| Cumberland Bone Phosphate Co., Portland, Me. | Superphosphate. | Schenectady.<br>Demster. | 3462<br>3525 |
| L. B. Darling Fertilizer Co., Pawtucket, R. I. | "A" brand | Greenport. | 3108 |
| L. B. Darling Fertilizer Co., Pawtucket, R. I. | "AA" brand. | Greenport. | 3111 |
| L. B. Darling Fertilizer Co., Pawtucket, R. I. | "B" brand. | Greenport. | 3109 |
| L. B. Darling Fertilizer Co., Pawtucket, R. I. | Blood, bone and potash. | Greenport. | 3112 |
| L. B. Darling Fertilizer Co., Pawtucket, R. I. | "C" brand. | Greenport. | 3110 |
| L. B. Darling Fertilizer Co., Pawtucket, R. I. | Pure dissolved bone. | Greenport. | 3113 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds o fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.03 | 8 | 10 | 2 | ——— | ——— |
| Found | 1.19 | 9.69 | 11.01 | 2.40 | 0.34 | 4.14 |
| Guaranteed | 0.82 | 7 | 9 | 1 | ——— | ——— |
| Found | 1.16 | 8.07 | 10.24 | 1.37 | 0.39 | 4.34 |
| Guaranteed | 2.06 | 9 | 11 | 3 | ——— | ——— |
| Found | 2.07 | 9.68 | 12.47 | 3.30 | 0.60 | 6.74 |
| Guaranteed | 0.82 | 7 | 9 | 1 | ——— | ——— |
| Found | 1.07 | 8.35 | 10.01 | 1.37 | 0.37 | 5.91 |
| Guaranteed | 2.06 | 8 | 10 | 2 | ——— | ——— |
| Found | 2.48 | 9.72 | 12.82 | 2.54 | 0.60 | 3.72 |
| Guaranteed | 2.88 | 5 | 10 | 7 | ——— | ——— |
| Found | 3.30 | 5.39 | 12.48 | 7.40 | 0.83 | 1.65 |
| Guaranteed | 2.88 | 8 | 10 | 7 | ——— | ——— |
| Found | 2.98 | 7.03 | 11.44 | 8.28 | 0.74 | 3.47 |
| Below guarantee | | 0.97 | | | | |
| Guaranteed | 3.50 | 7 | ——— | 5 | ——— | ——— |
| Found | 3.21 | 8.31 | 12.55 | 6.10 | 0.90 | 4.13 |
| Below guarantee | 0.29 | | | | | |
| Guaranteed | 4.50 | 7 | 9 | 7 | ——— | ——— |
| Found | 4.03 | 7.31 | 8.32 | 8.53 | 1.89 | 3.50 |
| Below guarantee | 0.47 | | | | | |
| Guaranteed | 4 | 6 | ——— | 10 | ——— | ——— |
| Found | 3.50 | 6.52 | 11.35 | 11.24 | 1.50 | 3.05 |
| Below guarantee | 0.50 | | | | | |
| Guaranteed | 2 | 14 | 16 | ——— | ——— | ——— |
| Found | 2.22 | 14.52 | 15.67 | | 1.44 | 8.44 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken | Station number. |
|---|---|---|---|
| Detrick Fertilizer and Chemical Co., Baltimore, Md. | Dilman Bros. special. | Geneva. | 3345 |
| Detrick Fertilizer and Chemical Co., Baltimore, Md. | Grain and grass mixture. | Havilah. | 3266 |
| Detrick Fertilizer and Chemical Co., Baltimore, Md. | Sheridan ammoniated bone. | Havilah. | 3267 |
| Louis F. Detrick, Baltimore, Md. | Bone and potash mixture. | Brocton. | 3250 |
| Louis F. Detrick, Baltimore, Md. | Kangaroo komplete kompound. | Brocton. | 3246 |
| Louis F. Detrick, Baltimore, Md. | Quick step bone phosphate. | Brocton. | 3247 |
| Louis F. Detrick, Baltimore, Md. | Sockless and shoeless aa phosphate. | Brocton. | 3248 |
| Louis F. Detrick, Baltimore, Md. | XXTRA acid phosphate. | Brocton. | 3249 |
| J. W. Dunbar, Attica, N. Y. | Grass and grain grower. | Attica. | 3351 |
| J. W. Dunbar, Attica, N. Y. | Oat and bean. | Attica. | 3350 |
| Eastern Farmers' Supply Association, Montclair, N. J. | Long Island special. | Jamaica. | 3078 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.47 | 7 | —— | 15 | —— | —— |
| Found | 2.21 | 9.43 | 10.37 | 14.57 | 1.65 | 6.77 |
| Below guarantee | 0.26 | | | 0.46 | | |
| Guaranteed | —— | 10 | 11 | 2 | —— | —— |
| Found | | 9.11 | 10.91 | 2.56 | | 3.87 |
| Below guarantee | | 0.89 | | | | |
| Guaranteed | 1.65 | 10 | 12 | 2 | —— | —— |
| Found | 1.85 | 9.88 | 13.09 | 2.45 | 1.52 | 4.39 |
| Guaranteed | —— | 10 | —— | 2.25 | —— | —— |
| Found | | 10.46 | 13.94 | 2.43 | | 7.01 |
| Guaranteed | 1.65 | 8 | —— | 3 | —— | —— |
| Found | 1.66 | 9.13 | 12.88 | 2.82 | 0.77 | 5.76 |
| Guaranteed | 2.27 | 8 | —— | 3 | —— | —— |
| Found | 2.21 | 9.68 | 12.69 | 2.60* | 1.03 | 7.18 |
| Below guarantee | | | | 0.40 | | |
| Guaranteed | 1.03 | 8 | —— | 1.25 | —— | —— |
| Found | 1.06 | 8.13 | 11.82 | 1.89 | 0.58 | 4.59 |
| Guaranteed | —— | 14 | 14.75 | —— | —— | —— |
| Found | | 13.95 | 15.24 | | | 10.83 |
| Guaranteed | 1.23 | 8 | —— | 3 | —— | —— |
| Found | 0.96 | 9.07 | 11.25 | 2.50* | 0.40 | 5.76 |
| Below guarantee | 0.27 | | | 0.50 | | |
| Guaranteed | 1.64 | 8 | —— | 5 | —— | —— |
| Found | 1.47 | 8.22 | 10.70 | 4.65* | 1.36 | 5.35 |
| Below guarantee | | | | 0.35 | | |
| Guaranteed | 3.25 | 8.50 | 9.50 | 8 | —— | —— |
| Found | 3.35 | 9.10 | 9.85 | 9.22 | 0.79 | 6.63 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Eureka Fertilizer Co., Avon, N. Y. | Eureka fertilizer. | Avon. | 3385 |
| Falcon Oil Works, Promised Land, N. Y. | Coarse fish scrap. | Jamaica. | 3082 |
| Farmers' and Builders' Supply Co., Owego, N. Y. | Ammoniated bone phosphate. | Owego. | 3598 |
| Farmers' and Builders' Supply Co., Owego, N. Y. | Buckwheat fertilizer. | Owego. | 3599 |
| Farmers' and Builders' Supply Co., Owego, N. Y. | Potato and tobacco fertilizer. | Owego. | 3600 |
| Farmers' and Builders' Supply Co., Owego, N. Y. | XXV. | Owego. | 3597 |
| Farmers' Fertilizer Co., Syracuse, N. Y. | Fair and square. | Franklinville. | 3294 |
| Farmers' Fertilizer Co., Syracuse, N. Y. | Farmers' soluble bone. | Dunkirk.<br>Tully. | 3241<br>3657 |
| Farmers' Fertilizer Co., Syracuse, N. Y. | Mortgage lifter. | Perry.<br>Fulton. | 3361<br>3687 |
| Farmers' Fertilizer Co., Syracuse, N. Y. | Phœnix ammoniated bone. | Dunkirk.<br>Norwich.<br>Tully. | 3242<br>3537<br>3656 |
| Farmers' Fertilizer Co., Syracuse, N. Y. | Reaper brand. | Fulton.<br>Norwich.<br>Tully. | 3295<br>3538<br>3655 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 10 | —— | 3.75 | —— | —— |
| Found | | 11.47 | 12.49 | 4.39 | | 8.25 |
| Guaranteed | 7 | —— | 5 | —— | —— | —— |
| Found | 8.45 | | 7.22 | | 0.93 | 0.36 |
| Guaranteed | 0.82 | 9 | —— | 2 | —— | —— |
| Found | 1.14 | 8.61 | 9.99 | 2.25 | 0.41 | 6.69 |
| Below guarantee | | 0.39 | | | | |
| Guaranteed | —— | 14 | 15 | —— | —— | —— |
| Found | | 12.70 | 17.48 | | | 3.99 |
| Below guarantee | | 1.30 | | | | |
| Guaranteed | 2.47 | 7 | 8 | 8 | —— | —— |
| Found | 2.94 | 7.02 | 9.35 | 9.89 | 1.04 | 3.49 |
| Guaranteed | 0.82 | 8 | 10 | 4 | —— | —— |
| Found | 1.16 | 8.29 | 9.32 | 4.03 | 0.45 | 6.09 |
| Guaranteed | 2.47 | 7 | 8 | 0.54 | —— | —— |
| Found | 1.86 | 7.55 | 8.63 | 1.17 | 0.98 | 4.30 |
| Below guarantee | 0.61 | | | | | |
| Guaranteed | —— | 6 | 7 | 2.25 | —— | —— |
| Found | | 6.46 | 7.36 | 2.34 | | 0.94 |
| Guaranteed | —— | 5 | —— | 3.25 | —— | —— |
| Found | | 6.15 | 15.39 | 3.14 | | 3.35 |
| Guaranteed | 1.40 | 5 | 6 | 1.63 | —— | —— |
| Found | 1.32 | 5.61 | 7.78 | 1.64 | 0.55 | 2.20 |
| Guaranteed | 1.65 | 5.50 | 7.50 | 4.32 | —— | —— |
| Found | 1.74 | 5.06 | 8.30 | 3.97 | 0.35 | 2.31 |
| Below guarantee | | 0.44 | | 0.35 | | |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Farmers' Fertilizer Co., Syracuse, N. Y. | Special potato and onion manure. | Tully.<br>Fulton. | 3658<br>3688 |
| Farmers' Fertilizer Co., Syracuse, N. Y. | Special ammoniated bone. | Potsdam. | 3777 |
| Farmers' Fertilizer Co., Syracuse, N. Y. | Standard bone phosphate, special formula. | Dunkirk.<br>Williamstown. | 3240<br>3758 |
| Farmers' Fertilizer Co., Syracuse, N. Y. | St. Lawrence Pomona grange. | Plum Brook. | 3779 |
| John Finster, Rome, N. Y. | Home trade bone eagle phosphate. | Rome. | 3219<br>3748 |
| H. Fitchard, Minetto, N. Y. | Minetto fertilizer. | Minetto.<br>Caughdenoy. | 3589<br>3737 |
| Florida Manufacturing Co., Syracuse, N. Y. | Mortgage lifter. | Potsdam. | 3778 |
| Geo. B. Forrester. New York City | Complete manure for potatoes. | Jamaica. | 3063 |
| Great Eastern Fertilizer Co., Rutland, Vt. | English wheat grower. | Voorheesville. | 3457 |
| Great Eastern Fertilizer Co., Rutland, Vt. | Garden special. | Jamaica.<br>Bridgehampton.<br>Mohawk. | 3089<br>3147<br>3515 |
| Great Eastern Fertilizer Co., Rutland, Vt. | General dissolved bone. | Voorheesville. | 3458 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.10 | 6.50 | ——— | 7 | ——— | ——— |
| Found | 2.28 | 7 | 7.83 | 6.60 | 0.15 | 3.62 |
| Below guarantee | | | | 0.40 | | |
| Guaranteed | 1.25 | 6 | 7 | 3.24 | ——— | ——— |
| Found | 1.28 | 5.56 | 9.28 | 3.53 | 0.30 | 0.59 |
| Below guarantee | | 0.44 | | | | |
| Guaranteed | 0.82 | 8 | 10 | 2.16 | ——— | ——— |
| Found | 1.10 | 7.82 | 9.50 | 2.06 | 0.30 | 4.39 |
| Guaranteed | 1.65 | 10 | ——— | 10 | ——— | ——— |
| Found | 1.51 | 11.44 | 13.34 | 10.98 | 1.04 | 7.53 |
| Guaranteed | 0.82 | 8 | 9 | 2 | ——— | ——— |
| Found | 0.91 | 7.17 | 9.70 | 1.73 | 0.44 | 1.62 |
| Below guarantee | | 0.83 | | 0.27 | | |
| Guaranteed | 2.75 | 5 | ——— | 1.50 | ——— | ——— |
| Found | 2.52 | 7.19 | 9.04 | 1.04 | 1 | 3.14 |
| Below guarantee | 0.23 | | | 0.46 | | |
| Guaranteed | ——— | 5 | ——— | 3.25 | ——— | ——— |
| Found | | 7.39 | 19.11 | 2.13 | | 3.29 |
| Below guarantee | | | | 1.12 | | |
| Guaranteed | 3.70 | 5.50 | ——— | 10 | ——— | ——— |
| Found | 4.20 | 7.08 | 7.18 | 10.95* | 3.96 | 6.05 |
| Guaranteed | 0.82 | 8 | 9 | 2 | ——— | ——— |
| Found | 0.98 | 8.78 | 10.68 | 1.90 | 0.72 | 3.62 |
| Guaranteed | 3.29 | 6 | ——— | 8 | ——— | ——— |
| Found | 3.38 | 6.99 | 9.07 | 8.18 | 1.07 | 4.91 |
| Guaranteed | ——— | 14 | ——— | ——— | ——— | ——— |
| Found | | 15.65 | 17.01 | | | 8.44 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Great Eastern Fertilizer Co., Rutland, Vt. | Grain and grass. | Camden. | 3754 |
| Great Eastern Fertilizer Co., Rutland, Vt. | Northern corn special. | Gloversville.<br>Caughdenoy. | 3508<br>3734 |
| Great Eastern Fertilizer Co., Rutland, Vt. | Oats, buckwheat and seeding down fertilizer. | Gloversville.<br>Adams. | 3507<br>3766 |
| Great Eastern Fertilizer Co., Rutland, Vt. | Soluble bone and potash. | Adams. | 3767 |
| Great Eastern Fertilizer Co., Rutland, Vt. | Vegetable, vine and tobacco. | Chester.<br>Lishaskill.<br>Caughdenoy. | 3191<br>3479<br>3735 |
| Geo. L. Harding, Binghamton, N. Y. | Harding's up-to-date. | Binghamton. | 3596 |
| S. M. Hess & Bro., Philadelphia, Pa. | Ammoniated bone superphosphate. | Sheridan. | 3251 |
| S. M. Hess & Bro., Philadelphia, Pa. | Keystone bone phosphate. | Mattituck.<br>Sheridan. | 3134<br>3252 |
| S. M. Hess & Bro., Philadelphia, Pa. | Potato and truck manure. | Mattituck. | 3135 |
| Isaac C. Hendrickson, Jamaica, N. Y. | High grade fertilizer. | Jamaica. | 3060 |
| Isaac C. Hendrickson, Jamaica, N. Y. | Long Island fertilizer for peas. | Jamaica. | 3059 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.47 | 8 | 9 | 2 | —— | —— |
| Found | 2.36 | 8.10 | 8.98 | 1.97 | 1.06 | 5.67 |
| Guaranteed | 2.47 | 8 | 9 | 2 | —— | —— |
| Found | 2.92 | 9.82 | 11.64 | 1.94 | 1.55 | 0.33 |
| Guaranteed | 0.82 | 8 | 7 | 4 | —— | —— |
| Found | 0.87 | 11.93 | 12.44 | 3.94 | 0.39 | 1.79 |
| Guaranteed | —— | 11 | 12 | 2 | —— | —— |
| Found | | 7.39 | 8.55 | 1.33 | | 1.50 |
| Below guarantee | | 3.61 | | 0.67 | | |
| Guaranteed | 2.05 | 8 | 9 | 3.25 | —— | —— |
| Found | 2.09 | 8.60 | 10.14 | 3.90 | 0.96 | 3.97 |
| Guaranteed | 3.15 | 6.25 | 10 | 4.50 | —— | —— |
| Found | 3.96 | 7.69 | 10.87 | 5.15* | 0.55 | 2.59 |
| Guaranteed | 1.60 | 8 | —— | 2 | —— | —— |
| Found | 1.82 | 10.29 | 11.66 | 2.17 | 0.59 | 0.53 |
| Guaranteed | 0.80 | 9 | —— | 1 | —— | —— |
| Found | 0.96 | 11.34 | 13.71 | 0.98 | 0.52 | |
| Guaranteed | 2.50 | 8 | —— | 6 | —— | —— |
| Found | 2.64 | 9.08 | 11.34 | 6.22 | 0.88 | 3.23 |
| Guaranteed | 3.29 | 8 | —— | 8 | —— | —— |
| Found | 1.96 | 8.08 | 9.24 | 8.57* | 1.40 | 3.03 |
| Below guarantee | 1.33 | | | | | |
| Guaranteed | 1.65 | 6 | —— | 6 | —— | —— |
| Found | 1.56 | 7.09 | 10.48 | 4.83* | 0.93 | |
| Below guarantee | | | | 1.17 | | |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Isaac C. Hendrickson, Jamaica, N. Y. | Long Island fertilizer. | Jamaica. | 3061 |
| Hughes & Wilkinson, Rome, N. Y. | Retriever ammoniated bone. | Rome. | 3747 |
| Imperial Fertilizer Co., New York City. | Imperial ten per cent guano. | Flatlands. | 3105 |
| Imperial Fertilizer Co., New York City. | Long Island special for potatoes and truck. | Flatlands. | 3104 |
| International Seed Co., Rochester, N. Y. | Grain and grass fertilizer. | Baldwinsville. | 3676 |
| International Seed Co., Rochester, N. Y. | Potato and truck manure. | Baldwinsville. | 3677 |
| Jarecki Chemical Co., Sandusky, Ohio. | C. O. D. phosphate. | North Java. | 3381 |
| Jarecki Chemical Co., Sandusky, Ohio. | Grain special. | South Lima. | 3388 |
| Jarecki Chemical Co., Sandusky, Ohio. | Lake Erie fish guano. | Perry. | 3360 |
| Jarecki Chemical Co., Sandusky, Ohio. | Wheat special. | North Java. | 3382 |
| Jones Fertilizing Co., Cincinnati, Ohio. | Miami Valley phosphate. | Otto. | 3286 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.47 | 6 | —— | 6 | —— | —— |
| Found | 1.88 | 6.13 | 8.48 | 5.72 | 0.45 | |
| Below guarantee | 0.59 | | | 0.28 | | |
| Guaranteed | 1.85 | 9 | —— | 4 | —— | —— |
| Found | 1.88 | 9.31 | 13.13 | 4.44 | 0.69 | 6.42 |
| Guaranteed | 8.78 | 6 | 8 | 3 | —— | —— |
| Found | 8.08 | 7.32 | 9 | 3.52 | 6.25 | 4.59 |
| Below guarantee | 0.70 | | | | | |
| Guaranteed | 3.71 | 7 | —— | 7 | —— | —— |
| Found | 3.51 | 7.31 | 8.12 | 7.62 | 1.85 | 6.95 |
| Guaranteed | 1.65 | 10 | 11 | 2 | —— | —— |
| Found | 1.83 | 9.70 | 12.66 | 2.64 | 0.63 | 3.38 |
| Below guarantee | | 0.30 | | | | |
| Guaranteed | 1.25 | 8 | 9 | 7 | —— | —— |
| Found | 1.66 | 9.47 | 11.91 | 6.68 | 0.74 | 4.13 |
| Below guarantee | | | | 0.32 | | |
| Guaranteed | —— | 14 | 15 | —— | —— | —— |
| Found | | 15.03 | 17.42 | | | 10.25 |
| Guaranteed | 1.20 | 9 | 10 | 4 | —— | —— |
| Found | 1.78 | 10.73 | 12.67 | 3.51* | 0.87 | 7.79 |
| Below guarantee | | | | 0.49 | | |
| Guaranteed | 1.65 | 10 | 11.50 | 1 | —— | —— |
| Found | 1.45 | 10.52 | 12.34 | 2.37* | 0.55 | 4.92 |
| Guaranteed | —— | 16 | 17 | —— | —— | —— |
| Found | | 14.78 | 17.37 | | | 9.32 |
| Below guarantee | | 1.22 | | | | |
| Guaranteed | 2.88 | 9 | —— | 2.50 | —— | —— |
| Found | 2.64 | 7 | 11.63 | 3.11 | 0.39 | 1.92 |
| Below guarantee | 0.24 | 2 | | | | |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Jones Fertilizing Co., Cincinnati, Ohio. | Special tobacco grower. | Otto. | 3285 |
| F. R. Lalor, Dunnville, Ont., Can. | Maple brand Canadian hard wood ashes. | Parrish. | 3733 |
| Lazaretto Guano Co. Baltimore, Md. | Ammoniated bone phosphate special. | Norwich. | 3545 |
| Lazaretto Guano Co. Baltimore, Md. | Bone and potash mixture. | Sherburne. | 3534 |
| Lazaretto Guano Co. Baltimore, Md. | Corn special fertilizer. | Unadilla. | 3552 |
| Lazaretto Guano Co. Baltimore, Md. | Corn and oats special. | Sherburne. | 3533 |
| Lazaretto Guano Co. Baltimore, Md. | Corn, oats and grass special. | Norwich. | 3541 |
| Lazaretto Guano Co. Baltimore, Md. | Dissolved bone phosphate. | Watertown. | 3769 |
| Lazaretto Guano Co. Baltimore, Md. | Eaton's ammoniated bone phosphate. | Norwich. | 3544 |
| Lazaretto Guano Co. Baltimore, Md. | Eaton's special potato manure. | Norwich. | 3543 |
| Lazaretto Guano Co. Baltimore, Md. | Extra ammoniated bone. | Amsterdam.<br>Oswego.<br>Lacona. | 3490<br>3699<br>3763 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.49 | 9 | —— | 2 | —— | —— |
| Found | 2.94 | 19.68 | 24.13 | 2.52* | 0.64 | 2.28 |
| Guaranteed | —— | —— | 1 | 4.50 | —— | —— |
| Found | | 0.64 | 1.50 | 5.15 | | |
| Guaranteed | 0.82 | 8 | —— | 4 | —— | —— |
| Found | 0.92 | 8.96 | 10.35 | 3.98 | 0.61 | 6.44 |
| Guaranteed | —— | 10 | 11 | 2 | —— | —— |
| Found | | 11.34 | 12.41 | 1.92 | | 7.39 |
| Guaranteed | 2.06 | 8 | 9 | 3 | —— | —— |
| Found | 1.91 | 9.07 | 9.94 | 3.23 | 1.05 | 5.96 |
| Guaranteed | 1.03 | 8 | 9 | 3 | —— | —— |
| Found | 1.25 | 10 | 11.32 | 2.76 | 0.77 | 5.07 |
| Below guarantee | | | | 0.24 | | |
| Guaranteed | 1.02 | 8 | 9 | 3 | —— | —— |
| Found | 1.19 | 9.70 | 10.98 | 3.12 | 0.72 | 6.62 |
| Guaranteed | —— | 14 | —— | —— | —— | —— |
| Found | | 14.62 | 15.94 | | | 10.85 |
| Guaranteed | 2.06 | 8 | 9 | 3 | —— | —— |
| Found | 1.85 | 9.26 | 10.16 | 3.36 | 0.93 | 6.53 |
| Below guarantee | 0.21 | | | | | |
| Guaranteed | 0.82 | 8 | 9 | 4 | —— | —— |
| Found | 0.89 | 9.04 | 10.50 | 4.15 | 0.50 | 6.61 |
| Guaranteed | 0.82 | 8 | —— | 4 | —— | —— |
| Found | 0.87 | 8.87 | 10.50 | 4.08 | 0.51 | 6.19 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Lazaretto Guano Co. Baltimore, Md. | Fruit and vine fertilizer. | Amsterdam. | 3489 |
| Lazaretto Guano Co. Baltimore, Md. | Hop and potato special—A brand. | Norwich. | 3542 |
| Lazaretto Guano Co. Baltimore, Md. | N. Y. standard potato manure. | Watertown. | 3768 |
| Lazaretto Guano Co. Baltimore, Md. | Northern corn grower. | Lorraine. | 3764 |
| Lazaretto Guano Co. Baltimore, Md. | Oats and buckwheat standard. | Unadilla. | 3553 |
| Lazaretto Guano Co. Baltimore, Md. | Potato, grain and grass phosphate. | Sherburne. | 3532 |
| Lazaretto Guano Co. Baltimore, Md. | Retriever animal bone. | Binghamton.<br>Watertown. | 3595<br>3771 |
| Liebig Manufacturing Co. Carteret, N. J. | Fruit and vine. | Marlborough. | 3205 |
| Liebig Manufacturing Co. Carteret, N. J. | Peach tree No. 1. | Marlborough. | 3186 |
| Liebig Manufacturing Co. Carteret, N. J. | Potato and corn. | Marlborough. | 3185 |
| Liebig Manufacturing Co. Carteret, N. J. | Soluble bone and potash No. 2. | Marlborough. | 3203 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizers. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.82 | 10 | 12 | 8 | — | — |
| Found | 0.81 | 10.51 | 11.31 | 7.82 | 0.57 | 7.75 |
| Guaranteed | 0.82 | 10 | 11 | 8 | — | — |
| Found | 0.93 | 10.72 | 11.53 | 7.67 | 0.70 | 7.40 |
| Below guarantee | | | | 0.33 | | |
| Guaranteed | 2.47 | 7 | — | 8 | — | — |
| Found | 2.34 | 7.35 | 9.44 | 8 | 1.01 | 4.68 |
| Guaranteed | 0.82 | 8 | 9 | 4 | — | — |
| Found | 0.90 | 8.56 | 10.16 | 3.82 | 0.47 | 6.17 |
| Guaranteed | 0.82 | 8 | 9 | 4 | — | — |
| Found | 0.81 | 8.92 | 10.44 | 4.11 | 0.50 | 6.55 |
| Guaranteed | 0.82 | 8 | 9 | 4 | — | — |
| Found | 0.95 | 9.01 | 10.28 | 3.93 | 0.64 | 6.01 |
| Guaranteed | 1.65 | 9 | — | 4 | — | — |
| Found | 2.04 | 10.61 | 13.75 | 4.19 | 0.80 | 6.62 |
| Guaranteed | 1.60 | 8 | — | 7 | — | — |
| Found | 2 | 9.01 | 10.05 | 7.45* | 0.54 | 0.78 |
| Guaranteed | 1.60 | 6 | — | 10 | — | — |
| Found | 1.98 | 7.87 | 8.52 | 11.22* | 0.44 | 0.94 |
| Guaranteed | 2.75 | 6 | 7 | 6 | — | — |
| Found | 2.67 | 7.56 | 9.12 | 6.52 | 0.79 | 5.07 |
| Guaranteed | — | 12 | — | 2 | — | — |
| Found | | 12.94 | 15.14 | 1.99 | | 3.49 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Liebig Manufacturing Co. Carteret, N. J. | Standard, ammoniated bone superphosphate. | Marlborough. | 3204 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Ammoniated dissolved bone phosphate. | Schuylerville.<br>Cortland.<br>Baldwinsville. | 3422<br>3631<br>3685 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Animal bone and potash No. 1. | Glens Falls.<br>Parrish. | 3398<br>3729 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Animal bone and potash No. 2. | Homer. | 3643 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Cauliflower and cabbage fertilizer. | Jamaica. | 3064 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Celebrated corn manure. | Glens Falls. | 3403 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Celebrated ground bone. | New Suffolk.<br>Troy. | 3127<br>3432 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Corn fertilizer No. 2. | Orient.<br>Glens Falls.<br>Lacona. | 3120<br>3339<br>3762 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Crescent bone dust. | Southampton. | 3159 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Harvest queen. | Amsterdam. | 3487 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Lawn fertilizer. | Utica. | 3521 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.25 | 10 | —— | 1.50 | —— | —— |
| Found | 2.31 | 10.70 | 11.84 | 1.51* | 0.83 | |
| Guaranteed | 1.81 | 9 | 11 | 1.50 | —— | —— |
| Found | 1.89 | 10.04 | 12.64 | 1.65 | 0.90 | 8.51 |
| Guaranteed | —— | 9 | 10 | 5 | —— | —— |
| Found | | 9.64 | 10.26 | 4.99 | | 7.72 |
| Guaranteed | —— | 10 | 11.50 | 3 | —— | —— |
| Found | | 10.56 | 11.96 | 3.10 | | 6 |
| Guaranteed | 3.70 | 7.50 | 8.50 | 7 | —— | —— |
| Found | 3.73 | 8.24 | 9.14 | 7.37 | 2.19 | 6.33 |
| Guaranteed | 3.70 | 7.50 | 8.50 | 7 | —— | —— |
| Found | 3.95 | 7.75 | 9.42 | 7.17 | 2.32 | 6.53 |
| Guaranteed | 2.70 | —— | 12 | —— | —— | —— |
| Found | 3.10 | | 14.05 | | 2.49 | 2.01 |
| Guaranteed | 1.81 | 9.25 | 12 | 4 | —— | —— |
| Found | 1.81 | 9.65 | 11.83 | 4.63 | 0.59 | 6.60 |
| Guaranteed | 2.26 | —— | 11 | —— | —— | —— |
| Found | 2.61 | | 15.11 | | 0.52 | 1.28 |
| Guaranteed | 1.24 | 9.50 | 11.50 | 2 | —— | —— |
| Found | 1.46 | 10.36 | 12.95 | 2.08 | 0.79 | 7.39 |
| Guaranteed | 1.65 | 7 | 8 | 3.50 | —— | —— |
| Found | 1.92 | 7.99 | 8.24 | 3.70* | 1.73 | 5.88 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Lister's Agri'l Chemical Works, Newark, N. J. | Perfect. | Baldwinsville. | 3683 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Potato manure No. 1. | Jamaica.<br>Orient.<br>Glens Falls. | 3065<br>3119<br>3402 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Potato manure No. 2. | Brant.<br>Glens Falls.<br>Parrish. | 3331<br>3401<br>3727 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Pure raw bone meal. | Troy. | 3430 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Special potato manure. | Bridgehampton.<br>Fort Edward.<br>Cortland. | 3145<br>3415<br>3627 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Special ten per cent manure. | Southampton.<br>Foster's Meadow. | 3157<br>3086 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Special wheat fertilizer. | Rochester. | 3789 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Standard pure bone phosphate. | Troy.<br>Bridgehampton.<br>Parrish. | 3431<br>3146<br>3728 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Success. | New Suffolk.<br>Fort Edward.<br>Lacona. | 3126<br>3414<br>3761 |
| Lister's Agri'l Chemical Works, Newark, N. J. | U. S. superphosphate. | Southampton.<br>Homer. | 3158<br>3642 |
| Lister's Agri'l Chemical Works, Newark, N. J. | Vegetable compound. | Glens Falls. | 3400 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.24 | 9.50 | 11.50 | 1.50 | —— | —— |
| Found | 1.44 | 10.41 | 11.89 | 2.26 | 0.75 | 6.81 |
| Guaranteed | 3.70 | 7.50 | 9.50 | 7 | —— | —— |
| Found | 3.79 | 8.52 | 9.43 | 7.12 | 2.20 | 7 |
| Guaranteed | 1.81 | 9.25 | 12 | 4 | —— | —— |
| Found | 1.97 | 11.96 | 13.45 | 4.29 | 0.70 | 7.77 |
| Guaranteed | 3.25 | —— | 23 | —— | —— | —— |
| Found | 3.22 | | 23.27 | | 0.90 | |
| Guaranteed | 1.65 | 8 | 9 | 3 | —— | —— |
| Found | 1.80 | 9.87 | 10.75 | 3.69 | 0.74 | 6.91 |
| Guaranteed | 1.85 | 8.50 | —— | 10 | —— | —— |
| Found | 1.83 | 9.99 | 12.40 | 9.91* | 0.65 | 6.79 |
| Guaranteed | 1.65 | 8 | 9 | 3 | —— | —— |
| Found | 1.82 | 10.34 | 12.99 | 4.16 | 0.64 | 9.47 |
| Guaranteed | 2.35 | 10 | 12 | 1.50 | —— | —— |
| Found | 2.51 | 12.23 | 14.18 | 2.05 | 1.03 | 8.26 |
| Guaranteed | 1.24 | 9.50 | 11.50 | 2 | —— | —— |
| Found | 1.50 | 10.90 | 12.68 | 2.53 | 0.71 | 7.23 |
| Guaranteed | 1.32 | 7 | 8 | 2 | —— | —— |
| Found | 1.67 | 9.39 | 12.73 | 2.43* | 0.67 | 5.26 |
| Guaranteed | 3.70 | 7.75 | 8.75 | 7 | —— | —— |
| Found | 3.95 | 7.45 | 8.87 | 7.28 | 2.27 | 6.51 |
| Below guarantee | | 0.30 | | | | |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Lonergan & Livingston, Albany, N. Y. | Meat and bone. | Albany. | 3446 |
| Lorillard Co., Jersey City, N. J. | Improved tobacco dust. | Jamaica. | 3062 |
| W. E. Lowe, Geneseo, N. Y. | Lowe's special. | Geneseo. | 3387 |
| Lowell Fertilizer Co., Lowell, Mass. | Animal brand for general use. | Argyle. | 3417 |
| Lowell Fertilizer Co., Lowell, Mass. | Bone fertilizer for corn and grain. | Argyle.<br>Newark Valley.<br>Pulaski. | 3416<br>3614<br>3722 |
| Lowell Fertilizer Co., Lowell, Mass. | Cereal. | Newark Valley. | 3616 |
| Lowell Fertilizer Co., Lowell, Mass. | Empire. | Fultonville.<br>Newark Valley.<br>Pulaski. | 3496<br>3615<br>3721 |
| Lowell Fertilizer Co., Lowell, Mass. | Complete manure for vegetables. | Fonda.<br>Pulaski. | 3493<br>3720 |
| Lowell Fertilizer Co., Lowell, Mass. | Potato phosphate. | Calverton. | 3141 |
| Frederick Ludlam, New York City. | Cereal. | Troy. | 3434 |
| Frederick Ludlam, New York City. | Dragon's tooth. | Calverton. | 3141 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 4 | 8 | 18 | ——— | ——— | ——— |
| Found | 3.95 | 8.73 | 18.78 | | 1.56 | |
| Guaranteed | 2.47 | ——— | ——— | 8 | ——— | ——— |
| Found | 2.69 | 0.26 | 0.72 | 8.89* | 1.98 | 0.26 |
| Guaranteed | ——— | 10 | 12 | 6 | ——— | ——— |
| Found | | 10.85 | 12.12 | 5.03* | | 7.59 |
| Below guarantee | | | | 0.97 | | |
| Guaranteed | 2.46 | 9 | 10 | 4 | ——— | ——— |
| Found | 2.97 | 9.07 | 10.53 | 3.99* | 1.31 | 4.16 |
| Guaranteed | 1.65 | 8 | 9 | 3 | ——— | ——— |
| Found | 1.79 | 8.50 | 10.53 | 3.24* | 0.68 | 4.38 |
| Guaranteed | 0.82 | 7 | ——— | 1 | ——— | ——— |
| Found | 1.08 | 7.20 | 9.23 | 0.93 | 0.44 | 2.93 |
| Guaranteed | 1.25 | 7 | 8 | 2 | ——— | ——— |
| Found | 1.51 | 7.90 | 9.81 | 1.98 | 0.62 | 3.65 |
| Guaranteed | 2 | 8 | 9 | 3.50 | ——— | ——— |
| Found | 2.07 | 11.15 | 13.64 | 3.61 | 0.93 | 6.62 |
| Guaranteed | 2.47 | 8 | 9 | 6 | ——— | ——— |
| Found | 2.80 | 9.68 | 11.07 | 5.55* | 1.39 | 5.61 |
| Below guarantee | | | | 0.45 | | |
| Guaranteed | 0.82 | 8 | 10 | 1 | ——— | ——— |
| Found | 1.09 | 9.05 | 13.25 | 1.37 | 0.30 | 4.20 |
| Guaranteed | 3 | 7 | ——— | 7 | ——— | ——— |
| Found | 3.67 | 8.93 | 10.54 | 7.13 | 1.39 | 6.17 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Z. F. Magill, Troy, N. Y. | Crematory ashes. | Troy.<br>Fonda. | 3437<br>3495 |
| Mapes Formula & Peruvian Guano Co., New York City. | Cabbage and cauliflower manure. | Littleneck. | 3093 |
| Mapes Formula & Peruvian Guano Co., New York City. | Cereal brand. | Newburg.<br>Binghamton. | 3179<br>3590 |
| Mapes Formula & Peruvian Guano Co., New York City. | Complete manure, "A" brand. | Littleneck.<br>Binghamton. | 3095<br>3591 |
| Mapes Formula & Peruvian Guano Co., New York City. | Complete manure for light soils. | Newburg. | 3180 |
| Mapes Formula & Peruvian Guano Co., New York City. | Corn manure. | Littleneck. | 3094 |
| Mapes Formula & Peruvian Guano Co., New York City. | Economical potato manure. | Orient.<br>Newburg.<br>Binghamton. | 3118<br>3178<br>3592 |
| Mapes Formula & Peruvian Guano Co., New York City. | Grass and grain spring top-dressing. | Newburg. | 3181 |
| Mapes Formula & Peruvian Guano Co., New York City. | Potato manure, L. I. special. | Littleneck. | 3096 |
| Mapes Formula & Peruvian Guano Co., New York City. | Pure ground bone. | Newburg. | 3177 |
| Maxson & Starin. Cortland, N. Y. | Cortland Co. special. | Cortland. | 3620 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.56 | —— | 3.91 | 2.15 | —— | —— |
| Found | 0.82 | 0.66 | 2.26 | 1.16 | 0.45 | |
| Below guarantee | | | | 0.99 | | |
| Guaranteed | 4.10 | 6 | 8 | 6 | —— | —— |
| Found | 3.90 | 5.47 | 7.95 | 6.87 | 1.85 | 2.97 |
| Below guarantee | | 0.53 | | | | |
| Guaranteed | 1.65 | 6 | 8 | 3 | —— | —— |
| Found | 2.24 | 7.60 | 9.01 | 3.78 | 0.41 | 5.89 |
| Guaranteed | 2.47 | 10 | 12 | 2.50 | —— | —— |
| Found | 3.17 | 10.54 | 12.97 | 3.14 | 1.59 | 7.10 |
| Guaranteed | 4.95 | 6 | 8 | 6 | —— | —— |
| Found | 5.29 | 7.51 | 9.49 | 6.90 | 2.13 | 5.52 |
| Guaranteed | 2.47 | 8 | 10 | 6 | —— | —— |
| Found | 2.63 | 8.77 | 10.15 | 6.87 | 1.42 | 7.07 |
| Guaranteed | 3.29 | 4 | 6 | 8 | —— | —— |
| Found | 3.41 | 5.92 | 7.80 | 7.84* | 1.63 | 2.99 |
| Guaranteed | 4.94 | 5 | 6 | 7 | —— | —— |
| Found | 5.24 | 6.12 | 7.43 | 7.77 | 3.33 | 4.22 |
| Guaranteed | 3.29 | 4 | 6 | 7 | —— | —— |
| Found | 3.68 | 5.68 | 8.94 | 7.35* | 1.79 | 2.21 |
| Guaranteed | 2.88 | —— | 24 | —— | —— | —— |
| Found | 3.98 | | 23.64 | | 0.30 | |
| Guaranteed | 2 | 9 | —— | 2 | —— | —— |
| Found | 1.94 | 9.43 | 11.70 | 2.36 | 0.49 | 6.06 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Maxson & Starin, Cortland, N. Y. | Fruit and vine. | Cortland. | 3619 |
| Maxson & Starin, Cortland, N. Y. | Potato and cabbage special. | Cortland. | 3622 |
| Maxson & Starin, Cortland, N. Y. | Vegetable and onion special. | Cortland. | 3621 |
| Maxson & Starin, Cortland, N. Y. | XXX guano. | Cortland. | 3618 |
| Wm. B. McDowell, Middletown, N. Y. | Bone dust. | Middletown. | 3201 |
| Wm. B. McDowell, Middletown, N. Y. | Fertilizer. | Middletown. | 3200 |
| Michigan Carbon Works, Detroit, Mich. | Desiccated bone. | Fredonia. | 3235 |
| Michigan Carbon Works, Detroit, Mich. | Homestead. | Lacona. | 3239 |
| Michigan Carbon Works, Detroit, Mich. | Homestead potato grower. | Evans. | 3275 |
| Michigan Carbon Works, Detroit, Mich. | Jarves drill phosphate. | Evans. | 3274 |
| Michigan Carbon Works, Detroit, Mich. | Perfection fruit grower. | Fredonia. | 3234 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilzer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.65 | 7 | ——— | 9 | ——— | ——— |
| Found | 1.61 | 7.73 | 10.03 | 8.59 | 0.58 | 5.10 |
| Below guarantee | | | | 0.41 | | |
| Guaranteed | 3.70 | 8 | ——— | 6 | ——— | ——— |
| Found | 3.38 | 8.87 | 10.79 | 5.90 | 1.82 | 6.07 |
| Below guarantee | 0.32 | | | | | |
| Guaranteed | 4.95 | 8 | ——— | 6 | ——— | ——— |
| Found | 4.23 | 9.92 | 10.03 | 6.92 | 2.59 | 6.58 |
| Below guarantee | 0.72 | | | | | |
| Guaranteed | 0.82 | 8 | ——— | 4 | ——— | ——— |
| Found | 0.91 | 8.62 | 10.25 | 4.02 | 0.51 | 6.06 |
| Guaranteed | 3.05 | 7 | 16 | 3.68 | ——— | ——— |
| Found | 3.57 | 7.16 | 14.07 | 3.47 | 1.08 | |
| Below guarantee | | | | 0.21 | | |
| Guaranteed | 5.35 | 5.58 | 11.48 | 8.60 | ——— | ——— |
| Found | 5.28 | 5.71 | 10.73 | 9.36* | 3.41 | |
| Guaranteed | 1.25 | ——— | 25 | ——— | ——— | ——— |
| Found | 1.34 | | 28.76 | | 0.45 | |
| Guaranteed | 1.85 | 8 | 8.50 | 1.50 | ——— | ——— |
| Found | 2.41 | 10.02 | 11.10 | 1.62 | 0.70 | 6.44 |
| Guaranteed | 1.94 | 8.50 | 10 | 5 | ——— | ——— |
| Found | 2.30 | 8.95 | 10.39 | 5.31 | 1.15 | 7.36 |
| Guaranteed | 1 | 8 | 10 | 0.75 | ——— | ——— |
| Found | 1.24 | 9.10 | 9.67 | 1.36 | 0.43 | 6.17 |
| Guaranteed | 0.80 | 10 | 11 | 7 | ——— | ——— |
| Found | 1.09 | 11.31 | 13.23 | 7.82 | 0.20 | 2.04 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Attica special. | Attica. | 3348 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Ballsmith & Moritz's special. | Attica. | 3349 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Buckwheat special. | Springville. | 3316 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Buffalo fertilizer. | Kingston.<br>Gloversville.<br>Tully. | 3207<br>3510<br>3653 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Buffalo guano. | West Winfield.<br>Fulton. | 3523<br>3689 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Cyclone pure bone meal. | Fredonia.<br>Johnstown. | 3229<br>3497 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Dissolved bone. | Gloversville. | 3511 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Dissolved bone and potash. | Otto.<br>Gloversville.<br>Boonville. | 3284<br>3512<br>3786 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Erie king. | Kingston.<br>Fort Edward.<br>Tully. | 3206<br>3411<br>3654 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Potato, hop and tobacco phosphate. | Calverton.<br>Fort Edward.<br>Pulaski. | 3140<br>3413<br>3723 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Rathbun's special. | Wellsville. | 3383 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.85 | 8 | 8.50 | 4 | —— | —— |
| Found | 1.04 | 7.31 | 9.82 | 4.21 | 0.64 | 5.54 |
| Below guarantee | | 0.69 | | | | |
| Guaranteed | 1.85 | 8 | 9 | 4 | —— | —— |
| Found | 1.77 | 8.47 | 10.13 | 3.53 | 0.54 | 6.26 |
| Below guarantee | | | | 0.47 | | |
| Guaranteed | 0.80 | 7 | —— | 1 | —— | —— |
| Found | 0.92 | 6.64 | 9.02 | 0.88 | 0.49 | 4.53 |
| Below guarantee | | 0.36 | | | | |
| Guaranteed | 1.85 | 8 | 9 | 1.50 | —— | —— |
| Found | 1.76 | 7.80 | 9.74 | 1.35 | 0.74 | 5.40 |
| Guaranteed | 0.80 | 8 | 9 | 4 | —— | —— |
| Found | 0.91 | 7.72 | 9.87 | 3.04 | 0.41 | 5.09 |
| Below guarantee | | 0.28 | | 0.96 | | |
| Guaranteed | 2.40 | —— | 22 | —— | —— | —— |
| Found | 3.58 | | 23.34 | | 1.55 | |
| Guaranteed | —— | 11 | 12.37 | —— | —— | —— |
| Found | | 11.65 | 12.39 | | | 5.94 |
| Guaranteed | —— | 9 | 11 | 1.65 | —— | —— |
| Found | | 10.22 | 10.75 | 1.76 | | 4.93 |
| Guaranteed | 0.80 | 7 | 9 | 2 | —— | —— |
| Found | 0.96 | 6.93 | 8.99 | 1.62 | 0.50 | 4.84 |
| Below guarantee | | | | 0.38 | | |
| Guaranteed | 2 | 8 | 9 | 4 | —— | —— |
| Found | 1.87 | 8.04 | 9.68 | 4.56 | 0.66 | 6.21 |
| Guaranteed | 0.82 | 7 | 9 | 1 | —— | —— |
| Found | 0.98 | 6.73 | 9.49 | 0.89 | 0.59 | 4.41 |
| Below guarantee | | 0.27 | | | | |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS CO-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number |
|---|---|---|---|
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Scoville's special. | Varysburg. | 3371 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Special bean fertilizer. | Perry.<br>Philadelphia. | 3365<br>3772 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Special potato fertilizer. | Calverton.<br>Langford.<br>Gloversville. | 3138<br>3339<br>3509 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Vegetable bone. | Springville.<br>Clinton. | 3315<br>3746 |
| Milsom Rendering and Fertilizer Co., Buffalo, N. Y. | Wheat, oats and barley phosphate. | Fredonia.<br>Fort Edward.<br>Fulton. | 3228<br>3412<br>3690 |
| Mittenmaier & Sons, Rome, N. Y. | Hop and potato fertilizer. | Rome. | 3218<br>3749 |
| Mittenmaier & Sons, Rome, N. Y. | Pride of America. | Rome.<br>Clinton. | 3217<br>3745 |
| Mittenmaier & Sons, Rome, N. Y. | Superphosphate. | Rome. | 3751 |
| Moller & Co., Maspeth, N. Y. | Champion No. 1. | Jamaica. | 3090 |
| National Fertilizer Co., Bridgeport, Conn. | Ammoniated bone phosphate. | Fonda. | 3491 |
| National Fertilizer Co., Bridgeport, Conn. | Chittenden's fish and potash. | Gloversville. | 3501 |

. lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.85 | 8 | ——— | 4 | ——— | ——— |
| Found | 2.17 | 8.30 | 9.79 | 4.10 | 0.87 | 6.16 |
| Guaranteed | 0.82 | 10 | 11 | 4 | ——— | ——— |
| Found | 1.21 | 9.98 | 12.13 | 4.32 | 0.71 | 7.25 |
| Guaranteed | 1.64 | 8 | 10 | 8 | ——— | ——— |
| Found | 1.72 | 7.91 | 8.78 | 8.04 | 0.22 | 6.17 |
| Guaranteed | 4.12 | 8 | ——— | 5 | ——— | ——— |
| Found | 4.04 | 9.15 | 9.85 | 5.35 | 0.34 | 6.57 |
| Guaranteed | 1.23 | 8 | 9 | 2 | ——— | ——— |
| Found | 1.19 | 7.92 | 9.81 | 1.02 | 0.70 | 4.83 |
| Below guarantee | | | | 0.38 | | |
| Guaranteed | 1 | 6 | ——— | 3 | ——— | ——— |
| Found | 0.91 | 6.01 | 9.87 | 3.47* | 0.40 | 3.07 |
| Guaranteed | 1 | 6 | ——— | 2 | ——— | ——— |
| Found | 1.03 | 6.31 | 9.45 | 2.39* | 0.39 | 2.79 |
| Guaranteed | 2 | 8 | ——— | 4 | ——— | ——— |
| Found | 1.20 | 6.45 | 10.24 | 3.91 | 0.43 | 2.75 |
| Below guarantee | 0.80 | 1.55 | | | | |
| Guaranteed | 3.30 | 6 | ——— | 6 | ——— | ——— |
| Found | 3.24 | 7.03 | 9.76 | 7.26* | 2.07 | 2.43 |
| Guaranteed | 1.65 | 8 | 10 | 2 | ——— | ——— |
| Found | 1.99 | 7.99 | 12.69 | 2.68* | 0.25 | 3.45 |
| Guaranteed | 2.50 | ——— | 8 | 3 | ——— | ——— |
| Found | 2.39 | 5.72 | 8.17 | 4.08 | 0.24 | 1.84 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade-name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| National Fertilizer Co., Bridgeport, Conn. | Chittenden's kainit. | Foster's Meadow. | 3088 |
| National Fertilizer Co., Bridgeport, Conn. | Chittenden's potato phosphate. | Springfield.<br>Gloversville.<br>Mattituck. | 3085<br>3502<br>3136 |
| National Fertilizer Co., Bridgeport, Conn. | Chittenden's root fertilizer. | Springfield. | 3070 |
| National Fertilizer Co., Bridgeport, Conn. | Universal. | Utica. | 3522 |
| National Fertilizer Co., Bridgeport, Conn. | Fish and potash. | Mattituck. | 3137 |
| National Fertilizer Co., Bridgeport, Conn. | Market garden fertilizer. | Springfield. | 3084 |
| Newburgh Rendering Co., Newburgh, N. J. | Pure meat and bone. | Newburgh. | 3202 |
| New York Fertilizer & Chemical Co., Roselle, N. J. | Cabbage, potato and vegetable manure. | Flatlands. | 3102 |
| New York Fertilizer & Chemical Co., Roselle, N. J. | Standard potato and vegetable manure. | Flatlands. | 3103 |
| Niagara Fertilizer Co., Buffalo, N. Y. | Grain and grass grower. | Springville.<br>Sherburne.<br>Williamstown. | 3313<br>3529<br>3760 |
| Niagara Fertilizer Co., Buffalo, N. Y. | Ground bone meal. | Springville. | 3312 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds o fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | ——— | ——— | ——— | 12 | ——— | ——— |
| Found | | | | 12.15 | | |
| Guaranteed | 2 | 6 | 8 | 8 | ——— | ——— |
| Found | 3.46 | 9.53 | 10.26 | 8.93* | 2.33 | 5.99 |
| Guaranteed | 3.30 | 8 | 10 | 6 | ——— | ——— |
| Found | 3.26 | 8.08 | 10.02 | 7.06 | 1.36 | 6.11 |
| Guaranteed | 0.82 | 9 | ——— | 1 | ——— | ——— |
| Found | 1.14 | 12.75 | 13.82 | 0.80 | 0.57 | 0.62 |
| Below guarantee | | | | | | |
| Guaranteed | 3 | ——— | 6 | 4 | ——— | ——— |
| Found | 2.37 | | 8.44 | 3.80 | 0.31 | |
| Below guarantee | 0.63 | | | | | |
| Guaranteed | 2.50 | 7 | 9 | 6 | ——— | ——— |
| Found | 3.51 | 8.47 | 10.87 | 6.24 | 1.78 | 5.79 |
| Guaranteed | 4 | ——— | 20 | ——— | ——— | ——— |
| Found | 5.68 | | 15.79 | | 1.27 | |
| Below guarantee | | | 4.21 | | | |
| Guaranteed | 4.10 | 6 | ——— | 8 | ——— | ——— |
| Found | 5.45 | 4.69 | 5.78 | 11.36 | 0.90 | 2.33 |
| Below guarantee | | 1.31 | | | | |
| Guaranteed | 3.28 | 5 | ——— | 10 | ——— | ——— |
| Found | 4.18 | 4.73 | 6.30 | 12.58 | 0.61 | 3.24 |
| Below guarantee | | 0.27 | | | | |
| Guaranteed | 0.82 | 7 | 8 | 1.08 | ——— | ——— |
| Found | 1.04 | 7.68 | 8.35 | 1.25 | 0.11 | 4.44 |
| Guaranteed | 2 | ——— | 25 | ——— | ——— | ——— |
| Found | 1.82 | | 30.54 | | 0.10 | |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Niagara Fertilizer Co., Buffalo, N. Y. | Queen City phosphate. | Springville. | 3314 |
| Niagara Fertilizer Co., Buffalo, N. Y. | Potato, hop and tobacco phosphate. | Springville.<br>Cobleskill. | 3311<br>3577 |
| Niagara Fertilizer Co., Buffalo, N. Y. | Triumph. | Ellicottville. | 3305 |
| Niagara Fertilizer Co., Buffalo, N. Y. | Wheat and corn producer. | Ellicottville.<br>Cobleskill.<br>Williamstown. | 3306<br>3578<br>3579 |
| Northwestern Fertilizer Co., Chicago, Ill. | Acidulated bone and potash. | Jamestown. | 3226 |
| Northwestern Fertilizer Co., Chicago, Ill. | Challenge corn grower. | Jamestown. | 3227 |
| Oakfield Fertilizer Co., Buffalo, N. Y. | Golden sheaf. | Jamestown. | 3223 |
| Oakfield Fertilizer Co., Buffalo, N. Y. | Great value. | Fredonia. | 3236 |
| Oakfield Fertilizer Co., Buffalo, N. Y. | High farming. | Fredonia. | 3237 |
| Oakfield Fertilizer Co., Buffalo, N. Y. | Potato and tobacco. | Jamestown. | 3225 |
| Oakfield Fertilizer Co., Buffalo, N. Y. | Pure ground bone. | Fredonia. | 3238 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 11 | —— | —— | —— | —— |
| Found | | 11.74 | 12.24 | | | 4.97 |
| Guaranteed | 1.64 | 8 | 9 | 2.70 | —— | —— |
| Found | 1.74 | 10.34 | 11.97 | 3 | 0.21 | 7.57 |
| Guaranteed | 2.47 | 8 | 9 | 2.16 | —— | —— |
| Found | 2.61 | 7.86 | 11.04 | 2.54 | 0.84 | 5.43 |
| Guaranteed | 1.23 | 8 | 9 | 2.16 | —— | —— |
| Found | 1.48 | 8.07 | 11.33 | 2.54 | 0.78 | 5.45 |
| Guaranteed | 0.82 | 10 | —— | 1.50 | —— | —— |
| Found | 0.99 | 10.97 | 14.65 | 1.52* | 0.75 | 8.12 |
| Guaranteed | 2.06 | 8 | 12 | 0.54 | —— | —— |
| Found | 2.63 | 7.60 | 12.08 | 0.93 | 1.07 | 4.71 |
| Below guarantee | | 0.40 | | | | |
| Guaranteed | 1.23 | 7 | —— | 1.89 | —— | —— |
| Found | 1.32 | 7.09 | 7.93 | 2.10 | 0.04 | 4.51 |
| Guaranteed | 0.82 | 6 | 7 | 1.08 | —— | —— |
| Found | 1.08 | 6.74 | 7.49 | 1.27 | 0.02 | 3.29 |
| Guaranteed | 1.85 | 8 | 9 | 2.43 | —— | —— |
| Found | 1.87 | 7.94 | 8.92 | 2.24 | 0.17 | 5.10 |
| Guaranteed | 2.47 | 6 | —— | 4.32 | —— | —— |
| Found | 2.77 | 5.11 | 6.91 | 4.36* | 0.12 | 2.94 |
| Below guarantee | | 0.89 | | | | |
| Guaranteed | 2.88 | —— | 25 | —— | —— | —— |
| Found | 3.37 | | 23.73 | | 1.03 | |
| Below guarantee | | | 1.27 | | | |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Oakfield Fertilizer Co., Buffalo, N. Y. | Standard. | Jamestown. | 3224 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Complete buckwheat fertilizer. | Oneonta. | 3565 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Complete corn manure. | Oneonta. | 3562 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Complete manure for general use. | Oneonta. | 3560 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Complete manure for vegetables. | Oneonta. | 3559 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Complete potato manure. | Oneonta. | 3561 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Corn fertilizer. | Unadilla. | 3555 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Economical manure. | Unadilla. | 3554 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Hop phosphate. | Oneonta. | 3563 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Kainit. | Oneonta. | 3564 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Potato fertilizer. | Oneonta. | 3557 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.47 | 10 | —— | 1.62 | —— | —— |
| Found | 2.63 | 10.10 | 11.60 | 1.89 | 0.16 | 6.81 |
| Guaranteed | 1.65 | 5 | 6 | 1 | —— | —— |
| Found | 1.50 | 5.13 | 6.21 | 1.44 | 0.85 | 1.49 |
| Guaranteed | 3.70 | 7 | 9 | 6 | —— | —— |
| Found | 3.70 | 7.35 | 8.04 | 6.39 | 1.41 | 3.83 |
| Guaranteed | 3.30 | 8 | 10 | 4 | —— | —— |
| Found | 3.08 | 8.71 | 9.06 | 4.20 | 0.45 | 5.31 |
| Below guarantee | 0.22 | | | | | |
| Guaranteed | 5 | 6 | 8 | 6 | —— | —— |
| Found | 4.60 | 6.89 | 7.74 | 6.22 | 0.82 | 4.72 |
| Below guarantee | 0.40 | | | | | |
| Guaranteed | 3.70 | 7.50 | 8 | 7 | —— | —— |
| Found | 4.02 | 8.19 | 9.65 | 6.99* | 2.20 | 4.11 |
| Guaranteed | 2.50 | 6 | 7 | 3 | —— | —— |
| Found | 2.45 | 6.83 | 7.68 | 4.96 | 0.28 | 2.71 |
| Guaranteed | 1.65 | 5 | 6 | 5 | —— | —— |
| Found | 1.69 | 6.03 | 7.31 | 4.88 | 0.45 | 2.05 |
| Guaranteed | 1.65 | 9 | 9 | 4 | —— | —— |
| Found | 1.75 | 9.06 | 10.31 | 4.10* | 0.78 | 4.34 |
| Guaranteed | —— | —— | —— | 12 | —— | —— |
| Found | | | | 14.58 | | |
| Guaranteed | 1.85 | 6 | 7 | 5 | —— | —— |
| Found | 1.73 | 6.03 | 7.31 | 4.88* | 0.88 | 1.91 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
| --- | --- | --- | --- |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Standard superphosphate. | Oneonta. | 3556 |
| Oneonta Fertilizer & Chemical Co., Oneonta, N. Y. | Superphosphate success. | Oneonta. | 3558 |
| Pacific Guano Co., Boston, Mass. | A No. 1 phosphate. | Oneida.<br>Sherburne.<br>Cooperstown. | 3215<br>3536<br>3572 |
| Pacific Guano Co., Boston, Mass. | C. A. D. special. | South Lima. | 3389 |
| Pacific Guano Co., Boston, Mass. | Dissolved bone phosphate. | Oneida.<br>Amsterdam. | 3214<br>3486 |
| Pacific Guano Co., Boston, Mass. | Dissolved bone and potash. | Springville.<br>Cooperstown. | 3319<br>3573 |
| Pacific Guano Co., Boston, Mass. | Nobsque guano. | Oneida.<br>Schuylerville.<br>Baldwinsville. | 3213<br>3421<br>3678 |
| Pacific Guano Co., Boston, Mass. | Potato, tobacco and hop fertilizer. | Oneida.<br>Sherburne. | 3216<br>3535 |
| Pacific Guano Co., Boston, Mass. | Soluble Pacific guano. | Springville.<br>Amsterdam.<br>Baldwinsville. | 3320<br>3485<br>3682 |
| Packers' Union Fertilizer Co., New York City. | Gardener's complete manure. | Southold. | 3125 |
| Packers' Union Fertilizer Co., New York City. | Potato manure. | Orient. | 3117 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.65 | 7 | 8 | 3 | —— | —— |
| Found | 1.88 | 7.50 | 8.58 | 3.30 | 0.91 | 2.75 |
| Guaranteed | 1 | 8 | 10 | 2.50 | —— | —— |
| Found | 1.02 | 7.98 | 8.99 | 2.64 | 0.65 | 2.47 |
| Guaranteed | 1.03 | 7 | 8 | 1.50 | —— | —— |
| Found | 1.29 | 9.04 | 10.75 | 2.14 | 0.56 | 4.81 |
| Guaranteed | 0.82 | 7 | —— | 15 | —— | —— |
| Found | 1.94 | 8.69 | 10.24 | 15.19 | 0.80 | 5.64 |
| Guaranteed | —— | 13 | 14 | —— | —— | —— |
| Found | | 15.52 | 16.07 | | | 11.30 |
| Guaranteed | —— | 10 | 11 | 2 | —— | —— |
| Found | | 11.49 | 13.17 | 2.16 | | 7.88 |
| Guaranteed | 1.15 | 8 | 9 | 2 | —— | —— |
| Found | 1.18 | 8.48 | 10.65 | 2.03 | 0.37 | 3.30 |
| Guaranteed | 2.06 | 8 | 9 | 3 | —— | —— |
| Found | 2.59 | 7.99 | 11.98 | 3.16 | 0.94 | 3.02 |
| Guaranteed | 2.05 | 8 | 10 | 1.50 | —— | —— |
| Found | 2.33 | 9.36 | 11.36 | 2.02 | 0.83 | 2.59 |
| Guaranteed | 2.47 | 8 | 10 | 10 | —— | —— |
| Found | 2.79 | 9.04 | 10.35 | 8.31 | 1.62 | 4.64 |
| Below guarantee | | | | 1.69 | | |
| Guaranteed | 2.06 | 8 | 9 | 6 | —— | —— |
| Found | 2.46 | 8.85 | 10.22 | 7.37 | 2.05 | 5.81 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Packers' Union Fertilizer Co., New York City | Universal. | Southold. | 3124 |
| Patapsco Guano Co., Baltimore, Md. | Grain and tobacco. | Baldwinsville. | 3681 |
| A. Peterson, Penfield, N. Y. | Farmers' benefit. | Penfield. | 3791 |
| A. Peterson, Penfield, N. Y. | Penfield standard. | Penfield. | 3790 |
| Moro Phillips Chemical Co., Springville, N. Y. | Springville fertilizer. | Springville. | 3310 |
| B. J. Pine, East Williston, N. Y. | Star raw bone superphosphate. | East Williston. | 3097 |
| Powers, Gibbs & Co., Wilmington, N. C. | Ammoniated guano. | Mohawk. | 3517 |
| Powers, Gibbs & Co., Wilmington, N. C. | Seabird ammoniated guano. | Mohawk. | 3516 |
| Powers, Gibbs & Co., Wilmington, N. C. | Special small grain guano. | Saratoga. | 3391 |
| Powers, Gibbs & Co., Wilmington, N. C. | Truck farmer's special guano. | Troy. | 3433 |
| Preston Fertilizer Co., Brooklyn, N. Y. | Ammoniated bone superphosphate. | Poughkeepsie. | 3168 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.82 | 8 | 9 | 5 | —— | —— |
| Found | 2.50 | 8.64 | 10.09 | 5.12 | 1.61 | 6.20 |
| Guaranteed | 1.65 | 8 | —— | 2 | —— | —— |
| Found | 2.68 | 9.01 | 9.81 | 3.01 | 2.24 | 6.07 |
| Guaranteed | 1.25 | 6 | —— | 2 | —— | —— |
| Found | 2.04 | 8.51 | 12.62 | 2.37 | 0.67 | 3.47 |
| Guaranteed | 2.25 | 8 | —— | 4 | —— | —— |
| Found | 2.85 | 8.13 | 13.16 | 5.62 | 1.17 | 2.98 |
| Guaranteed | 1 | 9 | —— | 2.50 | —— | —— |
| Found | 1.23 | 8.76 | 11.39 | 2.86 | 0.57 | 5.64 |
| Below guarantee | | 0.24 | | | | |
| Guaranteed | 2.47 | 6 | 8 | 7 | —— | —— |
| Found | 3.21 | 5.81 | 8.47 | 7.35* | 1.39 | 2.87 |
| Guaranteed | 0.82 | 8 | —— | 3 | —— | —— |
| Found | 1.32 | 10.31 | 11.65 | 2.66 | 0.21 | 7.27 |
| Below guarantee | | | | 0.34 | | |
| Guaranteed | 1.50 | 8 | —— | 2.50 | —— | —— |
| Found | 1.46 | 10.62 | 12.10 | 2.82 | 0.61 | 7.52 |
| Guaranteed | 0.82 | 8 | —— | 2 | —— | —— |
| Found | 1.31 | 8.34 | 9.69 | 1.99 | 0.33 | 1.72 |
| Guaranteed | 3.30 | 8 | —— | 5 | —— | —— |
| Found | 6.03 | 10.41 | 11.86 | 5.66 | 3.22 | 7.68 |
| Guaranteed | 2.50 | 9 | —— | 2 | —— | —— |
| Found | 2.59 | 8.63 | 16.62 | 1.94 | 2.08 | 4.18 |
| Below guarantee | | 0.37 | | | | |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number |
|---|---|---|---|
| Preston Fertilizer Co., Brooklyn, N. Y. | Blood and bone. | Poughkeepsie. | 3170 |
| Preston Fertilizer Co., Brooklyn, N. Y. | Cabbage and cauliflower. | Jamaica. | 3076 |
| Preston Fertilizer Co., Brooklyn, N. Y | Onion fertilizer. | Florida. | 3197 |
| Preston Fertilizer Co., Brooklyn, N. Y. | Pioneer. | Poughkeepsie. | 3169 |
| Preston Fertilizer Co., Brooklyn, N. Y. | Potato fertilizer. | Jamaica. | 3077 |
| Preston Fertilizer Co., Brooklyn, N. Y. | Potato, hop and onion. | Poughkeepsie. | 3167 |
| Preston Fertilizer Co., Brooklyn, N. Y. | Pure ground bone. | Glens Falls. | 3404 |
| Preston Fertilizer Co., Brooklyn, N. Y. | Soluble bone and potash. | Baldwinsville. | 3679 |
| Preston Fertilizer Co., Brooklyn, N. Y. | Special potato manure. | Oneida. | 3212 |
| Preston Fertilizer Co., Brooklyn, N. Y. | Ten per cent special. | Jamaica. | 3083 |
| Preston Fertilizer Co., Brooklyn, N. Y. | XXV brand. | Poughkeepsie. | 3166 |

lected in New York State During the Fall of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 4.10 | — | 18 | — | — | — |
| Found | 3.73 | | 18.51 | | 1.20 | |
| Below guarantee | 0.37 | | | | | |
| Guaranteed | 3.25 | 5 | — | 7 | — | — |
| Found | 2.92 | 9.17 | 13.10 | 5.93* | 1.84 | 4.52 |
| Below guarantee | 0.33 | | | 1.07 | | |
| Guaranteed | 3.50 | 7 | — | 6 | — | — |
| Found | 3.40 | 8.48 | 13.88 | 5.50* | 2.14 | 3.91 |
| Below guarantee | | | | 0.50 | | |
| Guaranteed | 1.50 | 10 | — | 1.75 | — | — |
| Found | 1.60 | 9.61 | 13.80 | 1.57* | 0.69 | 5.15 |
| Below guarantee | | 0.39 | | | | |
| Guaranteed | 3.25 | 8 | — | 7 | — | — |
| Found | 2.79 | 9.48 | 12.79 | 6.03* | 1.73 | 4.82 |
| Below guarantee | 0.46 | | | 0.97 | | |
| Guaranteed | 2.47 | 6 | — | 6 | — | — |
| Found | 2.95 | 5.61 | 10.73 | 6.02 | 1.24 | 1.37 |
| Below guarantee | | 0.39 | | | | |
| Guaranteed | 3.70 | — | 20.50 | — | — | — |
| Found | 3.94 | | 20.86 | | 1.20 | |
| Guaranteed | — | 10 | 11 | 1.50 | — | — |
| Found | | 11.82 | 12.81 | 1.79 | | 7.76 |
| Guaranteed | 2.50 | 5 | 7 | 5 | — | — |
| Found | 2.79 | 5.06 | 8.58 | 5.07 | 1.22 | 1.11 |
| Guaranteed | 8.20 | 6 | — | 4 | — | — |
| Found | 5.95 | 8.31 | 9.41 | 4.13 | 3.28 | 5.33 |
| Below guarantee | 2.25 | | | | | |
| Guaranteed | 1 | 8 | — | 1 | — | — |
| Found | 1.03 | 8.96 | 10.15 | 1.95 | 0.36 | 5 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Quinnipiac Co., New York City. | Ammoniated dissolved bone. | Varysburg.<br>Fruit Valley. | 3376<br>3705 |
| Quinnipiac Co., New York City. | Climax. | Varysburg.<br>Schuylerville.<br>Newark Valley. | 3375<br>3418<br>3617 |
| Quinnipiac Co., New York City. | Corn and grain manure. | Southampton. | 3152 |
| Quinnipiac Co., New York City. | Dissolved bone and potash. | Schuylerville. | 3420 |
| Quinnipiac Co., New York City. | Market garden manure. | Foster's Meadow.<br>Fruit Valley. | 3087<br>3704 |
| Quinnipiac Co., New York City. | Mohawk. | Varysburg.<br>Fruit Valley. | 3377<br>3707 |
| Quinnipiac Co., New York City. | Potato manure. | Southold. | 3121 |
| Quinnipiac Co., New York City. | Potato phosphate. | Varysburg.<br>Schuylerville.<br>Fruit Valley. | 3378<br>3419<br>3706 |
| Quinnipiac Co., New York City. | Special formula. | Bayside. | 3092 |
| Quinnipiac Co., New York City. | Special potato. | Webster station. | 3743 |
| Quinnipiac Co., New York City. | Uncas bone meal. | North Collins. | 3336 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.64 | 9 | 10 | 2 | ——— | ——— |
| Found | 2.02 | 8.97 | 12.19 | 2.07 | 0.76 | 3.66 |
| Guaranteed | 1.03 | 8 | 9 | 2 | ——— | ——— |
| Found | 1.15 | 8.47 | 11.72 | 2.95 | 0.46 | 2.01 |
| Guaranteed | 1.23 | 8 | 9 | 2 | ——— | ——— |
| Found | 1.30 | 9.29 | 11.04 | 2.12 | 0.65 | 4.02 |
| Guaranteed | ——— | 10 | 11 | 2 | ——— | ——— |
| Found | | 11.87 | 15.42 | 1.97* | | 5.39 |
| Guaranteed | 3.30 | 8 | 9 | 7 | ——— | ——— |
| Found | 3.25 | 7.87 | 11.03 | 7.10 | 1 | 3.75 |
| Guaranteed | 0.82 | 7 | 8 | 1 | ——— | ——— |
| Found | 1.29 | 8.34 | 10.24 | 1.53 | 0.76 | 4.18 |
| Guaranteed | 2.47 | 6 | 7 | 5 | ——— | ——— |
| Found | 2.62 | 5.62 | 9.17 | 6.19 | 0.77 | 1.51 |
| Below guarantee | | 0.38 | | | | |
| Guaranteed | 2.06 | 8 | 9 | 3 | ——— | ——— |
| Found | 2.10 | 9.10 | 13.40 | 3.14 | 0.42 | 2.73 |
| Guaranteed | 3.70 | 8 | ——— | 8 | ——— | ——— |
| Found | 3.71 | 8.21 | 9.41 | 8.39 | 2.11 | 4.83 |
| Guaranteed | 1.23 | 6 | ——— | 5 | ——— | ——— |
| Found | 1.47 | 6.53 | 8.26 | 4.91 | 0.80 | 4.06 |
| Guaranteed | 1.65 | ——— | 13.50 | ——— | ——— | ——— |
| Found | 2.20 | | 16.06 | | 0.78 | 0.31 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Read Fertilizer Co., New York City. | Acid phosphate. | Syracuse. | 3666 |
| Read Fertilizer Co., New York City. | Bone meal. | Cortland. | 3623 |
| Read Fertilizer Co., New York City. | Bone and potash. | Syracuse. | 3670 |
| Read Fertilizer Co., New York City. | Dissolved bone phosphate. | Syracuse. | 3663 |
| Read Fertilizer Co., New York City. | Farmer's friend. | Florida.<br>Clarksville.<br>Cortland. | 3195<br>3450<br>3625 |
| Read Fertilizer Co., New York City. | Fish, bone and potash. | Syracuse. | 3664 |
| Read Fertilizer Co., New York City. | High grade farmer's friend. | Unadilla.<br>Syracuse. | 3551<br>3661 |
| Read Fertilizer Co., New York City. | High grade farmer's friend for Long Island. | Mattituck. | 3139 |
| Read Fertilizer Co., New York City. | Leader guano. | Clarksville.<br>Syracuse. | 3452<br>3662 |
| Read Fertilizer Co., New York City. | N. Y. State superphosphate. | Syracuse. | 3668 |
| Read Fertilizer Co., New York City. | Original alkaline bone. | Syracuse. | 3671 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 12 | 13 | —— | —— | —— |
| Found | | 12.67 | 15.24 | | | 10.71 |
| Guaranteed | 2 | —— | 24 | —— | —— | —— |
| Found | 3 | | 25.10 | | 0.97 | |
| Guaranteed | —— | 8 | —— | 4 | —— | —— |
| Found | | 7.90 | 9.23 | 4.44 | | 4.69 |
| Guaranteed | —— | 10 | 12 | —— | —— | —— |
| Found | | 10.94 | 14.42 | | | 6.30 |
| Guaranteed | 2 | 9 | 10 | 2 | —— | —— |
| Found | 2.22 | 9.47 | 10.78 | 2.27 | 0.56 | 6.77 |
| Guaranteed | 2.47 | 4 | 5 | 4 | —— | —— |
| Found | 2.66 | 4.54 | 6.64 | 4.36 | 0.52 | 2.59 |
| Guaranteed | 3.20 | 5 | —— | 10 | —— | —— |
| Found | 3.35 | 5.30 | 7.17 | 10.48 | 1.28 | 3.74 |
| Guaranteed | 3.30 | 7 | —— | 7 | —— | —— |
| Found | 3.67 | 6.82 | 9.31 | 7.27 | 0.24 | 4.07 |
| Guaranteed | 0.82 | 7 | 8 | 2 | —— | —— |
| Found | 1.14 | 7.45 | 8.56 | 2.49 | 0.25 | 4.86 |
| Guaranteed | 1.22 | 9 | 10 | 2 | —— | —— |
| Found | 1.49 | 9.44 | 10.78 | 2.25 | 0.33 | 6.69 |
| Guaranteed | —— | 10 | 11 | 3 | —— | —— |
| Found | | 9.96 | 11.49 | 3.15 | | 6.43 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Read Fertilizer Co., New York City. | Potato manure. | Syracuse | 3667 |
| Read Fertilizer Co., New York City. | Practical potato special. | Cortland. | 3626 |
| Read Fertilizer Co., New York City. | Prime wheat and rye. | Syracuse. | 3665 |
| Read Fertilizer Co., New York City. | Pure ground bone. | Clarksville. | 3453 |
| Read Fertilizer Co., New York City. | Standard. | Florida.<br>Clarksville.<br>Cortland. | 3196<br>3451<br>3624 |
| Read Fertilizer Co., New York City. | Vegetable and vine. | Syracuse. | 3669 |
| John S. Reese & Co., Baltimore, Md. | Challenge crop grower. | Owego. | 3605 |
| John S. Reese & Co., Baltimore, Md. | Columbia "A." | Owego. | 3601 |
| John S. Reese & Co., Baltimore, Md. | Crown phosphate and potash. | Fort Edward.<br>Owego. | 3408<br>3606 |
| John S. Reese & Co., Baltimore, Md. | Dissolved phosphate. | Owego. | 3607 |
| John S. Reese & Co., Baltimore, Md. | Elm phosphate. | La Grange. | 3364 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.47 | 7 | 8 | 10 | —— | —— |
| Found | 2.42 | 6.85 | 7.58 | 10.09 | 0.88 | 5.74 |
| Guaranteed | 0.82 | 4 | —— | 8 | —— | —— |
| Found | 1.23 | 4.50 | 6.24 | 8.31 | 0.33 | 2.19 |
| Guaranteed | 1.64 | 8 | —— | 4 | —— | —— |
| Found | 1.91 | 8.27 | 9.72 | 4.41 | 0.81 | 6.44 |
| Guaranteed | 2.50 | —— | 22 | —— | —— | —— |
| Found | 3.16 | | 25.79 | | 0.63 | |
| Guaranteed | 0.82 | 8 | 9 | 4 | —— | —— |
| Found | 1.04 | 8.83 | 9.76 | 4.10 | 0.28 | 5.82 |
| Guaranteed | 1.64 | 6 | —— | 8 | —— | —— |
| Found | 1.94 | 6.65 | 7.96 | 8.04 | 0.52 | 4.79 |
| Guaranteed | 0.82 | 8 | —— | 2 | —— | —— |
| Found | 0.91 | 10.79 | 12.13 | 2.54 | 0.49 | |
| Guaranteed | 3.29 | 7 | —— | 9.50 | —— | —— |
| Found | 3.21 | 8 | 9.51 | 9.28 | 1.59 | 5.54 |
| Below guarantee | | | | 0.22 | | |
| Guaranteed | —— | 12 | —— | 2 | —— | —— |
| Found | | 13.28 | 14.46 | 1.65 | | 3.59 |
| Below guarantee | | | | 0.35 | | |
| Guaranteed | —— | 14 | —— | —— | —— | —— |
| Found | | 15.91 | 16.88 | | | 7.83 |
| Guaranteed | —— | 14 | —— | —— | —— | —— |
| Found | | 14.97 | 16.21 | | | 10.60 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| John S. Reese & Co., Baltimore, Md. | Pilgrim fertilizer. | Fort Edward.<br>Owego. | 3410<br>3604 |
| John S. Reese & Co., Baltimore, Md. | Potato phosphate. | Owego. | 3603 |
| John S. Reese & Co., Baltimore, Md. | Potato special. | Fort Edward.<br>Owego. | 3409<br>3602 |
| Jas. L. Reynolds Co., Mount Vernon, N. Y. | Bone. | Mount Vernon. | 3164 |
| Jas. L. Reynolds Co., Mount Vernon, N. Y. | Complete fertilizer. | Mount Vernon. | 3165 |
| Riverside Acid Works, Warren, Pa. | Grape and fruit special. | Silver Creek. | 3265 |
| Riverside Acid Works, Warren, Pa. | Harvest moon No. 1. | Silver Creek. | 3257 |
| Riverside Acid Works, Warren, Pa. | Harvest moon No. 2. | Silver Creek. | 3264 |
| Riverside Acid Works, Warren, Pa. | Rich acre. | Silver Creek. | 3256 |
| Rochester Fertilizer Works, Rochester, N. Y. | Blood and bone guano. | Rochester. | 3584 |
| Rochester Fertilizer Works, Rochester, N. Y. | Genesee guano. | Rochester. | 3585 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.23 | 6.50 | 7.50 | 3 | —— | —— |
| Found | 1.35 | 8.57 | 10.17 | 2.87 | 0.45 | 2.13 |
| Guaranteed | 2.06 | 8.50 | —— | 6 | —— | —— |
| Found | 2.75 | 6.89 | 8.55 | 7.37* | 1 | 4.03 |
| Below guarantee | | 1.61 | | | | |
| Guaranteed | 2.88 | 6.50 | —— | 7.50 | —— | —— |
| Found | 2.70 | 8.14 | 8.84 | 8.18 | 1.20 | |
| Guaranteed | 3 | —— | 12 | —— | —— | —— |
| Found | 4.04 | | 17.94 | | 1.24 | 0.20 |
| Guaranteed | 3.25 | 3.50 | —— | 8 | —— | —— |
| Found | 3.24 | 6 | 12.97 | 7.99 | 1.68 | |
| Guaranteed | 0.82 | 9 | 10 | 5.50 | —— | —— |
| Found | 1.19 | 9.10 | 12.97 | 3.96* | 0.06 | 6.39 |
| Below guarantee | | | | 1.54 | | |
| Guaranteed | 2.10 | 7 | 8.75 | 1.10 | —— | —— |
| Found | 1.76 | 8.67 | 8.67 | 1.48* | 0.01 | 6.53 |
| Below guarantee | 0.34 | | | | | |
| Guaranteed | 2.10 | 7 | 7.75 | 1.10 | —— | —— |
| Found | 1.72 | 8.12 | 12.08 | 1.21* | 0.08 | 3.08 |
| Below guarantee | 0.38 | | | | | |
| Guaranteed | 2.50 | 8 | 8.75 | 1.25 | —— | —— |
| Found | 2.16 | 9.32 | 9.93 | 1.61* | 0.03 | 6.33 |
| Below guarantee | 0.34 | | | | | |
| Guaranteed | 0.82 | 8 | —— | 1.62 | —— | —— |
| Found | 0.75 | 8.76 | 10.26 | 2.69* | 0.09 | 4.42 |
| Guaranteed | 1.65 | 8 | —— | 3.25 | —— | —— |
| Found | 1.67 | 9.68 | 11.70 | 3.98* | 0.10 | 5.29 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Rochester Fertilizer Works, Rochester, N. Y. | Potato manure. | Rochester. | 3587 |
| Rochester Fertilizer Works, Rochester, N. Y. | Vegetable phosphate. | Rochester. | 3586 |
| Lucien Sanderson, New Haven, Conn. | Early cabbage fertilizer. | Jamaica. | 3068 |
| Lucien Sanderson, New Haven, Conn. | Formula "A." | Jamaica. | 3069 |
| Geo. Schaal, Erie, Pa. | Erie City corn and potato. | Westfield. | 3259 |
| Geo. Schaal, Erie, Pa. | Special grape. | Westfield. | 3260 |
| Scheid & Fechter, East Buffalo, N. Y. | East star. | Morton's Corners. | 3321 |
| Sharpless & Carpenter, Philadelphia, Pa. | Gilt-edged potato manure. | Queens. | 3101 |
| M. L. Shoemaker & Co., Philadelphia, Pa. | Bone meal. | Southampton. | 3151 |
| M. L. Shoemaker & Co., Philadelphia, Pa. | Superphosphate for potatoes. | Southampton. | 3149 |
| W. H. Stamp, Warsaw, N. Y. | Farmer's pride. | Warsaw. | 3368 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.87 | 8 | ——— | 5.40 | ——— | ——— |
| Found | 2.66 | 8.37 | 11.31 | 4.33* | 0.20 | 4.78 |
| Below guarantee | 0.21 | | | 1.07 | | |
| Guaranteed | 0.41 | 8 | ——— | 8 | ——— | ——— |
| Found | 0.48 | 8.43 | 9.78 | 7.60* | 0.16 | 4.18 |
| Below guarantee | | | | 0.40 | | |
| Guaranteed | 4 | 5 | 8 | 5 | ——— | ——— |
| Found | 3.84 | 5.04 | 8.68 | 6.42 | 2.50 | 1.63 |
| Guaranteed | 3.30 | 7 | 10 | 6 | ——— | ——— |
| Found | 3.35 | 6.59 | 10.22 | 6.96 | 1.90 | 2.16 |
| Below guarantee | | 0.41 | | | | |
| Guaranteed | 2.47 | 9 | ——— | 4 | ——— | ——— |
| Found | 2.17 | 7.01 | 10.38 | 4.02 | 0.40 | 2.94 |
| Below guarantee | 0.30 | 1.99 | | | | |
| Guaranteed | 1.65 | ——— | 9 | 19 | ——— | ——— |
| Found | 1.52 | 6.35 | 8.86 | 10.68 | 0.31 | 2.41 |
| Below guarantee | | | | 8.32 | | |
| Guaranteed | 4.89 | 6.85 | 12.45 | 1.13 | ——— | ——— |
| Found | 4.97 | 4.64 | 9.33 | 0.95 | 1.63 | |
| Below guarantee | | 2.21 | | | | |
| Guaranteed | 2.47 | 7 | ——— | 6 | ——— | ——— |
| Found | 2.62 | 7.03 | 10.13 | 6.06 | 0.49 | 2.88 |
| Guaranteed | 4.10 | ——— | 20 | ——— | ——— | ——— |
| Found | 5.28 | | 22.54 | | 1.19 | |
| Guaranteed | 2.47 | 8 | 11 | 6 | ——— | ——— |
| Found | 2.49 | 11.30 | 13.19 | 7.23 | 1.55 | 7.35 |
| Guaranteed | 0.80 | 8 | ——— | 2 | ——— | ——— |
| Found | 1.11 | 9.44 | 10.30 | 2.15 | 0.58 | 0.29 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| W. H. Stamp, Warsaw, N. Y. | Wheat special. | Warsaw. | 3369 |
| Standard Fertilizer Co., Boston, Mass. | "A" brand. | Angola.<br>Voorheesville.<br>Mexico. | 3278<br>3455<br>3716 |
| Standard Fertilizer Co., Boston, Mass. | Ammoniated dissolved bone. | Mexico. | 3714 |
| Standard Fertilizer Co., Boston, Mass. | Complete manure. | Bridgehampton.<br>Canajoharie.<br>Canastota. | 3144<br>3514<br>3740 |
| Standard Fertilizer Co., Boston, Mass. | Dissolved bone phosphate. | Voorheesville. | 3454 |
| Standard Fertilizer Co., Boston, Mass. | Empire State. | Bridgehampton.<br>Canastota. | 3143<br>3739 |
| Standard Fertilizer Co., Boston, Mass. | Guano. | Mattituck.<br>Chester.<br>Schoharie. | 3133<br>3192<br>3580 |
| Standard Fertilizer Co., Boston, Mass. | Potato and tobacco fertilizer. | Fonda.<br>Mexico. | 3494<br>3717 |
| Standard Fertilizer Co., Boston, Mass. | Standard fertilizer. | Albany.<br>Johnstown.<br>Canastota. | 3449<br>3499<br>3741 |
| H. Stappenbeck, Utica, N. Y. | Bone meal. | Utica. | 3519 |
| H. Stappenbeck, Utica, N. Y. | Home trade bone superphosphate. | Utica.<br>Madison Center. | 3518<br>3744 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water soluble nitrogen in 100 pounds of fertilizer | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.80 | 10 | ——— | 4 | ——— | ——— |
| Found | 1.05 | 11 | 11.64 | 3.63 | 0.55 | 0.81 |
| Below guarantee | | | | 0.37 | | |
| Guaranteed | 0.82 | 7 | 9 | 1 | ——— | ——— |
| Found | 1.03 | 8.24 | 9.69 | 1.30 | 0.25 | 5.65 |
| Guaranteed | 1.65 | 9 | 10 | 2 | ——— | ——— |
| Found | 2.23 | 8.50 | 10.44 | 2.73 | 0.49 | 6.79 |
| Below guarantee | | 0.50 | | | | |
| Guaranteed | 3.30 | 8 | 9 | 7 | ——— | ——— |
| Found | 3.28 | 8.71 | 10.69 | 6.95 | 1.34 | 4.85 |
| Guaranteed | ——— | 10 | 12 | ——— | ——— | ——— |
| Found | | 11.07 | 12.46 | | | 8.49 |
| Guaranteed | 0.82 | 4 | ——— | 8 | ——— | ——— |
| Found | 1.67 | 7.18 | 9.31 | 7.22 | 0.98 | 3.17 |
| Below guarantee | | | | 0.78 | | |
| Guaranteed | 1.03 | 8 | 10 | 2 | ——— | ——— |
| Found | 1.28 | 8.68 | 11.36 | 2.10 | 0.64 | 4.08 |
| Guaranteed | 2 | 8 | 9 | 3 | ——— | ——— |
| Found | 2.10 | 8.40 | 10.16 | 3.39 | 0.30 | 5.61 |
| Guaranteed | 2 | 8 | 10 | 2 | ——— | ——— |
| Found | 2.82 | 9.09 | 10.50 | 2.41 | 2.17 | 3.75 |
| Guaranteed | 3.30 | ——— | 19 | ——— | ——— | ——— |
| Found | 3.44 | | 23.40 | | 2.10 | 0.40 |
| Guaranteed | 2.05 | 10 | ——— | 2 | ——— | ——— |
| Found | 2.20 | 10.94 | 11.95 | 2.82 | 0.98 | 7.96 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| H. Stappenbeck, Utica, N. Y. | Hop, fruit and vegetable special. | Utica. | 3520 |
| Swift & Co., Chicago, Ill. | Bone tankage and potash. | Cuba. | 3293 |
| Swift & Co., Chicago, Ill. | No. 1 ground tankage. | Carthage. | 3783 |
| Swift & Co., Chicago, Ill. | Pure bone and potash. | Cuba.<br>Oneonta. | 3292<br>3569 |
| Swift & Co., Chicago, Ill. | Pure bone tankage. | Franklinville. | 3298 |
| Swift & Co., Chicago, Ill. | Pure ground steamed bone. | Oneonta.<br>Carthage. | 3570<br>3782 |
| Swift & Co., Chicago, Ill. | Pure raw bone meal. | Fredonia.<br>Oneonta.<br>Carthage. | 3233<br>3568<br>3784 |
| I. P. Thomas & Son, Philadelphia, Pa. | Improved superphosphate. | Colosse. | 3719 |
| I. P. Thomas & Son, Philadelphia, Pa. | Normal bone phosphate. | Greenbush. | 3444 |
| I. P. Thomas & Son, Philadelphia, Pa. | S. C. phosphate. | Colosse. | 3718 |
| E. D. Tolles, Attica, N. Y. | Animal bone. | Attica. | 3358 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.05 | 9 | —— | 6 | —— | —— |
| Found | 2.08 | 10.37 | 12.02 | 9.13* | 0.98 | 2.50 |
| Guaranteed | 5 | —— | 16.75 | 3 | —— | —— |
| Found | 4.36 | 8.36 | 16.74 | 4.22* | 0.56 | |
| Below guarantee | 0.64 | | | | | |
| Guaranteed | 7.40 | —— | 6 | —— | —— | —— |
| Found | 7.94 | | 9.40 | | 0.55 | 0.47 |
| Guaranteed | 2 | —— | 24.50 | 3 | —— | —— |
| Found | 2.52 | 7.88 | 25.49 | 3.07 | 0.40 | |
| Guaranteed | 5 | —— | 17 | —— | —— | —— |
| Found | 5.31 | | 18.33 | | 0.59 | |
| Guaranteed | 3.25 | —— | 23.75 | —— | —— | —— |
| Found | 3.16 | | 27.04 | | 0.31 | |
| Guaranteed | 3.25 | —— | 23 | —— | —— | —— |
| Found | 4.13 | | 24.30 | | 0.38 | |
| Guaranteed | 0.82 | 10 | 12 | 1 | —— | —— |
| Found | 0.80 | 10.70 | 12.48 | 1.52 | 0.38 | 7.97 |
| Guaranteed | 1 | 8.50 | 9.50 | 1.50 | —— | —— |
| Found | 0.92 | 8.49 | 10.30 | 1.71 | 0.11 | 4.52 |
| Guaranteed | —— | 13 | 15 | —— | —— | —— |
| Found | | 15.08 | 16.80 | | | 10.90 |
| Guaranteed | 1.85 | 9 | 13.50 | 4 | —— | —— |
| Found | 2.06 | 9.70 | 13.33 | 4.43 | 0.79 | 6.97 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| E. D. Tolles, Attica, N. Y. | Barnyard manure. | Attica. | 3356 |
| E. D. Tolles, Attica, N. Y. | Dissolved bone phosphate. | Attica. | 3354 |
| E. D. Tolles, Attica, N. Y. | Guano. | Attica. | 3357 |
| E. D. Tolles, Attica, N. Y. | Potato manure. | Attica. | 3355 |
| E. Tuthill & Co., Promised Land, N. Y. | Riverhead Town club fertilizer. | Riverhead. | 3129 |
| E. Tuthill & Co., Promised Land, N. Y. | Southold Town club fertilizer. | Southold. | 3122 |
| E. Tuthill & Co., Promised Land, N. Y. | Special potato fertilizer. | East Williston. | 3098 |
| E. Tuthill & Co., Promised Land, N. Y. | W. & L. B. Young fertilizer. | Riverhead. | 3130 |
| Tygert-Allen Fertilizer Co., Philadelphia, Pa. | Cabbage manure. | Flatbush. | 3106 |
| Tygert-Allen Fertilizer Co., Philadelphia, Pa. | Dissolved S. C. phosphate. | Southold. | 3123 |
| Tygert-Allen Fertilizer Co., Philadelphia, Pa. | Potato manure. | Flatbush.<br>Bridgehampton. | 3107<br>3148 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertil izer. | Pounds of available phosphoric acid in 100 pounds of fertil-izer. | Pounds of total phosphoric acid in 100 pounds of fertil-izer. | Pounds of water-soluble potash in 100 pounds of fertil-izer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.82 | 8 | —— | 4 | —— | —— |
| Found | | 8.75 | 10.41 | 4.06 | 0.59 | 6.54 |
| Guaranteed | —— | 15 | —— | —— | —— | —— |
| Found | | 15.88 | 16.37 | | | 11.60 |
| Guaranteed | 1.85 | 9 | —— | 4 | —— | —— |
| Found | 1.87 | 9.54 | 10.80 | 4.31 | 0.96 | 6.84 |
| Guaranteed | 2.47 | 7 | —— | 8 | —— | —— |
| Found | 2.25 | 8.03 | 9.22 | 6.89 | 0.83 | 5.44 |
| Below guarantee | 0.22 | | | 1.11 | | |
| Guaranteed | 4 | 8 | —— | 10 | —— | —— |
| Found | 3.72 | 8.28 | 9.75 | 9.78 | 1.65 | 6.03 |
| Below guarantee | 0.28 | | | 0.22 | | |
| Guaranteed | 4 | 8 | —— | 10 | —— | —— |
| Found | 3.99 | 8.15 | 10 | 10.43 | 1.21 | 5.51 |
| Guaranteed | 4 | 8 | —— | 10 | —— | —— |
| Found | 4.26 | 7.57 | 9.70 | 9.23 | 1.19 | 5.48 |
| Below guarantee | | 0.43 | | 0.77 | | |
| Guaranteed | 3.30 | 8 | —— | 10 | —— | —— |
| Found | 2.97 | 7.84 | 10.02 | 11.08 | 0.57 | 5.63 |
| Below guarantee | 0.33 | | | | | |
| Guaranteed | 3.30 | 7 | 9 | 5 | —— | —— |
| Found | 3.63 | 7.64 | 9.30 | 6.67 | 2.48 | 5.89 |
| Guaranteed | —— | 12 | 13 | —— | —— | —— |
| Found | | 15.43 | 16.75 | | | 12.05 |
| Guaranteed | 3.30 | 6 | 9 | 9 | —— | —— |
| Found | 3.34 | 6.98 | 8.61 | 8.95 | 2.47 | 5.45 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
| --- | --- | --- | --- |
| F. G. Underwood, Oneida, N. Y. | Special pea fertilizer. | Oneida. | 3211 |
| F. G. Underwood, Oneida, N. Y. | Underwood fertilizer. | Oneida. | 3210 |
| M. E. Wheeler & Co., Rutland, Vt. | Corn fertilizer. | Dunkirk.<br>Phœnix.<br>Caughdenoy. | 3270<br>3693<br>3736 |
| M. E. Wheeler & Co., Rutland, Vt. | Electrical dissolved bone. | Franklinville.<br>Tully. | 3297<br>3660 |
| M. E. Wheeler & Co., Rutland, Vt. | Fruit fertilizer. | West Winfield. | 3528 |
| M. E. Wheeler & Co., Rutland, Vt. | Grass and oats. | Dunkirk. | 3269<br>3659 |
| M. E. Wheeler & Co., Rutland, Vt. | High grade Orleans Co. bean manure. | Franklinville. | 3296 |
| M. E. Wheeler & Co., Rutland, Vt. | Potato manure. | Varysburg.<br>West Winfield.<br>Phœnix. | 3374<br>3526<br>3694 |
| M. E. Wheeler & Co., Rutland, Vt. | Superior rye and oats fertilizer. | Johnstown. | 3500 |
| M. E. Wheeler & Co., Rutland, Vt. | Royal wheat grower. | Varysburg.<br>West Winfield. | 3373<br>3527 |
| Wilkinson & Co., Buffalo, N. Y. | Economical bone fertilizer. | Cornwall. | 3187 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds o available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1 | 7 | ——— | 8.50 | ——— | ——— |
| Found | 2.07 | 6.72 | 10.44 | 10.43 | 1.03 | 3.12 |
| Below guarantee | | 0.28 | | | | |
| Guaranteed | 2.60 | 7 | ——— | 7 | ——— | ——— |
| Found | 2.78 | 6.97 | 10.41 | 8.83 | 1.39 | 3.19 |
| Guaranteed | 1.64 | 8 | 9 | 2 | ——— | ——— |
| Found | 1.95 | 8.94 | 10.83 | 2.46 | 0.67 | 6.16 |
| Guaranteed | ——— | 13 | 15 | ——— | ——— | ——— |
| Found | | 15.79 | 16.66 | | | 7.55 |
| Guaranteed | ——— | 10 | 12 | 8 | ——— | ——— |
| Found | | 11.07 | 11.61 | 8.59 | | 7.84 |
| Guaranteed | ——— | 11 | 12 | 2 | ——— | ——— |
| Found | | 13.22 | 13.67 | 2.26 | | 6.06 |
| Guaranteed | 0.82 | 8 | ——— | 4 | ——— | ——— |
| Found | 1.03 | 8.96 | 9.88 | 4.23 | 0.62 | 7.29 |
| Guaranteed | 2.05 | 8 | 9 | 3.25 | ——— | ——— |
| Found | 2.56 | 8 | 10.81 | 3.66 | 0.77 | 5.47 |
| Guaranteed | 0.82 | 8 | 9 | 2 | ——— | ——— |
| Found | 1.14 | 9.16 | 10.85 | 2 | 0.32 | 5.64 |
| Guaranteed | 0.82 | 8 | 9 | 2 | ——— | ——— |
| Found | 1.03 | 8.67 | 9.64 | 2.42 | 0.79 | 6.41 |
| Guaranteed | 1.23 | 7 | 8 | 3 | ——— | ——— |
| Found | 1.48 | 6.82 | 9.64 | 3.70 | 0.72 | 4.69 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken | Station number. |
|---|---|---|---|
| Williams & Clark Fertilizer Co. New York City. | Acorn acid phosphate. | Brant.<br>New Scotland. | 3329<br>3459 |
| Williams & Clark Fertilizer Co. New York City. | Ammoniated bone superphosphate. | White Plains.<br>Kingston. | 3161<br>3208 |
| Williams & Clark Fertilizer Co., New York City | Ammoniated dissolved bone. | Amsterdam.<br>Williamstown. | 3483<br>3756 |
| Williams & Clark Fertilizer Co. New York City. | Ammoniated bone phosphate. | West Winfield. | 3525 |
| Williams & Clark Fertilizer Co. New York City. | Carteret bone meal. | Amsterdam. | 3482 |
| Williams & Clark Fertilizer Co. New York City. | Carteret bone meal with potash. | Saratoga. | 3390 |
| Williams & Clark Fertilizer Co., New York City | Dissolved bone and potash. | Brant.<br>Attica.<br>Williamstown. | 3328<br>3359<br>3755 |
| Williams & Clark Fertilizer Co., New York City. | Good grower potato phosphate. | New Scotland.<br>Lycoming. | 3460<br>3708 |
| Williams & Clark Fertilizer Co. New York City. | High grade special. | White Plains.<br>Cobleskill. | 3162<br>3579 |
| Williams & Clark Fertilizer Co. New York City. | Potato, hop and tobacco manure. | Sidney. | 3549 |
| Williams & Clark Fertilizer Co., New York City. | Prolific crop producer. | Brant.<br>New Scotland. | 3327<br>3461 |

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 13 | 14 | —— | —— | —— |
| Found | | 14.84 | 15.95 | | | 11.43 |
| Guaranteed | 2.50 | 9 | 10 | 2 | —— | —— |
| Found | 2.64 | 8.87 | 11.77 | 2.19 | 1.16 | 4.83 |
| Guaranteed | 1.64 | 8 | 9 | 2 | —— | —— |
| Found | 1.81 | 10.86 | 13.41 | 2.01 | 0.62 | 3.69 |
| Guaranteed | 1.64 | 8 | 9 | 2 | —— | —— |
| Found | 2.82 | 8.99 | 11.86 | 2.15 | 1.41 | 4.25 |
| Guaranteed | 1.65 | —— | 14 | —— | —— | —— |
| Found | 1.91 | | 12.28 | | 0.30 | 2.84 |
| Guaranteed | 1.65 | —— | 11 | 3 | —— | —— |
| Found | 2.19 | 4.16 | 12.63 | 3.14 | 0.32 | 0.80 |
| Guaranteed | —— | 10 | 14 | 2 | —— | —— |
| Found | | 11.22 | 15.38 | 2.12 | | 8.02 |
| Guaranteed | 1.23 | 6 | 7 | 5 | —— | —— |
| Found | 1.50 | 6.78 | 8.62 | 5.31 | 0.76 | 3.70 |
| Guaranteed | 3.71 | 7 | 8 | 7 | —— | —— |
| Found | 3.61 | 8.20 | 10.78 | 6.99 | 1.59 | 3.83 |
| Guaranteed | 2.06 | 8 | 9 | 3 | —— | —— |
| Found | 2.48 | 8.27 | 12.43 | 3.07 | 0.90 | 3.12 |
| Guaranteed | 0.82 | 6 | 7 | 1 | —— | —— |
| Found | 1.05 | 8.34 | 10.11 | 1.24 | 0.61 | 3.88 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Williams & Clark Fertilizer Co., New York City. | Pure bone meal. | Amsterdam. | 3481 |
| Williams & Clark Fertilizer Co., New York City. | Royal bone phosphate. | Otto.<br>Amsterdam.<br>Williamstown. | 3287<br>3480<br>3757 |
| Williams & Lander, Ardsley, N. Y. | [Not given.] | Ardsley. | 3163 |
| William Woolett, Gloversville, N. Y. | Bone and meat. | Gloversville. | 3513 |
| Zell Guano Co., Baltimore, Md. | Ammoniated bone superphosphate. | Solsville. | 3547 |
| Zell Guano Co., Baltimore, Md. | Calvert guano. | Johnsonburg. | 3380 |
| Zell Guano Co., Baltimore, Md. | Dilman Bros. special. | Geneva. | 3342 |
| Zell Guano Co., Baltimore, Md. | Dissolved bone phosphate. | East Rush. | 3341 |
| Zell Guano Co., Baltimore, Md. | Electric phosphate. | Johnsonburg. | 3379 |
| Zell Guano Co., Baltimore, Md. | High grade cabbage manure. | Geneva. | 3344 |
| Zell Guano Co., Baltimore, Md. | High grade celery manure. | Geneva. | 3343 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.47 | — | 20 | — | — | — |
| Found | 2.78 | | 20.63 | | 0.41 | 0.85 |
| Guaranteed | 1.25 | 7 | 8 | 2 | — | — |
| Found | 1.29 | 8.05 | 11.84 | 1.86 | 0.43 | 1.64 |
| Guaranteed | — | — | — | — | — | — |
| Found | 2.38 | 2.14 | 3.66 | 0.26 | 1.16 | |
| Guaranteed | 4.30 | — | 13.30 | — | — | — |
| Found | 2.18 | | 9.89 | | 1.26 | 1.55 |
| Below guarantee | 2.12 | | 3.41 | | | |
| Guaranteed | 1.60 | 8 | 10 | 2 | — | — |
| Found | 1.61 | 9.89 | 12.64 | 2.22 | 0.63 | 6.03 |
| Guaranteed | 0.60 | 9 | 11 | 1.50 | — | — |
| Found | 0.92 | 10.68 | 12.37 | 1.55 | 0.29 | 7.94 |
| Guaranteed | 2.45 | 7 | 8 | 15 | — | — |
| Found | 2.65 | 7.84 | 8.85 | 13.50 | 2 | 6.42 |
| Below guarantee | | | | 1.50 | | |
| Guaranteed | — | 14 | 15 | — | — | — |
| Found | | 15.21 | 16.66 | | | 12.47 |
| Guaranteed | — | 10 | 12 | 2 | — | — |
| Found | | 9.80 | 14.94 | 2.38 | | 1.22 |
| Guaranteed | 4.10 | 6 | 8 | 6 | — | — |
| Found | 4.20 | 6.43 | 9.49 | 6.30 | 2.12 | 3.42 |
| Guaranteed | 3.25 | 5 | 7 | 9 | — | — |
| Found | 3.49 | 6.67 | 9.63 | 9.19 | 1.96 | 2.87 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Zell Guano Co., Baltimore, Md. | High grade potato manure. | Perry Center. | 3363 |
| Zell Guano Co., Baltimore, Md. | Special compound for potatoes and vegetables. | Solsville. | 3548 |
| Zell Guano Co., Baltimore, Md. | Special high grade potato and cabbage manure. | East Rush. | 3340 |
| Zell Guano Co., Baltimore, Md. | Spring meadow special. | Oswego. | 3613 |

lected in New York State During the Spring of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 3.25 | 6 | 8 | 8 | ——— | ——— |
| Found | 2.60 | 6.81 | 9.94 | 9.85 | 0.69 | 2.93 |
| Below guarantee | 0.65 | | | | | |
| Guaranteed | 2.45 | 8 | 10 | 4 | ——— | ——— |
| Found | 2.48 | 10.87 | 11.86 | 4.49 | 1.71 | 8.91 |
| Guaranteed | 2.45 | 7 | 9 | 8 | ——— | ——— |
| Found | 2.63 | 7.48 | 10.40 | 7.84 | 1.43 | 2.94 |
| Guaranteed | 2.45 | 7 | 9 | 8 | ——— | ——— |
| Found | 2.64 | 8 | 11.60 | 7.90 | 1.53 | 3.49 |

## II. REPORT OF ANALYSES OF COMMERCIAL FERTILIZERS FOR THE FALL OF 1897.*

L. L. VAN SLYKE.

### SUMMARY.

(1) Samples collected. During the fall of 1897, the Station collected 270 samples of commercial fertilizers, representing 248 different brands. Of these different brands 172 were complete fertilizers; of the others, 38 contained phosphoric acid and potash without nitrogen; 7 contained nitrogen and phosphoric acid without potash; 28 contained phosphoric acid alone; and 2 contained potash salts only.

(2) Nitrogen. The 172 brands of complete fertilizers contained nitrogen varying in amounts from 0.58 to 4.89 per cent and averaging 1.69 per cent. The average amount of nitrogen found by the Station analysis exceeded the average guaranteed amount by 0.16 per cent, the guaranteed average being 1.53 per cent and the average found being 1.69 per cent.

In 144 brands of complete fertilizers, the amount of nitrogen found was equal to or above the guaranteed amount, the excess varying from 0.01 to 0.93 per cent and averaging 0.22 per cent.

In 28 brands, the nitrogen was below the guaranteed amount, the deficiency varying from 0.01 to 0.96 per cent and averaging 0.21 per cent. In 25 cases, the deficiency was less than 0.5 per cent.

The amount of water-soluble nitrogen varied from 0.01 to 3.81 per cent and averaged 0.58 per cent.

(3) Available phosphoric acid. The 172 brands of complete fertilizers contained available phosphoric acid varying in amount from 3.81 to 12.78 per cent and averaging 9.22 per cent. The

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average amount of available phosphoric acid found by the Station analysis exceeded the average guaranteed amount by 0.70 per cent, the guaranteed average being 8.52 per cent and the average found being 9.22 per cent.

In 136 brands of complete fertilizers, the amount of available phosphoric acid found was above the amount guaranteed, the excess varying from 0.02 to 3.85 per cent and averaging 1.01 per cent.

In 36 brands, the available phosphoric acid was below the guaranteed amount, the deficiency varying from 0.01 to 1.86 per cent and averaging 0.40 per cent. In 26 cases the deficiency was below 0.5 per cent.

The amount of water-soluble phosphoric acid varied from 0.65 to 9.08 per cent and averaged 5.75 per cent.

(4) Potash. The complete fertilizers contained potash varying in amount from 0.58 to 16.52 per cent and averaging 3.92 per cent. The average amount of potash found by the Station analysis exceeded the average guaranteed amount by 0.18 per cent, the guaranteed average being 3.74 per cent and the average found being 3.92 per cent.

In 118 brands of complete fertilizers, the amount of potash found was above the guaranteed amount, the excess varying from 0.01 to 3.59 per cent and averaging 0.46 per cent.

In 51 brands, the potash was below the guaranteed amount, the deficiency varying from 0.01 to 1.74 per cent and averaging 0.46 per cent. In 33 of these cases, the deficiency was less than 0.5 per cent.

In 18 cases among the 172 brands of complete fertilizers the potash was contained in the form of sulphate free from an excess of chlorides.

(5) The retail selling price of the complete fertilizers varied from $15 to $40 a ton and averaged $25.25. The retail cost of the separate ingredients unmixed varied from $11.26 to $29.28 and averaged $18.92, or $6.33 less than the selling price.

## INTRODUCTION.

### NUMBER AND KINDS OF FERTILIZERS COLLECTED.

During the entire year of 1897, we collected 1,005 samples of commercial fertilizers, representing 748 different brands. It is a matter of interest to notice to what extent dealers offer for sale complete fertilizers (those containing nitrogen, phosphoric acid and potash), compared with those containing only one or two of these ingredients. It is also of interest to consider the different forms in which incomplete fertilizers are offered for sale. The following tabulated statement indicates the different kinds of complete and incomplete fertilizers collected during the year.

CLASSES OF FERTILIZERS COLLECTED IN 1897.

| 1897. | Brands containing only nitrogen. | Brands containing only phosphoric acid. | Brands containing only potash. | Brands containing nitrogen and phosphoric acid without potash. | Brands containing potash and phosphoric acid without nitrogen. | Brands of complete commercial fertilizers. |
|---|---|---|---|---|---|---|
| Spring collection | 0 | 31 | 3 | 33 | 32 | 400 |
| Fall collection | 1 | 28 | 2 | 7 | 38 | 172 |
| Total for year | 1 | 59 | 5 | 40 | 70 | 572 |

In the spring collection, 80 per cent of the brands offered for sale consisted of complete fertilizers; in the fall, 69.3 per cent; and, during the year, an average of 76.5 per cent. Of unmixed materials, phosphoric acid was offered much more largely than nitrogen or potash, the average for the year being about 10.5 per cent of all brands offered. A smaller number containing phosphoric acid and nitrogen was found. It will be seen that the mixture of phosphoric acid and potash was quite largely used, averaging for the year over 12 per cent of all the brands collected.

### COMPOSITION OF FERTILIZERS COLLECTED IN 1897.

The tabulated statement below shows the average composition of the complete fertilizers collected during the year, together with a comparison of the guaranteed composition and that found by analysis.

AVERAGE COMPOSITION OF COMPLETE FERTILIZERS COLLECTED.

| | Per Cent Guaranteed. | | | Per Cent Found. | | | Average per cent found above guarantee. |
|---|---|---|---|---|---|---|---|
| | Lowest. | Highest. | Average. | Lowest. | Highest. | Average. | |
| Spring: | | | | | | | |
| Nitrogen ....... | 0.40 | 8.78 | 2.09 | 0.30 | 8.08 | 2.23 | 0.14 |
| Available phosphoric acid. .. | 1.93 | 0.11 | 7.63 | 0.83 | 19.68 | 8.44 | 0.81 |
| Insoluble phosphoric acid ... | ........ | ........ | ........ | 0.10 | 8.06 | 2.19 | ........ |
| Potash ......... | 0.14 | 19.00 | 4.30 | 0.08 | 15.58 | 4.57 | 0.27 |
| Water-soluble phosphoric acid .......... | ........ | ........ | ........ | 0.01 | 6.25 | 0.95 | ........ |
| Water-soluble nitrogen ...... | ........ | ........ | ........ | 0.20 | 12.47 | 4.97 | ........ |
| Fall: | | | | | | | |
| Nitrogen ........ | 0.41 | 5.00 | 1.53 | 0.58 | 4.89 | 1.69 | 0.16 |
| Available phosphoric acid ... | 3.00 | 11.00 | 8.52 | 3.81 | 12.78 | 9.22 | 0.70 |
| Insoluble phosphoric acid.... | ........ | ........ | ........ | 0.31 | 8.59 | 2.16 | ........ |
| Potash ......... | 1.00 | 15.00 | 3.74 | 0.58 | 16.52 | 3.92 | 0.18 |
| Water-soluble phosphoric acid .......... | ........ | ........ | ........ | 0.01 | 3.81 | 0.58 | ........ |
| Water-soluble nitrogen ...... | ........ | ........ | ........ | 0.65 | 9.08 | 5.75 | ........ |
| Average for year: | | | | | | | |
| Nitrogen ...... | ........ | ........ | 1.92 | ........ | ........ | 2.07 | 0.15 |
| Available phosphoric acid... | ........ | ........ | 7.90 | ........ | ........ | 8.67 | 0.77 |
| Insoluble phosphoric acid... | ........ | ........ | ........ | ........ | ........ | 2.18 | ........ |
| Potash ......... | ........ | ........ | 4.13 | ........ | ........ | 4.37 | 0.24 |
| Water-soluble phosphoric acid .......... | ........ | ........ | ........ | ........ | ........ | 0.84 | ........ |
| Water-soluble nitrogen ..... | ........ | ........ | ........ | ........ | ........ | 5.20 | ........ |

In the following tabulated statement we give the composition of the different kinds of incomplete fertilizers included in our year's collection.

AVERAGE COMPOSITION OF INCOMPLETE FERTILIZERS COLLECTED.

| CHEMICALS AND INCOMPLETE FERTILIZERS. | PER CENT GUARANTEED. | | | PER CENT FOUND. | | | Average per cent found above guarantee. |
|---|---|---|---|---|---|---|---|
| | Lowest. | Highest. | Average. | Lowest. | Highest. | Average. | |
| Nitrogen in | | | | | | | |
| Dried blood ..... | 12.35 | 12.35 | 12.35 | 13.49 | 13.49 | 13.49 | 1.14 |
| Phosphoric acid in dissolved phosphates: | | | | | | | |
| Available ....... | 10 | 16 | 13.18 | 10.88 | 17.32 | 14.27 | 1.09 |
| Insoluble........ | ........ | ........ | ........ | 0.36 | 4.78 | 2.05 | ........ |
| Water-soluble .. | ........ | ........ | ........ | 3.39 | 12.50 | 9.45 | ........ |
| Potash in | | | | | | | |
| Kainit.......... | 11 | 12 | 11.67 | 11.49 | 14.58 | 12.74 | 1.07 |
| Muriate......... | 50 | 50 | 50 | 49.36 | 50.84 | 50.10 | 0.10 |
| Bone meal and tankage: | | | | | | | |
| Nitrogen ....... | 1.35 | 8.20 | 3.24 | 1.34 | 7.94 | 3.57 | 0.35 |
| Phosphoric acid. | 6 | 25 | 18.50 | 9.40 | 30.09 | 20.28 | 1.78 |
| Mixtures containing phosphoric acid: | | | | | | | |
| Available....... | 5 | 13 | 10.10 | 6.15 | 15.33 | 11.05 | 0.95 |
| Insoluble ....... | ........ | ........ | ........ | 0.07 | 6.22 | 2.01 | ........ |
| Water-soluble... | ........ | ........ | ........ | 0.99 | 12.19 | 6.25 | ........ |
| Potash........... | 1 | 10 | 3.38 | 1.09 | 9.94 | 3.42 | 0.04 |

COMPARISON OF SELLING PRICE AND COMMERCIAL VALUATION.

Giving to the different constituents the values assigned in the schedule on page 36 for mixed fertilizers, 14 cents a pound for nitrogen, 5½ cents a pound for water-soluble phosphoric acid, 5 cents a pound for citrate-soluble phosphoric acid, 2 cents a pound for insoluble phosphoric acid, and 4½ cents a pound for potash, we can calculate the commercial valuation, or the price at which the separate unmixed materials contained in one ton of fertilizer having the composition indicated in the preceding table, could be purchased for cash at retail at the seaboard. Knowing the retail prices at which these goods were offered for sale, we can also readily estimate the difference between the actual selling price of the mixed goods and the retail cash cost of the unmixed materials; the difference covers the cost of mixing, freight, profits, etc. We present these data in the following table, including only complete fertilizers.

COMMERCIAL VALUATION AND SELLING PRICE OF COMPLETE FRTILIZERS.

| 1897. | Commercial Valuation of Complete Fertilizers. | | | Selling Price of One Ton of Complete Fertilizer. | | | Average increased cost of mixed materials over unmixed materials for one ton. |
|---|---|---|---|---|---|---|---|
| | Lowest. | Highest. | Average. | Lowest. | Highest. | Average. | |
| Spring .......... | $1 80 | $34 25 | $20 17 | $15 00 | $60 00 | $28 92 | $8 75 |
| Fall ............ | 11 26 | 29 28 | 18 92 | 15 00 | 40 00 | 25 25 | 6 33 |
| Average for year, | ........ | ........ | $19 75 | ........ | ........ | $27 70 | $7 95 |

In the following tabulated statement, we give a comparison of the selling price and commercial valuation for the various incomplete fertilizers collected during the year, using the prices given in the schedule on page 36 as our basis of calculation.

COMMERCIAL VALUATION AND SELLING PRICE OF INCOMPLETE FFRTILIZERS.

| CHEMICALS AND INCOMPLETE FERTILIZERS. | Commercial Valuation. | | | Selling Price. | | | Average increase of selling price over commercial valuation. |
|---|---|---|---|---|---|---|---|
| | Lowest. | Highest. | Average. | Lowest. | Highest. | Average. | |
| Dissolved phosphates............ | $12 43 | $19 27 | $15 90 | $11 00 | $26 50 | $16 40 | $0 50 |
| Kainit.............. | 10 34 | 13 12 | 11 47 | 12 00 | 15 00 | 14 00 | 2 53 |
| Muriate of potash.. | 44 42 | 45 79 | 45 10 | 38 00 | 40 00 | 39 00 | *6 10 |
| Bone-meal and tankage.............. | 16 00 | 36 80 | 29 74 | 20 00 | 50 00 | 28 55 | *1 19 |
| Mixtures containing phosphoric acid and potash...... | 9 02 | 22 43 | 15 58 | 13 00 | 32 00 | 21 04 | 5 46 |

*Selling price less than commercial valuation.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL.

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Armour Fertilizer Co., Chicago, Ill. | Ammoniated bone with potash. | Akron. | 4048 |
| Armour Fertilizer Co., Chicago, Ill. | Bone meal. | Akron. | 4047 |
| H. J. Baker & Bro., New York City. | Superphosphate of lime. | Weedsport. | 3956 |
| Bowker Fertilizer Co., Boston, Mass. | A. B. C. special. | Port Byron. | 3999 |
| Bowker Fertilizer Co., Boston, Mass. | Alkaline bone. | Gorham.<br>Newark. | 3865<br>3988 |
| Bowker Fertilizer Co., Boston, Mass. | Baldridge's Seneca queen. | MacDougall. | 3915 |
| Bowker Fertilizer Co., Boston, Mass. | Baldridge's Seneca County special. | MacDougall. | 3914 |
| Bowker Fertilizer Co., Boston, Mass. | Chemung Valley special. | Horseheads. | 3944 |
| Bowker Fertilizer Co., Boston, Mass. | Colgrove & Vann wheat special. | Willow Creek. | 3878 |
| Bowker Fertilizer Co., Boston, Mass. | Dissolved bone. | Wolcott. | 3967 |
| Bowker Fertilizer Co., Boston, Mass. | Grangers' special. | Clyde. | 3992 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.47 | 8 | 10 | 1.50 | —— | —— |
| Found | 3.09 | 9.49 | 12.43 | 3.80 | 0.76 | 5.43 |
| Guaranteed | 2.47 | 11 | 25 | —— | —— | —— |
| Found | 3.13 | 10.64 | 25.95 | | 0.39 | |
| Guaranteed | —— | 11 | —— | —— | —— | —— |
| Found | | 14.41 | 14.77 | | | 11.92 |
| Guaranteed | 2.47 | 7 | —— | 15 | —— | —— |
| Found | 2.22 | 6.59 | 10.19 | 16.52 | 1.43 | 3.16 |
| Below guarantee | 0.25 | 0.41 | | | | |
| Guaranteed | —— | 11 | —— | 1 | —— | —— |
| Found | | 10.86 | 17.08 | 1.20 | | 4.74 |
| Guaranteed | —— | 14 | —— | —— | —— | —— |
| Found | | 14 | 17.07 | | | 6.49 |
| Guaranteed | 0.75 | 10 | —— | 4 | —— | —— |
| Found | 0.99 | 11.37 | 12.64 | 4.11 | 0.08 | 7.39 |
| Guaranteed | 2.25 | 7 | —— | 8 | —— | —— |
| Found | 2.48 | 8.52 | 10.65 | 7.93 | 0.81 | 5.90 |
| Guaranteed | 0.75 | 8 | —— | 4 | —— | —— |
| Found | 0.91 | 9.48 | 11.63 | 4.31 | 0.32 | 5.63 |
| Guaranteed | —— | 13 | 15 | —— | —— | —— |
| Found | | 14.06 | 17.36 | | | 7.73 |
| Guaranteed | 0.82 | 8 | 10 | 4 | —— | —— |
| Found | 1.31 | 8.96 | 12.51 | 5.11 | 0.44 | 3.04 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Bowker Fertilizer Co., Boston, Mass. | Groveland special No. 2 for beans. | North Sparta. | 4028 |
| Bowker Fertilizer Co., Boston, Mass. | High grade wheat fertilizer. | North Sparta. | 4027 |
| Bowker Fertilizer Co., Boston, Mass. | Hopkins' special. | Canandaigua. | 3949 |
| Bowker Fertilizer Co., Boston, Mass. | Humphrey & Holdridge best grain phosphate. | Honeoye Falls. | 3900 |
| Bowker Fertilizer Co., Boston, Mass. | Humphrey & Holdridge best grain phosphate. | Honeoye Falls. | 3902 |
| Bowker Fertilizer Co., Boston, Mass. | Humphrey & Holdridge cabbage manure. | Honeoye Falls. | 3898 |
| Bowker Fertilizer Co., Boston, Mass. | Humphrey & Holdridge dissolved bone phosphate. | Honeoye Falls. | 3901 |
| Bowker Fertilizer Co., Boston, Mass. | Humphrey & Holdridge standard phosphate. | Honeoye Falls. | 3897 |
| Bowker Fertilizer Co., Boston, Mass. | Kinne's selected fertilizer. | Ovid. | 3887 |
| Bowker Fertilizer Co., Boston, Mass. | Potato manure. | Alton. | 3978 |
| Bowker Fertilizer Co., Boston, Mass. | Soluble bone. | Honeoye Falls.<br>Penn Yan.<br>Clyde. | 3899<br>3939<br>3991 |

lected in New York State During the Fall of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.75 | 7 | 9 | 9 | ——— | ——— |
| Found | 0.97 | 8.28 | 10.83 | 9.29 | 0.41 | 4.88 |
| Guaranteed | 1.50 | 10 | 12 | 5 | ——— | ——— |
| Found | 1.83 | 10.82 | 13.25 | 5.61* | 0.75 | 6.60 |
| Guaranteed | 1 | 10 | 11 | 4 | ——— | ——— |
| Found | 1.21 | 10.25 | 12.41 | 4.25 | 0.57 | 7.52 |
| Guaranteed | 1.23 | 10 | ——— | 6 | ——— | ——— |
| Found | 1.27 | 11.19 | 13.26 | 5.63 | 0.25 | 8.56 |
| Below guarantee | | | | 0.37 | | |
| Guaranteed | 1 | 10 | ——— | 6 | ——— | ——— |
| Found | 1.35 | 11.04 | 13.08 | 5.65 | 0.12 | 6.74 |
| Below guarantee | | | | 0.35 | | |
| Guaranteed | 2.25 | 7 | ——— | 8 | ——— | ——— |
| Found | 2.57 | 7.54 | 10.99 | 7.64 | 0.67 | 3.95 |
| Below guarantee | | | | 0.36 | | |
| Guaranteed | ——— | 14 | ——— | ——— | ——— | ——— |
| Found | | 14.52 | 16.57 | | | 12.50 |
| Guaranteed | 1 | 10 | ——— | 3 | ——— | ——— |
| Found | 1.36 | 10.83 | 12.88 | 2.82 | 0.09 | 7.54 |
| Guaranteed | 1 | 9 | ——— | 2.50 | ——— | ——— |
| Found | 1.31 | 10.18 | 12.28 | 2.86 | 0.41 | 6.50 |
| Guaranteed | 2.25 | 8 | 10 | 4 | ——— | ——— |
| Found | 2.10 | 9.07 | 13.31 | 4.28 | 0.89 | 5.03 |
| Guaranteed | ——— | 14 | ——— | ——— | ——— | ——— |
| Found. | | 14.48 | 17.22 | | | 5.48 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Bowker Fertilizer Co., Boston, Mass. | Special ammoniated bone. | Cato. | 3962 |
| Bowker Fertilizer Co., Boston, Mass. | Square brand bone and potash. | Port Byron. | 4000 |
| Bowker Fertilizer Co., Boston, Mass. | Stockbridge vine, squash, etc. | Port Byron. | 3998 |
| Bowker Fertilizer Co., Boston, Mass. | Yates' special. | Farmer. | 3884 |
| Bradley Fertilizer Co., Boston, Mass. | Alkaline bone. | Lockville. | 3987 |
| Bradley Fertilizer Co., Boston, Mass. | Farmers' new method. | Lockville. | 3985 |
| Bradley Fertilizer Co., Boston, Mass. | Fine ground bone. | Fayette.<br>Lockville. | 3920<br>3986 |
| Bradley Fertilizer Co., Boston, Mass. | Muriate of potash. | Fayette. | 3919 |
| Bradley Fertilizer Co., Boston, Mass. | Patent superphosphate of lime. | Jordan. | 3854 |
| Chemical Company of Canton, Baltimore, Md. | High grade standard guano. | East Lansing.<br>Himrods. | 3815<br>3927 |
| Chemical Company of Canton, Baltimore, Md. | Potato manure. | East Lansing. | 3813 |

lected in New York State During the Fall of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.50 | 7 | 8 | 1 | —— | —— |
| Found | 1.85 | 7.51 | 11.73 | 1.82 | 0.31 | 3.54 |
| Guaranteed | 1.50 | 6 | 12 | 2 | —— | —— |
| Found | 1.83 | 4.81 | 13.40 | 2.92 | 0.68 | 1.41 |
| Below guarantee | | 1.19 | | | | |
| Guaranteed | 5 | 3 | 5 | 4 | —— | —— |
| Found | 4.85 | 5.68 | 8.21 | 6.78 | 3.81 | 3.59 |
| Guaranteed | 1 | 9 | —— | 2.50 | —— | —— |
| Found | 1.14 | 10.32 | 12.10 | 2.62 | 0.32 | 6.54 |
| Guaranteed | —— | 11 | —— | 2.43 | —— | —— |
| Found | | 10.75 | 11.64 | 2.49 | | 6.13 |
| Below guarantee | | 0.25 | | | | |
| Guaranteed | 0.82 | 8 | 10 | 2.16 | —— | —— |
| Found | 1.23 | 9.69 | 12.34 | 2.33 | 0.40 | 3.99 |
| Guaranteed | 2.50 | —— | 21 | —— | —— | —— |
| Found | 3.15 | | 23.81 | | 0.61 | |
| Guaranteed | —— | —— | —— | 50 | —— | —— |
| Found | | | | 49.36 | | |
| Below guarantee | | | | 0.64 | | |
| Guaranteed | 2.05 | 8 | 10 | 1.50 | —— | —— |
| Found | 1.87 | 8.79 | 10.78 | 1.63 | 0.86 | 4.45 |
| Guaranteed | 2.05 | 9 | —— | 2.50 | —— | —— |
| Found | 2.21 | 8.79 | 10.93 | 2.49 | 0.92 | 6.48 |
| Below guarantee | | 0.21 | | | | |
| Guaranteed | 0.82 | 8 | 10 | 4 | —— | —— |
| Found | 0.88 | 7.57 | 9.39 | 5.43 | 0.01 | 1.32 |
| Below guarantee | | 0.43 | | | | |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Chemical Company of Canton, Baltimore, Md. | Special wheat, corn and grass mixture. | East Lansing. | 3814 |
| Clark's Cove Fertilizer Co., New York City. | Fayette special No. 2. | MacDougall. | 3916 |
| Clark's Cove Fertilizer Co., New York City. | Good acre potato, hop and tobacco grower. | Wallington. | 3979 |
| Clark's Cove Fertilizer Co., New York City. | Seneca Co. special. | MacDougall. | 3913 |
| Clark's Cove Fertilizer Co., New York City. | Triumph bone and potash. | East Lansing. | 3816 |
| Clark's Cove Fertilizer Co., New York City. | Unicorn ammoniated superphosphate. | Wallington. | 3980 |
| Cleveland Dryer Co., Cleveland, Ohio. | Forest city ammoniated superphosphate. | Cato.<br>Bergen. | 3963<br>4044 |
| E. Frank Coe Co., New York City. | Alkaline bone. | Aurora. | 3810 |
| E. Frank Coe Co., New York City. | Ammoniated bone special superphosphate. | Aurora. | 3807 |
| E. Frank Coe Co., New York City. | Ammoniated dissolved bone. | Canandaigua. | 3948 |
| E. Frank Coe Co., New York City. | Original ammoniated dissolved bone phosphate. | Batavia. | 4034 |

lected in New York State During the Fall of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.82 | 9 | 11 | 2 | —— | —— |
| Found | 1.32 | 10.09 | 15.89 | 1.46 | 0.19 | 4.97 |
| Below guarantee | | | | 0.54 | | |
| Guaranteed | —— | 12 | —— | 5 | —— | —— |
| Found | | 12.72 | 15.66 | 4.92 | | 7.02 |
| Guaranteed | 2.05 | 8 | 9 | 3 | —— | —— |
| Found | 2.14 | 9.13 | 13.66 | 3.24 | 0.43 | 3.02 |
| Guaranteed | 0.82 | 10 | —— | 4 | —— | —— |
| Found | 0.97 | 10.78 | 13.42 | 3.40* | 0.50 | 4.78 |
| Below guarantee | | | | 0.60 | | |
| Guaranteed | —— | 10 | 12 | 1 | —— | —— |
| Found | | 9.81 | 12.16 | 2 | | 2.09 |
| Guaranteed | 1.85 | 8.50 | 10 | 2.25 | —— | —— |
| Found | 1.94 | 9.41 | 13.02 | 1.81* | 0.59 | 4.97 |
| Below guarantee | | | | 0.44 | | |
| Guaranteed | 1.65 | 7 | 8 | 1 | —— | —— |
| Found | 1.86 | 8.25 | 10.67 | 1.37 | 0.68 | 6.51 |
| Guaranteed | 1 | 9 | 11 | 1.85 | —— | —— |
| Found | 1.43 | 11.06 | 13.41 | 2.03* | 0.69 | 8.21 |
| Guaranteed | 1.20 | 8 | 10 | 3 | —— | —— |
| Found | 1.41 | 9.51 | 12.28 | 3.28* | 0.66 | 6.98 |
| Guaranteed | 1.25 | 10 | —— | 2.25 | —— | —— |
| Found | 1.54 | 9.53 | 12.45 | 2.75* | 0.91 | 6.55 |
| Below guarantee | | 0.47 | | | | |
| Guaranteed | 1.25 | 10 | —— | 2.25 | —— | —— |
| Found | 1.35 | 9.93 | 12.69 | 3.28* | 0.72 | 6.88 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Acid phosphate. | Morganville. | 4038 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Allis' barley special. | Clifton Springs. | 3868 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Allis' wheat special. | Clifton Springs. | 3867 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Blood and animal matter. | Gasport. | 4055 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Complete wheat fertilizer. | Memphis. | 3858 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Dissolved bone phosphate. | Auburn. | 3842 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Dissolved bone and potash special. | Auburn. | 3840 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Dissolved rock. | Penn Yan. | 3934 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Eshelmann's special wheat. | Clarence Center. | 4050 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Grain and grass grower. | Auburn. | 3843 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Grain and grass grower. | Auburn. | 3844 |

lected in New York State During the Fall of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 13 | 14 | —— | —— | —— |
| Found | | 12.61 | 14.26 | | | 8.35 |
| Below guarantee | | 0.39 | | | | |
| Guaranteed | 0.82 | 8 | —— | 5 | —— | —— |
| Found | 1.15 | 9.35 | 9.86 | 5.36 | 0.04 | 5.24 |
| Guaranteed | 2 | 10 | —— | 2 | —— | —— |
| Found | 1.92 | 10.75 | 13.16 | 1.64 | 0.39 | 7.65 |
| Below guarantee | | | | 0.36 | | |
| Guaranteed | 8.20 | —— | 9 | —— | —— | —— |
| Found | 7.18 | 4.21 | 10.79 | | 0.20 | 0.34 |
| Below guarantee | 1.02 | | | | | |
| Guaranteed | 1.64 | 10 | 11 | 4 | —— | —— |
| Found | 1.32 | 12.34 | 14.87 | 3.28 | 0.14 | 8.91 |
| Below guarantee | 0.32 | | | 0.72 | | |
| Guaranteed | —— | 14 | 15 | —— | —— | —— |
| Found | | 15.23 | 16.55 | | | 10.75 |
| Guaranteed | —— | 10 | —— | 2 | —— | —— |
| Found | | 8.98 | 10.04 | 2.45 | | 3.95 |
| Below guarantee | | 1.02 | | | | |
| Guaranteed | —— | 14 | —— | —— | —— | —— |
| Found | | 14.11 | 15.38 | | | 10.23 |
| Guaranteed | 1.23 | 8 | —— | 3 | —— | —— |
| Found | 1.53 | 9.14 | 10.29 | 3.19 | 0.15 | 5.86 |
| Guaranteed | 0.82 | 7 | 8 | 1.08 | —— | —— |
| Found | 0.90 | 7.02 | 8.12 | 1.09 | 0.05 | 3.02 |
| Guaranteed | 2 | 10 | 13 | 1.60 | —— | —— |
| Found | 1.78 | 10.83 | 13.17 | 1.83 | 0.66 | 6.97 |
| Below guarantee | 0.22 | | | | | |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Ground bone meal. | Auburn. | 3839 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Hanlon Bros. special fertilizer. | Medina. | 4056 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | High-grade ammoniated wheat special. | MacDougall. | 3918 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Landon's dissolved bone with potash. | Poplar Ridge. | 3804 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Phosphoric acid and potash. | Auburn. | 3841 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Potash salts. | Morganville. | 4039 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Pure ground blood. | Gasport. | 4054 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Special high-grade ammoniated phosphate. | Poplar Ridge. | 3803 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Special high-grade wheat fertilizer. | Clyde. | 3990 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Special wheat. | East Bloomfield. | 3951 |
| Crocker Fertilizer & Chemical Co., Buffalo, N. Y. | Special wheat grower. | Weedsport. | 3960 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2 | — | 25 | — | — | — |
| Found | 1.84 | | 30.09 | | 0.21 | |
| Guaranteed | 0.82 | 10 | — | 8.10 | — | — |
| Found | 0.96 | 10.49 | 12.51 | 7.47 | 0.64 | 7.05 |
| Below guarantee | | | | 0.63 | | |
| Guaranteed | 0.82 | 10 | — | 4 | — | — |
| Found | 1.06 | 10.71 | 11.64 | 4.19 | 0.39 | 7.65 |
| Guaranteed | — | 10 | — | 2 | — | — |
| Found | | 9.77 | 10.83 | 1.46 | | 5.41 |
| Below guarantee | | 0.23 | | 0.54 | | |
| Guaranteed | — | 10 | 11 | 5.40 | — | — |
| Found | | 12.17 | 13.29 | 4.63 | | 7.81 |
| Below guarantee | | | | 0.77 | | |
| Guaranteed | — | — | — | 50 | — | — |
| Found | | | | 50.84 | | |
| Guaranteed | 12.35 | — | — | — | — | — |
| Found | 13.49 | | | | | |
| Guaranteed | 1.64 | 8 | 9 | 3 | — | — |
| Found | 1.98 | 8.14 | 10.57 | 4.07 | 0.15 | 5.48 |
| Guaranteed | 1.65 | 10 | — | 5 | — | — |
| Found | 2.58 | 9.91 | 10.93 | 3.30 | 1.33 | 7.66 |
| Below guarantee | | | | 1.70 | | |
| Guaranteed | 1.64 | 8 | — | 3 | — | — |
| Found | 2.09 | 8.55 | 9.68 | 2.84 | 0.05 | 5.65 |
| Guaranteed | 2 | 8 | 9 | 3.25 | — | — |
| Found | 2.44 | 9.76 | 12.04 | 5.86 | 0.14 | 6.30 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Crocker Fertilizer Co., Buffalo, N. Y. | Tompkins County guano special. | East Lansing. | 3819 |
| Crocker Fertilizer Co., Buffalo, N. Y. | Toynbee Bros. special wheat and rye. | Bowmansville. | 4052 |
| Crocker Fertilizer Co., Buffalo, N. Y. | Vegetable bone superphosphate. | Gasport. | 4053 |
| Crocker Fertilizer Co., Buffalo, N. Y. | Webster ammoniated superphosphate. | Webster. | 4013 |
| Crocker Fertilizer Co., Buffalo, N. Y. | Webster high-grade superphosphate. | Webster. | 4014 |
| Crocker Fertilizer Co., Buffalo, N. Y. | Yates special fertilizer. | Farmer. | 3883 |
| E. A. Cross, Hilton, N. Y. | King superphosphate. | Hilton. | 4062 |
| E. A. Cross, Hilton, N. Y. | Queen superphosphate. | Hilton. | 4061 |
| E. A. Cross, Hilton, N. Y. | Parma superphosphate. | Hilton. | 4060 |
| Cumberland Bone Phosphate Co., Portland, Me. | Bone and potash. | Ithaca. | 3820 |
| Cumberland Bone Phosphate Co., Portland, Me. | Concentrated phosphate. | North Rose. | 3977 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.03 | 9 | 10 | 2.50 | —— | —— |
| Found | 1.26 | 9.09 | 12.94 | 2.17 | 0.27 | 6 47 |
| Below guarantee | | | | 0.33 | | |
| Guaranteed | 1.23 | 10 | —— | 3 | —— | —— |
| Found | 0.97 | 9.70 | 10.72 | 4.47 | 0.34 | 6.04 |
| Below guarantee | 0.26 | 0.30 | | | | |
| Guaranteed | 5 | 6 | —— | 5.94 | —— | —— |
| Found | 4.89 | 6.90 | 7.52 | 6.87 | 1.07 | 5.63 |
| Guaranteed | 1.23 | 8 | —— | 4 | —— | —— |
| Found | 1.30 | 9.98 | 11.34 | 3.37 | 0.08 | 7.46 |
| Below guarantee | | | | 0.63 | | |
| Guaranteed | 1.85 | 8 | —— | 4 | —— | —— |
| Found | 2.16 | 9.23 | 11.36 | 4.08 | 0.30 | 6.53 |
| Guaranteed | 1.03 | 9 | —— | 2.50 | —— | —— |
| Found | 1.20 | 9.62 | 12.32 | 2.76 | 0.38 | 6.16 |
| Guaranteed | 2.35 | 8 | 10.25 | 3.40 | —— | —— |
| Found | 2.45 | 7.37 | 10.24 | 3.80* | 1.45 | 3.78 |
| Below guarantee | | 0.63 | | | | |
| Guaranteed | 2 | 8 | 10 | 3 | —— | —— |
| Found | 2.06 | 7.27 | 10.27 | 3.81 | 1.20 | 3.21 |
| Below guarantee | | 0.73 | | | | |
| Guaranteed | 1.65 | 8 | 9.50 | 3.20 | —— | —— |
| Found | 1.69 | 8.44 | 10.37 | 3.42 | 0.99 | 4.22 |
| Guaranteed | —— | 8 | 10 | 2.50 | —— | —— |
| Found | | 9 | 10.70 | 2.48 | | 4.26 |
| Guaranteed | 3.20 | 8 | 10 | 7 | —— | —— |
| Found | 3.28 | 7.83 | 10.25 | 6.51 | 1.50 | 3.32 |
| Below guarantee | | | | 0.49 | | |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Cumberland Bone Phosphate Co., Portland, Me. | Superphosphate. | North Rose. | 3976 |
| L. B. Darling Fertilizer Co., Pawtucket, R. I. | Animal fertilizer. | Moravia. | 3832 |
| Detrick Fertilizer Co., Baltimore, Md. | Ammoniated bone phosphate. | Rochester. | 4010 |
| Detrick Fertilizer Co., Baltimore, Md. | Imperial compound. | Rochester. | 4009 |
| Detrick Fertilizer Co., Baltimore, Md. | Potato fertilizer. | Rochester. | 4011 |
| Detrick Fertilizer Co., Baltimore, Md. | Soluble bone phosphate and potash. | Rochester. | 4012 |
| Louis F. Detrick, Baltimore, Md. | XXTRA acid phosphate. | Poplar Ridge. | 3806 |
| W. S. Farmer & Co., Baltimore, Md. | Clyde brand. | East Lansing. | 3812 |
| W. S. Farmer & Co., Baltimore, Md. | Harvest queen phosphate. | East Lansing. | 3811 |
| Carlton G. Fisher, Darien Center, N. Y. | Reliance brand. | Darien Center. | 4033 |
| Geneva Coal Co., Geneva, N. Y. | Dissolved bone and potash. | Geneva. | 3911 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer |
|---|---|---|---|---|---|---|
| Guaranteed | 2.05 | 8 | 10 | 2 | —— | —— |
| Found | 2.21 | 8.93 | 11.57 | 2 | 0.48 | 4.87 |
| Guaranteed | 3.30 | 6 | 10 | 4 | —— | —— |
| Found | 3.43 | 7.22 | 13.56 | 4.44 | 1.23 | 2.83 |
| Guaranteed | 1.23 | 9 | 11 | 1 | —— | —— |
| Found | 1.35 | 8.94 | 11.58 | 1.13 | 0.33 | 4.98 |
| Guaranteed | 0.82 | 9 | 10.50 | 1 | —— | —— |
| Found | 0.90 | 8.92 | 11.25 | 1.20 | 0.23 | 5.21 |
| Guaranteed | 2.06 | 8 | 9 | 4 | —— | —— |
| Found | 2.02 | 8.62 | 10.62 | 4.34 | 0.72 | 4.84 |
| Guaranteed | —— | 10 | 11 | 2 | —— | —— |
| Found | | 9.82 | 15.88 | 2.42 | | 4.08 |
| Guaranteed | —— | 14 | 14.75 | —— | —— | —— |
| Found | | 15.58 | 16.50 | | | 12 |
| Guaranteed | 0.82 | 9 | 10 | 2.50 | —— | —— |
| Found | 0.87 | 9.61 | 10.24 | 1.83 | 0.23 | 6.81 |
| Below guarantee | | | | 0.67 | | |
| Guaranteed | 1.23 | 10 | —— | 2.50 | —— | —— |
| Found | 1.19 | 9.64 | 10.61 | 2.37 | 0.43 | 7.24 |
| Below guarantee | | 0.36 | | | | |
| Guaranteed | 1.65 | 9 | 11 | 2 | —— | —— |
| Found | 1.73 | 8.95 | 11.23 | 2.35 | 0.58 | 5.58 |
| Guaranteed | —— | 13 | —— | 3 | —— | —— |
| Found | | 15.06 | 15.13 | 3.15 | | 11.76 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Geneva Coal Co., Geneva, N. Y. | Dissolved bone phosphate. | Geneva. | 3873 |
| Geneva Coal Co., Geneva, N. Y. | Early trucker for onions. | Geneva. | 3875 |
| Geneva Coal Co., Geneva, N. Y. | Harvest king. | Geneva. | 3910 |
| Geneva Coal Co., Geneva, N. Y. | Mortgage raiser. | Geneva. | 3872 |
| Geneva Coal Co., Geneva, N. Y. | New York standard wheat grower. | Geneva. | 3869 |
| Geneva Coal Co., Geneva, N. Y. | Oats and barley special. | Geneva. | 3870 |
| Geneva Coal Co., Geneva, N. Y. | Reclaimer animal bone fertilizer. | Geneva. | 3871 |
| Geneva Coal Co., Geneva, N. Y. | Standard corn and potato manure. | Geneva. | 3874 |
| Great Eastern Fertilizer Co., New York City. | General wheat special. | Union Springs.<br>Oakfield. | 3793<br>4035 |
| Great Eastern Fertilizer Co., New York City. | Northern corn special. | Jordan. | 3853 |
| [illegible]a C. Hall, Farmer, N. Y. | Black diamond guano. | Farmer. | 3880 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 14 | 15 | —— | —— | —— |
| Found | | 15.35 | 16.02 | | | 11.06 |
| Guaranteed | 3.30 | 7 | —— | 8 | —— | —— |
| Found | 3.02 | 6.81 | 8.96 | 8.88 | 1.65 | 3.48 |
| Below guarantee | 0.28 | | | | | |
| Guaranteed | 0.82 | 9 | —— | 2 | —— | —— |
| Found | 1.02 | 9.57 | 10.89 | 2.29 | 0.56 | 5.24 |
| Guaranteed | 0.82 | 10 | —— | 8 | —— | —— |
| Found | 0.84 | 10.46 | 11.25 | 7.92 | 0.53 | 7.62 |
| Guaranteed | 1.65 | 9 | —— | 2 | —— | —— |
| Found | 1.70 | 9.72 | 11.02 | 2.33 | 0.68 | 6.88 |
| Guaranteed. | 0.82 | 8 | —— | 4 | —— | —— |
| Found | 0.84 | 9.36 | 10.38 | 4.29 | 0.47 | 6.88 |
| Guaranteed | 1.85 | 9 | —— | 4 | —— | —— |
| Found | 1.99 | 10.15 | 14.16 | 4.18 | 0.76 | 7.25 |
| Guaranteed | 2.47 | 7 | —— | 8 | —— | —— |
| Found | 2.45 | 7.30 | 9.27 | 7.80 | 1.12 | 5.63 |
| Guaranteed | 1.60 | 8 | —— | 2 | —— | —— |
| Found | 1.90 | 9.69 | 11.88 | 2.23* | 0.57 | 5.96 |
| Guaranteed | 2.47 | 8 | 9 | 2 | —— | —— |
| Found | 2.30 | 9.57 | 13.31 | 2.29 | 0.28 | 7.21 |
| Guaranteed | 1.85 | 9 | —— | 4 | —— | —— |
| Found | 1.87 | 9.94 | 11.21 | 4.39 | 0.87 | 7.54 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Ira C. Hall, Farmer, N. Y. | Home rule. | Farmer. | 3882 |
| Ira C. Hall, Farmer, N. Y. | Seneca chief. | Farmer. | 3881 |
| Ira C. Hall, Farmer, N. Y. | Special wheat grower. | Farmer. | 3879 |
| J. S. Hewitt & Sons, Locke, N. Y. | Cayuga Co. pride fertilizer. | Locke. | 3828 |
| J. S. Hewitt & Sons, Locke, N. Y. | Special grain and grass fertilizer. | Locke. | 3827 |
| C. C. Hicks, Penn Yan, N. Y. | Cook's special. | Penn Yan. | 3929 |
| C. C. Hicks, Penn Yan, N. Y. | Guaranteed animal bone fertilizer. | Penn Yan. | 3931 |
| C. C. Hicks, Penn Yan, N. Y. | Ontario wheat special. | Penn Yan. | 3943 |
| C. C. Hicks, Penn Yan, N. Y. | Prolific fertilizer. | Penn Yan. | 3932 |
| C. C. Hicks, Penn Yan, N. Y. | Soluble bone. | Penn Yan. | 3933 |
| C. C. Hicks, Penn Yan, N. Y. | Standard guano. | Penn Yan. | 3930 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water soluble potash in 100 pounds of fertilizer. | Pounds of water soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.83 | 9 | —— | 2.50 | —— | —— |
| Found | 0.96 | 9.46 | 10.72 | 2.63 | 0.46 | 6.51 |
| Guaranteed | 1.85 | 9 | —— | 4 | —— | —— |
| Found | 2.09 | 9.81 | 13.44 | 4.33 | 0.78 | 7.41 |
| Guaranteed | 1.65 | 9 | —— | 2 | —— | —— |
| Found | 1.68 | 10.17 | 11.06 | 2.27 | 0.69 | 7.04 |
| Guaranteed | 1.85 | 8 | 9 | 4 | —— | —— |
| Found | 1.88 | 9.68 | 12.21 | 4.16 | 0.11 | 6.81 |
| Guaranteed | 0.82 | 8 | 9 | 4 | —— | —— |
| Found | 1.02 | 9.10 | 10.46 | 4.14 | 0.26 | 6.13 |
| Guaranteed | 0.82 | 8 | —— | 4 | —— | —— |
| Found | 0.80 | 9.39 | 10.41 | 4.27 | 0.45 | 6.73 |
| Guaranteed | 1.85 | 9 | —— | 4 | —— | —— |
| Found | 2.06 | 9.99 | 14.03 | 4.27 | 0.83 | 7.52 |
| Guaranteed | 1.65 | 10 | —— | 5 | —— | —— |
| Found | 1.82 | 11.02 | 11.96 | 5 | 0.90 | 8.68 |
| Guaranteed | 0.82 | 10 | —— | 8 | —— | —— |
| Found | 0.83 | 10.63 | 11.53 | 8.11 | 0.54 | 8.12 |
| Guaranteed | —— | 14 | —— | —— | —— | —— |
| Found | | 13.72 | 16.52 | | | 9.78 |
| Below guarantee | | 0.28 | | | | |
| Guaranteed | 1.23 | 10 | —— | 3 | —— | —— |
| Found | 1.49 | 10.29 | 11.20 | 3.09 | 0.91 | 8.42 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Lazaretto Guano Co., Baltimore, Md. | Alkaline dissolved bone phosphate. | Bergen. | 4045 |
| Lazaretto Guano Co., Baltimore, Md. | Dissolved bone and potash. | Bergen. | 4046 |
| Lazaretto Guano Co., Baltimore, Md. | New York Standard No. 2. | Bowmansville. | 4051 |
| Liebig Manufacturing Co., Carteret, N. J. | Dissolved bone. | Moravia. | 3830 |
| Liebig Manufacturing Co., Carteret, N. J. | High-grade bone and potash. | Union Springs. | 3796 |
| Liebig Manufacturing Co., Carteret, N. J. | Standard phosphate. | Union Springs. | 3795 |
| Liebig Manufacturing Co., Carteret, N. J. | T. & F. bone and potash. | Moravia. | 3829 |
| Lister Agr'l Chemical Works, Newark, N. J. | Animal bone and potash No. 2. | Pittsford. | 4001 |
| Lister Agr'l Chemical Works Newark, N. J. | Pontius' ammoniated dissolved bone and potash. | Kendaia. | 3892 |
| Locke Fertilizer Co., Locke, N. Y. | Farmers' favorite. | Locke. | 3824 |
| Locke Fertilizer Co., Locke, N. Y. | Full value animal bone. | Locke. | 3825 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 13 | —— | 3 | —— | —— |
| Found | | 15.[illegible] | 15.55 | 3.34 | | 12.19 |
| Guaranteed | —— | 10 | | 2 | —— | —— |
| Found | | 11.61 | 12.74 | 2.24 | | 8.01 |
| Guaranteed | 1.23 | 10 | —— | 3 | —— | —— |
| Found | 1.31 | 10.35 | 11.17 | 3.36 | 0.71 | 8.44 |
| Guaranteed | —— | 14 | —— | —— | —— | —— |
| Found | | 16.21 | 17.27 | | | 12.46 |
| Guaranteed | —— | 10 | —— | 5 | —— | —— |
| Found | | 13.12 | 15.41 | 4.19 | | 2.84 |
| Below guarantee | | | | 0.81 | | |
| Guaranteed | 1.25 | 10 | —— | 2.50 | —— | —— |
| Found | 1.58 | 12.78 | 14.98 | 2.32 | 0.78 | 1.03 |
| Guaranteed | —— | 13 | —— | 5 | —— | —— |
| Found | | 13.46 | 14.91 | 6.19 | | 10.04 |
| Guaranteed | —— | 9 | 10 | 3 | —— | —— |
| Found | | 9.70 | 10.42 | 3.91 | | 5.85 |
| Guaranteed | 0.82 | 8 | —— | 4 | —— | —— |
| Found | 1 | 8.76 | 10.40 | 3.87* | 0.60 | 6.62 |
| Guaranteed | 1.23 | 10 | —— | 3 | —— | —— |
| Found | 1.37 | 10.26 | 11.21 | 2.94 | 0.77 | 8.63 |
| Guaranteed | 1.85 | 9 | —— | 4 | —— | —— |
| Found | 2.10 | 11.03 | 14.77 | 4.18 | 0.76 | 7.56 |

*Potash present in form of sulphate

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Locke Fertilizer Co., Locke, N. Y. | Good enough fertilizer. | Locke. | 3823 |
| Locke Fertilizer Co., Locke, N. Y. | Imperial superphosphate. | Locke. | 3826 |
| Lowell Fertilizer Co., Lowell, Mass. | Animal brand. | Gorham. | 3907 |
| Lowell Fertilizer Co., Lowell, Mass. | Bone fertilizer for corn and grain. | Gorham. | 3908 |
| Lowell Fertilizer Co., Lowell, Mass. | Empire brand. | Moravia.<br>Gorham. | 3831<br>3906 |
| Lowell Fertilizer Co., Lowell, Mass. | Fruit and vine. | Manchester. | 3922 |
| Frederick Ludlam, New York City. | Acid phosphate. | Skaneateles. | 3851 |
| Frederick Ludlam, New York City. | Cereal brand. | Moravia. | 3837 |
| Frederick Ludlam, New York City. | Dragon's tooth brand. | Moravia. | 3838 |
| Frederick Ludlam, New York City. | P. G. brand. | Moravia. | 3836 |
| Maryland Fertilizing and Manufacturing Co., Baltimore, Md. | A. E. fertilizer. | East Lansing.<br>Fairport. | 3817<br>4021 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.85 | 9 | —— | 4 | —— | —— |
| Found | 1.87 | 9.33 | 10.79 | 4.27 | 0.88 | 7.61 |
| Guaranteed | 1.85 | 9 | —— | 2 | —— | —— |
| Found | 1.69 | 10.32 | 11.46 | 2.27 | 0.77 | 7.34 |
| Guaranteed | 2.46 | 9 | —— | 4 | —— | —— |
| Found | 2.49 | 9.34 | 10.79 | 3.90* | 1.28 | 6.39 |
| Guaranteed | 1.65 | 8 | —— | 3 | —— | —— |
| Found | 1.69 | 7.99 | 8.95 | 4.22 | 0.83 | 3.31 |
| Guaranteed | 1.23 | 7 | —— | 2 | —— | —— |
| Found | 1.36 | 7.71 | 9.41 | 2.21 | 0.78 | 4.96 |
| Guaranteed | 2.47 | 7 | —— | 6 | —— | —— |
| Found | 2.62 | 7.25 | 8.47 | 6.54* | 0.84 | 5.40 |
| Guaranteed | —— | 14 | 15 | —— | —— | —— |
| Found | | 15.32 | 17.50 | | | 9.38 |
| Guaranteed | 0.75 | 8 | 10 | 1 | —— | —— |
| Found | 0.90 | 9.25 | 14.36 | 1.16 | 0.23 | 3.62 |
| Guaranteed | 3 | 7 | —— | 7 | —— | —— |
| Found | 3.35 | 10.75 | 12.92 | 6.79 | 1.55 | 8.71 |
| Below guarantee | | | | 0.21 | | |
| Guaranteed | —— | 10 | 11 | 6 | —— | —— |
| Found | | 11.29 | 13.54 | 4.96 | | 7.25 |
| Below guarantee | | | | 1.04 | | |
| Guaranteed | —— | 9 | —— | 2.50 | —— | —— |
| Found | | 11.22 | 12.71 | 2.68 | | 7.38 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Maryland Fertilizing and Manufacturing Co., Baltimore, Md. | Alkaline bone. | Fairport. | 4022 |
| Maryland Fertilizing and Manufacturing Co., Baltimore, Md. | Bone superphosphate | Fairport. | 4020 |
| Maryland Fertilizing and Manufacturing Co., Baltimore, Md. | Linden superphosphate. | Elbridge. | 3852 |
| Maryland Fertilizing and Manufacturing Co., Baltimore, Md. | Sangston's cereal plant food. | Fairport. | 4019 |
| Maryland Fertilizing and Manufacturing Co., Baltimore, Md. | Tornado. | Fairport. | 4018 |
| Michigan Carbon Works, Detroit, Mich. | Banner dissolved bone. | MacDougall. | 3917 |
| Michigan Carbon Works, Detroit, Mich. | Homestead fertilizer. | Cato. | 3961 |
| Miller Fertilizer Co., Baltimore, Md. | A. Baldridge's Seneca queen. | MacDougall. | 3912 |
| Miller Fertilizer Co., Baltimore, Md. | Ground bone. | Moravia. | 3834 |
| Miller Fertilizer Co., Baltimore, Md. | Harvest queen phosphate. | Moravia. | 3835 |
| Miller Fertilizer Co., Baltimore, Md. | S. C. bone. | Moravia. | 3833 |

lected in New York State During the Fall of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer |
|---|---|---|---|---|---|---|
| Guaranteed | ——— | 11.75 | 12 | 3.50 | ——— | ——— |
| Found | | 12.96 | 13.85 | 3.45 | | 9.22 |
| Guaranteed | ——— | 10 | 11 | 2 | ——— | ——— |
| Found | | 12.88 | 14.09 | 1.49 | | 9.95 |
| Below guarantee | | | | 0.51 | | |
| Guaranteed | ——— | 11 | 12 | 1.50 | ——— | ——— |
| Found | | 10.80 | 13.08 | 2.26 | | 7.17 |
| Guaranteed | 1.03 | 10 | 11 | 2.25 | ——— | ——— |
| Found | 1.11 | 10.55 | 14.22 | 2.14 | 0.68 | 6.40 |
| Guaranteed | 0.41 | 11 | 12 | 3.25 | ——— | ——— |
| Found | 0.58 | 11.31 | 13.35 | 3.84 | 0.12 | 8.40 |
| Guaranteed | ——— | 30 | 34 | ——— | ——— | ——— |
| Found | | 27 | 35.42 | | | 0.48 |
| Below guarantee | | 3 | | | | |
| Guaranteed | 1.85 | 8 | ——— | 1.50 | ——— | ——— |
| Found | 2.26 | 10.63 | 11.38 | 2.33 | 0.95 | 8.20 |
| Guaranteed | ——— | 14 | ——— | ——— | ——— | ——— |
| Found | | 15.22 | 16.47 | | | 11.31 |
| Guaranteed | 2.47 | ——— | 15 | ——— | ——— | ——— |
| Found | 2.86 | | 18.47 | | 0.77 | 3.68 |
| Guaranteed | 1 | 10 | 11.50 | 2.25 | ——— | ——— |
| Found | 1.08 | 10.52 | 11.80 | 2.50 | 0.23 | 7.21 |
| Guaranteed | ——— | 14 | ——— | ——— | ——— | ——— |
| Found | | 15.26 | 16.55 | | | 11.13 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Milsom Rendering & Fertilizer Co., Buffalo, N. Y. | Acid phosphate. | Gorham. | 3866 |
| Milsom Rendering & Fertilizer Co., Buffalo, N. Y. | Ammoniated bone and potash. | Canandaigua. | 3947 |
| Milsom Rendering & Fertilizer Co., Buffalo, N. Y. | Buckwheat special fertilizer. | Wolcott. | 3975 |
| Milsom Rendering & Fertilizer Co., Buffalo, N. Y. | Cyclone pure bone meal. | Auburn. | 3845 |
| Milsom Rendering & Fertilizer Co., Buffalo, N. Y. | Grain special No. 1. | Canandaigua. | 3945 |
| Milsom Rendering & Fertilizer Co., Buffalo, N. Y. | Grain special No. 2. | Canandaigua. | 3946 |
| Milsom Rendering & Fertilizer Co., Buffalo, N. Y. | Noonan's dissolved bone and potash. | East Avon. | 4031 |
| Milsom Rendering & Fertilizer Co., Buffalo, N. Y. | Noonan's special. | East Avon. | 4032 |
| Milsom Rendering & Fertilizer Co., Buffalo, N. Y. | Perry's special dissolved bone with potash. | West Henrietta. | 3955 |
| Milsom Rendering & Fertilizer Co., Buffalo, N. Y. | Weed's wheat special. | Clyde. | 3997 |
| Geo. L. Munroe, Oswego, N. Y. | Pure Canada hard wood ashes. | Moscow. | 4025 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water soluble potash in 100 pounds of fertilizer. | Pounds of water soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 13 | —— | —— | —— | —— |
| Found | | 13.63 | 14.30 | | | 8.48 |
| Guaranteed | 2.46 | 8 | 11 | 7 | —— | —— |
| Found | 1.90 | 7.87 | 9.83 | 6.42* | 0.67 | 6.06 |
| Below guarantee | 0.56 | | | 0.58 | | |
| Guaranteed | 0.82 | 7 | 9 | 1.08 | —— | —— |
| Found | 0.97 | 8.38 | 10.35 | 1.16 | 0.60 | 6.31 |
| Guaranteed | 2.46 | —— | 24 | —— | —— | —— |
| Found | 2.65 | | 24.14 | | 0.40 | |
| Guaranteed | 1 | 10 | 11 | 6 | —— | —— |
| Found | 0.91 | 9.71 | 11.27 | 4.93 | 0.23 | 7.40 |
| Below guarantee | | 0.29 | | 1.07 | | |
| Guaranteed | 1.25 | 10 | 11 | 4 | —— | —— |
| Found | 1.30 | 9.22 | 11.05 | 4.61 | 0.80 | 7.13 |
| Below guarantee | | 0.78 | | | | |
| Guaranteed | —— | 10 | —— | 8 | —— | —— |
| Found | | 10.05 | 10.38 | 6.77 | | 5.65 |
| Below guarantee | | | | 1.23 | | |
| Guaranteed | —— | 12 | —— | 4 | —— | —— |
| Found | | 10.78 | 11.18 | 3.31 | | 6.07 |
| Below guarantee | | 1.22 | | 0.69 | | |
| Guaranteed | —— | 12 | 14 | 3 | —— | —— |
| Found | | 12.91 | 13.25 | 2.95 | | 8.22 |
| Guaranteed | 1.64 | 4 | 5 | 4 | —— | —— |
| Found | 1.75 | 3.81 | 5.67 | 3.97 | 0.32 | 2.35 |
| Guaranteed | —— | —— | 1 | 4.50 | —— | —— |
| Found | | | 1.46 | 4.72 | | |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Niagara Fertilizer Co., Buffalo, N. Y. | Brophel's special standard wheat fertilizer. | Moscow. | 4024 |
| Niagara Fertilizer Co., Buffalo, N. Y. | Brophel's standard brand wheat fertilizer No. 2. | Moscow. | 4023 |
| Niagara Fertilizer Works, Buffalo, N. Y. | Special wheat fertilizer No. 1. | Shortsville. | 3876 |
| Niagara Fertilizer Works, Buffalo, N. Y. | Special wheat fertilizer No. 1. | Shortsville. | 3877 |
| Niagara Fertilizer Works, Buffalo, N. Y. | Wheat special. | Waterloo | 3861 |
| Oakfield Fertilizer Co., Buffalo, N. Y. | Domestic. | Locke. | 3822 |
| Oakfield Fertilizer Co., Buffalo, N. Y. | Genesee Co. wheat grower. | Oakfield. | 4037 |
| Oakfield Fertilizer Co., Buffalo, N. Y. | Special corn and wheat manure. | Oakfield. | 4036 |
| Oakfield Fertilizer Co., Buffalo, N. Y. | Special hop "A." | Sodus. | 3982 |
| Oakfield Fertilizer Co., Buffalo, N. Y. | Standard fertilizer. | Sodus Center. | 3981 |
| Pacific Guano Co., New York City. | Dissolved bone phosphate of lime. | Wolcott. | 3974 |

lected in New York State During the Fall of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.82 | 8 | ——— | 2 | ——— | ——— |
| Found | 0.91 | 8.59 | 9.86 | 2.64 | 0.37 | 4.98 |
| Guaranteed | 2.10 | 8 | ——— | 2 | ——— | ——— |
| Found | 2.22 | 8.19 | 9.55 | 2.22 | 0.55 | 4.88 |
| Guaranteed | 1.64 | 8 | ——— | 3.25 | ——— | ——— |
| Found | 1.70 | 8.29 | 10.47 | 3.31 | 0.19 | 5.39 |
| Guaranteed | ——— | 12 | ——— | 2.16 | ——— | ——— |
| Found | | 12.03 | 15.30 | 2.51 | | 9.30 |
| Guaranteed | 0.82 | 10 | ——— | 3 | ——— | ——— |
| Found | 1.14 | 10.37 | 13.02 | 3.93 | 0.20 | 7.22 |
| Guaranteed | 1.65 | 8 | 9 | 1.08 | ——— | ——— |
| Found | 2.10 | 9.51 | 11.05 | 1.40 | 0.38 | 5.57 |
| Guaranteed | 1 | 10 | ——— | 5 | ——— | ——— |
| Found | 1.02 | 11.36 | 12.09 | 5.07 | 0.05 | 7.31 |
| Guaranteed | 3.70 | 8 | ——— | 6 | ——— | ——— |
| Found | 3.78 | 7.83 | 9.45 | 6.63 | 0.90 | 3.26 |
| Guaranteed | 0.82 | 6 | 8 | 6.50 | ——— | ——— |
| Found | 0.76 | 6.55 | 7.92 | 6.16 | 0.06 | 1.51 |
| Below guarantee | | | | 0.34 | | |
| Guaranteed | 2.47 | 10 | 11 | 1.62 | ——— | ——— |
| Found | 2.97 | 11.30 | 12.38 | 2.35 | 2.15 | 5.20 |
| Guaranteed | ——— | 12 | 13 | ——— | ——— | ——— |
| Found | | 13.74 | 15.76 | | | 9.86 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Pacific Guano Co., New York City. | Potato, tobacco and hop fertilizer. | Wolcott. | 3973 |
| Pacific Guano Co., New York City. | Special for potatoes and tobacco. | Pembroke. | 4049 |
| Packers' Union Fertilizer Co., New York City. | High-grade universal fertilizer. | Union Springs. | 3792 |
| Packers' Union Fertilizer Co., New York City. | Oats and clover fertilizer. | Baldwinsville. | 3860 |
| Packers' Union Fertilizer Co., New York City. | Old Abe universal fertilizer. | Baldwinsville. | 3859 |
| Patapsco Guano Co., Baltimore, Md. | Alkaline soluble bone. | Mandana. | 3850 |
| Patapsco Guano Co., Baltimore, Md. | Animal bone and potash. | Ovid. | 3888 |
| Patapsco Guano Co., Baltimore, Md. | Bone and potash compound. | Weedsport. | 3958 |
| Patapsco Guano Co., Baltimore, Md. | Grain and grass. | Ovid. | 3889 |
| Patapsco Guano Co., Baltimore, Md. | High-grade ammoniated bone and potash compound. | Weedsport. | 3957 |
| Patapsco Guano Co., Baltimore, Md. | Soluble bone. | Ovid. | 3890 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 2.05 | 8 | 9 | 3 | —— | —— |
| Found | 2.29 | 9.17 | 13.11 | 3.34 | 0.48 | 3.47 |
| Guaranteed | 2.06 | 8 | 9 | 3 | —— | —— |
| Found | 2.22 | 10.11 | 12.34 | 3.13 | 0.68 | 5.52 |
| Guaranteed | 0.82 | 8 | 9 | 5 | —— | —— |
| Found | 1.22 | 8.26 | 9.95 | 4.72 | 0.06 | 5.46 |
| Below guarantee | | | | 0.28 | | |
| Guaranteed | —— | 11 | —— | 2 | —— | —— |
| Found | | 11 | 13.90 | 1.96 | | 4.08 |
| Guaranteed | 0.82 | 8 | 9 | 5 | —— | —— |
| Found | 1.06 | 8.46 | 10.23 | 4.84 | 0.20 | 6.02 |
| Guaranteed | —— | 12 | —— | 3 | —— | —— |
| Found | | 14.37 | 14.87 | 2.81 | | 11.16 |
| Guaranteed | 1.85 | 9 | —— | 4 | —— | —— |
| Found | 2.02 | 10.40 | 14.67 | 3.86 | 0.72 | 7.48 |
| Guaranteed | —— | 10 | 11 | 3 | —— | —— |
| Found | | 10.87 | 11.95 | 1.92 | | 4.17 |
| Guaranteed | 1.23 | 10 | —— | 3 | —— | —— |
| Found | 1.40 | 10.60 | 11.30 | 3.20 | 0.78 | 8.19 |
| Guaranteed | 0.82 | 7 | 9 | 8 | —— | —— |
| Found | 0.95 | 8.52 | 9.77 | 8.60 | 0.43 | 5.12 |
| Guaranteed | —— | 14 | —— | —— | —— | —— |
| Found | | 15.74 | 16.44 | | | 11.31 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Moro Phillips Chemical Co., Philadelphia, Pa. | C. & G. complete fertilizer. | Sherwood. | 3800 |
| Moro Phillips Chemical Co., Philadelphia, Pa. | Half and half. | Sherwood.<br>Kendaia. | 3798<br>3894 |
| Moro Phillips Chemical Co., Philadelphia, Pa. | Soluble bone phosphate. | Sherwood.<br>Milo Center. | 3799<br>3941 |
| Moro Phillips Chemical Co., Philadelphia, Pa. | Special fertilzer. | Sherwood.<br>Milo Center. | 3802<br>3742 |
| Moro Phillips Chemical Co., Philadelphia, Pa. | Standard guano. | Sherwood.<br>Milo Center. | 3801<br>3940 |
| Moro Phillips Chemical Co., Philadelphia, Pa. | Standard phosphate. | Kendaia. | 3893 |
| Moro Phillips Chemical Co., Philadelphia, Pa. | Tompkins Co. guano special. | East Lansing. | 3818 |
| Quinnipiac Co., New York City. | Ammoniated bone phosphate. | Lima. | 3905 |
| Quinnipiac Co., New York City. | Ammoniated wheat manure. | East Bloomfield. | 3950 |
| Quinnipiac Co., New York City. | Bachman's special complete manure. | MacDougall. | 3928 |
| Quinnipiac Co., New York City. | Fish, bone and potash. | Fairhaven. | 3964 |

lected in New York State During the Fall of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1 | 8 | 9 | 1.50 | —— | —— |
| Found | 0.90 | 7.99 | 9.62 | 1.55 | 0.43 | 5.55 |
| Guaranteed | —— | 10 | 11 | 5.50 | —— | —— |
| Found | | 10.37 | 11.63 | 5.96 | | 5.17 |
| Guaranteed | —— | 14 | 15 | —— | —— | —— |
| Found | | 14.02 | 15.23 | | | 9.56 |
| Guaranteed | 1.85 | 9 | 10 | 4.75 | —— | —— |
| Found | 1.90 | 9.11 | 11.87 | 4.88 | 0.26 | 5.93 |
| Guaranteed | 0.82 | 10 | 12 | 4 | —— | —— |
| Found | 0.90 | 10.17 | 12.73 | 2.98 | 0.29 | 5.75 |
| Below guarantee | | | | 1.02 | | |
| Guaranteed | 1 | 9 | 11 | 2.50 | —— | —— |
| Found | 1.28 | 9.28 | 11.53 | 6.09 | 0.66 | 6.14 |
| Guaranteed | 1 | 9 | 11 | 2.50 | —— | —— |
| Found | 1.35 | 8.76 | 10.07 | 2.52 | 0.58 | 5.55 |
| Below guarantee | | 0.24 | | | | |
| Guaranteed | 0.82 | 8 | —— | 4 | —— | —— |
| Found | 1.07 | 8.46 | 12.26 | 3.82 | 0.52 | 2.42 |
| Guaranteed | 1.64 | 10 | —— | 5 | —— | —— |
| Found | 2.18 | 10.07 | 14.08 | 4.67 | 0.54 | 3.20 |
| Below guarantee | | | | 0.33 | | |
| Guaranteed | 0.82 | 10 | —— | 4 | —— | —— |
| Found | 1.27 | 9.89 | 12.70 | 4.06* | 0.33 | 4.58 |
| Guaranteed | 1.65 | 9 | 10 | 1 | —— | —— |
| Found | 2.06 | 9.06 | 13.44 | 1.16* | 0.67 | 4.08 |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Quinnipiac Co., New York City. | Grain and seeding phosphate. | Rochester. | 4005 |
| Quinnipiac Co., New York City. | Grain phosphate. | Lima. | 3904 |
| Quinnipiac Co., New York City. | Potash and bone. | Rochester. | 4006 |
| Quinnipiac Co., New York City. | Soluble dissolved bone. | Springport. | 3794 |
| Quinnipiac Co., New York City. | Soluble dissolved bone. | Dundee. | 3923 |
| Quinnipiac Co., New York City. | Special wheat fertilizer. | Mandana. | 3849 |
| Rasin Fertilizer Co., Baltimore, Md. | Rasin acid phosphate. | Penn Yan. | 3937 |
| Read Fertilizer Co., New York City. | Acid phosphate. | Himrods. | 3926 |
| Read Fertilizer Co., New York City. | Jones' ammoniated dissolved bone. | Himrods. | 3924 |
| Read Fertilizer Co., New York City. | Jones' special alkaline bone. | Himrods. | 3925 |
| Read Fertilizer Co., New York City. | Prime wheat fertilizer. | Poplar Ridge. | 3805 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.82 | 8 | 9 | 5 | —— | —— |
| Found | 1.14 | 8.46 | 10.89 | 5.24 | 0.36 | 5.12 |
| Guaranteed | 1.64 | 9 | —— | 4 | —— | —— |
| Found | 2.02 | 9.45 | 12 | 4.45 | 1.05 | 6.34 |
| Guaranteed | —— | 10 | 13.25 | 6 | —— | —— |
| Found | | 10.06 | 13.25 | 5.57 | | 3.27 |
| Below guarantee | | | | 0.43 | | |
| Guaranteed | —— | 14 | 15 | —— | —— | —— |
| Found | | 15.44 | 16.99 | | | 12.67 |
| Guaranteed | —— | 13 | 14 | —— | —— | —— |
| Found | | 14.76 | 16.43 | | | 11.66 |
| Guaranteed | 1.65 | 10 | —— | 4 | —— | —— |
| Found | 1.97 | 11.22 | 15.10 | 4.11 | 0.06 | 5.05 |
| Guaranteed | —— | 14 | —— | —— | —— | —— |
| Found | | 14.51 | 15.33 | | | 11.01 |
| Guaranteed | —— | 13 | —— | —— | —— | —— |
| Found. | | 15.06 | 15.71 | | | 10.29 |
| Guaranteed. | 0.83 | 10 | —— | 8 | —— | —— |
| Found | 0.72 | 9.75 | 12.50 | 6.66 | 0.12 | 5.54 |
| Below guarantee | | 0.25 | | 1.34 | | |
| Guaranteed | —— | 13 | —— | 3 | —— | —— |
| Found | | 13.88 | 16.64 | 2.10 | | 4.17 |
| Below guarantee | | | | 0.90 | | |
| Guaranteed | 1.65 | 8 | 9 | 4 | —— | —— |
| Found | 1.66 | 8.03 | 9.17 | 4.06 | 0.47 | 6.28 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Read Fertilizer Co., New York City. | Standard superphosphate. | Skaneateles. | 3846 |
| John. S. Reese & Co., Baltimore, Md. | Bone phosphate mixture. | Penn Yan. | 3936 |
| John. S. Reese & Co., Baltimore, Md. | Elm phosphate. | Penn Yan. | 3935 |
| John. S. Reese & Co., Baltimore, Md. | Half and half. | Fayette. | 3921 |
| John. S. Reese & Co., Baltimore, Md. | Specialalkaline bone. | Albion. | 4057 |
| Standard Fertilizer Co., Boston, Mass. | Bone and potash. | Wolcott. | 3968 |
| I. P. Thomas & Son Co., Philadelphia, Pa. | Farmers' choice bone phosphate. | Sherwood.<br>Churchville. | 3809<br>4043 |
| I. P. Thomas & Son Co., Philadelphia, Pa. | Improved superphosphate. | Sherwood. | 3808 |
| I. P. Thomas & Son Co., Philadelphia, Pa. | Normal bone phosphate. | Levanna. | 3797 |
| I. P. Thomas & Son Co., Philadelphia, Pa. | S. C. phosphate. | Penn Yan. | 3938 |
| Henry F. Tucker Co., Boston, Mass. | Imperial bone superphosphate. | Wolcott.<br>Rochester. | 3965<br>4007 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.88 | 8 | 9 | 4 | ——— | ——— |
| Found | 1.01 | 8.46 | 10.57 | 3.87 | 0.15 | 6.06 |
| Guaranteed | 0.82 | 10 | ——— | 3 | ——— | ——— |
| Found | 1.74 | 10.85 | 12.47 | 2.36 | 0.88 | 0.65 |
| Below guarantee | | | | 0.64 | | |
| Guaranteed | ——— | 14 | ——— | ——— | ——— | ——— |
| Found | | 14.72 | 15.70 | | | 10.71 |
| Guaranteed | 0.82 | 8 | ——— | 1 | ——— | ——— |
| Found | 0.98 | 11.85 | 13.85 | 0.58 | 0.30 | 1.55 |
| Below guarantee | | | | 0.42 | | |
| Guaranteed | ——— | 10 | 12 | 1 | ——— | ——— |
| Found | | 11.67 | 13.99 | 1.09 | | 6.04 |
| Guaranteed | ——— | 8 | 10 | 2.50 | ——— | ——— |
| Found | | 13.20 | 14.73 | 2.30 | | 7.66 |
| Guaranteed | 2 | 9.50 | 11 | 2 | ——— | ——— |
| Found | 2.57 | 9.46 | 12.59 | 2.18 | 0.90 | 5.71 |
| Guaranteed | 1 | 10 | 12 | 1 | ——— | ——— |
| Found | 0.80 | 9.94 | 10.88 | 1.36 | 0.37 | 6.98 |
| Guaranteed | 1 | 8.50 | 9 | 1.50 | ——— | ——— |
| Found | 1.54 | 9.35 | 12.06 | 2.70 | 0.34 | 5.35 |
| Guaranteed | ——— | 14 | ——— | ——— | ——— | ——— |
| Found | | 16.55 | 17.51 | | | 12.33 |
| Guaranteed | 1.03 | 8 | 9 | 2.15 | ——— | ——— |
| Found | 1.55 | 8.26 | 10.83 | 2.69 | 0.49 | 4.78 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Henry F. Tucker Co., Boston, Mass. | Original Bay State bone superphosphate. | Wolcott.<br>Rochester. | 3966<br>4008 |
| G. O. P. Turner, Churchville, N. Y. | Dissolved bone with potash. | Churchville. | 4042 |
| G. O. P. Turner, Churchville, N. Y. | High-grade guano. | Churchville. | 4040 |
| G. O. P. Turner, Churchville, N. Y. | None such. | Churchville. | 4041 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Acid phosphate. | Clifton Springs. | 3863 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Ammoniated phosphate. | East Bloomfield.<br>Sodus. | 3954<br>3984 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Cabbage special. | Clyde. | 3995 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Clifton. | Sodus. | 3983 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Hop and tobacco grower. | Jordan. | 3855 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Old Pittsburg. | East Bloomfield. | 3953 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Onion special. | Clyde. | 3996 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.65 | 9 | 10 | 2 | — | — |
| Found | 1.65 | 9.53 | 11.77 | 2.34 | 0.59 | 7.33 |
| Guaranteed | — | 10 | — | 3 | — | — |
| Found | | 13.75 | 14.69 | 3.03 | | 9.56 |
| Guaranteed | 2.50 | 9 | — | 4.75 | — | — |
| Found | 2.01 | 8.38 | 9.35 | 4.36 | 0.67 | 6.39 |
| Below guarantee | 0.49 | 0.62 | | 0.39 | | |
| Guaranteed | 1.25 | 10 | — | 7 | — | — |
| Found | 1.35 | 8.14 | 9.78 | 6.28 | 0.75 | 5.94 |
| Below guarantee | | 1.86 | | 0.72 | | |
| Guaranteed | — | 16 | — | — | — | — |
| Found | | 17.32 | 18.85 | | | 13.33 |
| Guaranteed | 1.65 | 8 | — | 1 | — | — |
| Found | 2.26 | 7.78 | 9.17 | 1.09 | 0.43 | 5.71 |
| Below guarantee | | 0.22 | | | | |
| Guaranteed | 3.29 | 5 | — | 7 | — | — |
| Found | 3.37 | 4.48 | 7.29 | 6.81 | 0.30 | 2.10 |
| Below guarantee | | 0.52 | | | | |
| Guaranteed | 2.47 | 10 | — | 2.50 | — | — |
| Found | 3.07 | 8.33 | 10.64 | 2.80 | 0.30 | 4.05 |
| Below guarantee | | 1.67 | | | | |
| Guaranteed | 3.29 | 6 | 7 | 5 | — | — |
| Found | 3.40 | 6.24 | 7.01 | 4.97 | 0.27 | 3.90 |
| Guaranteed | 1.65 | 8 | — | 3 | — | — |
| Found | 1.82 | 9.43 | 9.78 | 3.23 | 0.04 | 6.02 |
| Guaranteed | 2.47 | 7 | — | 8 | — | — |
| Found | 2.41 | 6.88 | 8.19 | 9.02 | 1.10 | 4.14 |

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Walker Fertilizer Co., Clifton Springs, N. Y. | Ontario brand. | East Bloomfield.<br>Clyde. | 3952<br>3994 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Potato and vegetable grower. | Jordan. | 3856 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Pure ground bone. | Clifton Springs. | 3864 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Special mixture. | Pittsford. | 4002 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Victoria bone. | Jordan. | 3857 |
| Walker Fertilizer Co., Clifton Springs, N. Y. | Wheat special No. 2. | Clifton Springs.<br>Clyde. | 3862<br>3993 |
| Walker, Stratman & Co., Pittsburg, Pa. | Four fold. | Gorham. | 3909 |
| Williams & Clark Fertilizer Co., New York City. | Americus brand potato phosphate. | Locke. | 3821 |
| Williams & Clark Fertilizer Co., New York City. | Goodrich grain fertilizer. | Lima. | 3903 |
| Williams & Clark Fertilizer Co., New York City. | Special " A " brand. | Pittsford. | 4003 |
| Williams & Clark Fertilizer Co., New York City. | Special " B " brand. | Pittsford. | 4004 |

lected in New York State During the Fall of 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | —— | 10 | —— | 4 | —— | —— |
| Found | | 10.59 | 11.99 | 3.78 | | 6.81 |
| Below guarantee | | | | 0.22 | | |
| Guaranteed | 2.47 | 6 | —— | 7 | —— | —— |
| Found | 2.76 | 5.62 | 7.92 | 6.82 | 0.25 | 3.63 |
| Below guarantee | | 0.38 | | | | |
| Guaranteed | 3.70 | —— | 21 | —— | —— | —— |
| Found | 4.15 | | 22.98 | | 2.14 | |
| Guaranteed | 0.82 | 7 | —— | 2 | —— | —— |
| Found | 0.96 | 7.54 | 7.85 | 2.62 | | 3.95 |
| Guaranteed | 0.82 | 8 | —— | 1.50 | —— | —— |
| Found | 0.83 | 8.36 | 8.98 | 1.75 | | 4.92 |
| Guaranteed | 1.65 | 11 | —— | 5 | —— | —— |
| Found | 1.63 | 11.44 | 12.69 | 5.13 | 0.01 | 6.78 |
| Guaranteed | 1 | 8 | —— | 1 | —— | —— |
| Found | 1.43 | 9.53 | 10.90 | 1.31 | 0.21 | 5.52 |
| Guaranteed | 2.47 | 6 | 7 | 5 | —— | —— |
| Found | 2.49 | 6.19 | 9.80 | 5.06 | 0.74 | 2.05 |
| Guaranteed | 2 | 10 | —— | 5 | —— | —— |
| Found | 2.37 | 10.90 | 13.61 | 4.47 | 1.42 | 5.89 |
| Below guarantee | | | | 0.53 | | |
| Guaranteed | 1.65 | 8 | 9 | 4 | —— | —— |
| Found | 2.01 | 8.39 | 9.54 | 4.87 | 1.90 | 6.20 |
| Guaranteed | 0.82 | 8 | 9 | 4 | —— | —— |
| Found | 1.30 | 6.87 | 8.75 | 4.57* | 0.36 | 4.06 |
| Below guarantee | | 1.13 | | | | |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Williams & Clark Fertilizer Co., New York City. | Standard grain. | Holley. | 4058 |
| Williams & Clark Fertilizer Co., New York City. | Standard grain and vegetable. | Holley. | 4059 |
| Wooster & Mott, Union Hill, N. Y. | Alkaline bone. | Union Hill. | 4016 |
| Wooster & Mott, Union Hill, N. Y. | Grain and grass. | Union Hill. | 4017 |
| Wooster & Mott, Union Hill, N. Y. | Storm king. | Union Hill. | 4015 |
| York Chemical Works, York, Pa. | Ammoniated bone and potash. | Romulus. | 3896 |
| York Chemical Works, York, Pa. | New York phosphate. | Romulus. | 3895 |
| Zell Guano Co., Baltimore, Md. | Dissolved S. C. phosphate. | Mandana. | 3848 |
| Zell Guano Co., Baltimore, Md. | Economizer. | Kendaia.<br>Wolcott. | 3891<br>3972 |
| Zell Guano Co., Baltimore, Md. | Fruit tree invigorator. | Wolcott. | 3969 |
| Zell Guano Co., Baltimore, Md. | Genesee fertilizer. | Wolcott. | 3970 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water-soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 1.02 | 8 | ——— | 4 | ——— | ——— |
| Found | 1.08 | 10.89 | 12.04 | 3.37* | 1.03 | 6.40 |
| Below guarantee | | | | 0.63 | | |
| Guaranteed | 1.64 | 8 | ——— | 4 | ——— | ——— |
| Found | 1.38 | 11.54 | 13.24 | 2.75* | 0.60 | 7.59 |
| Below guarantee | 0.26 | | | 1.25 | | |
| Guaranteed | ——— | 13 | ——— | 3 | ——— | ——— |
| Found | | 15.10 | 15.34 | 3.21 | | 11.68 |
| Guaranteed | 1.23 | 10 | ——— | 3 | ——— | ——— |
| Found | 1.22 | 10.77 | 11.68 | 3.35 | 0.60 | 8.39 |
| Guaranteed | 1.85 | 9 | ——— | 4 | ——— | ——— |
| Found | 1.85 | 9.69 | 10.90 | 4.30 | 0.94 | 7.11 |
| Guaranteed | 0.82 | 10 | ——— | 3 | ——— | ——— |
| Found | 1.13 | 10.18 | 12.47 | 3.59 | 0.53 | 4.83 |
| Guaranteed | 0.82 | 8 | ——— | 2 | ——— | ——— |
| Found | 0.98 | 9.53 | 12.08 | 2.72 | 0.28 | 3.16 |
| Guaranteed | ——— | 13 | 15 | ——— | ——— | ——— |
| Found | | 14.20 | 16.90 | | | 12.35 |
| Guaranteed | 0.80 | 9 | ——— | 2 | ——— | ——— |
| Found | 0.97 | 10.24 | 13.11 | 2.37 | 0.02 | 6.40 |
| Guaranteed | ——— | 10 | 12 | 8 | ——— | ——— |
| Found | | 10.88 | 13.39 | 7.55 | | 7.83 |
| Below guarantee | | | | 0.45 | | |
| Guaranteed | 2.05 | 8 | 10 | 2 | ——— | ——— |
| Found | 1.12 | 10.32 | 11.68 | 2 | 0.26 | 7.79 |
| Below guarantee | 0.93 | | | | | |

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

| MANUFACTURER. | Trade name or brand. | Locality where sample was taken. | Station number. |
|---|---|---|---|
| Zell Guano Co., Baltimore, Md. | Seneca Co. special. | Ovid. | 3885 |
| Zell Guano Co., Baltimore, Md. | Special grain fertilizer. | Clyde. | 3989 |
| Zell Guano Co., Baltimore, Md. | Special high-grade potato manure. | Wolcott. | 3971 |
| Zell Guano Co., Baltimore, Md. | Special high-grade wheat fertilizer. | Ovid.<br>North Sparta. | 3886<br>4026 |
| Zell Guano Co., Baltimore, Md. | 10 and 10. | Owasco. | 3847 |
| Zell Guano Co., Baltimore, Md. | Wilson's special No. 1. | York. | 4029 |

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

| | Pounds of nitrogen in 100 pounds of fertilizer. | Pounds of available phosphoric acid in 100 pounds of fertilizer. | Pounds of total phosphoric acid in 100 pounds of fertilizer. | Pounds of water soluble potash in 100 pounds of fertilizer. | Pounds of water-soluble nitrogen in 100 pounds of fertilizer. | Pounds of water soluble phosphoric acid in 100 pounds of fertilizer. |
|---|---|---|---|---|---|---|
| Guaranteed | 0.80 | 10 | —— | 5 | —— | —— |
| Found | 0.91 | 11.55 | 13.37 | 4.85 | 0.09 | 9.08 |
| Guaranteed | 0.82 | 8 | 10 | 4 | —— | —— |
| Found | 2.89 | 8.69 | 10.92 | 2.51 | 1.19 | 6.41 |
| Below guarantee | | | | 1.49 | | |
| Guaranteed | 3.25 | 6 | 8 | 8 | —— | —— |
| Found | 2.56 | 7.67 | 10.48 | 6.26 | 0.94 | 4.32 |
| Below guarantee | 0.69 | | | 1.74 | | |
| Guaranteed | 1.60 | 10 | —— | 5 | —— | —— |
| Found | 1.76 | 11.44 | 12.65 | 5.18 | 0.62 | 8.98 |
| Guaranteed | —— | 10 | 12 | 10 | —— | —— |
| Found | | 11.84 | 13.49 | 9.94 | | 9.87 |
| Guaranteed | 0.80 | 8 | 10 | 4 | —— | —— |
| Found | 0.96 | 9.76 | 11.64 | 3.80 | 0.08 | 7.84 |

## III. CONDITIONS REQUIRED FOR THE SUCCESSFUL GROWTH OF SUGAR BEETS.*

L. L. VAN SLYKE.

### SUMMARY.


The following elements determine whether sugar beets can be grown at a profit: (1) Richness in sugar; (2) purity of solids; (3) yield of beets; (4) cost of crop; (5) market price.

(1) Richness in sugar. Analyses of about 140 samples of beets grown in different parts of New York State during 1897 show a variation of sugar in the beets from below 12 to over 18.5 per cent, with a general average of 15.3 per cent. This average is somewhat higher than shown by other states.

The following conditions exercise a marked influence upon the development of sugar in beets: Climate; variety of beet; quality of seed; kind and quantity of plant food; soil; methods of cultivation; size of beets; and time of planting and harvesting.

(2) Purity of solids. The coefficient of purity is the proportion or percentage which the sugar constitutes of the total solids in the juice, and is found by dividing the per cent of sugar in juice by the per cent of total solids in juice. The higher the coefficient of purity, the larger will be the proportion of sugar crystallized out in manufacture. The purity is influenced by maturity of beet, kind of fertilizers used, size of beet and portion of root. Immature beets contain sugar of low purity, also beets grown with excess of highly nitrogenous manures. The sugar in large beets has a lower coefficient of purity than in smaller beets. The portion of beet growing above surface of soil has


* Partial reprint of Bulletin No. 135.

NOTE.—For the most comprehensive treatise published, the reader is referred to Farmers' Bulletin No. 52 on "The Sugar Beet," by H. W. Wiley, Chief of the Division of Chemistry, U. S. Department of Agriculture, Washington, D. C.

sugar of inferior purity. The coefficient of purity in the samples analyzed varied from below 75 to over 87, with an average of 82.5.

(3) Yield of beets. Twenty tons of marketable beets an acre may be regarded as a maximum yield in commercial operations. An average of 10 to 12 tons an acre may probably be expected in favorable seasons in this State.

(4) Cost of production. The cost of raising an acre of sugar beets may be placed between $40 and $50, when all conditions are favorable.

(5) Market price and profits. There is good reason to expect that beets will bring from $4 to $5 a ton according to varying conditions of sugar, purity, etc. In general, a profit of $5 to $10 an acre above all expenses may be regarded as a reasonable expectation from the crop.

(6) General considerations. The sugar beet is to be grown as an added crop with a comparatively small acreage at the beginning, increasing as conditions favor. The educational value derived from growing sugar beets is considerable. A farmer who learns to grow sugar beets well will grow other crops better for the experience. The soil on which sugar beets have been grown is left in better mechanical condition than by other crops.

## INTRODUCTION.

The growing of sugar beets for the production of sugar is, at the present time, attracting more attention in our State than any other subject connected with agriculture. Farmers are asking for reliable information in regard to those various phases of the subject which possess special interest for them. They want to know whether the soil and climate of our State are adapted to the successful raising of sugar beets; whether they may have a reasonable assurance of a fair profit, compared with other crops grown by them; and whether there is any degree of certainty that they may be sure of a cash crop and a steady market. The chief elements which determine whether sugar beets can be grown at a profit are the following:

I. Richness in sugar.
II. Purity of solids.
III. Yield of beets an acre.
IV. Cost of raising and transporting crop.
V. Market price and profits.
VI. General considerations.

## I. RICHNESS IN SUGAR.

When beets were first used as a source of sugar, the amount of sugar contained in them averaged about 6 per cent. As a result of careful selection and breeding during a period of many years, the amount of sugar has been increased to an average lying between the limits of 12 and 15 per cent. Many crops of beets show a sugar content of over 15 per cent, while in some exceptional cases, the sugar has been reported as high as 20 per cent and even higher in this State. Farmers must avoid the mistake of regarding exceptional cases as typical. When all the details are known about remarkably high yields of sugar in beets, it is usually found that special conditions exist which cannot readily be duplicated in commercial operations. The question of interest to each farmer pertains to the results he can secure on his farm, working under the conditions involved in growing beets on a commercial scale. From results secured by this Station during the past year with beets grown in various sections of the State, we can present data which ought to be of value in showing how much sugar has been obtained in beets.

Before presenting a summary of our data, we will explain certain terms which it will be necessary to use. In using the term "sugar," we mean the crystallizable sugar that goes by the chemical name of sucrose. The amount of sugar is stated in two ways: "Sugar in beet" and "sugar in juice." One hundred pounds of sugar beets contain, on an average, about 95 pounds of juice, and so the sugar in 100 pounds of beets is contained in 95 pounds of juice. Therefore, the juice is more concentrated with respect to sugar, and when the results are expressed in percentages, the number expressing the per cent of sugar is higher in the juice than in the beet.

We present below in tabulated form the results obtained in making analyses of about 140 samples of sugar beets grown in this State during 1897:

RESULTS OF ANALYSES OF SUGAR BEETS GROWN DURING THE SEASON OF 1897.

| VARIETY OF BEET. | Amount of sugar in beet. | Number of samples. | Average amount of sugar in beet. | Average amount of sugar in juice. | Average amount of total solids in juice. | Average co-efficient of purity of juice | Average weight of one beet. |
|---|---|---|---|---|---|---|---|
| | Per ct. | | Per ct. | Per ct. | Per ct. | | Ozs. |
| Klein Wanzlebener .... | 11 to 12 | 4 | 12 | 12 7 | 16.6 | 76.5 | 20 |
| Klein Wanzlebener .... | 12 to 13 | 11 | 13 | 13.7 | 18.3 | 75.4 | 18 |
| Klein Wanzlebener .... | 13 to 14 | 10 | 13.8 | 14.5 | 18.3 | 80.0 | 14 |
| Klein Wanzlebener .... | 14 to 15 | 11 | 14.7 | 15.5 | 19.3 | 80.3 | 17 |
| Klein Wanzlebener .... | 15 to 16 | 15 | 15.8 | 16.6 | 19.7 | 84.3 | 14 |
| Klein Wanzlebener .... | 16 to 17 | 11 | 16.5 | 17.4 | 20.4 | 85.3 | 16 |
| Klein Wanzlebener .... | 17 to 18 | 13 | 17.6 | 18.5 | 21.7 | 85.2 | 14 |
| Klein Wanzlebener .... | 18 to 19 | 3 | 18.5 | 19 5 | 22.7 | 85 9 | 13 |
| Vilmorin Improved .... | 11 to 12 | 3 | 11.7 | 12.3 | 16.4 | 75 0 | 16 |
| Vilmorin Improved .... | 12 to 13 | 5 | 12.8 | 13.5 | 17.6 | 76.7 | 24 |
| Vilmorin Improved .... | 13 to 14 | 9 | 13.8 | 14.5 | 17.6 | 82.4 | 19 |
| Vilmorin Improved .... | 14 to 15 | 8 | 14.8 | 15.6 | 18.8 | 83.0 | 16 |
| Vilmorin Improved .... | 15 to 16 | 17 | 15.6 | 16.4 | 20.0 | 82.0 | 16 |
| Vilmorin Improved .... | 16 to 17 | 9 | 16.6 | 17.5 | 20.0 | 87.5 | 15 |
| Vilmorin Improved .... | 17 to 18 | 6 | 17.8 | 18.7 | 21.9 | 85.4 | 18 |
| Vilmorin Improved .... | 18 to 19 | 2 | 18.6 | 19.6 | 23.4 | 83.8 | 24 |

SUMMARY.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Klein Wanzlebener .... | ........ | 78 | 15.3 | 16.1 | 19.6 | 82.2 | 15½ |
| Vilmorin Improved .... | ........ | 59 | 15.3 | 16.1 | 19.4 | 83.0 | 17½ |
| Average of all....... | ........ | .... | 15.3 | 16.1 | 19.5 | 82.5 | 16½ |

Below we present general averages of some of our results giving figures for several different counties. While these results are of interest, they possess little real value so far as they represent general conditions, because we have received too few samples from most counties to afford any fair basis for comparison. Readers are carefully cautioned against drawing any sweeping conclusions from the results presented in this manner.

RESULTS OF ANALYSES OF SUGAR BEETS GROWN IN DIFFERENT COUNTIES.

| COUNTY. | Amount of sugar in beet. | Amount of sugar in juice. | Co-efficient of purity. |
|---|---|---|---|
| | Per cent. | Per cent. | |
| Albany | 16.2 | 17.1 | 81 |
| Broome | 14.3 | 15 | 81.1 |
| Cayuga | 12.9 | 13.6 | 74 |
| Chautauqua | 14.7 | 15.5 | 82.4 |
| Clinton | 15.7 | 16.5 | 80.5 |
| Columbia | 16 | 16.8 | 82 |
| Cortland | 14.4 | 15.2 | 79.6 |
| Erie | 15.5 | 16.3 | 82.3 |
| Genesee | 14.1 | 14.8 | 79.2 |
| Lewis | 14.8 | 15.6 | 83.8 |
| Madison | 15.7 | 16.5 | 82.5 |
| Monroe | 15.2 | 16 | 86.5 |
| Oneida | 15.4 | 16.2 | 83.5 |
| Ontario | 15.5 | 16.3 | 82.3 |
| Orleans | 14.6 | 15.4 | 84.2 |
| Oswego | 14.3 | 15.1 | 87.3 |
| Otsego | 16.3 | 17.2 | 86.9 |
| St. Lawrence | 16.1 | 17 | 84.2 |
| Wyoming | 14.7 | 15.5 | 81.6 |

A few results are not inserted in the foregoing table, because the beets were considerably dried when received and the results were unduly high and misleading.

From these data it would appear that in making estimates, farmers would be wisely conservative in basing their calculations upon beets containing an average not exceeding 15 per cent of sugar. Disappointment will await most of those who, never having grown sugar beets, expect profits from the industry based upon figures that are much above the average actually obtained. It must also be kept in mind that the season of 1897 in New York was most favorable for beet growing and the results secured probably represent conditions better than average.

The average percentage of sugar in beets, as reported in other states, is as follows:

AVERAGE PERCENTAGE OF SUGAR IN BEETS GROWN IN DIFFERENT STATES.

| STATES. | SUGAR. | |
|---|---|---|
| | In beets. | In juice. |
| | Per cent. | Per cent. |
| California, average for five years | 14.2 | 14.9 |
| Utah, average for five years | 12.2 | 12.8 |
| Nebraska, average for five years | 12.8 | 13.5 |
| Oregon | 14.2 | 14.9 |
| Washington | 14. | 14.7 |
| Wisconsin | 11.8 | 12.4 |

## CONDITIONS INFLUENCING AMOUNT OF SUGAR IN BEETS.

Numerous conditions exercise a marked influence upon the development of sugar in beets. Among the most important, we may mention the following:

1. Climate.
2. Variety of Beet.
3. Quality of seed.
4. Plant-food.
5. Soil.
6. Methods of cultivation.
7. Size.
8. Time of planting and harvesting.

### 1. CLIMATE.

*Temperature.*—According to extended experience, it has been shown that the highest amount of beet sugar is commonly obtained in places whose mean summer temperature is about 70° F.

*Rainfall.*—The amount of rainfall most favorable to the development of sugar in beets is from two to four inches a month during the summer. Midsummer drought works injury to the development of sugar beets. Rains after the crop has matured and before it is harvested may start a new growth of the beets, by which the percentage of sugar is materially lowered.

*Sunshine.*—An abundance of sunshine also is essential to the largest development of sugar in beets.

Most of the tillable portions of New York practically fulfil the climatic conditions required for a satisfactory development of sugar in beets.

## 2. VARIETY OF BEET.

The amount of sugar present in a beet varies, to some extent, with the variety of beet grown. Taking standard varieties, we find greater differences in the sugar content of the same variety grown under different conditions than we do of different varieties grown under uniform conditions. The varieties most commonly grown the past year in this State have been Vilmorin Improved and Klein Wanzlebener. Several other varieties have been grown at this Station. We give below a tabulated statement showing the per cent of sugar contained in different varieties of beets grown during the season of 1897.

SUGAR IN DIFFERENT VARIETIES OF BEET.

| VARIETY. | Average amount of sugar in beet. *Per cent.* |
|---|---|
| Klein Wanzlebener | 15.3 |
| Vilmorin Improved | 15.3 |
| Klein Wanzlebener (grown at Geneva) | 15.7 |
| Vilmorin Improved (grown at Geneva) | 15.5 |
| Demesmay (grown at Geneva) | 12.2 |
| Vilmorin Elite (grown at Geneva) | 14.5 |
| Vilmorin's La Plus Riche (grown at Geneva) | 16.6 |

## 3. QUALITY OF SEED.

The importance of using only highly bred seed cannot be overestimated. In Europe the production of sugar-beet seed has become a separate branch of industry. Carefully selected and tested beets containing from 16 to 18 per cent of sugar and of high purity are used for this purpose.

## 4. PLANT FOOD.

*Kinds and amounts.*—It is safe to assume that sugar beets cannot be successfully grown on many farms in this state for any considerable length of time without the application of plant-food.

Analyses of sugar-beet roots show quite a wide range of variation in respect to fertilizing constituents, as may be roughly indicated in the subjoined table:

FERTILIZER CONSTITUENTS IN SUGAR BEETS.

| CONSTITUENTS. | POUNDS IN 2,000 POUNDS OF SUGAR BEETS. | |
|---|---|---|
| | Variation. | Average. |
| | Pounds. | Pounds. |
| Nitrogen | 3 to 5 | 4 |
| Phosphoric acid | 1 to 3 | 2 |
| Potash | 6 to 8 | 7 |
| Lime | 1 to 1½ | 1¼ |
| Magnesia | 1 to 1½ | 1¼ |

In basing upon the preceding average the composition of a fertilizer to be used in growing sugar beets, one may plan to use approximately the amount of nitrogen indicated, considerably more phosphoric acid than the analysis gives and a little more potash than is shown by analysis. As a rule, most of our soils contain enough lime and magnesia. As a general guide, we can suggest for use in fertilizing sugar-beet crops a mixture containing

| | |
|---|---|
| Nitrogen | 4 per cent. |
| Available phosphoric acid | 6 per cent. |
| Potash | 9 per cent. |

One hundred pounds of a fertilizer having this composition would supply plant-food needed for the growth of one ton of marketable beet roots. It is probable that in most cases the application of 1,000 pounds of such a fertilizer on each acre of land would satisfactorily maintain fertility, assuming that the soil was supplied with some available plant-food at the start. With large yields of beets, more than 1,000 pounds of such fertilizer might be required ultimately.

The foregoing estimates are based upon the supposition that all portions of the crop are returned to the soil, except the roots sold to the sugar factory. If the leaves and crowns are not left for the soil, the amount of fertilizer to be applied will need to be increased considerably, since these parts are much richer in plant-food materials than the marketable roots.

*Available sources of plant-food.*—Stable-manure, well rotted, has been extensively used with good results. It should be used with caution, however, as will be indicated later. It must be remembered also that the exclusive and continuous use of rich stable-manure may ultimately result in a one-sided nitrogenous fertilization and a gradual exhaustion of phosphoric acid and potash from the soil. Nitrogen can be supplied by stable-manure, nitrate of soda, sulphate of ammonia, fish-scrap, cottonseed meal, bone meal, or slaughter-house refuse, such as dried blood and tankage. Phosphoric acid can be furnished in the form of acid phosphate, bone meal, dissolved bone, etc. Potash can be supplied in any of the forms common in commerce and also by means of the molasses residue of beet-sugar factories. When lime is known to be needed, it can be supplied in the form of quicklime, land-plaster, ground shells, etc. Magnesia, when needed, can be furnished by the press-cake of sugar factories or in the form of German double sulphate of potash and magnesia.

*Mixtures of plant-food.*—The following mixtures of high-grade materials are offered as suggestions or illustrations of what could be used, the amounts given being for one acre of land:

MIXTURE NO. 1.

| | |
|---|---|
| Nitrate of soda | 60 pounds. |
| Dried blood | 200 pounds. |
| Fish-scrap | 150 pounds. |
| Acid phosphate | 400 pounds. |
| Sulphate or muriate of potash | 180 pounds. |

MIXTURE NO. 2.

| | |
|---|---|
| Bone meal | 500 pounds. |
| Sulphate of ammonia | 100 pounds. |
| Sulphate or muriate of potash | 180 pounds. |
| Acid phosphate | 100 pounds. |

MIXTURE NO. 3.

Stable manure, well-rotted, 8,000 pounds or more applied to the crop preceding the beets, supplemented by bone meal, 500 pounds (or acid phosphate, 300 pounds), and sulphate or muriate of potash, 180 pounds.

The phosphoric acid and potash can be applied to the soil at the time of putting in the beet crop.

The cost of these mixtures will probably average from $10 to $15 for 1,000 pounds. In purchasing plant-food materials farmers must be governed by the market conditions prevailing at the time of purchase and by other economical considerations.

*Special Suggestions.*—(1) Time of application. Stable-manure and other similar materials are best applied to the crop preceding the beet crop. Readily available forms of plant-food can be applied to the soil when the crop is put in or just before.

(2) Precautions. Excessive application of stable-manure or other nitrogenous materials should be avoided, in order to secure beets of good quality. Well-rotted is preferable to fresh stable-manure.

(3) Rotation. Beets will, as a rule, give best results in respect to sugar, when grown in rotation with other crops. It is wise not to grow more than two crops in succession on the same soil. A plan of rotation suggested by Dr. Wiley is wheat, beets and clover, one crop of which is cut for hay and the second crop turned under, this to be followed by potatoes, wheat and beets. Beets do best after some cereal.

### 5. Soil.

As a rule, good sugar beets can be grown on any soil which will produce a satisfactory crop of wheat, corn or potatoes. Fairly level soil, well drained, is essential for best results.

### 6. Methods of Cultivation.

Of the conditions under the farmer's control, requisite to success in growing sugar beets of high quality, there is none of greater importance than the methods employed in preparing and cultivating the soil. Plowing should be done in the late autumn to the depth of not less than 9 inches. A subsoiler should follow the plow, loosening the soil 6 or 7 inches deeper, thus giving a total depth of 15 inches or more. In the spring only the surface needs preparation, and this should be put in very fine tilth immediately before planting. The thinning should be done promptly when four leaves show.

During 6 to 8 weeks of the growing season, the soil should be cultivated once a week at least and in dry seasons more frequently. There is probably none of our common crops which is more exacting than the sugar beet in its demands for careful, prompt and regular attention, if satisfactory results are to be realized.

7. SIZE OF BEETS.

Large beets are inferior for sugar production. The size yielding most sugar weighs from one to two pounds, though factories do not usually reject beets weighing as much as three pounds. The beets which have come under our observation have varied in weight from seven ounces to three pounds and twelve ounces, the average being a fraction of an ounce over one pound.

8. TIME OF PLANTING AND HARVESTING.

The main consideration to be kept in mind in this State in respect to time of planting sugar beets, is to allow sufficient time for complete maturing. Taking our seasons as they average, the planting can usually be done in May. In planting later than June 1, much risk is incurred in reference to the proper ripening of the crop.

Before harvesting, the beets should ripen completely, since immature beets contain less sugar than the ripe ones. At maturity the leaves turn yellowish green and the outer ones bend down about the beet. It requires about 150 days for a crop to develop its highest sugar content, varying, of course, with the character of the season. Harvesting must take place before the second growth commences, since this decreases the amount of sugar.

II. PURITY OF SOLIDS IN JUICE.

While the percentage of sugar contained in a beet is highly important, it is not the only factor that determines the quality of the beet. The purity of the solids in the sugar beet juice must be considered also. Beet juice contains besides sugar other substances in solution. To illustrate, the juice of a certain sample of sugar beets contains 12.8 per cent of sugar and 18.2 per cent of total solids, including sugar and other materials. This leaves 5.4 per cent of solids not sugar. Having the per cent of sugar and the per cent of total solids, how do we state the purity of the juice? We divide the per cent of sugar (12.8) by the per cent of total solids (18.2) and the product, expressed in parts per hundred, is 70; and this we call the "Coefficient of Purity," which may be defined as the proportion or percentage which the sugar constitutes of the total solids in the juice. Thus, in the illustration given, of 100 parts of total solids in juice, the sugar forms 70 parts.

Why is the coefficient of purity regarded as an important element in determining the quality of sugar beets? Because the portion which is not sugar prevents complete crystallization and recovery of the sugar in the process of manufacture. Experience has shown that for each pound of non-sugar solids one pound of sugar is not recovered from the juice. In the illustration used above, we have in 100 pounds of juice 12.8 pounds of sugar and 5.4 pounds of non-sugar solids. Then, in this case, we should expect to recover only 7.4 pounds of sugar from the 12.8 pounds present in the juice.

To give another illustration, 100 pounds of juice contains 17.3 pounds of sugar and 19.8 pounds of total solids. The coefficient of purity is 87.5 and the amount of non-sugar solids is 2.5 pounds. From 100 pounds of such juice, 14.8 pounds of sugar could be recovered.

As a rule, sugar is recovered to the extent of 70 pounds for 100 pounds of sugar in the beet root.

From the preceding statements, the importance of the purity of beet juice can be appreciated as an element in determining the practical value of sugar beets for sugar production.

The tabulated statement on page 191 shows the results obtained by us in our season's work.

## CONDITIONS INFLUENCING COEFFICIENT OF PURITY.

Most of the conditions which affect the percentage of sugar contained in beets also influence the coefficient of purity. Among conditions specially to be mentioned are the following:

1. Maturity.
2. Fertilizers.
3. Size.
4. Portion of root.

### 1. MATURITY.

Unripe beets contain a large proportion of non-sugar solids and hence a lower coefficient of purity than ripe beets. Such beets have, therefore, a smaller proportion of sugar that can be recovered.

### 2. FERTILIZERS.

The excessive application of stable-manure or other nitrogenous fertilizers lowers the coefficient of purity. Soils containing a large amount of organic matter, like drained swamp lands, and recently cleared forest lands, produce beets having a low coefficient of purity.

### 3. SIZE.

The size of beets is often closely associated with the amount of nitrogenous plant-food employed. Excessive use of such manures tends to produce a rapid, rank growth of beets, large in size but poor in quality, especially in respect to coefficient of purity. Too great distance between roots in soil also tends to promote growth in size at the expense of quality.

### 4. PORTION OF ROOT.

The neck or crown of the beet root contains large amounts of non-sugar solids. The entire portion of the beet growing above ground is rich in those solids producing low coefficient of purity. It is, therefore, important to have the root grow above ground as little as possible.

## III. YIELD OF BEETS.

A very important element to be considered by the farmer who plans to raise sugar beets is the yield. However high in quality sugar beets may be, it is necessary to secure a good yield of roots in order to realize satisfactory money returns. Reliable data appear to indicate that we may regard 20 tons of marketable sugar beets of high quality as the largest yield an acre that can be realized in commercial operations. Yields are often reported exceeding 25 and 30 tons an acre, but such returns are open to suspicion, so far as they represent commercial conditions. Misleading yields are often obtained by weighing and counting the beets covering a definite small area and basing the estimate for an acre on the data so obtained. Another method employed in figuring out large yields is to obtain the average weight of a few beets and then assume that an acre contains forty thousand beets, each having the same weight as the average obtained. Moreover, reports of yields are often based on results secured in growing a fraction of an acre of beets under conditions which are more favorable than those met in working with several acres.

To obtain the fairest idea of yield under commercial conditions, we can do no better than to study the results furnished by actual operations where sugar beets have been successfully grown for a period of years on a commercial scale. Below we present results reported by the sugar-beet factory at Lehi, near Salt Lake City, Utah, and by the Chino Valley Beet Sugar Company, in Southern California, and also some data derived from German sources.

Yield of Marketable Beets Grown on One Acre.

| Reports given by | 1891. | 1892. | 1893. | 1894. | 1895. | Average |
|---|---|---|---|---|---|---|
| | Tons. | Tons. | Tons | Tons. | Tons | Tons. |
| Factory at Lehi, Utah | 6.6 | 6.5 | 9.7 | 11.47 | 11.54 | 9.16 |
| Chino Factory, Southern California | 7.26 | 7.5 | 11.7 | 9.16 | 11.03 | 9.33 |
| German factories | 12.8 | 11.2 | 11.0 | 13 0 | 12.4 | 12 1 |

There is no reason to believe that the average New York farmer will secure results largely in excess of those reported above. If an average yield of 10 tons an acre can be secured at the start, our farmers will realize larger returns than did those of California and Utah during the first years of their experience. The table above is encouraging in that it shows steady progress on the part of the farmers in securing larger yields. The commercial experience of others should impress our farmers that they are not to expect exceptionally large returns the first year, for this is likely, in the very nature of the case, to prove the poorest in yield; but acquired experience should bring with each year an increased yield. During the past season we secured a yield of 15.1 tons of marketable beet roots an acre on the Station farm.

Those factors which influence the quality of the sugar beet also affect the yield more or less, among which are the variety of beet grown, quality of seed, distance between plants, soil, cultivation, season, etc.

In this connection may be considered the amount of pure sugar produced an acre. Using the same sources of information as those given above, we have the following table:

YIELD OF PURE SUGAR FROM SUGAR BEETS GROWN ON ONE ACRE.

| REPORTS GIVEN BY | 1891. | 1892. | 1893. | 1894. | 1895. | Average. |
|---|---|---|---|---|---|---|
| | Pounds. | Pounds. | Pounds. | Pounds. | Pounds | Pounds. |
| Factory at Lehi, Utah | 1,162 | 1,227 | 1,719 | 2,336 | 2,539 | 1,797 |
| Chino Factory, Southern California | 1,510 | 1,680 | 2,621 | 2,198 | 2,670 | 2,136 |
| German factories | ...... | ...... | 3,276 | 3,149 | 3,514 | 3,313 |

It is a matter of much interest to note that the yield of sugar an acre increased quite rapidly from year to year in the Utah and California factories. This was due not only to an increase in yield of beets, but to an increase in the per cent of sugar and coefficient of purity.

Taking the averages obtained by our analyses and assuming the average yield of marketable beet roots to be 10 tons an acre, we estimate that, under these conditions, there would be a yield of about 2,400 pounds of commercial sugar.

## IV. COST OF RAISING AND TRANSPORTING CROP.

Numerous factors enter into the cost of raising sugar beets and these will vary in different places. Among such factors may be mentioned the value of land, the cost of labor and the extent to which hand labor and machine labor are employed. Some of the details of this subject are discussed hereinafter, when data are given derived from actual experience in raising beets on the Station farm. It may be regarded as a conservative estimate to place the price at which beets can be grown in New York under favorable conditions between the limits of $40 and $50 an acre.

The cost of transporting the crop from the farm to the factory must also be considered. The accessibility of a factory is a primary condition which will by itself determine the practicability of raising sugar beets. The cost of transportation is an item which must be calculated by each farmer for the conditions existing in his particular case.

## V. MARKET PRICE AND PROFITS.

Provided a factory is accessible, there is a good degree of certainty that for years to come there will be a sure market for all the beets raised. It cannot be foreseen definitely what unexpected conditions may arise to affect seriously the price to be paid for beets, but good beets ought to bring the farmer not less than $4 a ton and from this up to $5. In general, a profit from $5 to $10 an acre above all expenses may be regarded as a fair return from the crop.

## VI. GENERAL CONSIDERATIONS.

The sugar-beet crop is to be regarded as an additional one, to which a farmer, properly located, may give a portion of his time. It is not intended to take the place of other crops which one knows can be successfully grown. In commencing, farmers will be wise to limit their crop to one or two acres and increase it only as they see their way clear to do so.

The educational value to be derived from growing sugar beets properly can hardly be overestimated. The exacting demands of its successful culture require the best kind of farming. It is reasonable to assume that a farmer who grows sugar beets well will be likely to grow his other crops better than he did before raising beets.

In addition, it is to be remembered that the soil on which a crop of sugar beets has been grown is left in better mechanical condition than by other crops and that it is in better condition for growing other crops.

# REPORT

OF THE

# HORTICULTURAL DEPARTMENT.

S. A. BEACH, M. S., Horticulturist.
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C. P. CLOSE, B. S., Assistant.

## Table of Contents.

# REPORT OF THE HORTICULTURIST.

S. A. BEACH.

## I. TREATMENT OF LEAF SPOT IN PLUM AND CHERRY ORCHARDS IN 1896.*

### SUMMARY.

The following report of the work in treating the leaf spot disease of plum and cherry in 1896 is intended as a sequel to Bulletin 98 which contains an account of the work in 1895.

#### WORK WITH PLUMS.

The questions investigated in 1896 were:

(1) Can the disease be controlled with two treatments of Bordeaux mixture 1 to 11?

(2) If but two or three treatments are to be made when should they be given?

In the case of Italian Prune, on which variety the disease was most prevalent, the best results came from three treatments made May 25, June 17 and July 14.

The experiments indicate that if but two or three treatments are made the first should be given during the last week of May, or about ten days after the blossoms fall, and the second about three weeks later.

In seasons when the disease is no worse than it was in 1896 it may be practically controlled by two sprayings.

These experiments show an average increase in the yield of sprayed Italian Prunes of 24½ lbs. per tree at a cost of less than one cent per pound.

#### WORK WITH CHERRIES.

On orchard trees of Montmorency sprayed with Bordeaux mixture May 14, May 29 and June 15, 1895, only a slight amount of

* Reprint of Bulletin No. 117.

rot was found, while on adjacent trees of the same variety which were not sprayed, from one-twentieth to one-fifth of the fruit rotted.

On orchard trees of Montmorency sprayed June 15, 1895, with eau celeste soap mixture, only a slight amount of rot was found, while on adjacent unsprayed trees from one-twentieth to one-fifth of the fruit rotted.

From the middle of June, 1895, till the close of the season the unsprayed trees had much more and better foliage than did the trees which had been sprayed.

Generally the injury to the leaves in 1895 was much greater on the trees which were sprayed with eau celeste than it was on the trees sprayed with Bordeaux mixture but on one group of Reine Hortense the Bordeaux mixture caused the greater injury.

No injury to the leaves resulted from spraying orchard trees with Bordeaux mixture in 1896, even when they were drenched with it.

Bordeaux mixture applied as late as May 25 is liable to show on the fruit when it is ripe and injure its appearance.

## INTRODUCTION.

The leaf spot disease of plum and cherry was less destructive in New York orchards in 1896 than it has been in some former years, yet in some instances it did considerable damage to certain kinds of plums. Instances were also reported in which cherry trees lost a good deal of foliage by it, but usually they were troubled but little.

The character and appearance of this disease are explained in Bulletin 98 which contains an account of the investigations in treating it which were made by this station in 1895. As there stated, the objects of the investigations were:

1. To compare Bordeaux mixture with eau celeste soap mixture for preventing the disease on bearing trees.

2. To learn what is the fewest number of treatments by which the disease may be controlled and the best time for making them.

The results of the experiments with plums will first be considered.

## TREATMENT OF THE DISEASE ON BEARING PLUM TREES.

The investigations in 1895 showed that while the treatment with the eau celeste checked the disease it injured the foliage. The treatment with Bordeaux mixture did just as much good, or even more, in checking the disease, and it did not hurt the foliage. There was no good chance to compare these two remedies in August, either in 1895 or 1896, as the trees did not show enough injury early in August to permit of a satisfactory comparison of the two remedies. In the latter part of August and in September and October the good effects of the early spraying which was done in May and June showed very plainly. It seems probable that if the early treatments are thoroughly made there will be little need of spraying in August. Should August treatment be found necessary eau celeste might be preferable because it is less liable to show on the ripe fruit, but we are not prepared to say that it is preferable.

The Bordeaux mixture was so much superior to the eau celeste in the trials which were made in 1895 that no experiments in comparing the two mixtures for early treatment were made in 1896.

The investigations as to the fewest number of treatments with Bordeaux mixture, 1 to 11,* necessary to control the leaf spot on bearing plum trees and the best time for making them, were continued in 1896 in the same orchard of T. C. Maxwell & Bros. which was kindly offered to the Station for this purpose in 1895. The treatment gave marked results, especially with Italian prune, and to a large extent confirmed the results of the work in 1895. The weak Bordeaux mixture, 1 to 11, again proved entirely satisfactory and it is confidently recommended for treating plum leaf spot.

*Plan of the work in* 1896.—Four series of treatments were compared, namely:

Series 1. Italian Prune, Guii and Lombard were sprayed May 14, June 3 and June 17. The first treatment, May 14, was given soon after the blossoms fell.

*The 1 to 11 formula for Bordeaux mixture requires one pound sulphate of copper to make eleven gallons of the mixture.

Series 2. Italian Prune, Guii and Lombard were sprayed May 25 and June 24.

Series 3. Italian Prune and Lombard were sprayed May 25, June 17 and July 14. Guii was not included in this series for it ripened its fruit in August and the last application July 14 would be liable to show on the ripe fruit.

Series 4. Guii sprayed May 25 and June 17.

One hundred and sixty-eight trees were included in these experiments, so it appears that the tests were sufficiently extended to insure reliable results.

*Results.*—Through the early part of the season the trees, whether sprayed or not, showed but little of the leaf spot. Later the disease became more noticeable, especially on the Italian Prune. With this variety the trees in Series 2 showed a little more injury than corresponding trees in Series 1 and 3 but were far superior to the unsprayed trees.

As early as August 12 the ground under many of the unsprayed Italian Prune was thickly strewn with fallen leaves and in consequence of this loss of foliage the fruit was prematurely ripening and dropping. At this time the unsprayed Guii trees had lost some leaves but unsprayed Lombard were in nearly as good condition as the sprayed Lombard.

October 3 a careful estimate of the amount of loss or injury to foliage was made from which the following summary is derived.

INJURY UPON SPRAYED AND UNSPRAYED PLUMS.

| | Amount of Injury. | | |
|---|---|---|---|
| | Italian Prune. | Lombard. | Guii. |
| | Per cent. | Per cent. | Per cent. |
| Series 1. Treated May 14, June 3 and June 17 | 1 to 5; average about 3. | About 10. | About 6. |
| Not treated | 50 to 90. | About 10. | About 15. |
| Series 2. Treated May 25 and June 24 | Average about 6. | About 3. | About 10. |
| Not treated | 50 to 90. | About 25. | About 15. |
| Series 3. Treated May 25, June 17 and July 14 | Average about 2. | About 5. | |
| Not treated | 50 to 90. | About 10. | |
| Series 4. Treated May 25 and June 17 | ............... | .......... | About 3. |
| Not treated | ............... | .......... | About 15. |

An examination of this table shows that in the case of Italian Prunes the best results came from the three treatments given in Series 3, namely May 25, June 17 and July 14. The experiments of 1895 showed that when no more than three sprayings are given during the season it is not best to begin before the trees blossom but rather make the first spraying after the blossoms fall. The experiments of 1896 indicate that it is better to put off the first treatment till the last week of May, or till about ten days after the blossoms fall.

The attempts to control the disease with two treatments which were tried in 1895 and 1896 show that when the disease is no worse than it was in those years it may be practically controlled by two treatments; but it is hardly safe to recommend this plan unqualifiedly till it has stood the test of a season when the attacks of the leaf spot fungus are unsually severe.

In view of the results of the investigations of 1895-6, the following line of treatment is confidently recommended, instead of that which was suggested on page 14 of Bulletin 98.

*Course of treatment recommended for plum leaf spot.*—When but two treatments are to be made during the season, let the first be given about ten days after the blossoms fall—that is, usually about May 25. It should not be made later than June 1. Make the second treatment about three weeks after the first. Better results may be expected from three treatments and three treatments are especially recommended in seasons when the disease is very abundant. Make them as follows:

First. About ten days after the blossoms fall.

Second. About three weeks after the first.

Third. From three to four weeks after the second.

## YIELD OF FRUIT INCREASED BY SPRAYING FOR THE PLUM LEAF SPOT.

Aside from the results bearing directly on the questions under investigation in 1895 and 1896 the experiments in treating plums for the leaf spot brought out some very important and definite information as to the influence of such treatment on the yield of trees which are subject to the attacks of this disease. It has already been said that the injury from the leaf spot was especially severe on the Italian Prune, sometimes called Fellenberg, a variety which usually begins to ripen here the first week of September. Of the trees of Italian Prune which were under experiment in 1896 (see page 210), 48 were sprayed and 24 were left unsprayed. As early as August 12 the ground under many of the unsprayed trees was thickly strewn with fallen leaves, and consequently the fruit was ripening and dropping prematurely, while under the sprayed trees very little fallen leaves or fruit was to be seen. The amount of fallen fruit and leaves was so much greater under the unsprayed trees that by looking at the ground one could easily tell which trees had not been sprayed.

Because the treated trees held their foliage much better, their fruit ripened later and on the whole averaged larger than the fruit on the unsprayed trees. Remembering that the later fruit, as a rule, brings better prices, it is at once apparent that the increased yield in this case does not fully represent the increase in receipts from sprayed as compared with unsprayed trees. The following is a statement of the picked fruit, drops and waste from these trees and the date of picking. The yield is measured both by nine-pound baskets and by pounds, except for the waste:

YIELD OF PLUMS FROM SPRAYED AND UNSPRAYED TREES.

| DATE. | Grade. | Baskets. | Pounds. | Average pounds per basket. |
|---|---|---|---|---|
| | 48 SPRAYED TREES. | | | |
| September 1 | Picked | 369 | 3,374 | 9.14 |
| September 24 | Picked | 48 | 436 | 9.08 |
| | Drops | 17 | 181 | 10.65 |
| | Waste | ...... | 110 | ...... |
| | 24 UNSPRAYED TREES. | | | |
| August 25 | Picked | 104 | 897 | 8.63 |
| September 12 | Picked | 36 | 427 | 11.86 |
| | Drops | 12 | 84 | 7.00 |
| | Waste | ...... | 290 | ...... |

The amount and character of the average yield per tree is as follows:

AVERAGE YIELD PER TREE.

| | Sprayed. | | | Not Sprayed. | | |
|---|---|---|---|---|---|---|
| | Baskets. | Pounds. | Per cent. | Baskets. | Pounds. | Per cent. |
| Picked fruit | 8.69 | 79.38 | 93 | 5.83 | 55.17 | 78 |
| Drops | 0.35 | 3.77 | 4 | 0.50 | 3.50 | 5 |
| Waste | ...... | 2.29 | 3 | ...... | 12.08 | 17 |
| Total marketable | 9.04 | 82.15 | 97 | 6.33 | 58.67 | 83 |

From these records it appears that where the trees were sprayed the average yield per tree of picked fruit was increased 44 per cent, the marketable drops increased 8 per cent and the waste decreased 81 per cent. The total yield of marketable fruit as recorded in pounds was 45 per cent greater where the trees were sprayed than where they were not sprayed. The extra cost of picking, packing and hauling to market would be, in this case, 13 cents. With the apparatus used by Messrs. Maxwell & Bros. the cost of spraying would be 8 cents per tree, counting the applications which were actually made, *i. e.*, two applications for sixteen trees and three applications for thirty-two trees. Thus the extra expense of securing and putting on the market an increased yield per tree of 24.48 lbs. of fruit was only 21 cents. So it appears that spraying for leaf spot in this instance secured an average increase of 24½ pounds of marketable fruit per tree at a cost of less than one cent per pound.

## TREATMENT OF THE DISEASE ON BEARING CHERRY TREES.

The experiments which have been tried by this Station during the last two years for preventing the leaf spot on bearing cherry trees have not met with very encouraging results. It was stated in Bulletin 98 that in 1895 the treatment injured the foliage. Generally speaking the eau celeste treatment caused more injury than did the Bordeaux mixture, although there was one exception to this in which Reine Hortense was more injured by the Bordeaux mixture than by the eau celeste.

The work was continued in 1896 for the purpose of learning whether heavy applications of Bordeaux mixture were more apt to harm cherry leaves than light ones, and also for the purpose of determining the fewest number of treatments necessary to control the leaf spot on bearing cherry trees and when they should be made. Mr. C. K. Scoon, Geneva, N. Y., kindly offered the use of his orchard for this work. One hundred and fifty-five trees were included in the experiment; part of them English Morello and part Montmorency Ordinaire.

But little leaf spot was seen, even on the unsprayed trees, so that but little difference could be seen between treated and untreated trees. In October a few of the latter showed more yellow and fallen leaves than did sprayed trees which stood near by, but there was not enough difference to support any conclusions as to the merits of the different methods of treatment.

*Foliage not hurt by spraying.*—Contrary to the experience of 1895 no injury to the foliage followed the use of Bordeaux mixture in 1896, even when the leaves were literally drenched with it. It is difficult to find any theory which offers a satisfactory explanation for the harmful effect of the Bordeaux mixture on the cherry foliage in 1895. It is the only instance in our experience in which cherry leaves have been injured by spraying with Bordeaux mixture.

*Fruit spotted by the spray.*—In 1896 the first treatment was given May 14, soon after the blossoms fell. The following treatment was made in one instance May 25, in another May 29 and in a third June 3. In all cases the fruit still showed the spots of Bordeaux mixture when it ripened, nearly two months later, although considerable rain had fallen in the meantime.

The results of these tests do not give conclusive evidence as to the best way to treat the leaf spot on bearing cherry trees and no definite line of treatment can as yet be recommended.

# II. SPRAY PUMPS AND SPRAYING.*

WENDELL PADDOCK.

## SUMMARY.

We are constantly in receipt of inquiries concerning spraying apparatus and methods of spraying, which show that elementary instruction on this subject is still needed. The following pages were prepared to meet this want, and the bulletin is addressed to those persons who are seeking such information.

Some of the spraying machinery now on the market that has been tested at this station is illustrated and described and the addresses of the firms manufacturing it are given. The formulas of the principal mixtures used in spraying are given and many necessities and conveniences are mentioned.

*Important notice.*—Do not spray trees or plants when in bloom. It is in no instance necessary or desirable. By so doing not only are we liable to injure the delicate parts of the flowers, but what is more important, to poison the bees and other insects that are our friends. It would be impossible to grow some of our fruits commercially without the aid of insects in fertilizing the blossoms.

## INTRODUCTION.

Since spraying has become one of the operations of culture with so many farmers and fruit growers, it would seem as if explicit directions were now almost superfluous. Numerous bulletins on the subject have been issued by our experiment stations, and the pages of agricultural and horticultural papers are alive with discussions on the subject. However, that there are many localities in the State where the methods of spraying are not understood is revealed by the numerous letters of inquiry that are received at this Station.

*Reprint of Bulletin No. 121.

In order to simplify correspondence, as well as to supply a still popular demand, it was thought best to issue another bulletin on spraying machinery. Accordingly, a circular letter was sent to some of the leading manufacturers requesting them to send their pumps to the Station for testing. The majority of the firms addressed responded to the request and kindly sent their pumps free of charge.

In testing pumps it is not our purpose to try to decide what one is best, as some forms are better adapted to certain kinds of work than others. In the following pages we have tried to point out the good and bad features as they have appeared to us in our tests, so that the reader who intends to buy a spraying outfit may have a clear idea of what the pumps are like before he places his order. The illustrations are for the most part quite plain, so that extended descriptions need not be given.

Many of the hints on spraying that are given have been printed a number of times in former bulletins of this Station. However, we still receive numerous questions concerning these points, so a repetition of them will not be out of place here.

*Selection of a pump.*—When selecting a pump one should not have in view the cheapest one that will do good work. Almost any of the pumps now on the market will work satisfactorily for a time, but there are a number of other qualifications that should be considered. The durability, capacity, ease of working, ease with which the parts may be gotten at and repaired or replaced, and the efficiency of the agitator, are among the essentials that should be thought of.

*Work intelligently.*—We sometimes receive such questions as the following: "Isn't it about time for me to spray my orchard?" When the questioner is asked what he intends to spray for, perhaps the answer will be, "Oh, I don't know, only I thought it must be about time to begin." It is safe to say that such persons will not be able to see much benefit to be derived from spraying.

Occasionally inquiries are made concerning the use of Bordeaux mixture for poisoning insects, and the value of Paris green for combating plant diseases. It cannot be too strongly emphasized that *Bordeaux mixture is used only to prevent the spread of plant diseases*, such as apple scab, though it serves as a repellent against some insects. *Paris green is used to poison insects that chew their food*, as do the potato beetle and the canker worm. *Kerosene emulsion is used to kill insects that suck their food*, as do plant lice and scales.

This brings to mind the man who has sprayed and complains that he can see no benefit resulting from his labor. Such complaints can usually be attributed to one of two causes. Either the work was not properly done, or else insects and diseases were not present in sufficient numbers to do any appreciable amount of injury. This only helps to emphasize the fact that each person must become acquainted with these pests for himself, for in no other way can he intelligently combat them. It will not do to follow printed instructions or spray calendars too closely, for spraying cannot be done by rule, since the conditions are not the same from year to year. There are a few pests, such as the apple scab and codling moth, that are universally distributed, and we may expect attacks from them each season. It will pay to spray every season for such pests. We occasionally have seasons when the weather conditions are not suitable for the spread of insects and diseases, but they are the exception. Even in such seasons the spray will have some value, as it will tend to further diminish the spread of the pests, so that they may be more readily held in check when conditions favorable to their increase do arise. Therefore we must not conclude that spraying will not pay because we do not get flattering results in any one season, for the next year may bring conditions when our plants will most need protection.

A very little reading and study will enable any one to become familiar enough with the common insects and diseases to know them when he sees them and to learn how to combat them. The first thing to be done, then, is to find out what we are going to spray for, and how and when to apply the remedy. Bulletin No. 86 of this Station gives general directions for combating the principal fungous and insect pests, and other bulletins have been issued on special insects and diseases at intervals as they have demanded attention. A supply of many of these is still on hand and copies may be had for the asking.

## HAND MACHINES.

### PUMPS.

*The Eclipse.*—The style of pumps illustrated in Figures 1 and 2 is a comparatively new idea in spray pumps. Though they have but recently been introduced, a large number of them are in use, and they seem to be giving satisfaction. The Eclipse, illustrated in Figure 1, was the first of the two to be put on the market. This pump is manufactured by Morrill & Morley, Benton Harbor, Mich., and is listed at $20. The illustration gives a good idea of the form of the pump. All parts that come in contach with the liquid are made of brass, and, as can be seen, the pump is placed directly in the barrel. The cylinder is at the bottom, and is made of solid brass, there being no stuffing-box. The plunger consists of a short cylinder of brass around the center of which is fitted a small amount of packing. The arrangement of the parts is such that the piston cannot work clear through the cylinder, consequently the cylinder wears more at the center that at either end. In one season's hard use we find that the wear becomes so great that sufficient packing cannot be gotten in to fill up the center of the cylinder. However, a worn-out cylinder can be quickly replaced at a cost of seventy-five cents.

The agitator, as is shown in the cut, consists of a wide spoon-shaped blade or paddle, which is fastened at one end by a hinge to the lower end of the cylinder. A rod connecting with the pump handle moves the blade up and down with every stroke. This device is quite satisfactory.

The air chamber surrounds the discharge pipe, and is of sufficient capacity to insure a steady spray.

When the cylinder or plunger needs attention the pump must be taken from the barrel, but this is not a difficult task, since the pump is removed by unscrewing two bolts that are entirely

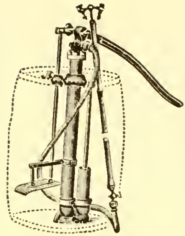

FIG. 1.—THE ECLIPSE.

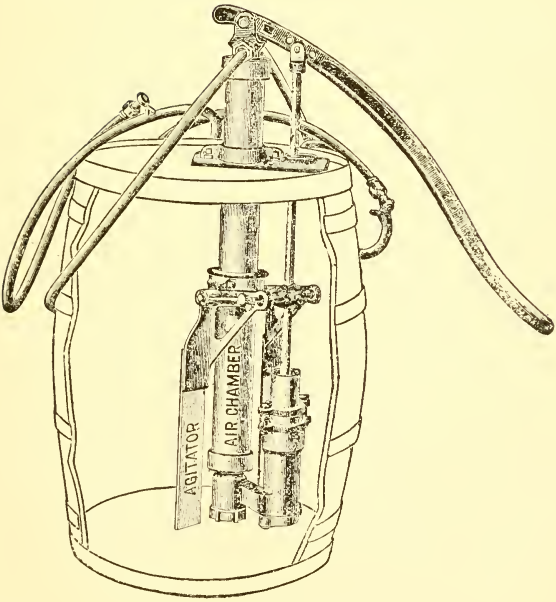


FIG. 2.—THE POMONA.

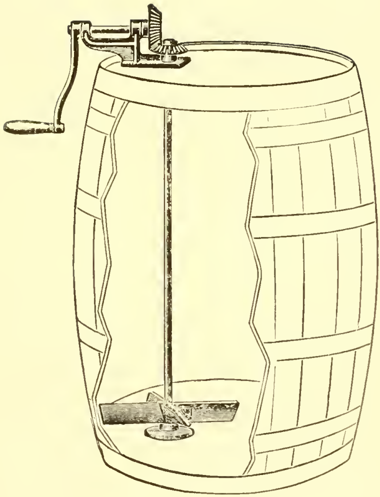

Fig. 3.—An Agitator.

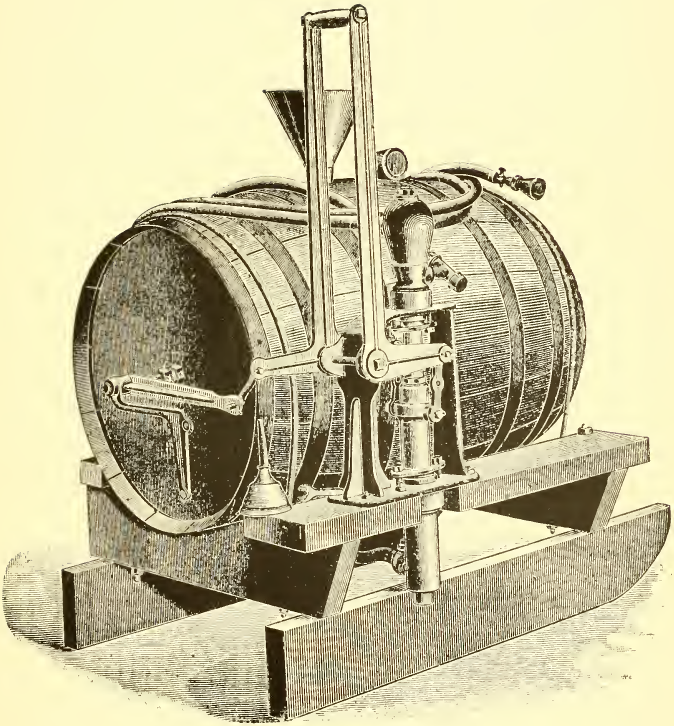

FIG. 4.—THE CASWELL PUMP, NO. 2.

on the outside of the barrel; this is quite different from the old way of loosening four or more rusty bolts that can be reached only through a small hole in the top of the barrel.

*The Pomona.*—The Pomona pump, illustrated in Figure 2, is manufactured by the Gould Pump Company, Seneca Falls, N. Y. It is listed at $20. It is much like the Eclipse in its construction, but a change has been made for the better in the plunger and cylinder. Instead of the long cylinder and short plunger, with packing on the latter, a comparatively short cylinder provided with a stuffing-box is used, while a long brass plunger passes entirely through the cylinder with each stroke of the handle. With this arrangement one part of the cylinder cannot wear more than another.

Two styles of agitators are furnished with this pump. One is worked by the pump handle as shown in the cut. The other style is illustrated in Figure 3, which explains itself. Either one does good work, but the liquid may be more thoroughly stirred by the latter.

*The Caswell.*—Figure 4 illustrates the Caswell pump, manufactured by the Caswell Pump Company, Sandusky, Ohio. The list price is $20. These pumps have been thoroughly tested and have proven to be satisfactory. One of the largest fruit growing firms in this vicinity has used the Caswell for several years and is enthusiastic in its praise. All of the parts are made of brass, and are easy of access when any repairs become necessary. Either of the two valves may be gotten at by unscrewing a cap. This feature is quite an improvement over the old way of having to take the pump out of the barrel and all to pieces before any of the working parts can be reached. The plunger has an up and down motion, but the arrangement of the handle is such that it is similar in motion to that of a horizontal pump. Thus the weight of the body may be thrown on both the forward and backward strokes. The pump cannot be put on a barrel, but is bolted to the wagon frame, or to a frame made for the purpose, as shown in the cut. The agitator is not as good as could be desired, and when a larger tank is to be used some other form must be devised.

*The Advance.*—The Advance pump, illustrated in Figure 5, is manufactured by the Deming Pump Company, Salem, Ohio. The list price is $18.

In appearance this pump is much like the ones that were first placed on the market. The similarity is principally in appearance, as many improvements have been made. By detaching the stuffing-box cap the plunger and the lower valve may be taken out of the cylinder. Accordingly the pump need not be taken from the barrel and nearly to pieces when any repairs becomes necessary. The large air chamber, together with the large cylinder, insures a steady spray. The agitator consists of two blades and a plunger that are operated by a connection with the pump handle, as shown in the cut.

The pump was received so late in the season that it was impossible to give it a thorough test. It is certainly well made and powerful, and no doubt will prove to be a satisfactory outfit.

*The Empire Queen.*—This pump is manufactured by the Field Force Pump Company, Lockport, N. Y. The list price is $9. This is one of the old style pumps that must needs be unbolted and taken from the barrel and pretty much to pieces when any repairs become necessary. Therefore, where a large amount of work is to be done and repairs necessarily become more or less frequent it is likely that the improved forms will be cheaper in the end. In smaller orchards the low price might make it more economical than the more expensive pumps, since the wear would be much lighter. It does good work while in repair.

The agitator, however, is not as efficient as could be desired, as it has an easy motion and does not agitate the liquid violently as is necessary in order to do the best work.

*The Geiger.*—This pump is manufactured by the Geiger Pump Company, Rochester, N. Y., and is listed at $20. It may be classed among the novelties in spraying machinery, and as such only severe testing will determine its value. It works on the principle of the semirotary pumps. All who have tried pumps of this class know that they are very satisfactory as long as the parts fit closely. There are no valves to get out of order; no

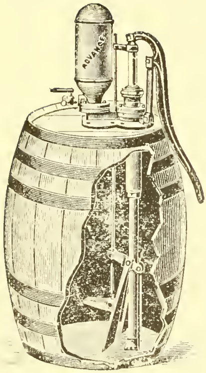


Fig. 5.—The Advance.

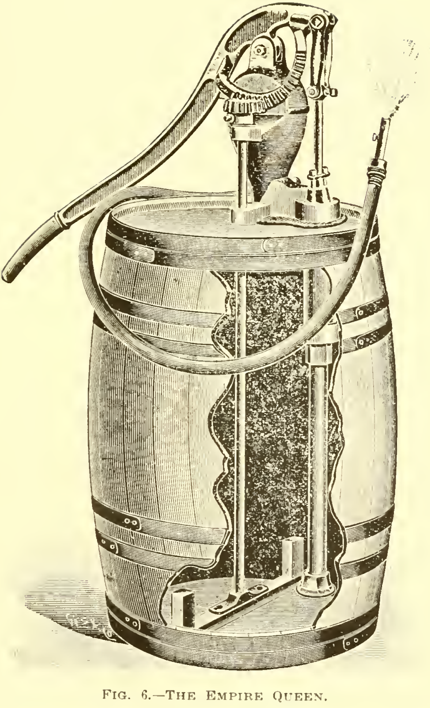

FIG. 6.—THE EMPIRE QUEEN.

Fig. 7.—The Geiger

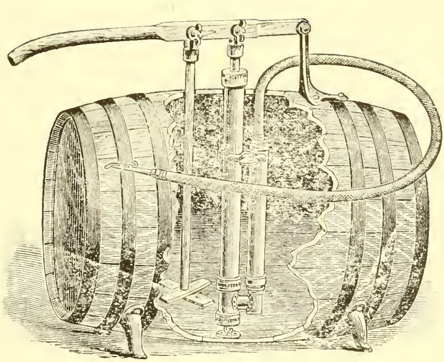

Fig. 8.—The Defender.

leather or rubber or packing of any form to be replaced; these points are of great importance. However it has been our experience that one season's hard use wears the cylinder so that it must be replaced.

The agitator of the Gieger is made to revolve by means of gearing and a crank, and consists of a blade or paddle fastened to a piece of tubing. The suction pipe is inside the tube and takes up the liquids through sieves in the blade of the agitator. As the pump was not received early enough in the season for us to give it a thorough test we are not able to speak positively as to its merits.

*The Defender.*—The P. C. Lewis Manufacturing Company, Catskill, N. Y., manufactures the Defender pump, which sells for $10. It is made to fasten on the side of a barrel, and is light and simple in its construction, as may be seen in the illustration. All parts that come in contract with the liquids are made of brass; the valves are made of leather but they are easily replaced when worn out, as the parts may be unscrewed with the hand. It is unfortunate that the hose couplings are of an unusual size, as the hose that is supplied with most pumps cannot be used interchangeably with this.

In spite of its small size the pump is quite powerful but it taxes its capacity to supply four nozzles. Its convenient form and light weight will commend it for many kinds of work, while its low cost brings it within the reach of all.

*Bucket pumps.*—These pumps are made to fasten on a pail, and are very useful where a small amount of spraying is to be done. They are manufactured in great variety and may be obtained from most dealers at a small cost.

*Knapsack sprayers.*—These machines are small spraying outfits that are designed to carry on the back, hence the name. There are several patterns manufactured by different firms, which differ from each other only in minor details. In general they consist of a copper tank, holding from three to five gallons, that is held in place on the back by straps over the shoulders. A small force pump is operated by one hand while the nozzle is directed by the other.

In a former bulletin these sprayers were recommended as being almost indispensable. With greater experience we find that so much hard, dirty work is involved in their use that we do not feel like recommending them except in cases where bucket and barrel pumps cannot be used to advantage.

Knapsacks may be obtained of most dealers in spraying supplies at a price ranging from $10 to $15.

## POWDER GUNS.

Powder guns are used to apply poison and repellents for insects in the green-house or on small plantations of fruit or vegetables. The well-known Leggett Powder Gun may be taken as an example of these guns. It consists of a reservoir and an inclosed fan operated by a crank, which blows the powder out through a tube. It is supplied with a number of nozzles and tubes which are used in the different kinds of work. It is made principally of tin, and weighs about five pounds.

Some manufacturers assert that these guns are just the thing for poisoning bugs in large potato fields, using the clear Paris green. Most fungicides cannot be applied in a dry form, and since it is often advantageous to use both insecticides and fungicides it would seem to be better economy where a large amount of work is to be done to invest in a machine that will apply a remedy for both insects and diseases at the same time.

*The Lightning Potato Bug Killer.*—This little contrivance is quite convenient for applying poison and repellents for insects in the green-house or in small plantations of fruit or vegetables. It consists of a small hand bellows with a funnel-shaped spout. The material to be applied is poured into the bellows through the spout, through which it is puffed out in a cloud-like form. Where small amounts of tobacco dust, pyrethrum, hellebore or Paris green are to be applied this bellows will be very useful.

These implements may be obtained from dealers in florists' supplies at a small cost.

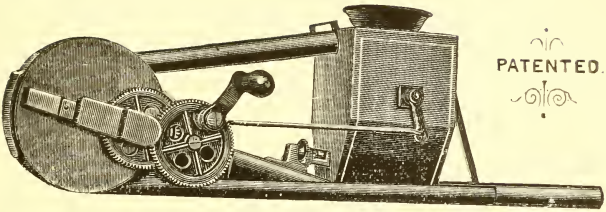


Fig. 9.--The Leggett Powder Gun.

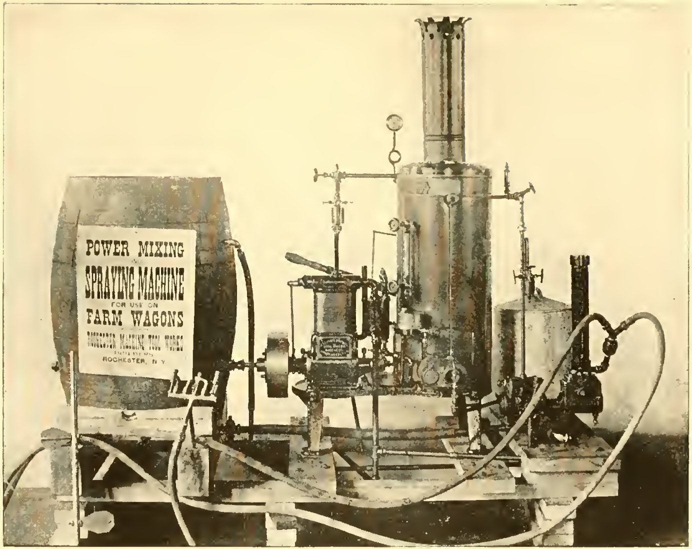


FIG. 10.—STEAM SPRAYER.

## POWER SPRAYING MACHINES.

*Steam sprayers.*— It is likely that in the near future some form of power spraying machines will be in common use on our large fruit farms. It is only about two years ago that steam was first used in spraying, so there has not been sufficient time to fully develop this form of spraying machinery. However, several firms are now manufacturing steam spraying outfits, and it is probable that great improvements will soon be made.

The Rochester Machine Tool Works, Rochester, N. Y., manufacture the power spraying machine illustrated in Figure 10. The outfit consists of a one-horse-power engine and boiler, a small steam pump and a spray tank. The entire outfit weighs about six hundred pounds, and may be loaded on an ordinary wagon.

The boiler burns kerosene, and will consume about three and one-half gallons in ten hours if run at full capacity. The pump is powerful, but since no air chamber is provided the spray is not as steady as could be desired.

The manufacturers appreciate the necessity of agitating the spraying mixture, and the engine is furnished for the purpose alone. It is to be hoped that some cheaper method of agitating may be devised. The manner of attaching the suction pipe to the bottom of the tank should be changed. No matter how perfect the agitation may be the particles of the mixture will settle in a pipe attached in this manner. Aside from the annoyance of clogging the nozzles, it not infrequently happens that the suction pipe becomes entirely stopped up. This cannot happen if the pipe enters the barrel from the top.

The list price of this outfit complete is $250.

*Horse-power sprayers.*— In spraying large areas of potatoes or truck crops where the machine may be kept in continuous motion, horse-power sprayers may be used to advantage. These machines may be divided into two classes, those that are provided with a pump, and those that discharge the liquid by force of gravity; of the two styles the former is much to be preferred.

since the liquid is forced through fine nozzles, and is, consequently, more intelligently applied. From four to six rows may be sprayed at a time, and where the machine is provided with a pump the nozzles can usually be adjusted so that they make satisfactory sprayers for vineyards that are located on level ground. Where the vineyard is planted on uneven or hilly land it is much more satisfactory to direct the nozzle by hand, even though a power machine is used.

Before buying, the purchaser should investigate the object thoroughly, so as to get a machine that is suited to his particular wants. The addresses of a few of the firms who are manufacturing horse-power sprayers are given below:

The Caswell Pump Company, Sandusky, O.; Thomas Peppler, Heightstown, N. J.; the Field Force Pump Company, Lockport, N. Y.; The Riverhead Agricultural Works, Riverhead, N. Y.

The machines manufactured by these firms, except the one last mentioned, were illustrated and described in Bulletin No. 74 of this Station. Copies of the bulletin may still be had upon application.

The mycologist of this Station, who is located on Long Island, sends the following description of the Hudson Sprayer, manufactured by the Riverhead Agricultural Works:

"The Hudson Spraying Machine is designed specially for applying Bordeaux mixture to potatoes, for which work it is well adapted. It sprays four rows at each passage. The parts are so arranged that each row receives the spray from two nozzles, which can readily be adjusted to suit the size of the plants. The machine is balanced, rider on or off, barrel full or empty. The capacity of the barrel is 45 gallons, and the liquid is drawn from the bottom. Thorough agitation of the liquid is effected by means of two diagonal paddles. The pipe carrying the nozzles is placed in front of the wheels, thus making it possible for the barrel to be filled by a man standing on the ground. The pump is a rotary one and supplied with a small air chamber. The 'shut off' and 'out gear' movements are made by one handle. With slight alterations the machine can be adapted to orchard

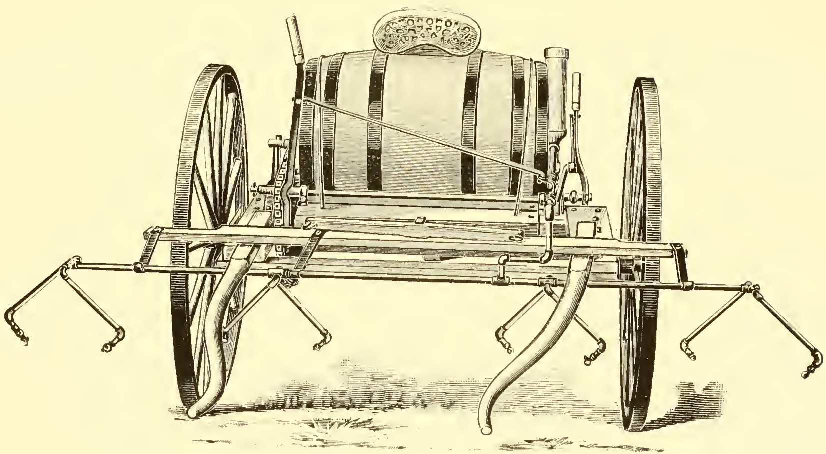

Fig. 11.—The Hudson Sprayer.


Fig. 12. A Home-made Outfit

spraying. We have tested this machine through the whole of one season on seven acres of potatoes at Jamesport, L. I., and have found it quite satisfactory. It is manufactured by the Riverhead Agricultural Works, Riverhead, N. Y. Price, $75."

## HOME MADE CONVENIENCES.

Spraying is hard, dirty work at best, and any machinery or method that will facilitate the work is eagerly sought. Many ideas for improvement that are adapted to the needs of different conditions will suggest themselves as the work progresses.

If in a large orchard a tank larger than a kerosene barrel is wanted it should be made of a round form so there will be no corners for the mixtures to settle in.

Where very tall trees are to be sprayed it may be advantageous to build a platform on the rear of the wagon for a man to stand on who is to spray the tops of the trees. The height of the platform will depend on the height of the trees to be sprayed. Fig. 12 shows such an outfit that was made here at the Experiment Station to be used in our orchards.

We have seen a very serviceable home made outfit for spraying potatoes. It consisted of a barrel pump mounted in a light one-horse wagon and by means of a hose and a few feet of gas pipe a simple arrangement was made to fasten to the rear of the wagon that extended out over four rows. By attaching nozzles at proper intervals to the pipe the four rows were sprayed as the wagon moved over them. With a boy to drive and a man to pump, a large amount of territory may be gotten over in a day with such an oufit. The same pump will of course serve to spray trees as well. By the exercise of ingenuity the necessity of buying expensive apparatus may often times be avoided and the home-made tools may be even more serviceable as they are made to suit the conditions that exist on our own farms.

## SUNDRY NOTES.

*Nozzles.*—In order to do the best work a nozzle should throw a fine mist-like spray that will float in the air and slowly settle. With such a spray nearly all of the leaf surface may be thinly coated with the minute particles and yet be almost unnoticed by the casual observer.

The best work cannot be done with a nozzle that throws a coarse spray, or by drenching the trees till the particles collect in drops on the leaves and branches and fall to the ground.

Each season brings its array of new and modified forms of nozzles, but for our work we have yet to find any nozzle that is as satisfactory as the Vermorel, providing that it is of the right pattern. Various forms are on the market, but those that have no joint between the nozzle chamber and elbow, are a source of annoyance, as the best of them sometimes become clogged in the elbow, and where there is no joint it is next to impossible to reach the obstruction. Vermorels that are not open to objection are illustrated in Figures 13 and 14.

The Vermorel produces a very fine mist-like spray, which it can throw but a very few feet beyond its orifice. Therefore where very tall trees are to be sprayed it may be necessary to use a nozzle that will throw a spray to a greater distance. The McGowen nozzle is quite satisfactory for such work. In any case it will be seen that where trees are to be sprayed the Vermorel nozzle must be lifted up among the branches. The bamboo extension was devised for this purpose.

*Double discharge nozzles.*— For most spraying it is most advantageous to use more than one nozzle on a single line of hose, as the work can be done much quicker than when only one nozzle is used. Various forms of connections are manufactured for this purpose. Triple connections are also used where it is desired to use three nozzles on the same hose.

*Bamboo extension.*—This consists of a three-eighths inch brass tube inside of a bamboo pole. At the lower end of the tube is a stop-cock and hose connection, while the nozzle is attached to the upper end. Several other methods of elevating the nozzle are used, such as the use of small iron or galvanized pipe, but this form is mentioned in particular for the reason that it is light and convenient to handle. Extensions may be made of any convenient length.

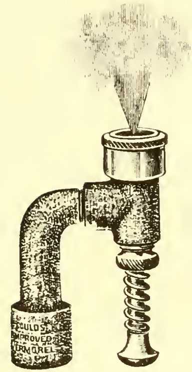

FIG. 13.—VERMOREL NOZZLE.

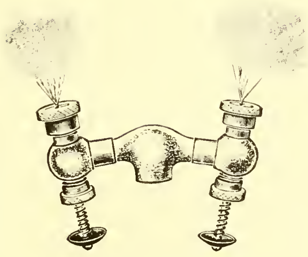

FIG. 14.—DOUBLE VERMOREL.

*Bordeaux mixture.*—There are several different formulas for making Bordeaux mixture, any one of which will no doubt give excellent results if the directions are closely followed. The formula given below has been used at this Station for the past five years, and it is also generally used by the fruit growers of this vicinity. In no case has it proven unreliable, so we do not hesitate to recommend it as being one of the best and certainly the quickest method by which Bordeaux mixture can be made. Much has been written of late for and against the practice of using the potassium ferrocyanide test for determining the amount of lime to be used, and many nice points have been brought forth as to just how this test should be applied. We still adhere to the common method of applying it, as we have always found it reliable:

| | | |
|---|---|---|
| *Formula.*— | Copper sulphate | 4 lbs. |
| | Lime | 3 lbs. |
| | Water | 45 gals. |

Dissolve the copper sulphate in hot water or by suspending in a coarse cloth or bag in a considerable amount of cold water, so that the sulphate is just covered. It will not all dissolve if placed in the bottom of a vessel of cold water. When dissolved dilute the solution to two-thirds of the required amount. Next slake the lime and add it to the solution in the form of a thin whitewash—the thinner the better. Strain it if necessary to keep out particles that would clog the nozzle. The mixture should be thoroughly stirred while the lime is being added. It is essential that the copper solution should be quite dilute before the lime is added, otherwise a heavy precipitate is formed.

*Weighing the lime.*—It is easy to see that the weighing and slaking of the required amount of lime each time a barrel full of the mixture is to be made will require a considerable amount of time in the course of a day, which at this busy season is quite an item. By using the color test the necessity of weighing the lime is done away with and enough lime may be slaked at one time to last through the season. A convenient way to keep the lime is to slake it in a barrel that is partially sunk in the ground, as is shown in Figure 15. When treated in this manner it will keep indefinitely in the form of paste if the surface is kept covered with a small amount of water. It will be economy to buy a good quantity of fresh lime. Air slaked lime is worthless.

*Potassium ferrocyanide test.*—Fill the spray tank two-thirds full with the copper sulphate solution, then pour in the milk of lime. Stir the mixture thoroughly and add a drop of the potassium ferrocyanide. If enough lime has been added the drop will not change color when it strikes the mixture, otherwise it will immediately change to a dark reddish brown color. More lime must then be added until the ferrocyanide does not produce the reddish brown color. Even after the test shows no color more lime should be added so as to be sure that all of the copper will be precipitated, for in case the mixture has not been thoroughly stirred some of the copper may still remain in solution in the bottom of the barrel while the test shows no color at the surface.

An excess of lime will do no harm, while the free copper solution will injure the foliage.

The potassium ferrocyanide, or yellow prussiate of potash, is a poisonous yellow salt which readily dissolves in water. A few cents worth dissolved in about ten times its volume of water will last through the season.

*Stock solution of copper sulphate.*—Where a good deal of spraying is to be done it will be found advantageous to make up a stock solution of copper sulphate. This may be made by dissolving any number of pounds of the sulphate in one-half as many gallons of water. A gallon of the solution will contain two pounds of the sulphate, therefore two gallons will contain the required amount for a barrel of Bordeaux mixture. Suspend the sulphate in the top of the water, otherwise it will not all dissolve if the water is cold. The stock solution must be kept well covered in order to prevent evaporation.

*Saturated solution of copper sulphate.*—An up-to-date orchardist recently suggested that a saturated solution of copper sulphate

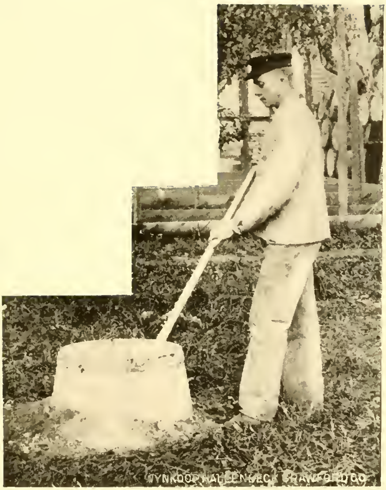


Fig. 15.—Method of Keeping Lime Paste.

would be more convenient than the ordinary stock solution as there would be no necessity of weighing the copper sulphate or of measuring the water. This gentleman has followed this plan for two seasons with good results. However this method can only be commended to careful men who will take pains to see that the solution is always a saturated one. A large vessel of cold water is provided in which is suspended a large amount of copper sulphate, more than the water can possibly take up. This should be prepared at least a day before the solution is wanted for use in order that the sulphate may have time to dissolve. As the solution is taken out more water should be added to the vessel from time to time and copper sulphate should be constantly kept in suspension. By exercising a due amount of care a fairly even solution may be maintained. One gallon of water at ordinary temperature, 59° F., will dissolve 49 ounces of copper sulphate. Therefore one and one-third gallons of such a solution will contain the required four pounds of copper sulphate for a barrel of Bordeaux mixture.

Bordeaux mixture should be used soon after it is made, or at least on the same day that it is made, as it soon begins to deteriorate in value.

*Kerosene emulsion.*—Kerosene emulsion is made by dissolving one-half pound of common soap or whale oil soap in one gallon of soft water. Heat the mixture, and when boiling hot remove it from near the fire and add it to two gallons of kerosene. The whole is now thoroughly mixed by pumping continuously through a small force pump for about five minutes. Mix until the ingredients form a creamy mass that becomes thick when cool and from which the oil does not separate. When using on foliage dilute with from ten to fifteen parts of water; when used as a winter treatment it may be applied as strong as one part of the mixture to four parts of water. After the stock emulsion becomes cold it hardens so that it is necessary to melt it before it can be successfully diluted. It takes fire very readily, so it is always a safe plan to have a fire out of doors when making the emulsion. This emulsion is used to kill insects that have sucking mouth parts; it is not a poison but kills by contact.

When applying the mixture with pumps that have rubber balls for valves, it must not be forgotten to replace the balls with marbles as the kerosene soon destroys rubber. There is a large amount of whale oil soap of poor quality on the market which accounts for trouble that some people experience in forming the emulsion. Only the better grades of whale oil soap should be used.

*Paris green.*—Paris green is used to poison insects that have biting mouth parts. It may be applied either in the dry form or in a spray. When the spray is used the Paris green may be combined with Bordeaux mixture, or it may be applied mixed with water. In either cases the same amount of poison is used. For pomaceous fruits, such as apple and pears, one pound of Paris green to one hundred and fifty or two hundred gallons is commonly used. For stone fruits the mixture should be weaker, using one pound of Paris green to two hundred and fifty or three hundred gallons. When used with water, two pounds of fresh slaked lime must be added for each pound of Paris green, to prevent injury to the foliage.

The adulteration of Paris green has come to be a great source of annoyance and loss to the farmer and fruit grower. There should be but one grade of Paris green and that the pure article, yet many dealers have different grades for sale. The cheaper goods must necessarily be adulterated. Where adulteration is suspected, if some of the poison is crushed between two pieces of window glass or between the thumb and finger, oftentimes the small lumps will be found to be white inside, showing that some adulterant has been used. The ammonia test which is very simple though not infallible may also be used. Pure Paris green will readily dissolve in ammonia and the solution will be of a deep blue color. If there is any residue, or if the solution does not become blue at once, adulteration may be suspected.

Plate I.—Raspberry Canes Attacked by Anthracnose. From Drawing by W. P. Wheeler.

# III. ANTHRACNOSE OF THE BLACK RASPBERRY.*

WENDELL PADDOCK.

## SUMMARY.

The following pages give an account of experiments in combating anthracnose of the black raspberry, which were continued through three successive years. While the treatment was successful in preventing the spread of the disease to the new canes, in no instance did the sprayed rows yield enough more fruit to make the spraying a paying operation. Each person must decide from the conditions existing in his own plantation whether or not it will pay to spray for this disease.

In localities where anthracnose has been sufficiently virulent to warrant treatment the following measures are suggested.

(1) Use only healthy plants and adopt a short rotation of crops.

(2) Protect the new shoots in the spring by spraying them with Bordeaux mixture when they are about six inches high; or better still, spray for the first time when the first few scab spots appear on the young canes. Follow the first spraying with two others, or more if it seems best, at intervals of about ten to fourteen days. Remove all old canes and badly diseased new ones as soon as the fruiting season is over.

## INTRODUCTION.

The growing of most of our fruits of commercial importance is attended with more or less difficulty because of the attack of plant diseases and injurious insects. In this respect the raspberry is no exception, but it is less liable to such attacks than are many fruits.

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There are only a few diseases that are widely distributed in the raspberry plantations of New York. Of this number, orange rust and anthracnose are particulary troublesome. Orange rust is easily recognized by the bright orange color that its masses of spores give to the underside of the leaves or other growing parts of the plant on which they chance to form. Anthracnose, however, is not so easily recognized and so is all the more dangerous. Great confusion exists in regard to the appearance of this disease and its effect on the plant, so a somewhat extended popular description is given.

*What are plant diseases?*—In order that we may more readily grasp the discussion let us consider briefly the nature of plant diseases. The fungi that cause plant diseases are minute plants of low order that live as parasites on higher plants. It requires the assistance of a powerful microscope to make out the characters of most of these tiny plants, yet they are just as truly plants as are the trees upon which some of them live. They have organs called mycelium that correspond to roots and modified branches of the mycelium bear minute bodies called spores, that are similar to and perform the same office as seeds. Under favorable conditions of moisture and temperature the spores are borne in innumerable quantities and they readily germinate under the same conditions. The spores are very small and light so are borne on the slightest breath of air. Scattered by the winds or other agencies the disease spreads rapidly when the weather conditions are suitable.

*What is anthracnose?*—The name anthracnose is a popular term that has come to be applied to plant diseases that are caused by one of the two groups of fungi known as Colletotrichum or Glœosporium. The anthracnose of the raspberry belongs to the Glœosporium group. The different species of this genus attack their host plants differently. The one that lives on raspberries may attack any part of the plant but is more commonly found on the canes and it spreads principally by attacking the young shoots. The fungus remains dormant during the winter on the canes but as soon as suitable weather comes in the spring, spores are formed on the diseased areas and infection begins. It makes its first appearance on the young canes oftentimes when they are from six to ten inches high and at any point on them where the spores may chance to fall. It is supposed that the germ tube of the spores can enter only young and tender tissue, consequently the spread of the disease is toward the tip of the cane naturally following the tender growing part. Therefore we find the small spots toward the top, while the larger, older ones are lower down on the cane. The disease first appears on the new canes as small, dark or purple colored spots, few at first but increasing rapidly in number providing a diseased spot on an old cane is in close proximity and the weather conditions are favorable for the production and germination of spores. The new spots rapidly increase in size, changing from the dark color to a brown or dirty white in the center as the fungus feeds outward in all directions and leaves the dead tissues behind. The slightly raised outlines of the spot vary in color from dark-brown to bright purple. As the cane grows older it throws out numerous layers of corky tissue around the diseased spots in its effort to heal the wounds, thus giving the diseased canes a rough, scabby appearance. If badly infected the spots are so numerous on the cane that they soon grow into one another and form large blotches or scabs sometimes six or eight inches long, often entirely encircling the cane and thus effectually girdling it.

This minute plant lives on the juices contained in the cells of the tissue that lies just beneath the outer bark, the most vital part of the plant; here the threads of the mycelium cross and interlace and ramify in all directions absorbing nourishment that should go to build up the cane. As the disease advances it leaves the cells of the tissue discolored and collapsed. Where a scab spot nearly or entirely encircles a cane the supply of sap is cut off and the cane withers and dies. It is not known that the fungus works into the wood but its attacks occasionally cause the canes to crack and expose the pith.

While the anthracnose of the raspberry may be said to be preeminently a disease of the canes, it sometimes attacks the leaves, where it produces small brown spots. The curling and browning of the leaves is often caused by anthracnose but it is usually the result of a diminished sap supply, caused by the attacks of the disease on the canes below rather than by a direct attack on the leaves. The disease also frequently attacks the leaf stems and small fruiting branches where it appears as small, dark or grayish patches on the bark the same as on the canes. If the attack is severe the leaves may wither and die and the fruit dry up on the bushes.

Where a plantation is badly diseased the casual observer may not notice that there is anything wrong with the plants the first two years from setting. In the third year when they should bear their largest crop of fruit the plants may still look fairly well, the new canes make a moderate growth and the fruiting stems give promise of a good yield of fruit, but before the berries have a chance to ripen they shrivel and dry on the stems and the foliage assumes an unhealthy color. If the plants are not removed, the next spring the foliage is scant and pale, and before midsummer the leaves become shriveled and dry and many of the plants die.

Fortunately, however, it is not often that anthracnose is so disastrous in its effects. In many localities it remains about the same from year to year without killing the plants or causing the fruit to dry up on the bushes. Yet the unsuspecting grower complains that his crops are not what they used to be. The plants, enfeebled by the disease, are more liable to winter-injury; and the constant drain on their vitality tends in many ways to lessen the fruit production. Then, again, traces of anthracnose may be found in a great many plantations where it has never spread enough to do any appreciable amount of injury.

The disease is more prevalent in some locations than in others, and some varieties of berries are more susceptible to its attacks than are others. While anthracnose is more severe on black raspberry it does not confine its attacks to this species but occurs on the other species that are commonly cultivated as well as on the blackberry.

## EXPERIMENTS IN TREATING THE DISEASE AT CLIFTON.

In the spring of 1894, a communication was received from Mr. S. A. Hosmer, of Clifton, N. Y., in regard to anthracnose on raspberries. He kindly offered the Station the remains of his once large plantation to use in experimenting with treatment for the disease.

The plantation at one time consisted of 25 acres and was regarded as producing one of the most paying crops of the farm; but through the ravages of anthracnose the acreage was yearly reduced until scarcely three acres of badly infested plants remained. Seemingly every cane was diseased, immense scabs and blotches from four to eight inches in length and reaching nearly or quite around the cane being not uncommon. This plantation, consisting entirely of Gregg, was set out in the spring of 1890. There were 50 rows in the patch remaining which occupied about three acres of land.

It would seem that here were ideal conditions for experimenting with methods of treatment for combating the disease. Accordingly experiments were planned which were carried on through three successive years.

*Plan of the experiment.*— Primarily, the experiment was undertaken to see if the disease could be successfully combated; secondly, different solutions were used for the first treatment, so that a comparison might be made as to their effectiveness in treating the disease.

Knowing that a remedy for any fungous disease must be a preventive rather than a cure, and that many fungi begin their work very early in the spring, it was planned to give the first treatment before the leaf buds opened; at this time strong solutions could be used as there would be no foliage to be injured; accordingly the rows were treated as shown in the accompanying table:

The first three rows were sprayed with copper sulphate solution, using three pounds to eleven gallons of water. The next three with a saturated solution of iron sulphate in water, while the next three were left unsprayed for comparison. This plan was carried on throughout the plantation until the last two rows

TABLE I.—TREATMENTS APPLIED TO RASPBERRIES FOR PREVENTION OF ANTHRACNOSE.

| | | | | |
|---|---|---|---|---|
| Apr. 18, sprayed with copper sulphate solution.<br>May 1, sprayed with Bordeaux mixture.<br>May 16, do.<br>May 30, do.<br>June 21, do.<br>Aug. 9, do. | Apr. 18, sprayed with iron sulphate solution.<br>May 1, sprayed with Bordeaux mixture.<br>May 16, do.<br>May 30, do.<br>June 21, do.<br>Aug. 9, do. | Unsprayed. | Apr. 18, sprayed with acid copper solution.<br>May 1, sprayed with Bordeaux mixture.<br>May 16, do.<br>May 30, do.<br>June 21, do.<br>Aug. 9, do. | Apr. 18, sprayed with acid solution.<br>May 1, sprayed with Bordeaux mixture.<br>May 16, do.<br>May 30, do.<br>June 21, do.<br>Aug. 9, do. |
| Rows.<br>1, 2, 3<br>10, 11, 12<br>19, 20, 21<br>28, 29, 30<br>37, 38, 39<br>46, 47, 48 | Rows.<br>4, 5, 6<br>13, 14, 15<br>22, 23, 24<br>31, 32, 33<br>40, 41, 42 | Rows.<br>7, 8, 9<br>16, 17, 18<br>25, 26, 27<br>34, 35, 36<br>43, 44, 45 | Row.<br>49 | Row.<br>50 |

were reached, making in all 18 rows treated with copper sulphate, 15 rows treated with iron sulphate and 15 untreated or check rows; of the last two rows one was sprayed with a solution made up of ten parts of a saturated solution of copper sulphate to one part of sulphuric acid, and the other with a 10 per cent solution of sulphuric acid. After the first treatment all treated rows were sprayed alike with Bordeaux mixture using one pound of copper sulphate to make eleven gallons of the mixture.

## EXPERIMENTS IN 1894.

*Dates of spraying.*— The first spraying was made April 18, just as the leaf buds were beginning to swell. All of the different mixtures were applied on the same day. That evening a heavy rain set in which lasted three days.

The second spraying was given May 1, when the leaves were about one-fourth grown. At this time it was noticed that there were numerous small dark spots on the canes in the rows that had been sprayed with the sulphuric acid solution, which indicated that the acid had been applied too strong. The heavy rain that came on just as the work was finished undoubtedly washed off a good deal of the acid and thus saved the plants from serious injury.

The next treatment was made May 16. The leaves were nearly full grown, while the largest of the new canes were about eight inches in height. The work of the fungus on the new canes was now noticed for the first time; a few of the small characteristic spots were seen on the new shoots where they grew close to a diseased spot on an old cane. Immediately after this spraying was given the severe spring rains set in which lasted intermittently for 21 days.

On May 30, a fourth spraying was given. It was noticed at this time that the previous spraying had seriously injured both the fruit and foliage. On looking about for a cause for the injury it was found that the capacity of the measure that was used in making the Bordeaux mixture had been mistaken, consequently the mixture was made much stronger than was intended. The injury was probably due to this fact as raspberries on the Station plats that were sprayed throughout the season with Bordeaux mixture, using one pound of copper sulphate to make eleven gallons of the mixture, were not injured. Raspberry foliage was not found to be particularly liable to injury from Bordeaux mixture at this strength. However, as the new canes are the only parts of the plants that need protection, the spray should be directed toward them alone.

A fifth treatment was given on June 21. The difference in the amount of disease on the treated and untreated rows was very noticeable at this time. Nearly every fruiting stem and new cane on the unsprayed plants was attacked by anthracnose while in the sprayed rows the appearance of the disease was much less noticeable.

After the fruiting season was over the old canes were removed and burned, when the last spraying for the season was given on August 9.

The plantation was visited on November 22, when the plants of both the sprayed and unsprayed rows were found to have made a vigorous growth. The canes in the treated rows were nearly free from disease while those that were not sprayed were still badly affected.

The yields of the different rows are given below in Table II.

TABLE II.—YIELD OF RASPBERRIES DIFFERENTLY SPRAYED DURING THE SEASON OF 1894.

| DATES OF PICKING. | Sprayed once before leaf buds opened with copper sulphate solution followed by five sprayings with Bordeaux mixture. 18 rows. | Sprayed once before leaf buds opened with iron sulphate solution followed by five sprayings with Bordeaux mixture. 15 rows. | Unsprayed. 15 rows. |
|---|---|---|---|
| | Quarts. | Quarts. | Quarts. |
| July 13 | ........ | ........ | 109 |
| July 16 | 158 | 137 | 225 |
| July 18 | 41 | 52 | 99 |
| July 20 | 57 | 67 | 83 |
| July 23 | 109 | 99 | 75 |
| July 25 | 33 | 47 | 27 |
| Total | 398 | 402 | 618 |
| Average per row | 22 | 26 4-5 | 41 |

The record of yields tends to prove nothing except that the treatment seriously injured the fruiting canes in the treated rows. It should be borne in mind, however, that this injury was due to the fact that the Bordeaux mixture used in a single application was improperly made. The almost entire absence of anthracnose on the treated rows as compared to the considerable amount found on the unsprayed rows at the close of the season goes to show that the treatment was effective.

## EXPERIMENTS IN 1895.

The plantation was given the same treatment throughout the season of 1895.

*Dates of spraying.*—The first spraying, when the different solutions were applied, was given on April 26, just as the leaf buds began to swell. The second treatment was begun May 11, but on account of rain it was not completed until May 13. At this time the new canes had just begun to grow. On May 24, a third spraying was given, when the largest of the new canes were twelve to fourteen inches high. At this time it was noticed that the two rows that had been sprayed with the sulphuric acid solutions had been seriously injured by the application. A fourth treatment was given on June 10. A few of the characteristic spots of anthracnose were now noticed for the first time on the new canes in the untreated rows, showing that the disease was spreading very slowly. June 24 a fifth treatment was made. It was again noted that the disease had spread but little on the unsprayed plants and practically none could be found on the treated canes. As soon as the fruiting season was over the old canes were removed from all the rows, and a sixth spraying was given August 15.

The yield for the season of 1895 is given below in Table III.

TABLE III.— YIELD OF RASPBERRIES DIFFERENTLY SPRAYED DURING THE SEASON OF 1895.

| DATES OF PICKING. | Sprayed once before leaf buds opened with copper sulphate solution followed by five sprayings with Bordeaux mixture. 18 rows. | Sprayed once before leaf buds opened with iron sulphate solution followed by five sprayings with Bordeaux mixture. 15 rows. | Unsprayed. 15 rows. |
|---|---|---|---|
| | Quarts. | Quarts. | Quarts. |
| July 5 | 177 | 184 | 154 |
| July 8 | 210 | 293 | 218 |
| July 10 | 181 | 87 | 111 |
| July 12 | 201 | 177 | 159 |
| July 15 | 204 | 175 | 31 |
| July 17 | 66 | 52 | 148 |
| July 19 | 38 | 29 | 38 |
| Total. | 1,077 | 997 | 859 |
| Average per row | 59 5-6 | 66 | 57 |

Again the record of yields fails to show any material gain resulting from the treatment. The cause of the slight increase in yield of the rows that were sprayed once before the leaf buds opened with iron sulphate would be difficult to explain.

The plantation was visited on Nov. 19, when it was found that the canes in all of the rows that had been sprayed were practically free from disease, and since the removal of the old canes in August but comparatively little was to be found on the unsprayed rows.

## EXPERIMENTS IN 1896.

Although the plantation had passed the age of greatest fruitfulness, the owner decided to keep it another season, and so it was determined to continue the experiment, hoping that ideal conditions, from the experimenter's standpoint, might arise when the yields of fruit from the treated and untreated rows would show marked results in favor of the treatment.

*Dates of spraying.*—The first spraying, with the strong solutions, was given the plants on April 22, when the leaf buds were swelling. The second spraying was given on May 9. The third on May 25 and the fourth on June 8. On the latter date, a few of the scab spots were noticed the first time on the young canes. The new canes were now practically out of danger from attacks of the disease because of their size and the scarcity of the scab spots on the old canes, therefore the treatment was discontinued.

The yields of the different rows for the season of 1896 are given in Table IV.

TABLE IV.—YIELDS OF RASPBERRIES DIFFERENTLY SPRAYED DURING THE SEASON OF 1896.

| DATES OF PICKINGS.* | Sprayed once before leaf buds opened with copper sulphate solution followed by three sprayings with Bordeaux mixture. 15 rows. | Sprayed once before leaf buds opened with iron sulphate solution. followed by three sprayings with Bordeaux mixture. 15 rows. | Unsprayed. 15 rows. |
|---|---|---|---|
| | Quarts. | Quarts. | Quarts. |
| | 40 | 51 | 52 |
| | 155 | 181 | 174 |
| | 131 | 130 | 112 |
| | 156 | 164 | 135 |
| | 188 | 196 | 170 |
| | 69 | 101 | 88 |
| | 103 | 80 | 70 |
| Total | 842 | 903 | 831 |
| Average per row | 47 | 60 | 55 |

* As the pickings were not made under Station direction the dates can not be given for this year.

The results show no gain resulting from the treatment. The yield of the rows sprayed once before the leaf buds opened with copper sulphate solution falls below that of the unsprayed rows; while the rows that were sprayed with iron sulphate gave a little larger yield than the check rows.

## EXPERIMENTS AT MANCHESTER.

In the spring of 1896 a letter was received at the Station from Mr. Luther Rice, Manchester, N. Y., in which he made inquiries about treatment for raspberry anthracnose. Mr. Rice is an extensive grower of raspberries, and at times has found anthracnose to be a serious pest. On visiting his place it was found that a small plantation of one variety, consisting of thirteen rows, about twenty rods long, was badly diseased. The plantation was two years old, so it would seem that here were favorable conditions for continuing the spraying experiments.

*Plan of the experiment.*—From our previous experience we had come to doubt the advisability of giving the early spraying with strong solutions. Therefore, in this experiment it was planned to compare the early with the late treatment, at the same time using the copper and iron solutions for the early treatment as before. It became evident that spraying with sulphuric acid solutions is too heroic a measure to be used on raspberries, therefore this line of treatment was dropped.

TABLE V. — TREATMENT APPLIED TO RASPBERRIES AT MANCHESTER FOR PREVENTION OF ANTHRACNOSE.

| | | | | |
|---|---|---|---|---|
| Apr 18, sprayed with copper sulphate solution.<br>May 2, sprayed with Bordeaux mixture.<br>May 12, do.<br>June 3, do. | Apr. 18, sprayed with iron sulphate solution.<br>May 2, sprayed with Bordeaux mixture.<br>May 12, do.<br>June 3, do. | May 12, sprayed with Bordeaux mixture.<br>June 3, do. | Unsprayed. | May 2, sprayed with Bordeaux mixture.<br>May 12, do.<br>June 3, do. |
| Rows.<br>1, 5, 9 | Rows.<br>2, 6, 10 | Rows.<br>3, 7, 11 | Rows.<br>4, 8, 12 | Row.<br>13 |

The rows, Nos. 1, 5, and 9 were sprayed once before the leaf buds opened, with copper sulphate solution, using three pounds of the sulphate to eleven gallons of water. Rows No. 2, 6 and 10 were sprayed once before the leaf buds opened, with a saturated solution of iron sulphate. Rows No. 3, 7 and 11 were sprayed for the first time when the rows that were sprayed with the strong solution received the third treatment. Row No. 13 was sprayed for the first time when the rows that were sprayed with the strong solutions received their second treatment.

*Dates of spraying.*—The first spraying, when the strong solutions were used, was given on April 18, when the leaf buds were beginning to swell. In the subsequent treatments Bordeaux mixture was used on all of the treated rows. The second spraying was given on May 2, when the canes were in nearly full leaf. Row 13 was sprayed for the first time on this date. All of the treated rows were sprayed on May 12, when some of the largest of the new canes were about two feet high. Rows 3, 7 and 11 were sprayed for the first time on this date. The last spraying for the season was given on June 3.

*Record of yields.*—The record of yields for the season was not complete, but it did not indicate that there was any increase in yield on the rows that were sprayed. Neither did any of the rows that received the different lines of treatment show any increase in yield over that of their neighbors.

The plantation was visited on Dec. 12, when it was found that the difference in the amount of disease on the sprayed and unsprayed rows was quite marked. All of the rows that had been sprayed were comparatively free from disease, while the unsprayed rows were still quite badly affected. The results were sufficiently marked so that it is deemed advisable to continue the experiment through another season.

## CONCLUSIONS.

Ordinarily it will not pay to keep a plantation of black raspberries after it has produced its third crop. When such short rotations are followed, and the best of culture is given, it would seem that the danger from anthracnose must be reduced to a minimum, providing the plants are free from disease when planted.

In some instances, however, where raspberries are grown as a farm crop it will pay to fruit the plantation longer. Although the plants have passed the period of greatest fruitfulness, it may be that for a few seasons longer they will produce crops of fruit that will pay better than any other crop the grower might be able to put in their place.

If anthracnose makes its appearance, the old canes should be removed and burned immediately after the fruiting season is over. If in the following spring the new canes are protected with Bordeaux mixture, it is possible practically to free the plantation from the disease. While the results obtained from these experiments show conclusively that anthracnose of the black raspberry can be successfully combated with Bordeaux mixture, in no instance did the spraying prove profitable, and because of this fact the question at once arises as to whether or not it will pay to spray for this disease. In dealing with any plant disease that does not do serious damage every season, it will pay to spray in those instances only when there is danger of an attack that will be severe enough to endanger the life of the plants or materially injure the crop of fruit. Each grower must decide this point for himself.

The following letter from Mr. Hosmer gives his estimate of the treatment for raspberry anthracnose, which is based on the experiments that were conducted at his place:

"I am not cultivating raspberries so extensively as formerly, but if I had known then what I have since learned of the disease and the efficacy of the treatment you have employed in my plantation, it would have resulted in a saving to me of thousands of dollars. I had thirty acres of fine bushes almost completely ruined by the anthracnose in the midst of their prime.

"Yours truly,

"S. A. HOSMER."

*When to spray.*—No definite rule can be given as to the exact time when the spraying should be begun or how long it should be continued, since no two seasons will ever bring with them the same conditions. The experiments carried on at Manchester during the season of 1896 go to show that the early treatment with strong solutions is unnecessary, as the rows that were sprayed for the first time after the new canes were several inches high were as free from disease as were the rows that received the early treatment. The treatment for any plant disease must be preventive, for we cannot cure the diseased spots that are already formed. All that spraying does is to prevent the formation of new disease spots by protecting the plants with some fungicide. Therefore, there is no need of beginning to spray much before the disease begins to spread. At no time during the three seasons through which our experiments have run did the scab spots begin to form on the new canes until after they were six inches high. However, it will require but very little attention on the part of the grower to determine when the disease becomes active, and at the first appearance of the small, dark-colored spots on the new canes the first spraying should be given. Let this treatment be followed by two or three other sprayings, as may seem best, at intervals of ten to fourteen days. If the spraying is done intelligently and the old canes, together with the badly diseased new ones, are removed as soon as the fruiting season is over, there should be no reason why the disease cannot be kept under control.

If there is reason to suspect that the plants are diseased before they are planted, they should be closely trimmed and as soon as growth begins the new shoots should be protected with Bordeaux mixture. The spraying can be very easily and cheaply done at this time, and in localities where attacks of anthracnose have been severe it would, no doubt, prove to be a paying operation even though the plants were supposed to be free from disease when planted.

So much depends on the conditions that are met with each successive season that it is possible to give only general directions for treatment. The experiments show that the disease can be successfully combated by giving proper attention to sanitary conditions and protecting the young canes with Bordeaux mixture. But the questions as to the exact dates on which to apply the treatment, and whether it will pay to spray at all, can only be decided by the grower himself.

# IV. FORCING TOMATOES: COMPARISON OF METHODS OF TRAINING AND BENCHING.*

S. A. BEACH.

## SUMMARY.

Single-stem training is clearly superior to three-stem training for forcing tomatoes in winter — in this climate. The superiority is seen in the larger yield of early ripening fruit and in the larger total yield. There is but slight difference in the average size of fruit produced under the two methods of training, but on the whole the fruit of the single-stem plants seems to be slightly the larger.

Plants in two or two and a half inch pots plunged in the soil so that roots may be formed above the pot as compared with similar plants knocked out of the pots and planted in the soil on the bench sometimes show slight gain in yield when plants are trained to single stem, but this treatment is a disadvantage when plants are trained to three stems.

## INTRODUCTION.

In the larger cities the demand for tomatoes which have been grown under glass begins as soon as the supply of fruit from out of doors is cut off by freezing weather, and it continues till the Florida tomatoes appear in market, which is usually sometime in February. In local markets tomatoes from forcing houses often bring good prices much later than this because they are really superior to the southern grown fruit which is picked before it is ripe, and many persons are willing to pay an extra price for the choice forced tomatoes which are ripened on the vines and delivered fresh to the consumer.

To supply this demand the tomatoes must be ripened during the most unfavorable season for ripening fruit, including as it

* Partial reprint of Bulletin No. 125.

does the short and frequently dark days of December and January. Unlike lettuce, radishes and other vegetables which come to perfection in a comparatively cool temperature, the tomato delights in a warm, sunny location both for setting vigorous fruit abundantly and for ripening it. In growing tomatoes so as to market the fresh fruit during December, January and February, peculiar difficulties are met which do not attend the growing of this fruit in other portions of the year when there is more sunlight.

The inexperienced grower, eager to secure strong, vigorous plants is quite apt to overdo the matter. Either by furnishing an abundance of rich soil in which the plant is allowed to grow unchecked, or by the too liberal use of liquid manure or other fertilizers, he may produce so rank a growth that the plant is unnecessarily slow in coming into bearing.

Those who have had more experience grow thrifty but stocky plants for forcing. They seek a healthy growth yet hold the plant somewhat in check till it has a degree of maturity favorable to the production of fruit. Some gardeners try to prevent too vigorous growth by setting the plants in a very small amount of soil, and later add commercial fertilizers or liquid manure according to the apparent needs of the plant. Excellent results have been secured in this way, but the soil dries out very quickly so that it requires very close attention to the watering.

Others check the root growth by planting in boxes or pots. It is reported that on the island of Guernsey, where large quantities of tomatoes are forced for the London market, the plants are frequently grown in pots. In this country planting in boxes is more frequently advocated. These may be from eight inches to a foot wide, about a foot deep and several feet long, with plants set every two feet. If separate boxes are used for each plant they commonly hold from one to one and a half cubic feet of soil.

Some gardeners plant in an abundance of good soil in beds or on benches where the roots may grow unrestrained and try to control the growth by leading out two of the first shoots, one on each side of the main stem, thus training the plant to three stems as shown in Plate II. The two-foot rule near the center stem


Plate II.—Tomato Plant Showing Method of Training to Three Stems in Forcing House.

PLATE III.—TOMATO PLANT SHOWING FIRST STAGES OF THREE STEM TRAINING: ALSO MANNER OF PRUNING OFF PART OF FOLIAGE TO PREVENT TOO VIGOROUS GROWTH.

will help in forming a correct idea of the size of the plant. These gardeners take off all other shoots and resort to severe pruning of the foliage if necessary, to prevent too rampant growth. Some leaves are removed entirely and others are partly pruned away as shown in the accompanying illustration, Plate III. They hold that the vigorous side shoots, which are allowed to grow in this style of training, have a tendency to check the main or central stem so that no difficulty will be experienced in getting the first clusters of fruit to set within about a foot of the soil.

During the winters 1895-6 and 1896-7 some experiments were made at this Station for the purpose of comparing single-stem with three-stem training. A method of checking the growth which is sometimes used in forcing cucumbers was also tried. It provides for restricting the roots in small pots which are plunged in the soil so that roots may be sent out from the stem above the pot. Plants were grown from the same lots of seed and were carefully selected to get specimens as nearly alike as possible at the start. The soils were very thoroughly mixed and evenly distributed to the plants. In applying fertilizers equal quantities were given to each plant. In short, the aim has been to keep conditions affecting the plants as nearly alike as possible in all points excepting the ones which were to be compared.

We will now consider the tests of single-stem as compared with three-stem training, especially for forcing in winter.

## SINGLE–STEM vs. THREE–STEM TRAINING.

### Experiments of 1895–6.

#### *First test.*

The variety selected for these tests was the Lorillard, which is conceded to be one of the best kinds for winter forcing. Plate IV shows a cluster of Lorillard life size as grown in the forcing house. Some fruits grow considerably larger than those illustrated here and in mid-winter they are often smaller than these. As grown in the forcing house the flesh is quite solid and the seeds are few as shown in Plate V. For a second crop to be fruited in late winter or spring some other variety, like Mayflower, may be preferred.

Seed of Lorillard from a well-known seedsman was sown in flats* August 23, 1895. The flats were filled with soil composed of one measure of sand, one of well-rotted manure and four of potting soil, thoroughly mixed. September 4 the seedlings were transplanted into 2½-inch pots. The soil for the pots consisted of sod from a clay loam piled alternately with layers of coarse stable manure. After this was rotted it was thoroughly mixed and used for potting the plants.

*Benching.*—The plants were benched September 26th. At this time they varied from 1¼ to 4¼ inches in height and were stocky and healthy. The benches had perforated tile bottoms and were given no extra drainage. Over the tile bottom a thin layer of moss (sphagnum) was spread, then an inch of well-rotted stable manure and lastly an inch of soil. The soil was prepared by mixing thoroughly three measures of the potting soil just described with two and a half measures of sand, two of good leaf mold and two of well-rotted, mixed stable manure. One hundred and three plants were selected for this experiment and were divided into two lots. One lot, consisting of fifty-two plants, was put on the side benches in the east half of the tomato house. These plants were not taken out of the 2½-inch pots which were set immediately on the layer of manure on the bench. The soil was mounded around and over the pot and covered with leaf mold up to the seed leaves (cotyledons) so as to induce the sending out of roots from the stem above the pot. These plants will be referred to on the following pages as being "in pots."

Another lot, consisting of fifty-one plants, was set on the side benches in the west half of the same house. Each plant was taken from the pot, the lower part of the ball of earth attached to it was broken and it was set on the soil on the bench. A mound of earth was then drawn around each plant and covered with leaf mold up to the seed leaves the same as was done with the plants benched in pots as described above. These plants will be referred to hereafter as plants "not in pots," meaning by that, that they were transplanted from the 2½ inch pots to the soil on the bench. Some of the plants in each of the two lots were

*Boxes twelve inches square and three inches deep.

PLATE IV.— LORILLARD. FROM LIFE SIZE PHOTOGRAPH OF FRUIT FORCED IN WINTER.

Plate V.—Lorillard. Showing Section of Fruit Produced in Forcing House.

trained to single stems, all sides shoots being removed and the others were trained to three stems. The accompanying diagram, Plate VI, shows the arrangement of the plants.

The side benches in which these plants were grown are thirty-four inches wide, inside measurement. The plants were set in two rows one six inches from the back side of the bench and one six inches from the front side, the plants in the front row alternating with those in the back row. The single-stem plants stood a foot and a half apart in the row and the three-stem plants twice that distance. This gave to each single-stem plant two and one-eighth square feet of bench room and to each three-stem plant four and one-fourth square feet.

Of the fifty-one plants not in pots, thirty-three were trained to single stem and eighteen were trained to three stems. At the time they were transplanted to the bench, the thirty-three plants for single stem training averaged 3.35 inches high and the eighteen plants for three stem training averaged 2.57 inches high. Thus it appears that when they were benched the single-stem plants averaged .78 of an inch higher than the three-stem plants. A month later, October 28th, they were still in the lead, having an average height of 12.58 inches as compared with 11.25 inches for the three-stem plants. The length of time from seed planting till the first fruit ripened, the average weight per fruit, and the yield in ounces per square foot of bench room, are all summarized in the following table:

TABLE I.— PLANTS NOT IN POTS. TIME OF RIPENING FIRST FRUITS. AVERAGE WEIGHT PER FRUIT. AND YIELD PER SQUARE FOOT OF BENCH.

| TRAINING. | Number of plants. | Average days from seed planting till first fruit ripened | Average weight per fruit in ounces.* | Yield per square foot of bench in ounces. |
|---|---|---|---|---|
| Single stem | 31 | 157.90 | 2.00 | 12.79 |
| Three stem | 17 | 160.15 | 1.93 | 11.52 |

*Quite a number of fruits, which were included in the total yield, were very small and they reduce the average weight per fruit to the amount shown in this and following tables.

## EXPLANATION OF PLATE VI.

### FIRST TEST.

Three-stem plants in pots, 102 and 1 to 18.

Three-stem plants not in pots, 50 to 67.

Single-stem plants in pots, 68 to 108.

Single-stem plants not in pots, 103 and 19 to 49.

### SECOND TEST.

Three-stem plants in pots, 114, 115, 118, 119, 130, 131.

Three-stem plants not in pots, 112, 113, 116, 117, 128, 129, 132.

Single-stem plants in pots, 106, 107, 110, 111, 122, 123, 126, 127.

Single-stem plants not in pots, 104, 105, 108, 109, 120, 121, 124, 125, 133.

The number shows the location of the plant on the bench. Plants 18 and 133 had more room than others of their class and Plant 67 had less. Plants 43 and 98 were accidentally injured. All these were excluded from the experiment.

From this table it appears that the single-stem plants kept the lead from the beginning, ripened their first fruit a few days earlier, gave somewhat greater yield per square foot of bench area occupied by them and produced a little larger fruit on the average than did the plants trained to three stems.

Of the fifty-two plants in pots, thirty four were trained to single stems and eighteen to three stems. When they were put on the benches, the plants selected for single-stem training averaged 2.45 inches high and those selected for three-stem training averaged 3.33 inches, so the plants which were designed for three-stem training averaged .88 of an inch higher than the single-stem plants. A month later, October 28, the three-stem plants were still in the lead, having an average height of 9.75 inches, which was 1.44 inches more than the average of the single-stem plants. The time of ripening the first fruits, the average weight per fruit, and the yield are shown in the following table:

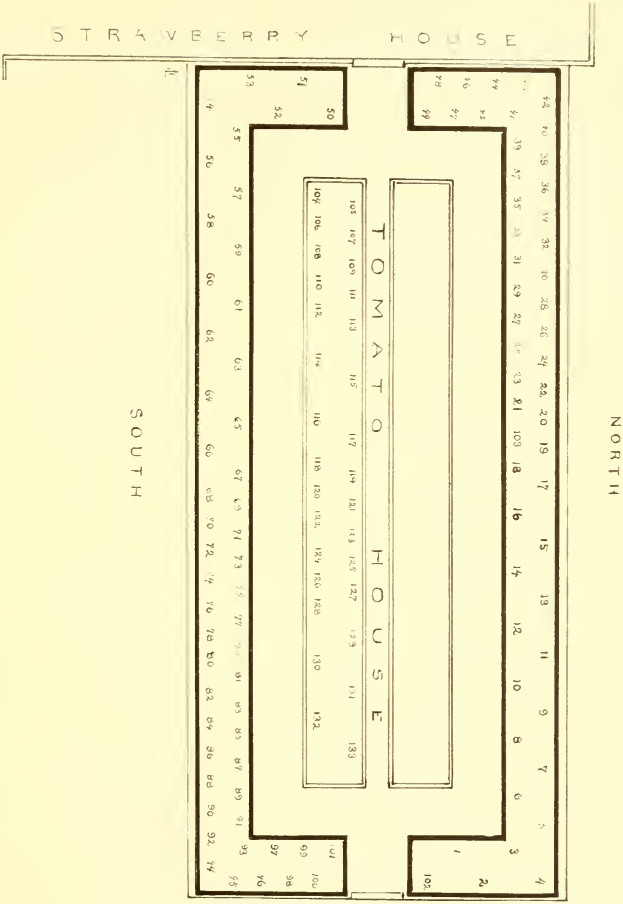


PLATE VI.—DIAGRAM OF TOMATO HOUSE, 1895-6.

TABLE II.—PLANTS IN POTS. TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT, AND YIELD PER SQUARE FOOT OF BENCH.

| TRAINING. | Number of plants. | Average days from seed planting till first fruit ripened. | Average weight per fruit in ounces.* | Yield per square foot of bench in ounces. |
|---|---|---|---|---|
| Single-stem | 33 | 160.15 | 1.76 | 13.21 |
| Three-stem | 17 | 159.17 | 2.04 | 11.74 |

*See note, Table I.

In this case, as in the one given above, the single-stem plants eventually took the lead in the yield per square foot of the bench area which they occupied, although at the time they were put on the benches and for at least a month afterwards the three-stem plants were the larger. These three-stem plants gave larger sized fruits than did the corresponding single-stem plants.

In tests which were made the following season, it was shown that the north side-bench was a more favorable location for tomatoes during the winter months than the south side-bench. This is, no doubt, largely due to the fact that the purlin and the eaves are rather wide, and shade the plants on the south bench to a considerable extent. Since the single-stem plants in pots were located on the south side-bench, while the corresponding three-stem plants had the more favorable location on the north side-bench and were larger plants at the time they were benched, the fact that the single-stem plants gave the larger yield per square foot is all the more significant.

## SECOND TEST.

Some Lorillard plants which had been started in flats and transplanted to 2½-inch pots in a way similar to that described under the first test, were set on the south middle-bench of the tomato house December 12, 1895. The plan of arrangement is shown in the diagram, Plate VI. The bench was prepared by putting a layer of moss (sphagnum) over the bottom and covering this with about 2½ inches of potting soil like that used for the first test. First a group of plants for single stem-training was put on the bench, then a group designed for three stem training, then another group for single-stem training and lastly a group of three-stem training. Half of the plants were kept in the 2½-inch pots, and the earth was mounded over the pots up to the seed leaves. The others were knocked out of the pots and transplanted directly to the bench. First a plant not in a pot was transplanted to the bench, then a plant in a pot was placed on the bench, thus alternating the two classes till the bench was filled. By this arrangement the differences in light and temperature for the two classes of plants were not great enough to materially affect the results of the test.

The plants were set in two rows, those in the front row coming opposite the middle of the space between the plants in the back row. Plants for single-stem training were put eighteen inches apart; those designed for three-stem training were set three feet apart. As this bench measured thirty-eight inches wide inside measurement this made the area allotted to each single-stem plant 2⅜ square feet and that for each three-stem plant 4¾ square feet.

Of the sixteen plants which were taken out of the pots and transplanted to the bench, nine, averaging 5.94 inches in height, were for single-stem training, and seven, averaging 5.93 inches in height were for training to three stems. Thus it appears that there was practically no difference in the average height of the two classes of plants when they were benched. The following table summarizes their record.

TABLE III.—PLANTS NOT IN POTS. TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT, AND YIELD PER SQUARE FOOT OF BENCH ROOM.*

| TRAINING. | Number of plants. | Average days from benching till first fruits ripened. | Average weight per fruit in ounces.† | Yield per square foot of bench in ounces. |
|---|---|---|---|---|
| Single-stem | 9 | 99.78 | 2.87 | 20.26 |
| Three-stem | 7 | 97.71 | 2.79 | 15.97 |

* See foot note, p. 253.
† See note, Table I.

In this case the three-stem plants on the average ripened their first fruits a little earlier than the single-stem plants, but the single-stem plants yielded at the rate of twenty-seven pounds more fruit per hundred square feet of bench and their fruits averaged slightly larger than those of the three-stem plants.

Of the fourteen plants in pots, eight, averaging 5.91 inches in height, were for single-stem training and six, averaging 5.92 inches high, were for three-stem training. Thus it appears that the two lots of plants averaged practically the same in height at this time. The following is a summary of their later records.

TABLE IV.—PLANTS IN 2½ INCH POTS PLUNGED ON THE BENCH. TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT, AND YIELD PER SQUARE FOOT OF BENCH.*

| TRAINING. | Number of plants. | Average days after benching till first fruits ripened. | Average weight per fruit in ounces.† | Yield per square foot of bench in ounces. |
|---|---|---|---|---|
| Single-stem | (8) | (108.25) | (2.55) | (17.58) |
| Single-stem | 7 | 102.57 | 2.58 | 19.42 |
| Three-stem | 6 | 96.00 | 2.72 | 15.34 |

* Some of the items do not agree with those which were published in Bulletin 125, because the tables have been corrected, an error in transcribing the record having been discovered.
† See note, Table I.

For some unknown reason one of the single-stem plants was very late in ripening its first fruits and was very unproductive, yielding but a few undersized fruits. By including the records of this plant in the averages, as is done in the first line of the table where the figures appear in small type and in parentheses, it gives a wrong impression of the general character of this lot of plants. Leaving this plant out, as is done in the second line of the table, a more just comparison with the corresponding three-stem plants may be made. It then appears that while the single-stem plants ripened their first fruits somewhat later than did the three-stem plants, and the fruit averaged slightly smaller, yet they gave a greater yield, the increase being at the rate of 25½ pounds per hundred square feet of the bench area which they occupied.

*Temperature of the house during the winter.*—The range of temperature for the house during the winter is indicated by the following table which shows the daily temperature at the east and west ends of the house taken at 7 a. m., 12 m. and 6 p. m. The records are averaged by weeks from September 28, 1895 to March 14, 1896, a period of twenty-four weeks. In twelve cases, or just half the time, the weekly average for 7 a. m. at the west end was slightly higher than at the east end, the difference varying from 0.13° to 2.00°. The weekly average at the east end at noon was higher than at the west end in ten cases, and one week the noon average was the same for both ends of the house. The weekly average for 6 p. m. was higher at the west than at the east end in but seven instances. From November 22 to February 8 the 6 p. m. average was uniformly lower at the west end. This may be accounted for by the fact that during the short days of winter the head greenhouse, into which the west end of the tomato house opens, cuts off the sunlight from that end of the house during the latter part of the afternoon.

| DATE. | AVERAGE PER WEEK. | | | | | |
|---|---|---|---|---|---|---|
| | EAST END. | | | WEST END. | | |
| | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. |
| Sept. 28–Oct. 4, 1895 | 56.50 | 69.57 | 61.25 | 56.43 | 66.93 | 61.17 |
| Oct. 5–11 | 60.43 | 72.00 | 64.14 | 59.97 | 70.86 | 60.57 |
| Oct. 12–18 | 53.79 | 67.57 | 60.86 | 55.79 | 66.57 | 61.07 |
| Oct. 19–25 | 56.29 | 64.57 | 58.93 | 57.57 | 69.58 | 61.57 |
| Oct. 26–Nov. 1 | 58.43 | 65.29 | 62.00 | 57.86 | 66.71 | 61.71 |
| Nov. 2–8 | 60.64 | 74.29 | 65.29 | 61.33 | 70.00 | 64.57 |
| Nov. 9–15 | 56.93 | 64.79 | 57.58 | 57.57 | 65.50 | 61.08 |
| Nov. 16–22 | 60.14 | 69.93 | 65.07 | 58.71 | 72.00 | 65.71 |
| Nov. 23–29 | 61.93 | 71.93 | 66.29 | 60.43 | 68.29 | 63.14 |
| Nov. 30–Dec. 6 | 55.21 | 66.57 | 62.14 | 54.93 | 68.29 | 61.79 |
| Dec. 7–13 | 55.71 | 66.93 | 63.29 | 56.07 | 63.00 | 62.36 |
| Dec. 14–20 | 63.86 | 69.80 | 65.83 | 63.71 | 66.30 | 63.40 |
| Dec. 21–27 | 60.43 | 67.50 | 63.29 | 61.00 | 68.67 | 62.67 |
| Dec. 28–Jan. 3, 1896 | 55.86 | 65.71 | 63.14 | 56.14 | 65.57 | 62.14 |
| Jan. 4–10 | 60.86 | 66.57 | 64.17 | 59.86 | 69.71 | 62.67 |
| Jan. 11–17 | 61.50 | 68.80 | 69.20 | 60.25 | 72.00 | 66.40 |
| Jan. 18–24 | 64.43 | 72.50 | 69.43 | 61.00 | 71.67 | 67.33 |
| Jan. 25–31 | 62.50 | 73.25 | 71.67 | 64.00 | 72.33 | 68.67 |
| Feb. 1–7 | 65.29 | 77.50 | 69.57 | 64.57 | 73.00 | 66.14 |
| Feb. 8–14 | 64.57 | 71.80 | 67.50 | 64.17 | 76.00 | 68.00 |
| Feb. 15–21 | 65.14 | 76.86 | 66.14 | 66.00 | 75.67 | 66.86 |
| Feb. 22–28 | 67.71 | 73.57 | 70.57 | 68.57 | 72.14 | 70.43 |
| Feb. 29–March 6 | 67.14 | 76.43 | 67.29 | 67.57 | 78.14 | 65.71 |
| March 7–13 | 68.00 | 72.43 | 63.00 | 68.43 | 72.43 | 65.00 |
| Average | 60.98 | 70.26 | 64.90 | 61.04 | 70.06 | 61.17 |

## EXPERIMENTS OF 1896-97.

### *Third Test.*

Seed of Lorillard for a third test was planted in flats August 15, 1896, in a soil composed of equal measures of well-rotted manure, sand, leaf-mold and loam, all thoroughly mixed. About half an inch of drainage was placed in the bottom of the flats. By using a marker* to make the furrows, the seed was planted at uniform depth. The seeds were put about one-fourth inch apart in the row.

On the eighth day the seeds began to germinate and all which germinated on that day were marked for transplanting. Nearly five hundred of the plants which germinated August 23d were pricked off from the flats into two-inch pots September 2d, and plunged in moss on a greenhouse bench so that the conditions of moisture, light and heat for the entire lot could be kept as nearly uniform as possible.

Rainy weather interfered with the proper preparation of soil so that the plants were not transplanted to the benches till October 22d. The plants were still in good condition but they would have been transplanted earlier had it not been for the delay in preparing soil for the benches.

*Soil for benches.*—The soil for the benches was prepared by mixing thoroughly one measure of leaf-mold, one of sand, one of horse manure pretty well rotted and turned several times, and one of loam. The loam was composted sod piled in alternate layers with manure, well-rotted and well-mixed. Enough of this soil was prepared to fill benches six inches deep having an area of six hundred square feet. To this was added fourteen pounds of a fertilizer mixture composed of six parts by weight of acid phosphate having 14 per cent available phosphoric acid and four parts by weight of high-grade sulphate of potash containing the equivalent of 50 per cent actual potash. This is at the rate of five hundred pounds of the mixture per acre, taking into account simply the area of bench surface.

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* The marker consisted of a short board on which were fastened parallel strips of wood one-fourth of an inch thick. By pressing the marker on the soil furrows were made by these strips which were uniformly one-fourth of an inch deep.

*Selection of plants.*—From the nearly five hundred plants which had germinated in one day and which now were growing in two-inch pots, sixty fine, healthy plants were selected for the test. The size of the plants at this time may be seen by referring to Plate VII, which is from a photograph of one of the plants after it was knocked out of the pot and ready for transplanting. Enough plants for the test could not be found which were uniform in height so those which were selected were assigned to places on the benches as follows:

Twenty plants each $6\frac{1}{2}$ inches high for single-stem training on the north bench.

Ten plants each 7 inches high for three-stem training on the north bench.

## EXPLANATION OF PLATE VIII.

The number shows the location of the plant on the bench. On account of their location Plants 1 and 62 were not included in the experiment; Plant 2 was discarded because its roots found their way under a partition into the soil of another part of the bench, and Plants 11 and 31 were discarded on account of accidental injury.

Three-stem plants in pots, 14, 15, 27, 30, 31, 42, 43, 46, 58 and 59.

Three-stem plants not in pots, 12, 13, 16, 28, 29, 44, 45, 57, 60, 61.

Single-stem plants in pots, 2, 3, 6, 7, 10, 11, 18, 19, 22, 23, 26, 34, 35, 38, 39, 47, 50, 51, 54, 55.

Single-stem plants not in pots, 1, 4, 5, 8, 9, 17, 20, 21, 24, 25, 32, 33, 36, 37, 40, 41, 48, 49, 52, 53, 56, 62.

10 plants each $6\frac{1}{4}$ inches high } for single-stem training on the
10 plants each $6\frac{3}{4}$ inches high } south bench.

5 plants each $7\frac{1}{4}$ inches high } for three-stem training on the
5 plants each $7\frac{1}{2}$ inches high } south bench.

It will be observed that the plants for single-stem training on the south bench averaged $6\frac{1}{2}$ inches, which is the height of each of the single-stem plants assigned to the north bench. The sequel did not show that the slight differences in the height of the plants when they were transplanted to the bench, made any perceptible

PLATE VII.—TOMATO PLANT READY FOR TRANSPLANTING TO BENCH OF FORCING HOUSE.

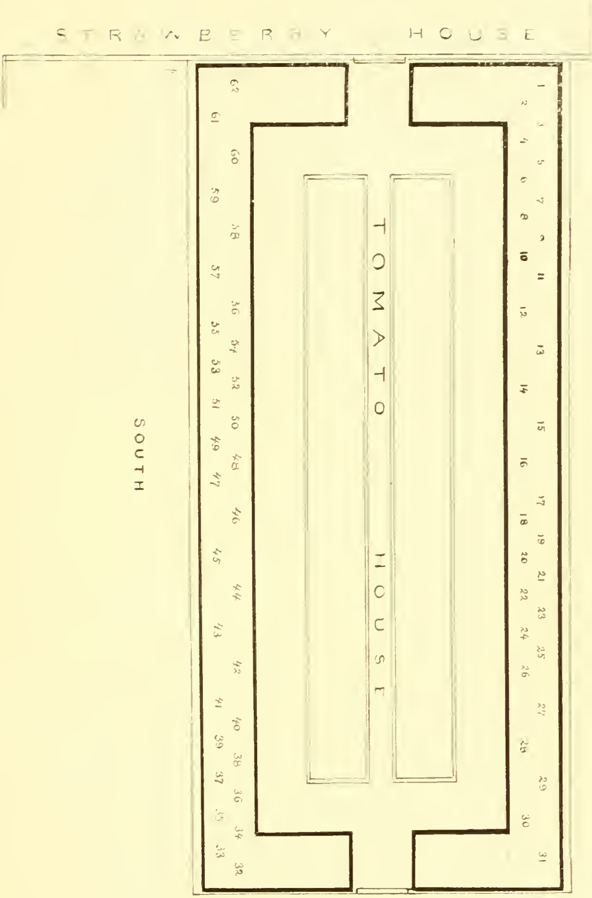


PLATE VIII.—DIAGRAM OF TOMATO HOUSE, 1896-7.

differences in the yields.* The tests which were made the previous winter indicated that the three-stem training gives a smaller yield on the same area of bench than the single-stem training. For this reason the tallest plants were assigned to three-stem training so that there might be no appearance of favoring the single-stem plants in planning the test. For the same reason the tallest three-stem plants were put on the south bench as the previous season's test indicated that the shading of the bench by a purlin made that a less favorable location than the north bench.

*Planting on benches.*—October 22 the plants were moved to permanent places on the side benches of the tomato house and arranged as shown in the accompanying diagram, Plate VIII.

The plan of the previous season was followed in that no drainage was put on the bottom of the bench, as it was thought that the perforated tile furnished ample drainage. Five quarts of soil were mounded around each plant. Part of the plants were transplanted to this soil and part were left in the pots in which they were growing and the soil was spread under and mounded over the pot. They will be referred to, the same as on previous pages, as "plants in pots" and "plants out of pots."

The plants were set in two rows, one row ten inches from the front the other ten inches from the back of the bench. The benches are thirty-four inches wide, inside measurement. The plants in the front row alternated with those in the back row so that each plant came opposite the middle of the space between

*In some instances plants which were the taller at the time of transplanting were more productive and in some cases they were less productive than the shorter plants. The average yields are as follows:

| No. of plants. Training. | Height when transplanted: Inches. | Average yield per plant: Ounces. |
|---|---|---|
| 4. Single-stem in pots | 6.25 | 58.44 |
| 6. Single-stem not in pots | 6.25 | 58.54 |
| 5. Single stem in pots | 6.75 | 53.25 |
| 5. Single-stem not in pots | 6.75 | 61.25 |
| 3. Three-stem in pots | 7.25 | 88.00 |
| 2. Three-stem not in pots | 7.25 | 106.125 |
| 2. Three-stem in pots | 7.50 | 57.50 |
| 3. Three-stem not in pots | 7.50 | 97.83 |

The three-stem plants which measured 7½ inches at the time of transplanting were less productive than the three-stem plants which measured 7¼ inches. This may be partly accounted for by the fact that the former were nearer the west end of the house and during the short days of winter became shaded from the sun earlier in the afternoon than those towards the middle or east end of the house.

two plants in the other row. The plants in pots were not grouped as in the first test but were alternated with plants out of pots, first a plant in a pot then a plant out of a pot and so on throughout the house. This was done both with single-stem and with three-stem plants.

It was thought that in the first test the plants were crowded too closely together, so in this test the single-stem plants were set two feet apart in the row thus allowing each plant $2\frac{5}{6}$ square feet of bench surface. The three-stem plants were four feet apart in the row thus giving each of them an area of $5\frac{2}{3}$ square feet.

*Adding soil to benches.*— The mound of earth which was put around the plants as they were transplanted to the benches was covered with moss (sphagnum) to prevent the too rapid evaporation of moisture. The moss served this purpose admirably. December 30, a layer of about an inch of soil was covered over all the bench. In about a week the plants began to fill this new soil with roots. Another layer of about two inches of soil was added to the benches March 16, and April 19 a third layer of about two inches. June 1, all fruit, both green and ripe, was picked and the experiment was closed.

*Plants not in pots.*— Of the thirty plants not in pots twenty were trained to single-stem and ten to three stems. The single-stem plants averaged 1.94 inches high when pricked off and 6.49 inches when benched. The plants for three-stem training averaged 2.00 inches when pricked off and 7.20 inches when benched. The more vigorous plants were assigned to three-stem training yet eventually the single-stem plants gave the larger yield as shown by the following table:

TABLE V.— PLANTS NOT IN POTS.—TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

| TRAINING. | Number of plants. | Average days from seed planting till first fruit ripened. | Average weight per fruit in ounces.* | Yield per square foot of bench. |
|---|---|---|---|---|
| Single-stem | 20 | 172.45 | 2.77 | 24.56 |
| Three-stem | 10 | 171.30 | 2.49 | 19.53 |

* See note, Table I.

In this test the three-stem plants were in four groups, two on the north bench and two on the south bench, alternating with corresponding groups of single-stem plants. This arrangement secured more uniform conditions than could be secured by the plan adopted for the first test. The results here set forth are therefore considered more satisfactory and more reliable than those which appeared with the first test. They do not conflict with the conclusions drawn from the first test but rather emphasize them. The single-stem training, other things being equal, gives decidedly better results than the three-stem training both in yield and in average size of fruit produced. Although the first fruits ripened on the average a day earlier on the three-stem plants than on the single-stem plants, yet in the amount of fruit ripened early the single-stem plants again take the lead as is shown in the following statement of the yield by weeks for the first six weeks after the first fruit was picked:

TABLE VI.— PLANTS NOT IN POTS.—YIELD FOR SIX WEEKS AFTER FIRST FRUIT RIPENED.

| TRAINING. | Number of plants. | YIELD IN OUNCES PER FIFTY ONE SQUARE FEET OF BENCH.* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | First week. | Second week. | Third week. | Fourth week. | Fifth week. | Sixth week. | Total for six weeks. |
| Single-stem ........ | 20 | 10.35 | 38.93 | 81.00 | 17.33 | 40.73 | 66.83 | 255.17 |
| Three-stem......... | 10 | 4.50 | 36.00 | 54.00 | 21.83 | 9.90 | 16.20 | 142.43 |

*This area is taken as a basis for making this table, so that this may be compared with Table VIII, page 262.

This table shows clearly the superiority of single-stem training in producing fruit early, while Table V shows its superiority in total yield for the season. It will be noticed that the yield drops at the fourth week and then gradually increases. The falling off in yield which begins at the fourth week is due to the difficulty experienced in getting fruit to set during the latter part of December and early in January. As the days get longer and the amount of light increases the fruit sets more readily. When there is an abundance of sunshine, simply jarring the blossoms as may be done by rapping the plants with a padded stick, will cause the fruit to set well. During periods of little sunshine, especially when the days are shortest, more difficulty is experienced in getting the fruit to set. The blossoms that are not properly fecundated soon fall off as shown in Fig. 16. When the weather is not favorable for the setting of fruit the blossoms should be pollinated by hand during the driest part of every second or third day. This may be done by jarring the open flowers over a camel's hair brush or small spoon and touching the stigma with the pollen that has thus been gathered. By passing from flower to flower in this way the blossoms become fertilized satisfactorily. Small and one-sided fruit which is liable to be found on plants in the forcing house in winter, may be due either to an insufficient supply of pollen or to close fertilization, that is to say, to the fertilizing of the blossom with its own pollen exclusively.*

*Plants in pots.*—Of the thirty plants which were assigned to this part of the test, two were discarded because they were accidentally injured. A third was thrown out because it sent its roots under a partition and into the soil of an adjacent part of the bench. By its rampant growth it soon showed that it had reached

*Fink, who has made some very interesting observations in this line,** finds that:

1. The vigor of the fruit is seen soon after pollination takes place. "Of two flowers pollinated at about the same time, one is sometimes half grown before the other makes more than enough growth to make certain the fact that fertilization has taken place. The one that makes this rapid growth from the start ripens nearly as much in advance and is larger than the one that stops growing for a time. * * * I think there are two causes for this difference in development, *i. e.*, insufficient pollination and insufficient nourishment."

2. The amount of pollen applied to the stigma influences the size and shape of the fruit. "Tomatoes produced from large amounts (of pollen) were large and regular, produced a large number of seeds and did not fail to come to maturity in a single instance; while those from small amounts were smaller in size, had fewer seeds, were not so regular in shape and several stopped growing at the size of a pea. * * * I tried cutting off one side (of the stigma). The result is usually a one-sided tomato but not always. * * * I also tried pollinating one side only and got one-sided fruit as a result."

3. Pollination may be done effectively during the first four to eight days after the blossom opens. The best time to get pollen for applying to the stigmas is about two days after the blossoms open, when the anthers or pollen sacs begin to open. "The pollen sacs open sooner (after the blossoms open) in small than in large flowers and sooner in dry than in wet weather. * * * The best time to pollinate artificially is in the driest part of the day."

4. On the whole, fruits produced by close pollination "are below average size and usually contain fewer than the average number of seeds."

**Fink, Bruce, Pollination and Reproduction of Lycopersicum Esculentum. Bull. Geol. and Nat. Hist. Surv. Minn., 9: 636-643. 9 N. 1896.

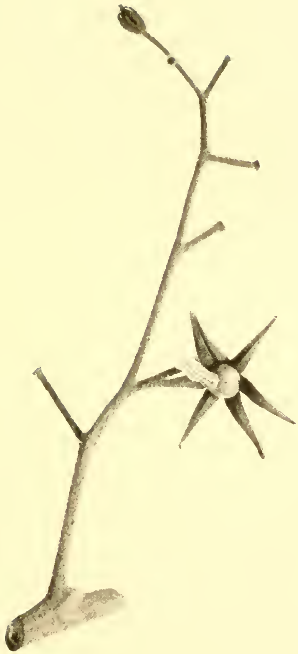

FIG 16.—THE FRUIT FAILS TO SET WHEN THE STIGMA IS NOT PROPERLY POLLINATED.

a supply of food not available to its neighbors and during the rest of the winter it was allowed to stand as an object lesson on the bad effects of over-feeding tomatoes in the forcing house. Of the twenty-seven plants finally included in this part of the test, eighteen were trained to single stem. These averaged 1.80 inches high when they were pricked off and 6.00 inches when they were benched. Nine corresponding plants designed for three-stem training averaged 2.05 inches high when they were pricked off and 7.15 inches when they were benched. In this case, although the more vigorous plants were assigned to three-stem training, the single-stem plants eventually out-yielded them as the following table shows:

TABLE VII.—PLANTS IN POTS. TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

| TRAINING. | Number of plants. | Average days from seed planted till first fruit ripened. | Average weight per fruit in ounces.* | Yield per square foot of bench. |
|---|---|---|---|---|
| Single-stem | 18 | 173.78 | 2.84 | 23.20 |
| Three-stem | 9 | 168.89† | 2.45 | 16.04 |

* See Table I, Note 1.

† This is the average for eight plants as the first flower cluster on one plant was cut off by an insect, thus delaying the setting of the first fruit.

As explained in discussing Table V, page 258, the plants in this test were so arranged on the benches that more uniform conditions were secured than was possible with the plan which was followed in the first test. The superiority of the single-stem training, both in size of fruit and in total yield is again emphasized by this table. Although the three-stem plants ripened their first fruit an average of five days earlier than the single-stem plants, yet in the amount of fruit ripened during the six weeks after the first fruit was picked the single-stem plants were ahead, as the following table shows:

TABLE VIII.—PLANTS IN POTS. YIELD FOR SIX WEEKS AFTER FIRST FRUIT RIPENED.

| TRAINING. | Number of plants. | OUNCES PER FIFTY-ONE SQUARE FEET OF BENCH.* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | First week. | Second week. | Third week. | Fourth week.† | Fifth week. | Sixth week. | Total for six weeks. |
| Single-stem | 18 | 4.75 | 27.25 | 87.50 | 30.00 | 16.75 | 46.00 | 212.25 |
| Three-stem | 9 | 4.50 | 40.50 | 27.00 | 4.75 | 18.00 | 29.50 | 124.25 |

*Fifty-one square feet is the bench area actually occupied by each lot of plants. Compare with Table VI.

†The decrease in yield at this period is considered in the discussion which follows Table VI. See page 259.

## PLANTS KEPT IN SMALL POTS AND PLUNGED IN THE SOIL ON THE BENCH VS. PLANTS TRANSPLANTED TO THE BENCH.

In the first pages of this bulletin, while setting forth some of the considerations which led to an investigation of the merits of single-stem training as compared with three-stem training, the necessity of avoiding too rampant a growth in forcing tomatoes was considered and some of the various ways of holding the plants in check were mentioned. In forcing cucumbers, some gardeners plant the seed in small pots, like two-inch pots, and do not move the plants from these pots. When they are ready to be put in permanent place on the bench for fruiting the pot containing the plant is plunged in the soil on the bench. The soil is mounded over the pot so that new roots are sent out from the stem above the pot. It has been stated on previous pages that in tests conducted during the winters of 1895-6 and 1896-7 some of the potted tomato plants were plunged into the bench soil in pots after the method used in forcing cucumbers, and other plants were knocked out of the pots and transplanted directly to the bench soil. These two methods will now be compared. The records of these plants have been given in another connection on previous pages, and the methods of sowing seed, selecting plants, preparing soil, training, etc., may be found by consulting those pages.

## Experiments of 1895–6.

### *First Test Using Single-stem Plants.*

September 26, 1895, sixty-seven plants were put on the benches of the tomato house for training to single stem, thirty-three of which were transplanted to the soil on the bench. These are referred to in this bulletin as plants "not in pots." The remaining thirty-four plants were plunged in the soil of the bench in the $2\frac{1}{2}$-inch pots in which they were growing and the soil was mounded over the top of the pot so as to favor the sending forth of roots from the stem above the pot. These are referred to as plants "in pots." The arrangement of the two lots of plants may be seen by consulting the diagram, Plate VI.

At the time they were put on the benches the plants in pots had an average height of 2.45 inches and the corresponding plants not in pots averaged 3.35 inches high. On account of this difference in size the two classes of plants may not be strictly comparable, but as they may give some indication of the comparative value of the two methods of treatment, their records are given for what they are worth.

By October 5 many of the plants in pots were sending out roots above the pots, which soon filled the surrounding soil. They did not make as vigorous growth as the corresponding plants out of pots did, but it must be remembered that they were somewhat smaller plants to start with. Besides this, they occupied one-half of the south bench which, as has already been pointed out, page 251, is a less favorable location for forcing tomatoes in winter than is the north bench on which the plants not in pots were located. The arrangement of the plants may be seen by consulting the diagram, Plate VI.

October 28, about a month after they were benched, the plants in pots averaged 8.31 inches high and those not in pots averaged 12.58 inches. Their later record is summarized in the following table:

TABLE IX —SINGLE-STEM PLANTS. TIME OF RIPENING FIRST FRUITS, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

| METHOD OF BENCHING. | Number of plants. | Average days from seed planting till first fruit ripened. | Average weight per fruit in ounces. | Average number of fruits per plant. | Yield in ounces per square foot of bench. |
|---|---|---|---|---|---|
| In pots | 33 | 160.15 | 1.76 | 15.97 | 13.21 |
| Not in pots | 31 | 157.90 | 2.00 | 13.60 | 12.79 |

*Second Test Using Single-stem Plants.*

Plants were arranged on the south middle bench of the tomato house December 12, 1895, for a second test. The plan of treatment which was followed has already been given, see page 251. The location of the plants on the bench may be seen by consulting the diagram, Plate VI. Of the seventeen plants in this test which were trained to single stem, eight were in pots and nine were not in pots. In discussing Table IV, page 253, it was shown that one of the plants in pots was very late in ripening its first fruits and was very unproductive, yielding but few small fruits. In the following table the first line, where the numbers are given in parentheses, includes the record of this exceptional plant, while the record in the following line excludes the record of this plant and therefore gives a much better idea of the general character of this lot of plants.

TABLE X.—SINGLE-STEM PLANTS. TIME OF RIPENING FIRST FRUITS, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

| METHOD OF BENCHING. | Number of plants. | Average days from benching till first fruit ripened. | Average weight per fruit in ounces. | Average number of fruits per plant. | Yield in ounces per square foot of bench. |
|---|---|---|---|---|---|
| In pots | (8) | (108.38) | (2.55) | (16.38) | (17.58) |
| In pots | 7 | 102.57 | 2.58 | 17.86 | 19.42 |
| Not in pots | 9 | 99.78 | 2.87 | 16.78 | 20.26 |

When they were put on the bench, the plants in pots averaged 5.91 inches high and the plants out of pots 5.94 inches. With respect to size the two lots of plants started on practically an equal footing, and may be considered comparable, after discarding one of the plants in pots, which sent its roots into the soil of an adjacent bench, as above explained. The table shows that the plants in pots gave a larger number of fruits than the plants not in pots, but they were a little late in ripening first fruits, their fruit was slightly smaller and the yield per square foot of bench was a little less, so that nothing was gained by keeping the plants in pots.

## EXPERIMENTS OF 1896-7.

### *Third Test Using Single-stem Plants.*

Seed of Lorillard for this test was sown Aug. 15, 1896. The method of selecting the plants, the arrangement on the benches, the preparation of soil, etc., are all explained on previous pages. See pages 255 to 258. Forty plants were selected for single-stem training, twenty to be grown in pots and twenty out of pots. Because of accidental injury, two of the plants in pots were thrown out of the experiment. The following statement permits of a comparison of the growth of the two lots during the early part of the experiment.

TABLE XI.—SINGLE-STEM PLANTS. HEIGHT OF YOUNG PLANTS.

| METHOD OF BENCHING. | No. of plants. | AVERAGE HEIGHT IN INCHES. | | |
|---|---|---|---|---|
| | | When pricked off. Sept. 2d. | When benched. Oct. 22d. | Two weeks after first blossoms opened. Nov. 19th. |
| In pots | 18 | 1.85 | 6.51 | 14.40 |
| Not in pots | 20 | 1.94 | 6.49 | 14.81 |

These figures show that during the early periods of growth the plants were remarkably uniform. The records concerning their yield are summarized in the following table:

TABLE XII. — SINGLE-STEM PLANTS — TIME OF RIPENING FIRST FRUITS, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

| METHOD OF BENCHING. | Number of plants. | Average days from seed planting till first fruit ripened. | Average weight per fruit in ounces. | Average number of fruits per plant. | Yield in ounces per square foot of bench. |
|---|---|---|---|---|---|
| In pots | 18 | 173.78 | 2.84 | 23.17 | 23.20 |
| Not in pots | 20 | 172.45 | 2.77 | 25.15 | 24.56 |

These two lots of plants are certainly comparable as great care was used to select uniform plants and to give them similar conditions from the time the seed was planted till the last fruit was picked, excepting only that one lot was in pots and the other was not in pots. In this case the results are slightly different from those of the first and second tests as set forth in Tables IX and X. The plants in pots again ripened the first fruits later, and the yield was slightly less than that of the plants not in pots, but the average weight per fruit was slightly greater. In no case is the difference marked with single-stem plants and the testimony favors the conclusion that little or no advantage is gained by growing them in pots in the way they were grown for these tests.

The influence of benching in pots when plants are trained to three stems will now be considered.

## EXPERIMENTS OF 1895–6.

### *First Test Using Three-stem Plants.*

The plants designed for three-stem training which were put on the benches September 26, 1895, were arranged as shown in the diagram, Plate VI. This arrangement proved to be faulty, inasmuch as the lots of plants to be compared were separated into groups, and these groups, being located in different parts of the house, did not have equal exposure to sunlight, as has already been explained on page 251. For this reason the results of the first test are not considered wholly satisfactory.

The three-stem plants were separated into two lots. The plants of one lot were grown in small pots plunged in the soil of the bench, as has already been explained, and the plants of the other lot were knocked out of the small pots at the time they were transplanted to the benches. The eighteen plants in pots averaged 3.33 inches high when they were benched and about a month later, October 28th, they averaged 9.75 inches. The location which they were given proved more favorable than that of the corresponding plants not in pots. The plants not in pots averaged 2.57 inches high when they were benched and 11.25 inches October 28th. Records are summarized in Table XIII for the seventeen plants of each lot which were finally included in the experiment.

TABLE XIII. — THREE-STEM PLANTS. TIME OF RIPENING FIRST FRUITS, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

| METHOD OF BENCHING. | Number of plants. | Average days from seed planting till first fruit ripened. | Average weight per fruit in ounces. | Average number of fruits per plant. | Yield in ounces per square foot of bench. |
|---|---|---|---|---|---|
| In pots ................... | 17 | 159.17 | 2.04 | 24.94 | 11.97 |
| Not in pots ............... | 17 | 159.50 | 1.93 | 25.35 | 11.52 |

*Second Test Using Three-stem Plants.*

In arranging plants for the second test the plants in pots were alternated with plants out of pots throughout the bench so that the two classes of plants in this test are strictly comparable. The method of selecting plants and the plan of treatment has already been explained on page 251. The diagram, Plate VI, shows the location of the plants on the south middle bench of the tomato house.

The six plants in pots which were included in this test averaged 5.92 inches high December 12 when they were benched and 22.08 inches about a month later, January 14. The seven corresponding plants not in pots averaged 5.93 inches high when they were benched and 20.29 inches January 14. From their succeeding records the following table is derived:

TABLE XIV.—THREE-STEM PLANTS. TIME OF RIPENING FIRST FRUIT, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

| METHOD OF BENCHING. | Number of plants. | Average days from benching till first fruit ripened. | Average weight per fruit in ounces. | Average number of fruits per plant. | Yield in ounces per square foot of bench. |
|---|---|---|---|---|---|
| In pots | 6 | 96 | 2.72 | 26.50 | 15.34 |
| Not in pots | 7 | 97 | 2.79 | 27.14 | 15.97 |

In this case as with single-stem plants, the two methods of benching which were tried showed no striking difference in results. The third test will now be considered.

## EXPERIMENTS OF 1896–7.

### *Third Test Using Three-stem Plants.*

Seed of Lorillard for this test was sown August 15, 1896. The method of selecting the plants, the preparation of the soil, etc., are explained on pages 255 to 258.

The plants in pots were benched alternately with plants out of pots as in the second test, and the two lots of plants are considered strictly comparable. Of the twenty plants selected for three-stem training ten were not grown in pots and ten were kept in pots. One of the plants in pots was accidentally broken and was thrown out of the test. The records show a remarkably uniform growth of the young plants as may be seen from the following table:

TABLE XV.—THREE-STEM PLANTS. HEIGHT OF YOUNG PLANTS.

| METHOD OF BENCHING. | Number of plants. | AVERAGE HEIGHT IN INCHES | | |
|---|---|---|---|---|
| | | When pricked off Sept. 2. | When benched Oct. 22. | Two weeks after first blossoms opened.* Nov. 19. |
| In pots | 9 | 2.08 | 7.19 | 12.19 |
| Not in pots | 10 | 2.00 | 7.20 | 12.80 |

*With the three-stem plants the tips of the main stems were pinched out just beyond the first flower cluster, so as to favor the growth of the side shoots for the three-stem training. On this account the height of three-stem plants should not be compared with the height of the single-stem plants on November 19th.

From the complete records of the test the following table is derived:

TABLE XVI. THREE-STEM PLANTS. TIME OF RIPENING FIRST FRUITS, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

| METHOD OF BENCHING. | Number of plants. | Average days from seed planted till first fruits ripened. | Average weight per fruit in ounces. | Average number of fruits per plant. | Yield in ounces per square foot of bench. |
|---|---|---|---|---|---|
| In pots | 9 | 168.89* | 2.45 | 37.11 | 16.04 |
| Not in pots | 10 | 171.30 | 2.49 | 44.40 | 19.53 |

*This is the average for eight plants as the first flower cluster on one plant was cut off by an insect, thus delaying the setting of the first fruit.

In this case the plants in pots ripened their first fruits a little earlier but yielded less weight of fruit than the plants not in pots, the difference being at the rate of twenty and a half pounds per hundred square feet of bench.

## CONCLUSIONS.

These tests of single-stem vs. three-stem training and of plants plunged on the bench in small pots vs. transplanted plants not in pots have been continued two seasons. Not counting the plants which have been discarded during the course of the experiments, sixty-six three-stem plants and one hundred and nineteen single-stem plants have been under test making a total of one hundred and eighty-five plants.

Only one variety has been used in the experiments but that is one almost universally used by gardeners in this country for winter forcing, namely, the Lorillard. The tests have been conducted on a sufficiently extensive scale so that the results are conclusive so far as this variety is concerned. Probably with other varieties they would be somewhat modified in detail, but the general results would doubtless be the same whatever the kind of tomato used.

It is not to be expected, however, that single-stem plants will outyield three-stem plants in every instance regardless of the influences which surround them. Various things influence the productiveness of tomato plants and the skillful gardener studies to combine all these influences to the end that he may get a large yield of fruit of marketable size. In the hands of a skillful gardener plants trained to three stems may do better than the same plants trained to single stems would do in the hands of an unskillful man. In other words, the advantage gained by training tomatoes to single stems in the forcing house are not great enough to overcome the results of neglect or lack of skill.

We are confident that, other things being equal, the different methods under consideration will give results in accordance with the conclusions which are given below.

### SINGLE-STEM VS. THREE-STEM TRAINING.

The single-stem training is clearly superior to three-stem training for winter forcing of tomatoes in this climate, both in the amount of fruit ripened early in the season and in the yield on equal areas. There is but slight difference in the average size of fruit produced but on the whole the fruit on single-stem plants seems to average slightly larger than that on three-stem plants.

### PLANTS BENCHED IN POTS VS. PLANTS BENCHED NOT IN POTS.

Plants kept in small pots and plunged in soil on the bench as compared with similar plants taken from the pots and transplanted to the bench sometimes show slightly more satisfactory results when the plants are trained to single-stem. When the plants are trained to three-stems, keeping them in small pots as just described seems to be a disadvantage.

PLATE IX.—FROM PHOTOGRAPHS OF A DISEASED TOMATO.

# V. NOTE ON A TOMATO DISEASE.*

S. A. BEACH.

A peculiar disease of the tomato, the cause of which is not well understood, has occurred in the forcing house at this Station. Tomatoes which were attacked by what is apparently the same disease have also been found in other greenhouses. Specimens of the diseased fruit were furnished Mr. Stewart, the Station Mycologist, at Jamaica, N. Y., who has prepared from them the following description of the disease:

This disease has the general characters of the so-called black rot of field grown tomatoes, which attacks the blossom end of the early fruits and which is supposed to be caused by the fungus, *Macrosporium tomato*, Cke. It begins as a slightly depressed, circular, brown spot which gradually enlarges, retaining its circular form, until it frequently covers as much as one half of the entire surface of the tomato. See Plate IX. In the great majority of cases the spot originates at the blossom end of the fruit, but it may originate at any point on the fruit. In color, the spots are at first brown; later, they become brownish black or greenish black and are bounded by a conspicuous double ring of light brown. In texture, the diseased tissue is leathery and dry with the surface usually smooth and glassy but sometimes wrinkled and velvety. The diseased portion shrivels so much that the fruit becomes much flattened on that side. The boundary line between the healthy and diseased tissue is definitely marked. Inside, the tissues are blackened for a considerable distance below the surface and there is somewhat less than the normal amount of moisture.

It occurred most frequently on the early fruits of rapidly growing plants but continued to appear to some extent throughout the season. The fruits are attacked in all stages of development,

*Partial reprint of Bulletin No. 125.

but, as observed in the forcing houses at this Station, there are no indications that either the stem or the leaves are attacked by the disease.

The remarkable feature of this rot is the total absence of fungus hyphæ from the tissues of the fruits in the early stages of the disease. Neither is there, at this time, any species of bacterium very abundant. Micrococci in zoögloea may be frequently seen but not in large numbers. Old specimens often show species of Fusarium and Penicillium and various bacteria. Fragments of diseased tissue were taken, with sterilized instruments, from the interior of fruits recently attacked by the disease, and cultivated on neutral agar in Petri dishes. Nothing developed in any of these cultures. A Petri-dish culture on agar acidified with malic acid, likewise, gave negative results. If any organism is connected with this disease it is one which does not grow readily on agar.

## VI. STRAWBERRIES IN 1897.*

WENDELL PADDOCK.

### SUMMARY.

The Station has no more plants of the Hunn for distribution.

Of strawberries in one-year beds Beder Wood was the most productive early berry. It is also a satisfactory general purpose variety as it took second rank as to yield among the kinds that were fruited in one-year beds. Marshall is worthy of a trial for fancy fruit. Glen Mary was the most productive berry and produced the largest late yield.

None of the strawberries in two-year beds succeeded more than moderately well, owing no doubt, to winter injury and an unfavorable growing season. Earliest produced the largest early yield while Robinson was the most productive and gave the largest late yield.

### INTRODUCTION.

The soil at the Station gardens is not well adapted to strawberry culture as it is composed of a stiff clay loam. Such soil is particularly hard to work in a wet season as some little time must elapse after each rain before the ground is in a condition to be worked. In the meantime weeds grow apace and if great care is not exercised to start the cultivator at the right time a crust soon forms and the soil becomes hard and compact. When such conditions arise the ground can only be gotten in good condition by cultivating at the proper time after another rain. The amount of rainfall at Geneva during a portion of the spring was rather large and considerable difficulty was experienced in keeping the soil in good tilth and in subduing the weeds.

The strawberries are grown in matted rows. As soon as the ground is lightly frozen in early winter the beds are mulched. Last winter coarse stable manure was used which had not become well rotted and which became more or less frozen before it

*Reprint of Bulletin No. 127.

was distributed over the beds. The result was that the plants were killed here and there in the rows in places where the frozen lumps chanced to fall.

The strawberry crop was not as satisfactory as could be desired owing in part to the conditions that have been described above. Not only were the yields of some varieties low but in many cases the berries were smaller in size than they should have been. These facts should be taken into consideration when the records of yields that are given in the following pages are consulted.

The blossoms of the strawberry are either pistillate, imperfectly staminate or staminate. The pistillate flowers are imperfect in their development in that they produce no pollen and are therefore incapable of setting fruit when planted by themselves. The imperfectly staminate flowers produce a small amount of pollen but not enough to enable them to set fruit satisfactorily; for our purpose varieties that have such flowers may be classed with the pistillate berries. The so-called staminate flowers are perfect in their development and so produce pollen. Accordingly varieties that have staminate flowers are able to set fruit when planted by themselves as well as to furnish a supply of pollen for the pistillate varieties. When pistillate varieties are planted it is very important that staminate varieties that blossom at the same time be planted with them. It is the custom with some growers to put a staminate variety in every third or fourth place in the row with the pistillate kinds. It is no doubt a better plan to plant every third row to a staminate variety as this arrangement admits of the different varieties being picked separately. Insects may be depended on to distribute the pollen.

In the description of varieties the letter P following the name of a variety indicates that it bears pistillate blossoms and needs to be planted near staminate kinds. The staminate varieties are indicated by the letter S following the name.

Of the newer varieties only a few were fruited on the station grounds this season. These have been described in full. Others of the more common kinds have been briefly mentioned; more complete descriptions may be had by consulting former bulletins and reports of this Station. In all cases where the name of the person from whom a certain variety was obtained is not given it is to be presumed that plants can be obtained of or through any reliable dealer. The varieties that fruited in one-year-old beds are discussed first after which the kinds that were grown in two-year beds are considered.

## NOTES ON VARIETIES.

### The Hunn Strawberry.

As we still receive requests for plants of the Hunn strawberry it seems desirable to state that the Station has no more plants of this or other varieties of strawberries for distribution.

Before deciding to name and disseminate the variety it was thought best to test it in another portion of the State. Accordingly plants were sent to Mr. W. D. Barns, Middle Hope, N. Y. In the season of 1896 Mr. Barns was able to market some of the fruit, when it proved to be a very satisfactory late market berry. His report was published in Bulletin No. 109 of this Station. In the season of 1897 the variety was even more satisfactory. Concerning it Mr. Barns writes: "It is a matter of congratulation that under peculiarly unfavorable circumstances it has shown itself the most valuable strawberry we have."

Plants of the Hunn were first sent out by the Station in the fall of 1895 and a second distribution was made in the spring of 1897. Persons who secured plants when the first distribution was made should have quite a stock of plants by this time, therefore, if the variety succeeds it will soon become quite common. Under the terms of the contract entered into with Mr. Barns he will be at liberty to dispose of plants in the spring of 1898.

It is too much to expect that any one variety of strawberry will succeed equally well in all locations. In fact the force of evidence and trend of opinion point to the conclusion that certain varieties will be restricted more and more to special localities. If then the Hunn succeeds in a comparatively few sections of the State we will feel that it has not been a mistake to disseminate the variety.

### Varieties in One-year-old Beds.

**Beauty**, P. *From J. H. Haynes, Delphi, Ind.* Berry medium size, attractive scarlet color, good quality, moderately productive. Blossoms with Beder Wood.

**Beder Wood**, S. A productive, early berry of medium size and good quality. Succeeds where many varieties fail.

**Canada Wilson**, S. *From Birdseye and Son, Hopewell, N. Y.* Very similar to the old Wilson.

**Clarence**, S. (*Thompson No. 101.*) *From Thompson's Sons, Rio Vista, Va.* Fruit above medium, scarlet color, good quality. Moderately productive.

**Columbian**, S. *From W. F. Allen, Salisbury, Md.* Fruit medium or below in size. Unproductive in this locality.

**Eleanor**, S. *From Thompson's Sons, Rio Vista, Va.* Fruit medium or above, good color and quality. Not very productive, but worthy of a trial on account of its earliness.

**Enormous**. P. *From Thompson's Sons, Rio Vista, Va.* Blossoms with Beder Wood. Fruit large to very large, bright scarlet color, good quality. Ranks fourth in productiveness among varieties that were fruited in one-year-old beds. Worthy of a trial on account of size, color and productiveness.

**Gandy**, S. Well known in many localities as a profitable late variety. It does not succeed in some locations.

**Giant**, S. *From W. Y. Velie, Marlboro, N. Y.* Plants vigorous and productive of large fruits. The berries are soft and of a light color, therefore the variety cannot be recommended as a market berry.

**Glen Mary**, S. *From W. F. Allen, Salisbury, Md.* Sharpless type. Foliage healthy, leaves large with tall leaf stalks, runners moderately abundant, fruit-stems long, prostrate. Fruit large to very large, rather irregular in shape, good scarlet color. The most productive variety that fruited on the Station grounds in 1897. Recommended for trial on account of health, vigor and productiveness of the plants and the size and appearance of the berries.

**Greenville**, P. A satisfactory berry in many localities. Sharpless type. Blossoms with Sharpless.

**Haverland**, P. A standard variety. Fruits large, long conic, showy scarlet color.

**Hersey**, S. *From S. Hersey, Hingham, Mass.* Fruit small to medium, light scarlet color, firm, fair quality. Unproductive this season.

*Hull No. 3*, S. *From E. J. Hull, Olyphant, Pa.* Fruit large, light scarlet color, moderately firm, moderately productive.

**Maple Bank**, P. *From E. B. Stevenson, Lowville, Canada.* Blossoms with Sharpless. Fruit medium size, scarlet color, firm. Not productive this season.

**Marshall**, S. Does not succeed in many localities; where it does well it is very satisfactory. Fruit of largest size, dark scarlet color, good quality, firm. Recommended for trial where the best of culture can be given.

**Mary**, P. Plants strong but make few runners. Fruit very large but irregular and rough, moderately productive. Blossoms with Sharpless.

**Michel**, S. First early, fruit medium size, unproductive. Of value where very early fruit is desired.

**Middlefield**, P. A good variety for home use; has been only moderately productive on our grounds. Blossoms with Sharpless.

**Murray**, P. *From Thompson's Sons, Rio Vista, Va.* Fruit medium to large, dark scarlet color. Unproductive on our soil. Blossoms with Beder Wood.

**Omega**, P. *From Thompson's Sons, Rio Vista, Va.* Moderately productive. Fruit large, light scarlet color. Blossoms with Sharpless.

**Robinson**, S. *From Thompson's Sons, Rio Vista, Va.* Fruit medium to large, scarlet color, good quality. Ranks fifth in productiveness this season among varieties that were fruited in one-year-old beds.

**Thompson**, S. *(Lady Thompson.)* Has proven a failure on our soil. Fruit medium size, light scarlet color, unproductive.

*Thompson No. 100*, S. *From Thompson's Sons, Rio Vista, Va.* Fruit medium size, good, scarlet color. Unproductive this season.

**Vera**, P. *From E. B. Stevenson, Lowville, Ontario, Canada.* Foliage moderately vigorous, runners abundant. fruit stems medium, prostrate. Fruit medium size, conical, scarlet color, moderately firm, quality good. Ranks seventh in productiveness among varieties that were fruited in one-year-old beds. Blossoms with Sharpless.

Williams, S. *From Ellwanger & Barry, Rochester, N. Y.* Fruit medium to large, rather soft, fair in quality, moderately productive.

TABLE I. — LIST OF STRAWBERRIES FRUITED IN ONE-YEAR-OLD BEDS, WITH A COMPARATIVE STATEMENT OF THE EARLY AND LATE YIELD OF EACH VARIETY.

| Rank as to yield, 1897. | NAME OF VARIETY. | Yield of 66 square feet. | Per cent of crop picked before June 25. | Per cent of crop picked after July 5. |
|---|---|---|---|---|
| | | Ounces. | | |
| 1 | Glen Mary | 544½ | 1 | 26 |
| 2 | Beder Wood | 401 | 22 | 17 |
| 3 | Haverland | 238 | 5 | 15 |
| 4 | Enormous | 240 | 15 | 8 |
| 5 | Robinson | 227½ | 00 | 28 |
| 6 | Vera | 217½ | 21 | 6 |
| 7 | Beauty | 212½ | 00 | 63 |
| 8 | Canada Wilson | 208½ | 9 | 13 |
| 9 | Omega | 204½ | 00 | 19 |
| 10 | Giant | 191 | 00 | 53 |
| 11 | Williams | 188½ | 00 | 21 |
| 12 | Marshall | 184½ | 20 | 9 |
| 13 | Clarence | 182½ | 00 | 31 |
| 14 | *Hull No* 3 | 178 | 00 | 25 |
| 15 | Greenville | 172 | 00 | 7 |
| 16 | Sherman | 158 | 00 | 13 |
| 17 | Mary | 157 | 00 | 20 |
| 18 | *Thompson No.* 100 | 150 | 8 | 12 |
| 19 | Gandy | 148 | 00 | 42 |
| 20 | Eleanor | 135 | 27 | 4 |
| 21 | Thompson *Lady Thompson* | 127 | 11 | 23 |
| 22 | Sharpless | 123 | 00 | 10 |
| 23 | Murray | 122½ | 21 | 3 |
| 24 | Hersey | 122 | 00 | 6 |
| 25 | Maple Bank | 118 | 00 | 10 |
| 26 | Middlefield | 104 | 00 | 10 |
| 27 | Columbian | 102 | 00 | 12 |
| 28 | Michel | 80 | 58 | 00 |

EARLY VARIETIES IN ONE-YEAR-OLD BEDS.

The date of the beginning of mid-season of strawberries in this locality for the season of 1897 may properly be assumed to be June 25. By referring to Table I we find that six varieties yielded a fifth or more of their crop before this date. These varieties may be called early for this season. They are given below in Table II.

Table II.—Early Varieties Ranked According to Yield Before June 25.

| Name of Variety. | Date of first picking. | Yield before July 5. | Total yield 1897. | Rank as to total yield, 1897 |
|---|---|---|---|---|
| | | Ounces. | Ounces. | |
| Beder Wood | June 21 | 88 | 401 | 2 |
| Michel | June 16 | 46 | 80 | 28 |
| Vera | June 16 | 45 | 217½ | 6 |
| Marshall | June 21 | 36 | 184½ | 12 |
| Eleanor | June 18 | 36 | 135 | 20 |
| Murray | June 21 | 25 | 122½ | 23 |

Beder Wood has proven to be reliable here in either one, two or three-year-old beds. It can be strongly recommended as a general purpose berry. While it is ranked among the early varieties, it has a long fruiting period, as the last berries were picked on July 9. Michel is of value only when very early berries are desirable. Vera does not appear to possess special merit. Marshall is fickle in its behavior and requires high culture. Where it succeeds it is one of the best of the fancy berries. It usually ranks with the mid-season varieties. Eleanor and Murray are no improvement on better known sorts.

## Late Varieties in One-year-old Beds.

July 5 may be regarded as the close of mid-season. Table I shows that eight varieties ripened a fourth or more of their crop after this date. These varieties may be called late for this season. They are given below in Table III.

Table III.—Late Varieties Ranked According to Yield After July 5.

| Name of Variety. | Date of last picking. | Yield after July 5. | Total yield. 1897. | Rank as to total yield. |
|---|---|---|---|---|
| | | Ounces. | Ounces. | |
| Glen Mary | July 13 | 142 | 54[illegible]½ | 1 |
| Beauty | July 9 | 135 | 212½ | 7 |
| Giant | July 13 | 101 | 191 | 10 |
| Robinson | July 9 | 64 | 227½ | 5 |
| Clarence | July 9 | 57 | 182½ | 13 |
| Gandy | July 13 | 52 | 148 | 19 |
| *Hall No. 3* | July 9 | 44 | 175 | 14 |

Glen Mary was the most productive variety on our grounds this season. This fact together with its large per cent of late yield, its large fruit and vigorous, healthy foliage will recommend it for further trial. Beauty is only moderately productive but of excellent quality. Giant is of large size and moderately productive but of light color and soft. Gandy is the standard late variety in many sections. It does not succeed in all localities. Robinson is fairly productive. The berries are of medium size and good quality. Clarence and *Hull No. 3* are no improvement on better known varieties.

## VARIETIES IN TWO-YEAR-OLD BEDS.

TABLE NO. IV—LIST OF STRAWBERRIES FRUITED IN TWO-YEAR-OLD BEDS, WITH A COMPARATIVE STATEMENT OF THE EARLY AND LATE YIELD OF EACH VARIETY.

| Rank as to yield, 1897. | NAME OF VARIETY. | Yield of 66 square feet. | Per cent picked before June 25. | Per cent picked after July 5. |
|---|---|---|---|---|
| | | Ounces. | | |
| 1 | Robinson | 286 | 0 | 40 |
| 2 | *See No. 4* | 214 | 0 | 18 |
| 3 | Omega | 200 | 0 | 32 |
| 4 | Thompson | 199½ | 13 | 17 |
| 5 | Bissell | 187 | 15 | 24 |
| 6 | Enormous | 175 | 20 | 17 |
| 7 | *See No. 5* | 162 | 5 | 4 |
| 8 | *Slaymaker No. 9* | 161 | 16 | 22 |
| 9 | *See No. 3* | 185 | 4 | 6 |
| 10 | Tubbs | 148 | 19 | 15 |
| 11 | Clarence | 147 | 0 | 24 |
| 12 | Parker Earle | 134 | 0 | 15 |
| 13 | *Hull No. 3* | 127 | 0 | 14 |
| 14 | William Belt | 124 | 0 | 23 |
| 15 | Staples | 101 | 39 | 1 |
| 16 | Mary | 100 | 0 | 38 |
| 17 | Earliest | 97 | 75 | 5 |
| 18 | Murray | 95 | 19 | 19 |
| 19 | Maple Bank | 93 | 4 | 5 |
| 20 | Beecher | 83 | 00 | 7 |
| 21 | Hersey | 83 | 18 | 12 |
| 22 | Eleanor | 72 | 25 | 8 |
| 23 | Margaret | 72 | 36 | 7 |
| 24 | *Thompson No. 100* | 66 | 35 | 12 |
| 25 | Canada Wilson | 52 | 19 | 14 |
| 26 | Columbian | 46 | 0 | 17 |
| 27 | *Slaymaker No. 8* | 35 | 22 | 8 |
| 28 | Allen | 34½ | 0 | 9 |

### Early Varieties in Two-year-old Beds.

Again assuming that June 25th was the beginning of mid-season for this locality, Table IV shows that six varieties ripened more than a fourth of their crop before this date. These varieties may be called early for this season.

Table V.—Early Varieties Fruited in Two-Year-Old Beds Ranked According to Yield Before June 25.

| Name of Variety. | Date of first picking. | Yield before June 25. | Total yield, 1897. | Rank as to total yield, 1897. |
|---|---|---|---|---|
| | | Ounces. | Ounces. | |
| Earliest | June 16 | 73 | 97 | 17 |
| Staples | June 16 | 40 | 102 | 15 |
| Margaret | June 21 | 26 | 72 | 23 |
| *Thompson No.* 100 | June 21 | 23 | 66 | 24 |
| Eleanor | June 18 | 18 | 72 | 22 |
| *Slaymaker No.* 8 | June 23 | 7 | 35 | 27 |

Earliest closely resembles Michel of which it is a seedling. Staples did not do well in a two-year-old bed as the plants lacked vigor; but it is worthy of a trial as an early sort. Margaret is not adapted to our stiff soil as the plants have not done well in either one or two-year-old beds. *Thompson No. 100* was unsatisfactory in a two-year-old bed as were also Eleanor and *Slaymaker No. 8*. A part of the failure of the varieties in two-year-old beds was no doubt due to winter injury as has been explained above.

### Late Varieties in Two-year-old Beds.

Table IV shows that seven varieties yielded over a fourth of their crop after July 5th, therefore these may be called late for this season.

Table VI.—Late Varieties Fruited in Two-Year-Old Beds Ranked According to Yield After July 5.

| Name of Variety. | Date of last picking. | Yield after July 5. | Total yield, 1897. | Rank as to total yield, 1897. |
|---|---|---|---|---|
| | | Ounces. | Ounces. | |
| Robinson | July 9 | 114 | 286 | 1 |
| Omega | July 7 | 14 | 200 | 3 |
| Bissel | July 9 | 45 | 187 | 5 |
| Mary | July 9 | 38 | 100 | 16 |
| *Slaymaker No.* 9 | July 6 | 35 | 161 | 8 |
| Clarence (*Thompson No.* 101) | July 9 | 33 | 147 | 11 |
| William Belt | July 9 | 29 | 124 | 14 |

Robinson, Omega, Mary and Clarence have been mentioned under varieties that fruited in one-year-old beds. Bissel stood first in productiveness among varieties that fruited in one-year-old beds in 1896. This season it takes fifth place in productiveness among varieties that were fruited in two-year-beds. The fruit is medium size, good color and moderately firm.

*Slaymaker No. 9*, from Slaymaker & Son, Dover, Del., bears fruit large in size but rather light in color and low in quality. It is no improvement over known sorts.

William Belt received favorable mention last season. This season it takes a low rank because of the severe winter injury that the plants sustained.

## LIST OF STRAWBERRIES RECEIVED IN 1897.

*Babcock No. 4.* From D. W. Babcock, Cromwell, Conn.

Bismark. From L. J. Farmer, Pulaski, N. Y.

Bouncer. From L. J. Farmer, Pulaski, N. Y.

Bryant. From Birdseye & Son, Hopewell, N. Y.

*Bubach Seedling.* From W. E. Doxie, Wappinger Falls, N. Y.

Carrie. From L. J. Farmer, Pulaski, N. Y.

Clyde. From L. J. Farmer, Pulaski, N. Y.

*Cumberland Triumph Seedling.* From W. E. Doxie, Wappinger Falls, N. Y.

Evans. From Slaymaker & Son, Dover, Del.

Fred. Stahelin. From F. C. Stahelin, Bridgman, Mich.

Gertrude. From W. F. Allen, Salisbury, Md.

Hall Favorite. From L. J. Farmer, Pulaski, N. Y.

Holland. From L. J. Farmer, Pulaski, N. Y.

Isabella. From J. H. Hale, South Glastonbury, Conn.

Jersey Market. From L. J. Farmer, Pulaski, N. Y.

Leader. From J. H. Hale, South Glastonbury, Conn.

*Lovett Seedling.* From W. E. Doxie, Wappinger Falls, N. Y.

Michigan. From L. J. Farmer, Pulaski, N. Y.

More Favorite. From C. J. More, Jamestown, N. Y.

*Morgan No. 1.* From J. A. Morgan, Scottsville, N. Y.

Noland. From J. P. Noland, Peninsula, Ohio.

Ocean City. From Slaymaker & Son, Dover, Del.

Ridgeway. From L. J. Farmer, Pulaski, N. Y.

Rural Gem. From J. H. Pease & Son Thompsonville, Conn.

Sample. From C. S. Pratt, Reading, Mass.

Seaford. From L. J. Farmer, Pulaski, N. Y.

*Stenger No. 1.* From B. F. Stenger, Charlottsville, Ind.

*Stenger No. 2.* From B. F. Stenger, Charlottsville, Ind.

Tennyson. From Harrison's Nurseries, Berlin, Md.

# VII. VARIETY TESTS WITH RASPBERRIES, BLACKBERRIES AND DEWBERRIES.*

WENDELL PADDOCK.

## SUMMARY.

*Poscharsky No. 15* takes first rank among black raspberries both as to total yield and the amount of fruit produced early in the season. Palmer has a long season as it is classed with both early and late berries. *Babcock No. 5* and Mills were the two most productive late berries.

Of red raspberries, Pomona gave the largest early yield and ranks second in productiveness. Cline ripens most of the crop in a few days and, as is usual with very early berries, is unproductive. Kenyon and Olathe were the most satisfactory late red raspberries. Of the mid-season varieties Loudon, Cuthbert and King deserve special mention.

Shaffer and Columbian are as yet the two standard varieties of purple raspberries.

Of blackberries, Dorchester, Success, New Rochelle and Stone Hardy were the most productive in 1897. Dorchester and New Rochelle have not always been hardy here. Early King produced the largest early yield.

Lucretia is as yet the only dewberry of importance in this section.

## INTRODUCTION.

The stiff clay loam of the Station gardens is not well adapted to small fruit culture, but raspberries and blackberries succeed much better than strawberries. Early in the season the ground between the rows was plowed to a depth of about three inches with a one-horse plow. This effectually loosened the surface soil as could be seen by comparison with adjacent land that had not been plowed. The influence of the plowing could be noticed as long as cultivation was continued. After plowing the ground

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was smoothed with the cultivator and an endeavor was made to keep the soil from becoming compact by giving frequent cultivation.

Nearly all varieties came through the winter in good condition and set a full crop of fruit. The dewberries alone received winter protection which was given them by throwing a few shovelfuls of earth on the prostrate vines. Abundant rains when the fruit was ripening brought all the berries to maturity and thus it happens that some of the varieties that have not usually done well on our grounds make a good showing in the following tables.

Descriptive notes are given of some of the newer kinds and the older sorts have in some cases been briefly mentioned. In all cases where the source from which the plants were obtained is not given it is supposed that such varieties may be had of any reliable dealer.

## BLACK RASPBERRIES.

### NOTES ON VARIETIES.

*Babcock No. 3. From D. W. Babcock, Cromwell, Conn.* An attractive, large berry but only moderately productive on our soil.

*Babcock No. 5. From D. W. Babcock, Cromwell, Conn.* While the fruit is not quite as large as No. 3, it has been much more productive. It takes second rank this season. Both of the Babcock seedlings make a good showing among the late varieties as may be seen by consulting Table I. For this reason both are considered worthy of testing.

**Black Diamond.** *From C. W. Stewart, Newark. N. Y.* Fruit large with medium grains, good black color, firm, good quality and will evidently be productive. Its season is about with Gregg. A promising variety.

**Eureka.** A standard variety in many localities. It has a long season which extends from medium early to medium late.

**Hopkins.** *From A. M. Purdy, Palmyra, N. Y.* An early berry of large size but only moderately productive here.

**Lawrence.** *From A. H. Griesa, Lawrence, Kansas.* Fruit very large, moderately firm, good color and quality; evidently productive. Season a little later than Eureka. Worthy of further testing.

**Mills.** *From C. Mills, Fairmount, N. Y.* This variety has been favorably reported on in former reports of this Station. The fruit is of medium size and good quality. It stands third in productiveness this season.

**Onondaga.** *From C. Mills, Fairmount, N. Y.* Fruit large, attractive, good quality. It was only moderately productive this season.

**Palmer.** *From C. Mills, Fairmount, N. Y.* A standard variety in many places.

**Progress.** *From D. B. Garvin & Son, Wheeling, W. Va.* Berries medium size, good black color and moderately firm. It ranks fourth in productiveness this season.

*Poscharsky Seedlings. From F. W. Poscharsky, Princeton, Ill.* Neither *No. 3* nor *No. 9* are any improvement over better known sorts. *No. 15* ranks first in productiveness and in the amount of fruit produced early. The fruit is medium to large, firm, somewhat seedy, sweet and of very good quality. Where very early berries are desired this variety will be worthy of a trial.

*Townsend No. 2. From G. Townsend, Gordon, O.* Fruit medium to large, very good quality. It ranks sixth in productiveness this season.

TABLE NO. I.— LIST OF BLACK RASPBERRIES FRUITED IN 1897 WITH A COMPARATIVE STATEMENT OF THE PERCENTAGE OF EARLY AND LATE YIELD OF EACH VARIETY.

| Rank as to yield, 1897. | NAME OF VARIETY. | When set. | Yield of row 25 feet long. | Per cent of crop picked before July 17. | Per cent of crop picked after July 23. | Per cent of canes winter killed. |
|---|---|---|---|---|---|---|
| | | | Ounces | | | |
| 1 | *Poscharsky No.* 15 | 1894 | 466 | 42 | 11 | 5 |
| 2 | *Babcock No.* 5 | 1894 | 419 | 3 | 35 | 10 |
| 3 | Mills | 1894 | 409 | 0 | 33 | 5 |
| 4 | Pioneer | 1894 | 401 | 24 | 26 | 3 |
| 5 | Eureka | 1894 | 390 | 22 | 24 | 3 |
| 6 | *Townsend No.* 2 | 1894 | 359 | 10 | 16 | 5 |
| 7 | *Babcock No.* 3 | 1894 | 335 | 0 | 33 | 0 |
| 8 | Palmer | 1894 | 285 | 28 | 31 | 3 |
| 8 | *Poscharsky No.* 3 | 1894 | 285 | 35 | 15 | 5 |
| 9 | Onondaga | 1894 | 247 | 3 | 33 | 10 |
| 10 | Hopkins | 1894 | 216 | 32 | 20 | 10 |
| 11 | *Poscharsky No.* 9 | 1894 | 186 | 37 | 18 | 5 |

## EARLY BLACK RASPBERRIES.

The mid-season of black raspberries for 1897 may be regarded as extending from July 17 to July 23. Those varieties that ripened a fourth or more of their crop before July 17 may be called early for this season. Table I shows five such varieties. These are arranged below in Table II.

TABLE II.—EARLY BLACK RASPBERRIES ARRANGED ACCORDING TO THEIR YIELD BEFORE JULY 17.

| NAME OF VARIETY. | Date of first picking. | Yield before July 17. | Total yield. | Rank as to total yield. |
|---|---|---|---|---|
| | | Ounces. | Ounces. | |
| *Poscharsky No.* 15 | July 8 | 193 | 466 | 1 |
| *Poscharsky No.* 3 | July 8 | 100 | 285 | 8 |
| Palmer | July 8 | 80 | 285 | 8 |
| Hopkins | July 13 | 69 | 216 | 10 |
| *Poscharsky No.* 9 | July 8 | 69 | 186 | 11 |

*Poscharsky No. 15* has made a good record this season. It is remarkable in that it gives the largest total yield as well as the largest early yield. *Poscharsky Nos. 3* and *9* are no improvement on better known sorts. Palmer is a well known early variety. Hopkins bears fruit of good size but is not productive enough on our soil to compare favorably with better known sorts.

## LATE BLACK RASPBERRIES.

Assuming that mid-season ended on July 23 all varieties that ripened a fourth or more of their crop after this date may be called late for this season. Table I shows six such varieties. These are arranged below in the order of their yield after July 23.

TABLE III.—LATE BLACK RASPBERRIES ARRANGED ACCORDING TO THEIR YIELD AFTER JULY 23.

| NAME OF VARIETY. | Date of last picking. | Yield after July 23. | Total yield. | Rank as to total yield. |
|---|---|---|---|---|
| | | Ounces. | Ounces. | |
| *Babcock No.* 5 | July 30 | 147 | 419 | 2 |
| Mills | Aug. 4 | 135 | 409 | 3 |
| *Babcock No.* 3 | Aug. 4 | 110 | 335 | 7 |
| Pioneer | July 30 | 104 | 401 | 4 |
| Palmer | July 30 | 88 | 285 | 8 |
| Onondaga | Aug. 2 | 82 | 247 | 9 |

*Babcock No. 5* and Mills can safely be recommended for trial. Palmer and Onondaga have not usually been as productive on our soil as they have elsewhere. However they are standard varieties in some localities.

## RED RASPBERRIES.

TABLE IV.—LIST OF RED RASPBERRIES FRUITED IN 1897, WITH A COMPARATIVE STATEMENT OF THE PERCENTAGE OF EARLY AND LATE YIELDS OF EACH VARIETY.

| Rank as to yield 1897. | NAME OF VARIETY. | When set. | Yield of matted row 25 feet long. | Per cent of crop picked before July 16. | Per cent of crop picked after July 26 | Per cent of canes winter killed. |
|---|---|---|---|---|---|---|
| | | | Ounces. | | | |
| 1 | Loudon | 1894 | 503 | 7 | 22 | 0 |
| 2 | Pomona | 1892 | 495 | 30 | 9 | 0 |
| 3 | Cuthbert | 1892 | 478 | 0 | 22 | 3 |
| 4 | King | 1894 | 471 | 15 | 13 | 0 |
| 5 | Kenyon | 1894 | 463 | 5 | 27 | 0 |
| 6 | I. X. L. | 1894 | 441 | 21 | 20 | 0 |
| 7 | Pride of Kent | 1893 | 401 | 19 | 11 | 3 |
| 8 | Superb | 1892 | 326 | 13 | 20 | 0 |
| 9 | Royal Church | 1892 | 322 | 4 | 20 | 5 |
| 10 | Talbot | 1894 | 306 | 10 | 26 | 0 |
| 11 | Clarke. | 1894 | 288 | 10 | 16 | 0 |
| 12 | Reder | 1893 | 258 | 19 | 12 | 0 |
| 13 | Olathe | 1893 | 249 | 0 | 25 | 3 |
| 14 | Turner | 1892 | 233 | 20 | 9 | 3 |
| 15 | Reliance | 1893 | 228 | 16 | 18 | 5 |
| 16 | Miller Woodland | 1892 | 211 | 8 | 28 | 5 |
| 17 | Cline | 1893 | 180 | 62 | 2 | 1 |
| 18 | Naomi | 1893 | 179 | 15 | 20 | 10 |
| 19 | Pride | 1893 | 157 | 37 | 6 | 1 |
| 20 | Superlative | 1894 | 152 | 40 | 4 | 5 |
| 21 | Brandywine | 1892 | 146 | 2 | 30 | 5 |
| 22 | Harris | 1893 | 145 | 30 | 15 | 10 |

### EARLY RED RASPBERRIES.

Assuming that mid-season of red raspberries began on July 16 those varieties that ripened a fourth or more of their crops before this date may be called early for this season. Table IV shows that there were six in this class. They are given below in Table V.

TABLE V.—EARLY RED RASPBERRIES ARRANGED ACCORDING TO THEIR YIELD BEFORE JULY 16.

| NAME OF VARIETY. | Date of first picking. | Yield before July 16. | Total yield. | Rank as to total yield. |
|---|---|---|---|---|
| | | Ounces | Ounces. | |
| Pomona | July 7 | 148 | 495 | 2 |
| Cline | July 6 | 111 | 180 | 17 |
| Superlative | July 8 | 61 | 152 | 20 |
| Pride | July 7 | 58 | 157 | 19 |
| Harris | July 10 | 43 | 145 | 22 |

Pomona, from Wm. Parry, Parry, N. J., has always been satisfactory on our grounds. It is not only early but productive as well, ranking second in yield in 1897 among all the varieties. Cline, from G. W. Cline, Winona, Ont., is very early and yields most of its fruit in a few days after beginning to ripen. Pomona was much more satisfactory as its early yield was not only larger but it has a long season as well. Superlative, from Ellwanger & Barry, Rochester, N. Y., has berries of the largest size and Idaeus type.

## LATE RED RASPBERRIES.

Again referring to Table IV we find that five varieties produced a fourth or more of their crop after July 26. These are given below in Table VI as late varieties.

TABLE VI.—LATE RED RASPBERRIES ARRANGED ACCORDING TO THEIR YIELD AFTER JULY 23.

| NAME OF VARIETY. | Date of last picking. | Yield after July 26. | Total yield. | Rank as to total yield. |
|---|---|---|---|---|
| | | Ounces. | Ounces. | |
| Kenyon | August 9 | 125 | 463 | 5 |
| Talbot | August 7 | 78 | 306 | 10 |
| Olathe | August 7 | 60 | 249 | 14 |
| Miller Woodland | August 9 | 59 | 211 | 17 |
| Brandywine | August 2 | 44 | 146 | 22 |

Kenyon, from A. M. Kenyon, McGregor, Ia., has fruit of medium size, moderately firm, rather dark when fully ripe and only fair in quality. It ranks fifth in yield this season and produced the largest precentage of late yield of any variety. Of the other berries included in the list of late varieties Olathe, from Stayman & Black, Lawrence, Kan., has been the most satisfactory.

### MID SEASON VARIETIES.

Loudon, from C. A. Green, Rochester, N. Y., ranks first in yield this season among the red raspberries. It has a long fruiting season and gives a good late yield, though the percentage of late yield is not as large as some others. The fruit resembles the Marlboro; the plants are vigorous and have been perfectly hardy here thus far. Cuthbert is one of the standard red raspberries and is perhaps more grown than any other red variety. It is not firm enough to ship long distances.

King, from Cleveland Nursery Co., Rio Vista, Va., bears fruit of large, fine, bright color, firm, good quality; plants vigorous and hardy. It ranks fourth in productiveness among all the red raspberries that fruited this season.

## PURPLE RASPBERRIES.

TABLE VII.—LIST OF PURPLE RASPBERRIES FRUITED IN 1897, WITH A COMPARATIVE STATEMENT OF THE PERCENTAGE OF EARLY AND LATE YIELD OF EACH VARIETY.

| Rank as to yield, 1897. | NAME OF VARIETY. | When set. | Yield of row 25 feet long. | Per cent of crop picked before July 16. | Per cent of crop picked after July 26. | Per cent of canes winter-killed. |
|---|---|---|---|---|---|---|
| | | | Ounces. | | | |
| 1 | Smith Purple | 1895 | 481 | 20 | 16 | 3 |
| 2 | Shaffer | 1895 | 414 | 0 | 27 | 25 |
| 3 | Addison | 1894 | 382 | 50 | 1 | 5 |
| 4 | Columbian | 1894 | 376 | 0 | 30 | 3 |
| 5 | Teletaugh | 1895 | 376 | 14 | 4 | ...... |
| 6 | Beckwith | 1894 | 195 | 0 | 51 | 3 |
| 7 | Redfield | 1895 | 123 | 0 | 26 | 3 |

By referring to the above table it will be seen that only one variety, Addison, gave a large percentage of early yield. This berry is not worth growing in this locality as the berries are small and crumble badly.

Smith Purple, from B. F. Smith, Lawrence, Kan., was the most productive. This variety has all of the characteristics of the black raspberries aside from its purple color.

Shaffer and Columbian have been the most satisfactory purple berries. There seems to be but little difference in productiveness between the two.

Teletaugh, from J. F. Street, West Middletown, Ind., is a new comer and has not been sufficiently tested to decide as to its merits. The berries are large, dark purple with an abundance of bloom that gives them a mouldy appearance. The fruit is firm and rather tart. Its season is somewhat earlier than Shaffer or Columbian.

## BLACKBERRIES.

TABLE VIII.—YIELD OF BLACKBERRIES IN 1897.

| Rank as to yield, 1897. | NAME OF VARIETY. | When set. | Yield of row 25 feet long. | In marketable condition. | Per cent of canes winter-killed. |
|---|---|---|---|---|---|
| | | | Ounces. | | |
| 1 | Dorchester | 1893 | 755 | July 26 to Sept. 2 | 0 |
| 2 | Success | 1892 | 606 | July 30 to Sept. 7 | 0 |
| 3 | New Rochelle | 1893 | 589 | July 26 to Sept. 2 | 0 |
| 4 | Stone Hardy | 1893 | 588 | Aug. 9 to Sept. 2 | 0 |
| 5 | Early Mammoth | 1892 | 528 | July 28 to Aug. 30 | 0 |
| 6 | Agawam | 1893 | 467 | July 28 to Aug. 30 | 0 |
| 7 | Erie | 1893 | 443 | July 30 to Aug. 7 | 3 |
| 8 | Western Triumph | 1895 | 438 | Aug. 2 to Aug. 30 | 0 |
| 9 | *Ford No. 1* | 1892 | 408 | Aug. 7 to Sept. 7 | 0 |
| 10 | Woodland | 1892 | 371 | July 30 to Sept. 2 | 0 |
| 11 | Ancient Briton | 1893 | 352 | Aug. 2 to Aug. 30 | 0 |
| 12 | Early King | 1892 | 330 | July 30 to Sept. 7 | 0 |
| 13 | Lovett | 1893 | 317 | Aug. 7 to Aug. 30 | 0 |
| 14 | Wilson, Jr. | 1893 | 211 | July 23 to Aug. 30 | 5 |
| 15 | Sandford | 1894 | 195 | Aug. 9 to Aug. 30 | 0 |
| 16 | Black Chief | 1893 | 187 | Aug. 7 to Sept. 7 | 0 |
| 17 | Early Harvest | 1895 | 170 | July 15 to Aug. 17 | 0 |
| 18 | Child Tree | 1894 | 122 | July 26 to Aug. 21 | 3 |
| 19 | Fruitland | 1892 | 71 | Aug. 12 to Aug. 30 | 0 |

Most of the blackberries came through the winter uninjured by the cold. On this account some of the varieties take a high rank in yield that have not heretofore been productive here.

Dorchester is a well known old variety. It has not always been hardy here.

Success, from L. W. Carr and Co., Erie, Pa., received favorable notice in our report for 1896 and this season it takes second rank in yield. The berries are of medium size with medium grains and small core; quality good.

New Rochelle (*Lawton*), is a well known old sort. It is one of the finest of blackberries when grown at its best but the plants are not hardy enough to be reliable in this locality.

Stone Hardy ranked second in yield last season and takes fourth place this year. The fruit is of medium size and good quality.

Early Mammoth, from Cleveland Nursery Co., Rio Vista, Va., is said to be a hybrid between the blackberry and dewberry. The fruit varies from the largest size to small, imperfect berries. The plants are not usually hardy here.

Agawam is a well known variety. The plants are quite hardy in this locality. The fruit is of medium size and good quality.

Erie is an old variety. It has not been as productive here as some others.

Ancient Briton took first rank in yield last year which may account in part for its low place this season. This has been regarded as one of the most reliable varieties. The fruit is of medium size.

Early King, from Ellwanger & Barry gave the largest early yield and its total yield was satisfactory for such an early sort. The canes are of medium size and the plants are vigorous. Fruit medium size, good quality.

Wilson Jr. belongs in the same class with Early Mammoth and resembles that variety in bush and fruit. They both need winter protection in this locality.

Early Harvest has been quite satisfactory in former years as an extra early variety. Last season fully established plants took third rank as to yield. The berries are of medium size and good quality.

## DEWBERRIES.

TABLE IX.—YIELD OF DEWBERRIES IN 1897.

| Rank as to yield, 1897. | NAME OF VARIETY. | Yield of row of 20 feet long. | In marketable condition. |
|---|---|---|---|
| | | Ounces. | |
| 1 | Lucretia | 198 | July 17 to Aug. 12 |
| 2 | Bartel | 102 | July 15 to Aug. 2 |
| 3 | Austin Improved | 68 | July 17 to Aug. 2 |
| 4 | Mammoth | 38 | July 15 to July 30 |

So far as tested here Lucretia is the only satisfactory dewberry. Austin Improved did not come up to our expectations this season. The berries were imperfect and sour.

## LIST OF RASPBERRIES RECEIVED IN 1897.

Bishop. From B. F. Smith, Lawrence, Kansas.
Cumberland. From D. Miller, Camp Hill, Pa.
Egyptian. From B. F. Smith, Lawrence, Kansas.
Great American. From J. L. Childs, Floral Park, N. Y.
Highland Hardy. From S. D. Willard, Geneva, N. Y.
Munger. From W. N. Scarff, New Carlisle, Ohio.
New Cardinal. From A. H. Griesa, Lawrence, Kansas.
Perpetual King. From C. J. More, Jamestown, N. Y.

## LIST OF BLACKBERRIES RECEIVED IN 1897.

Clark. From M. Crawford, Cuyahoga Falls, Ohio.
Rathbun. From Fred E. Young, Rochester, N. Y.

# VIII. RESULTS WITH OAT SMUT IN 1897.*

C. P. CLOSE.

## SUMMARY.

In the experiments conducted by the author in 1897 Ceres powder, lysol, formalin and potassium sulphide were compared with the Jensen hot water treatment for the prevention of oat smut.

Sprinkling the seed with a 1 per cent solution either of lysol or formalin entirely prevented smut. The seed which was sprinkled with solution of potassium sulphide varying in strength from 1 per cent to 5 per cent gave from 0.6 per cent to 1 per cent of smutted heads. Ceres powder used in the same strength was even less effective, as the seed treated with it gave from 1 per cent to 2.9 per cent of smutted heads.

In the experiments in soaking seed, the treatments which entirely prevented smut are: 0.3 per cent lysol, seed soaked 1 hour; 0.2 per cent formalin, seed soaked 1 hour; 2 per cent potassium sulphide, seed soaked 1.5 hours; and 4 per cent Ceres powder, seed soaked 0.5 hour.

The hot water treatment kept the crop wholly free from smut.

None of the above treatments injured the seed.

For sprinkling one bushel of seed one gallon of the solution is required. A gallon of 1 per cent solution of lysol costs 5 cents. The same amount of 1 per cent formalin solution will cost 4 cents.

In soaking a bushel of oats one hour about one and four-fifths gallons of solution will be absorbed. This amount of 0.3 per cent lysol solution will cost 2.7 cents, a like amount of 0.2 per cent formalin solution will cost 1.4 cents, of 2 per cent potassium sulphide 5.4 cents and of 4 per cent Ceres powder 39.6 cents.

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* Reprint of Bulletin No. 131.

Lysol sells for about 65 cents per pint; formalin for about 50 cents per pint; potassium sulphide for 18 cents per pound; and Ceres powder in bottles of 2.2 lbs for $1.50.

The Jensen hot water treatment consists in soaking the seed for a given time in water at a certain temperature, 133° for 10 minutes being usually recommended.

Sprinkling is done by applying the solution with a sprinkling pot and shoveling the pile over until all the seed is saturated.

Smut is a parasitic plant which grows inside of the stalks of oats. The black masses which appear in the heads of oats are the spores, or seeds, by which the smut is propagated.

Oats attacked by smut are usually dwarfed, and often weakened so much that many stalks never head out.

The following table shows cost per bushel of seed for chemicals in the least expensive successful treatments.

Cost of Chemicals for Prevention of Oat Smut.

| Material. | Sprinkling. | | Soaking. | | |
|---|---|---|---|---|---|
| | Strength of solution. | Cost per bushel. | Strength of solution. | Length of time. | Cost per bushel. |
| | Per cent. | Cents. | Per cent. | Hours. | Cents. |
| Lysol | 1 | 5 | 0.3 | 1 | 2.7 |
| Formalin | 1 | 4 | 0.2 | 1 | 1.4 |
| Potassium sulphide | ...... | ...... | 2. | 1.5 | 5.4 |
| Ceres powder | ...... | ...... | 4. | 0.5 | 39.6 |

The cost of material per acre for treating seed with the 0.2 per cent formalin solution is 3½ cents, allowing two and one-half bushels of seed per acre. Sprinkling with solutions of lysol or formalin weaker than 1 per cent was not tried, but they may prove effective in preventing smut.

## INTRODUCTION.

The results of some investigations in 1897 in treating seed oats for the prevention of smut are presented in this Bulletin.

The hot-water treatment, which originated with Prof. Jensen, is one of the most effective remedies for preventing oat smut, but since it involves heating the water and keeping it at a certain temperature for a given time, many have the idea that the operation is too complicated, therefore the remedy has not come into general use.

Soaking or sprinkling the seed with some solution may be considered a simpler process, and should it prove to be equally as effective, would probably become popular more rapidly than the hot-water treatment. Prof. Jensen has lately been advocating a remedy, Ceres powder, to be used in this way. This substance is reported as giving excellent results in some parts of Europe, and has received favorable mention in this country by Kellerman.* A bureau has been opened in Chicago to advertise Ceres powder and push its sale. Since this remedy is thus being brought to public notice in this country it was decided to test it here and to compare it with other remedies for oat smut. The other remedies which were tried were hot water, formalin, potassium sulphide and lysol.

So far as known to the writer, lysol has not before been used as a preventive of smut. In these experiments, as will be shown later, it has given excellent results. Formalin† and potassium sulphide† have been tried before with varying success, according to the strengths used.

In order to give the different remedies a thorough test, some of the treatments which were tried on the Station farm were duplicated on larger areas under different environment in another part of the State. The details of the work will accordingly be considered under two heads: (1) Experiments at the Station and (2) experiments at Trumansburg.

## EXPERIMENTS AT THE STATION.

A piece of ground that would give conditions as nearly uniform as possible was selected for this purpose. This was divided into plats twenty feet long, each of which contained three rows, one foot of space between the rows and one and one-half feet

* Report of Society for the Promotion of Agricultural Science, 1896; p. 64.

† Bolley, H. L., N. Dak. Exp. Sta. Bul. No. 27, Kellerman, W. A., Proceedings of the Society for the Promotion of Agricultural Science, 1896; Kellerman, W. A., Kan. Exp. Sta. Bul. No. 22; Wheeler, C. F., Mich. Institute Bul. No. 3; Year Book U. S. Dept. Agr., 1896, p. 259.

between the plats. Untreated plats were distributed so as to form checks for each series of from three to six treated plats. Four rows of untreated seed were sown at each end of the piece so as to make the conditions of light, etc., of the end plats as nearly like those of the center plats as possible.

### SEEDING OF PLATS.

Owing to heavy rains the seeding could not be done until May 22 to 26, three weeks after the seed was treated. An equal amount of seed was sown in each row. The seed oats used were selected because of the abundance of smut they contained. This fact gave assurance that the untreated seed used for checks would produce at least an average amount of smut which could be used as a basis of comparison for the treated plats.

### CHEMICALS USED AND KIND OF TREATMENT.

Plats were sown with seed which had been *sprinkled* with 1, 2, 3, 4, 5 and 6 per cent solutions of lysol, 1, 2 and 3 per cent solutions of formalin, and with 1, 2, 3, 4 and 5 per cent solutions of potassium sulphide and of Ceres powder. Other plats were seeded with oats which had been *soaked* for 1, 2 and 3 hours in solutions containing 1 part in 1,000 of lysol and of formalin, for 1 and 2 hours in 2 to 1,000 solutions and for 1 hour in solutions of these same substances containing 3, 4, 5 and 6 parts in 1,000; while the seed treated with potassium sulphide and Ceres powder was soaked for 0.5, 1 and 1.5 hours in solutions of these materials containing 20 and 40 parts in 1,000.

### GERMINATION, GROWTH AND PERCENTAGES OF SMUTTED HEADS.

No attempt was made to compare the yield of the different plats, because the seeding was done so late in the spring that the short growth and small heads were unsatisfactory for this purpose. The percentage of smutted heads was determined by counting the stalks. This was done at the time of harvesting, August 16 to 20. The different treatments, with their respective germinations of seed, growth of plants and percentages of smutted heads are given in the following table. The untreated plats are considered normal in germination and growth.

RESULTS OF TREATMENT OF SEED OATS BY SPRINKLING WITH FUNGICIDES.

| MATERIAL. | Strength of solution. | Smutted heads. | Remarks. |
|---|---|---|---|
| | Per cent. | Per cent. | |
| Lysol | 1 | 0 | Germination and growth normal. |
| Lysol | 2 | 0 | Germination and growth normal. |
| Lysol | 3 | 0 | About two-thirds of the seed grew; it was slow in germinating but the plants made a taller and more stocky growth, were very rusty, and much later in maturing than where the seed was treated with less lysol. |
| Lysol | 4 | 0 | Less than one-fourth of the seed grew and that gave plants like the next above. |
| Lysol | 5 | 0 | About one-twentieth of the seed grew. It gave plants like those in the 3 per cent treatment. |
| Lysol | 6 | 0 | Only a few seeds grew; the plants were like those in the 3 per cent treatment. |
| Untreated | ........ | 10 | |
| Formalin | 1 | 0 | Germination and growth normal. |
| Formalin | 2 | 0 | Very few seeds grew and two-thirds of these did not produce heads. |
| Formalin | 3 | 0 | Even fewer seeds grew than in the one next above and one-fourth of these did not produce heads. |
| Untreated | ........ | 8.7 | |
| Potassium sulphide | 1 | 0.7 | Germination and growth normal. |
| Potassium sulphide | 2 | 0.8 | Germination and growth normal. |
| Potassium sulphide | 3 | 0.9 | Germination and growth normal. |
| Potassium sulphide | 4 | 1.0 | Germination and growth normal. |
| Potassium sulphide | 5 | 0.6 | Germination and growth normal. |
| Untreated | ........ | 6.4 | |
| Ceres powder | 1 | 2.9 | Germination and growth normal. |
| Ceres powder | 2 | 1.5 | Germination and growth normal. |
| Ceres powder | 3 | 2.7 | Germination and growth normal. |
| Ceres powder | 4 | 1.0 | Germination and growth normal. |
| Ceres powder | 5 | 1.3 | Germination and growth normal. |
| Untreated | ........ | 6.4 | Germination and growth normal. |

RESULTS OF TREATMENT OF SEED OATS BY SOAKING IN FUNGICIDES.

| MATERIAL. | Strength of solution. | Length of time. | Smutted heads. | Remarks. |
|---|---|---|---|---|
| | *Parts in 1000.* | *Hours.* | *Per cent.* | |
| Lysol | 1 | 1 | 3.7 | Germination and growth normal. |
| Lysol | 2 | 1 | 1.3 | Germination and growth normal. |
| Lysol | 3 | 1 | 0 | Germination and growth normal. |
| Lysol | 4 | 1 | 0 | Germination and growth normal. |
| Lysol | 5 | 1 | 0 | Germination and growth normal. |
| Lysol | 6 | 1 | 0 | Germination and growth normal. |
| Untreated | ........ | ...... | 8 | |
| Lysol | 1 | 2 | 5.3 | Germination and growth normal. |
| Lysol | 1 | 3 | 3.3 | Germination and growth normal. |
| Lysol | 2 | 2 | 0.7 | Germination and growth normal. |
| Formalin | 1 | 2 | 0.3 | Germination and growth normal. |
| Formalin | 1 | 3 | 0.3 | Germination and growth normal. |
| Formalin | 2 | 2 | 0 | Germination and growth normal. |
| Untreated | ........ | ...... | 4.7 | Germination and growth normal. |
| Formalin | 1 | 1 | 0.2 | Germination and growth normal. |
| Formalin | 2 | 1 | 0 | Germination and growth normal. |
| Formalin | 3 | 1 | 0 | Germination and growth normal. |
| Formalin | 4 | 1 | 0 | Germination and growth normal. |
| Formalin | 5 | 1 | 0 | Germination and growth normal. |
| Formalin | 6 | 1 | 0 | Germination and growth normal. |
| Untreated | ........ | ...... | 5.4 | |
| Potassium sulphide* | 20 | 0.5 | 0.1 | About 25 per cent of seed failed to grow; plants made normal growth. |
| Potassium sulphide | 20 | 1.5 | 0 | Germination and growth normal. |
| Potassium sulphide | 40 | 0.5 | 0 | Germination and growth normal. |
| Potassium sulphide | 40 | 1 | 0 | Germination and growth normal. |
| Potassium sulphide | 40 | 1.5 | 0 | Germination and growth normal. |
| Untreated | ........ | ...... | 1.5 | |
| Ceres powder | 20 | 0.5 | 0.5 | About 20 per cent of seed failed to grow; plants made normal growth. |
| Ceres powder | 20 | 1 | 0.4 | About 20 per cent of seed failed to grow; plants made normal growth |
| Ceres powder | 20 | 1.5 | 0.2 | Germination and growth normal. |
| Untreated | ........ | ...... | 1.5 | Germination and growth normal. |
| Ceres powder | 40 | 0.5 | 0 | Germination and growth normal. |
| Ceres powder | 40 | 1 | 0 | Germination and growth normal. |
| Ceres powder | 40 | 1.5 | 0.1 | Germination and growth normal. |
| Untreated | ........ | ...... | 8.7 | |

*Record for plat from seed soaked one hour in potassium sulphide was lost.

WHAT THE ABOVE RESULTS SHOW.

*With lysol.*—The 1 per cent and 2 per cent solutions sprinkled did not injure the seed and entirely prevented smut. The 3 per cent solution sprinkled injured the seed so that one-third of it did not germinate, while the plants from the other two-thirds were stocky, very late in maturing and very rusty. Solutions stronger than 3 per cent injured the seed more in proportion to their increased strengths.

Soaking the seed for 1 hour with from 3 to 6 parts per 1,000 prevented the growth of smut, while untreated seed gave 8 to 10 per cent of smutted heads. When the seed was soaked in weaker solution, the smutted heads varied from 0.7 per cent to 5.3 per cent. None of the seed soaked in lysol solutions was injured.

*With formalin.*—The 1 per cent solution sprinkled on the seed was effective and did not injure the seed. The 2 per cent solution, sprinkled, killed about 95 per cent of the seed and the 3 per cent solution sprinkled killed even more than this. Two to six parts per 1,000 on seed soaked one hour, and 2 parts per 1,000 on seed soaked two hours killed all smut spores without injuring the seed. Weaker solutions gave from 0.3 per cent to 0.7 per cent of smut, while untreated seed gave from 4.7 per cent to 8.7 per cent of smut.

*With potassium sulphide.*—Seed sprinkled with from 1 per cent to 5 per cent solution was not injured, but gave from 0.6 per cent to 1 per cent of smut, while the untreated seed gave 6.4 per cent. That soaked in a 2 per cent solution for 1.5 hours and in the 4 per cent solution from 0.5 to 1.5 hours prevented smut and caused no injury to the seed.

*With Ceres powder.*—Seed treated by sprinkling with from 1 per cent to 5 per cent solutions gave from 1 per cent to 2.9 per cent of smutted heads, but was not injured; the untreated seed gave 6.4 per cent of smut. The 2 per cent treatments soaking 0.5 hour and 1 hour injured the seed about 20 per cent and gave 0.5 per cent, or less, of smutted heads. The seed soaked in a 2 per cent solution 1.5 hours gave 0.2 per cent smut; that soaked in a 4 per cent solution 1.5 hours gave 0.1 per cent and was not injured. The 4 per cent treatments, where seed was soaked 0.5 hour and 1 hour, prevented smut without injuring the seed.

## EXPERIMENTS AT TRUMANSBURG.

Since the experiments at the Station were of necessity conducted on small plats, it was deemed advisable to duplicate a few of them on a larger scale in a locality where the oat smut was abundant the previous season. Accordingly, arrangements were made with Messrs. King & Robinson, Trumansburg, Tompkins county, by which a plat of two-sevenths of an acre was used for each different treatment.

On April 13 the seed was treated by sprinkling in lots of one bushel as follows:

STRENGTH OF FUNGICIDE SPRINKLED ON OATS.

| Material. | Strength of solution. Per cent. |
|---|---|
| Ceres powder * | 0.78 |
| Potassium sulphide | 5 |
| Potassium sulphide | 3 |
| Formalin | 5 |
| Formalin | 3 |

### METHOD OF TREATMENT.

The oats were placed on the barn floor in piles of one bushel each. The necessary amount of each chemical was put in one gallon of water and was applied with a sprinkling pot. By spreading the pile somewhat and alternately sprinkling and turning the oats, each bushel was thoroughly saturated and absorbed practically the whole gallon of the mixture. To dry them the piles were spread and shoveled over occasionally for two or three days.

### SEEDING AND GROWTH.

The seed was drilled in April 21 at the rate of two and one-fourth bushels per acre. Three check or untreated plats were sown for the five treated plats. The seed treated with Ceres

* This strength is at the rate of one ounce in one gallon of water, practically as per directions of the manufacturers of Ceres powder, who recommended one ounce of the powder in one gallon of water sprinkled on 33⅓ pounds of seed.

powder and potassium sulphide germinated as well and made as good growth as the untreated seed did. The experiment with formalin was short and decisive. None of the seed germinated, thus proving that the 5 per cent and 3 per cent solutions were fatal to the seed. As soon as it was certain that this seed would not grow, another bushel was given the hot-water treatment and the plat seeded May 4, at the same rate per acre as before. This made a fairly good growth, but rusted badly, due, no doubt, to late sowing. At the time of harvesting, August 3, the grain of all the plats was flat upon the ground, having been broken down by heavy rain and wind storms. The yields were undoubtedly reduced a little by this condition, since lodged grain is difficult to harvest, but as all of the plats were in the same condition the yields are comparable.

### PERCENTAGE OF SMUT AND YIELD OF PLATS.

The percentage of smutted heads was obtained by selecting representative parts of each plat and counting the stalks.

TREATMENT, PERCENTAGE OF SMUT AND YIELD PER ACRE OF OATS.

| MATERIAL. | Strength of solution sprinkled. | Smutted heads. | Yield. |
|---|---|---|---|
| | Per cent. | Per cent. | Bushels. |
| Ceres powder | 0.78 | 6.3 | 59.72 |
| Potassium sulphide | 5.0 | 0.85 | 57.64 |
| Potassium sulphide | 3.0 | 1.4 | 54.36 |
| Hot water | .............. | 0 | 54.58 |
| Untreated | .............. | 11.8 | 54.36 |

That the hot-water treatment did not give a larger yield is undoubtedly due to late sowing and to the rusting of the plants.

### COMPARISON OF RESULTS.

At Trumansburg the seed sprinkled with a 0.78 per cent Ceres powder solution gave 6.3 per cent of smutted heads. The only experiment at the Station to compare with this is where seed was sprinkled with a 1 per cent solution and gave 2.9 per cent of smut. Seed sprinkled with a 5 per cent potassium sulphide solution at Trumansburg gave 0.85 per cent of smut, while at the Station seed treated with the 5 per cent solution gave 0.6 per cent. With the 3 per cent potassium sulphide solution the result at Trumansburg is 1.4 per cent and at the Station 0.9 per cent of smutted heads. These results show a slight difference in favor of the work done at the Station. There was also less smut on the untreated plats at the Station, 10 per cent being the highest. At Trumansburg the untreated plats gave 11.8 per cent of smutted heads.

## COST OF MATERIALS.

*Lysol.*—This material can be purchased in small quantities for about 65 cents per pound, or pint. In carboy lots it sells for about 30 cents per pound.

The 1 per cent treatment, sprinkled, will cost about 5 cents per bushel of seed.

In soaking the seed in a solution of 1 part in 1,000 the cost is 0.5 cent per gallon of the solution.

*Formalin.*—Formalin and the "40 per cent Solution of Formaldehyde Gas" are exactly the same material, but in purchasing it is well to ask for the latter, because it is quoted much lower in price than formalin.* The 40 per cent solution of formaldehyde gas sells for about 50 cents per pound, or pint, in small lots, and in carboy lots for about 30 cents per pound. The material for one gallon of the 1 per cent solution costs 4 cents. A gallon of the solution 1 part in 1,000 costs 0.4 cent.

*Potassium sulphide* may be obtained for about 18 cents per pound. A gallon of 1 per cent solution will cost a trifle less than 1.5 cents. The same amount of solution 1 part in 1,000 will cost less than 0.2 cent.

*Ceres powder* is put up in bottles holding one kilogram or 2.2 pounds. A single bottle sells for $1.50 and a lot of ten for $10. The rate per ounce for single bottle is about 4.25 cents. This is sufficient for one gallon of the solution necessary for sprinkling one bushel of seed as advocated by the manufacturers. A gallon of the 1 per cent solution requires 1.28 ounces and costs nearly 5.5 cents.

* De Schweinitz, E. A., Year Book U. S. Dept. Agr., 1896, p. 262.

The cost of material for the least expensive treatments which entirely prevented the smut is herewith given:

COST OF FUNGICIDES FOR PREVENTION OF OAT SMUT.

| MATERIAL. | SPRINKLING. | | SOAKING. | | |
|---|---|---|---|---|---|
| | Strength of solution. | Cost per bushel. | Strength of solution. | Length of time. | Cost per bushel. |
| | Per cent. | Cents. | Per cent. | Hours. | Cents. |
| Lysol | 1 | 5 | 0.3 | 1 | 2.7 |
| Formalin | 1 | 4 | 0.2 | 1 | 1.4 |
| Potassium sulphide | ---------- | ---------- | 2 | 1.5 | 5.4 |
| Ceres powder | ---------- | ---------- | 4 | 0.5 | 39.6 |

## HOT WATER TREATMENT.

This treatment is really a very simple operation, but something about the thought of doing it seems formidable to many persons, and they hesitate to try it. The Station has recommended the following plan as easy, cheap and practical. Heat the water in a large kettle and near the kettle sink a barrel in the ground so the top will be a foot or more above the surface. Pour part of the hot water into the barrel and take the temperature with a good thermometer—be sure to have a *good* one—and add either cold or hot water until a temperature of 138° is reached. The dipping is done by putting about a bushel of oats in a course gunny sack, tying this to one end of a pole and resting the pole over a post, thus making a lever, by which the sack of oats may be raised or lowered very easily. When the oats are dipped into the water at 138° the temperature is immediately lowered and hot water must be added at once to keep the temperature about 133°. Keep the seed moving all the time and take out at the end of ten minutes. Spread the oats on a barn floor or other convenient place and shovel them over three times a day for a few days; then they may be sown with a force drill; or, when they are taken out of the hot water, pour cold water over them, spread them out to drain, and in two or three hours they may be sown broadcast. As the oats absorb considerable water it is necessary to sow about half a bushel* more per acre than when untreated seed is used. This is on the basis of two and one-half bushels per acre. Two men in one day can treat enough seed to sow twenty acres.*

## NOTES ON SMUT.

### What Is It?

The so-called smut is a parasitic plant, that is, a plant which feeds upon some other plant as a host, and grows upon, or inside of it. It comes from a spore, which is comparable to a seed in the higher plants, grows and produces fruit, with which to perpetuate itself much the same as any other plant. The black masses of smut so noticeable when the grain is ripening consist of countless numbers of minute ripened spores, the fruit of the parasitic plant. These spores are often blown from the oat-head as soon as they ripen, thus leaving a naked stalk, but more often, perhaps, they remain in black disagreeable masses.

### How the Smut Plant Grows.

Since the smut spores are microscopic in size a large number may be attached to the kernels without being noticed. In this way they are unavoidably sown with the oats in the spring. While the oats are germinating and growing the smut spores are doing the same thing, only in a little different way. Each germinating spore sends out a minute tube which penetrates the little oat plant when it is perhaps from two to four days old. After entering the oat plant the minute tube develops into branching threads, which grow up within the plant. There is no evidence of their presence until the heads are forming, but at this time the kernels of oats are filled with these branching threads which rob them of their nourishment and ripen myrids of new spores. Thus, what should have been a head of oats turns out to be a worse than worthless mass of dusty spores. It sometimes happens that only a part of the head or panicle is thus affected and the stalks from each stool may or may not all be attacked by the parasite.

*Holden, P. G., Mich. Exp. Station Bul. 87.

## GROWTH OF SMUTTED OAT-PLANTS.

Since the smut parasite robs its host, the growing oat-plant, of much nourishment, the latter is naturally much weakened, and only a part of the smutted plants attain the average height of healthy ones. The others are dwarfed more or less and often to such an extent that they grow only a few inches high. A large number of diseased plants, especially those much dwarfed, are so weakened that they cannot push their panicles, or heads, out of the sheath of the upper leaf. Upon opening these closed heads they are found to be full of smut masses. Thus it is that the casual observer sees only the high smut and concludes that the crop is only slightly smutted.

## INFECTION OF SEED OATS BY SMUT SPORES.

The seed is infected in several ways. Many of the spores ripen before the oats do, are blown about by the wind and become lodged on the ripening grain. In case the smut ripens early while some of the oats are still in bloom the spores are liable to become attached to the growing ovaries of the grain in such a position that the glume or husk of the individual oat kernels envelopes the spores, thus making it difficult to destroy them. The wholesale agent of infection is the threshing machine, and the crop from a field practically free from smut is liable to become infected by spores carried in the machine from an infected neighboring field. Then the use of sacks, grain bins, etc., that have held smutted grain helps to distribute the smut spores.

# IX. SPRAYING IN 1897 TO PREVENT GOOSEBERRY MILDEW.*

C. P. CLOSE.

## SUMMARY.

For ten years this Station has advocated potassium sulphide as the best remedy for gooseberry mildew.

In the season of 1897 potassium sulphide, Bordeaux mixture, lysol and formalin were tested side by side.

The plantation was divided into six sections. In two of these the spraying was begun very early, just as the buds were breaking; in two others eleven days latter; and in the remaining two sections twelve days after the preceding two sections.

The first mildew appeared May 26. By June 7 portions of the plantation were badly mildewed. At this date the lysol and formalin seemed to have done no good. Bordeaux mixture was more effective, but not so good as potassium sulphide where the treatments were begun very early and medium early.

All of the fruit was picked July 6 and 7 so as to market it green. Bushes sprayed very early with potassium sulphide at the rate of 1 oz. to 3 gals. of water gave only 5 per cent of mildewed fruit; those sprayed very early with it at the rate of 1 oz. to 2 gals. of water gave 6.6 per cent. Bushes sprayed very early with lysol, 1 oz. to 1 gal. of water, gave 24.5 per cent and those sprayed very early with Bordeaux mixture gave 37.4 per cent of mildewed fruit, while the untreated bushels gave 57.7 per cent to 78.7 per cent.

The foliage was not injured by any of the fungicides.

At 18 cents per pound for potassium sulphide, the cost of the solution which gave the best results is about one-fifth of one cent per bush for the seven sprayings.

*Reprint of Bulletin No. 133.

The Station recommends potassium sulphide, 1 oz. to 3 gals. or 1 oz. to 2 gals. of water, as the most effective fungicide for gooseberry mildew.

As a rule only the English varieties and their seedlings are attacked by mildew although the American varieties are not always exempt.

## INTRODUCTION.

Potassium sulphide was first used as a remedy for the powdery mildews in Europe about 1884. In 1886 it was used to a very limited extent in this country. In the following year, 1887, this Station* made the first practical test of the efficiency of potassium sulphide in combating gooseberry mildew, and although the material was not applied until the mildew was well established, the results showed that there was a beneficial effect from its use. Since then its efficiency has been proven by successive tests† and it has been recommended by the Station as the best remedy for holding mildew in check.

After Bordeaux mixture came into general use some authorities‡ advocated it as a substitute for potassium sulphide early in the season, but so far as known to the writer, these recommendations were not based on comparative tests of the two fungicides. The only record of such a comparison which he finds is that of an undecisive test made at this Station in 1892. Accordingly, in 1897, experiments were planned so as to compare them side by side. For comparison with Bordeaux mixture and potassium sulphide two other fungicides, lysol and formalin, were tried. So far as the writer has been able to find out, lysol and formalin have never before been used for this purpose.

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*Arthur. Sulphide of Potassium as a Fungicide. N. Y. Agl. Exp. Sta. Rept. 1887, pp. 348-350.

†Goff. Potassium Sulphide for Gooseberry Mildew. N. Y. Agl. Exp. Sta. Rept. 1888, pp. 153-154. Hunn. Gooseberries. N. Y. Agl. Exp. Sta. Rept. 1889, p. 334; 1890, p. 307; 1891, p. 474. Beach and Paddock. Gooseberry Mildew. N. Y. Agl. Exp. Sta. Rept. 1895, p. 354.

‡Lodeman. The Spraying of Plants, p. 292; and Spray Calendars, Cornell Univ. Agl. Exp. Sta., Feb., 1895, and Feb., 1896. Taft. Spray Calendar, Mich. Agl. Exp. Sta., Apr., 1894; Green, Selby and Webster. Spray Calendar, Supplement to Ohio Agl. Exp. Sta., Bul. 79. Spray Calendar, Md. Agl. Exp. Sta., Apr., 1896. Spray Calendar, Del. Agl. Exp. Sta., Apr., 1895. Craig [Canadian] Exptl. Farms Rept. 1895.

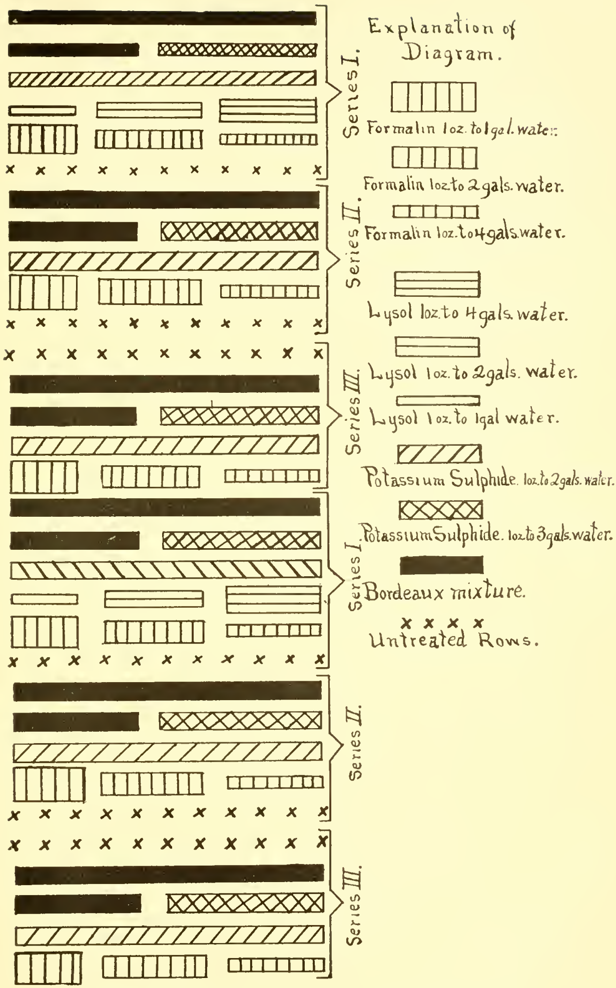


DIAGRAM 1.—GOOSEBERRY PLATS FOR MILDEW TREATMENT.

## OBJECT AND PLAN OF THE EXPERIMENT.

### OBJECT.

The object of the experiment was to compare sprayings begun very early with those begun medium early and late. Bordeaux mixture and different strengths of formalin and lysol were also to be compared with different strengths of potassium sulphide.

### PLAN OF EXPERIMENT.

The Industry plantation of King & Robinson, Trumansburg, N. Y., was used for the experiments. It consisted of 32 rows with 11 plants to the row. As shown by the diagram opposite, the plantation was divided into six plats. Each treatment was applied to two plats separated by plats receiving different applications. This arrangement was for the purpose of equalizing for each remedy the differences in soil and location which might exist in different parts of the plantation.

For convenience in comparing the effects of very early with medium and late spraying, three series of treatments were made. Series I was begun very early, April 12, just as the buds were breaking and successive applications were made at intervals of about ten days until seven had been given. Series II was begun April 23 when the second treatment of Series I was made. The first treatment of Series III was applied May 5 when the third treatment of Series I and the second treatment of Series II were given. During the remainder of the season the dates of treatment were the same for all applications. An untreated row was left as a check for each series.

### MATERIALS USED.

Bordeaux mixture, 1-to-11 formula, was used upon one set of bushes in each series until the fruit was large enough so that spotting with the mixture would injure its sale; then potassium sulphide, 1 oz. to 2 gals. of water, was substituted for the remainder of the season.

Potassium sulphide was used in two strengths, 1 oz. to 2 gals. of water and 1 oz. to 3 gals. of water.

Lysol and formalin were each used in three strengths, 1 oz. to 1 gal. of water, 1 oz. to 2 gals. and 1 oz. to 4 gals. These strengths were settled upon arbitrarily for trial since there were no previous experiments which might be followed as a guide.

The foliage was not injured by any of the solutions.

### Method of Application.

The first spraying was given with a knapsack sprayer, but this was inconvenient, especially where so many different solutions were used and the sprayer had to be washed out after each solution was applied. After the first application a bucket pump made by the Deming Co., Salem, Ohio, was tried and gave good satisfaction. With a seven-foot hose all parts of the plant could be readily reached.

### Division of Series and Dates of Spraying.

The table opposite shows upon which rows the different strengths of fungicides were applied and gives the dates of application. The division into series is shown in the diagram opposite page 309.

## RESULTS.

### Development of Mildew.

The plantation was closely watched for the first appearance of mildew and at the fifth spraying, May 26, a little was found on the fruit, especially on the untreated rows. On the treated rows there was a very slight difference in favor of the potassium sulphide treatments. All of the bushes had made a good, healthy growth and nearly all were loaded with fruit. At this time the berries were so large that potassium sulphide, 1 oz. to 2 gals. of water, was substituted for all Bordeaux mixture treatments so as to avoid having spotted fruits at the marketing season.

At the time of the sixth spraying, June 7, the entire plantation was examined to find out which treatments seemed to be most effective. During the few days previous to this date the disease appeared on the young leaves; and in the amount of mildew on the foliage there seemed to be no difference between the treated and untreated bushes. The fruit on the untreated bushes was

TABLE I. DIVISION OF SERIES AND DATES OF SPRAYING.

| BORDEAUX MIXTURE. | POTASSIUM SULPHIDE | | LYSOL. | | | FORMALIN. | | |
|---|---|---|---|---|---|---|---|---|
| 1 to 11 formula.* | 1 oz. to 3 gals. | 1 oz. to 2 gals. | 1 oz. to 1 gal. | 1 oz. to 2 gals. | 1 oz. to 4 gals | 1 oz. to 1 gal. | 1 oz. to 2 gals. | 1 oz. to 4 gals. |
| *Series I. Very Early Treatment. Applications April* 12, 23, *May* 5, 17, 26, *June* 7, 21. | | | | | | | | |
| Row 1, and 5 bushes of row 2........... | Last 6 bushes of 2 | Rows 3, 19 | Bushes 1–3, row 4 | Bushes 4–7, row 4 | Bushes 8–11, row 4 | Bushes 1–3, row 5 | Bushes 4–7, row 5 | Bushes 8–11, row 5 |
| Row 17, and 5 bushes of row 18........... | Last 6 bushes of 18 | | 1–3, row 20 | 4–7, row 20 | 8–11, row 20 | 1–3, row 21 | 4–7, row 21 | 8–11, row 21 |
| *Series II. Medium Early Treatment. Applications April* 23, *May* 5, 17, 26, *June* 7, 21. | | | | | | | | |
| Row 7, and 5 bushes of row 8........... | Last 6 bushes of 8 | Rows 9, 25 | | | | Bushes 1–3, row 10 | Bushes 4–7, row 10 | Bushes 8–11, row 10 |
| Row 23, and 5 bushes of row 24........... | Last 6 bushes of 24 | | | | | 1–3, row 26 | 4–7, row 26 | 8–11, row 26 |
| *Series III. Late Treatment. Applications May* 5, 17, 26, *June* 7, 21. | | | | | | | | |
| Row 13, and 5 bushes of row 14........... | Last 6 bushes of 14 | Rows 15, 31 | | | | Bushes 1–3, row 16 | Bushes 4–7, row 16 | Bushes 8–11, row 16 |
| Row 29, and 5 bushes of row 30........... | Last 6 bushes of 30 | | | | | 1–3, row 32 | 4–7, row 32 | 8–11, row 32 |

* Last three treatments in each series potassium sulphide, 1 oz. to 2 gals. water.

NOTE.—There were six check rows, numbers 6, 11, 12, 22, 27 and 28.

very badly mildewed. The treatments with lysol and formalin in some instances seemed to have slightly checked the mildew on the fruit. The combined treatment of Bordeaux mixture and potassium sulphide had checked the disease, but the most favorable results appeared where the potassium sulphide had been used for very early and medium early treatments.

## PICKING THE FRUIT.

The last spraying was made June 21. Messrs. King & Robinson wished to market the fruit green, so on July 6 and 7 it was picked. The mildewed fruit and perfect fruit were weighed separately for each different treatment. In order to have an accurate basis of comparison the yields are figured so as to give the average per plant in each experiment. The results are so arranged in the following table that the reader can easily compare the same remedies in the different series. It must be borne in mind that Series I received seven sprayings beginning April 12, Series II received six sprayings beginning April 23, and Series III received five sprayings beginning May 5.

TABLE II.— AVERAGE YIELD AND PERCENTAGE OF MILDEW PER BUSH FOR EACH TREATMENT.

| FUNGICIDE. | Series 1. Spraying begun very early. Seven applications. | | | Series 2. Spraying begun medium early. Six applications. | | | Series 3. Spraying begun late. Five applications. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average yield per bush. | | Mildewed fruit. | Average yield per bush. | | Mildewed fruit. | Average yield per bush. | | Mildewed fruit. |
| | Free. | Mildewed. | | Free. | Mildewed. | | Free. | Mildewed. | |
| | Ozs. | Ozs. | Per ct. | Ozs. | Ozs. | Per ct. | Ozs. | Ozs. | Per ct. |
| Bordeaux mixture:* | | | | | | | | | |
| 1 to 11 formula | 26.2 | 15.7 | 37.4 | 34.8 | 14.3 | 29.1 | 18.1 | 25 | 58 |
| Potassium sulphide: | | | | | | | | | |
| 1 oz. to 3 gallons water | 76.8 | 4 | 5 | 45.3 | 8 | 15.1 | 70 | 10.5 | 13 |
| 1 oz. to 2 gallons water | 56.2 | 4 | 6.6 | 42.6 | 6 | 12.3 | 38 5 | 5 | 11 5 |
| Formalin: | | | | | | | | | |
| 1 oz. to 1 gallon water | 21 | 20 | 48.8 | 3.5 | 12.6 | 78.3 | 22 | 28 | 56 |
| 1 oz. to 2 gallons water | 17 | 24.5 | 59.1 | 9 | 50 | 84.7 | 10 | 25 | 71.4 |
| 1 oz. to 4 gallons water | 28.4 | 31 5 | 52 6 | 21 | 39 | 65 | 17.6 | 41 8 | 70.4 |
| Checks | 19.4 | 26.5 | 57.7 | 9 | 33.2 | 78.7 | 9 | 33.2 | 78.7 |
| Lysol: | | | | | | | | | |
| 1 oz. to 1 gallon water | 37 | 12 | 24 5 | | | | | | |
| 1 oz. to 2 gallons water | 19 | 25 | 56 8 | | | | | | |
| 1 oz. to 4 gallons water | 44 | 26 | 37.1 | | | | | | |
| Check | 19.4 | 26.5 | 57.7 | | | | | | |

* Last three treatments in each series potassium sulphide, 1 oz. to 2 gals. water.

From a study of Table II we see that, with the exception of Bordeaux mixture, the very early treatments gave the best results. Where the treatment with potassium sulphide, 1 oz. to 3 gals. water, was begun very early only 5 per cent of the fruit mildewed. Where it was begun medium early there was three times as much mildewed fruit, while in the treatment begun late there was a little more than two and one-half times as much. The bushes treated very early with potassium sulphide, 1 oz. to 2 gals. water, yielded 6.6 per cent of mildewed fruit and those where the treatments was begun medium early and late gave nearly twice as much.

Lysol ranks next to potassium sulphide in effectiveness. It was used in Series I only and the bushes treated with 1 oz. to 1 gal. water gave 24.5 per cent of mildewed fruit; bushes treated with the weaker strengths gave 56.8 per cent and 37.1 per cent respectively of mildewed fruit.

The best result with Bordeaux mixture was where the sprayings were begun medium early and 29.1 per cent of the fruit mildewed. With the very early treatment 37.4 per cent of the fruit mildewed and where spraying was begun late 58 per cent of the fruit mildewed.

Formalin seemed to have little if any effect in checking the mildew. The bushes in Series I treated with 1 oz. to 1 gal. of water gave 48.8 per cent of mildewed fruit. The amount of mildewed fruit in the other experiments with formalin varied from 52.6 per cent to 78.3 per cent, while the largest amount from the untreated bushes was 78.7 per cent.

The average cost of the various fungicides is given in the table below.

Table III.—Average Cost of Fungicides.

| Fungicide. | Per pound. | For One Gallon of Solution. | | | |
|---|---|---|---|---|---|
| | | 1 oz. to 1 gallon water. | 1 oz. to 2 gallons water. | 1 oz. to 3 gallons water. | 1 to 11 formula. |
| | Cents. | Cents. | Cents. | Cents. | Cents. |
| Lysol | 65 | 4.06 | 2.03 | ...... | ...... |
| Formalin | 50 | 3.125 | 1.56 | ...... | ...... |
| Potassium sulphide | 18 | ...... | 0.54 | 0.375 | ...... |
| Bordeaux mixture | ...... | ...... | ...... | ...... | 0.5 |

By formalin as used in this article is meant the 40 per cent solution of formaldehyde gas. When purchasing, it is well to ask for the 40 per cent solution of formaldehyde gas as it is quoted much lower than the same material under the name of formalin.*

## RECOMMENDATION.

For holding the gooseberry mildew in check the Station recommends potassium sulphide as the most effective remedy. It may be applied at the rate of 1 oz. to 2 or 3 gals. of water beginning *very early* in the season, just as the buds are breaking, and repeating about every ten days, depending, of course, upon the condition of the weather.

## GENERAL APPEARANCE OF MILDEW.

The mildew is a parasitic plant, or fungus, which appears on the surface of the fruit and young shoots. When first noticed it is composed of glistening, white threads which give it a frost-like appearance. As the fungus develops the threads become more numerous and matted, lose their glistening color and finally become a mass of brownish felt-like substance. It has now completed its growth and ripened its winter spores and can usually be peeled off the berries without rupturing the skin.

If the attack is severe the tender young leaves and shoots will be seriously injured, if not killed, and the growth checked. The growth of the berries will also be checked and they are likely to be misshapen and even to crack open thus letting in the germs of decay.

The spores by which the fungus is reproduced correspond to the seeds in higher plants but are very much simpler in construction. There are two kinds of spores, the summer spores and the winter spores. The summer spores (conidia) are formed on vertical branches of the glistening white threads which make up the fungus. As the vertical branch grows in length a partition appears near the upper end. This partition soon cuts off all connection with the lower part of the branch and the upper part

*De Schweinitz, E. A., Year Book U. S. Dept. of Agr., 1896, p. 262.

develops into a spore. While this spore is developing at the tip the branch is growing longer and the formation of new spores is begun in the same way lower down. As soon as the tip spore ripens it drops off, and as the branch is continually growing and forming new spores, there is a succession of ripe spores scattered broadcast to spread the disease. When these spores alight on the leaves or fruit with proper conditions of moisture and temperature present, growth immediately takes place; and since thousands of these spores are formed daily the disease is spread very rapidly.

The fertilization and development of the winter spores correspond to the fertilization and development of seeds of higher plants but are quite different and usually take place late in the season of growth of the fungus. In certain instances where two threads come near to or cross each other an enlargement or cell forms on each, one partaking of the functions of the male organs and the other of the female organs of a flower. At a certain stage of the development protoplasm passes from the male cell to the female cell and the latter is thus fertilized. Growth immediately begins and by the time the fungus assumes a brownish color black specks may be seen upon it; these specks are the winter spore cases (perithecia). Within the dark covering of the winter spore case will be found an inner spore case (ascus) which contains eight of the winter spores. In this double covering of spore cases the winter spores live over winter. By spring the cases break open and the spores escape. They are blown about by the wind and when they reach the leaves or fruit of the gooseberry bush under favorable conditions growth takes place and the pest is started for the season.

As a rule only the English varieties and their seedlings are attacked by mildew, although the American varieties are not always exempt. A comparison of the susceptibility to mildew of the English varieties as grown at this Station is given in Bulletin No. 114.

# X. WOOD ASHES AND APPLE SCAB.*

S. A. BEACH.

## SUMMARY.

In an experiment including 124 trees in full bearing and continued for five years, liberal applications of hard-wood ashes did not increase the immunity of apples from the scab. With few exceptions, the varieties on treated sections yielded larger percentages of scabbed fruit than those on untreated sections.

On the treated sections of the orchard the foliage in many cases was improved, but it cannot be said that the improvement was due to increased immunity from the scab.

Where the ashes were used, the color of the fruit was much improved in some seasons with some varieties, but in a season which favored the perfect development of the fruit none of the varieties showed any improvement in color as compared with the same varieties on untreated sections.

Apparently the use of ashes had a general tendency to hasten the perfect development of the fruit. When the season was not especially favorable to the perfect development of the fruit, it improved the keeping quality, but in a season very favorable to the perfect development of the fruit the ripening processes were generally carried so far where the ashes were used that the apples did not keep so well as where no ashes were used.

The yield, except with the Baldwins, was greater on the treated sections; but the data are not such as make it safe to draw definite conclusions as to the effect of the use of ashes on the yield.

Decided differences were shown between varieties as to the ability to resist scab, and preliminary investigations indicate that this difference in resistant power is correlated with structural peculiarities.

*Reprint of Bulletin No. 140.

## INTRODUCTION.

The apple stands first in importance among the cultivated fruits of New York. Within the borders of this State no other fruit is so largely grown for home use and none equals it in commercial importance. It is more or less subject to injury both in foliage and fruit by a disease commonly known as the scab*, which is caused by a parasitic fungus, *Fusicladium dendriticum* (Wallr.) Fckl. Some kinds of apples are usually quite subject to injury from the scab while others generally suffer but slightly from its attacks. Among the varieties which are naturally susceptible to the disease are Fameuse or Snow, Fall Pippin, Primate and White Winter Pearmain. Among those which are resistant to the disease in a marked degree are Ben Davis, Black Gilliflower, Grimes Golden, Hubbardston, Maiden Blush, Talman and Yellow Transparent. It is certain that local conditions influence the spread of the disease because the same variety is injured more by it in some localities than in others. Moist locations offer conditions which favor its development.

It is well known that the amount of injury from the scab varies with the season. Continued dark, wet, cool weather at blooming time and immediately thereafter favors the growth and spread of the fungus and may bring about such an outbreak of the scab as to cause the destruction of large numbers of forming fruits, thus greatly diminishing the crop. Under such conditions of light, moisture and temperature the young foliage and fruit are abnormally developed and become unusually susceptible to the attacks of the fungus, while these very conditions favor, or at least are not unfavorable, to the healthy growth of the fungus.

From what has been said in the preceding paragraphs it appears that the amount of injury which is caused by the scab fungus

*This disease, as it occurs on the fruit, is so well known that it is unnecessary to give an extended description of it here. In very severe attacks it forms great brown patches which crack open, disfigure the fruit and render it unfit for market. The injured spots vary in size from such as these down to minute dots which easily pass unnoticed. On the leaves the fungus forms olive-brown patches varying in size as on the fruit. The spots occur on either the upper or under surface and often cause the leaf to become crumpled. The diseased tissue may finally crack and fall away, thus giving the leaves a ragged appearance.

varies according to the natural susceptibility of the variety to its attacks; that with any given variety it varies in different localities and in different seasons, and that the conditions of light, temperature and moisture, especially when the fruit it setting, have much to do with the prevalence of the disease.

So far as known to the writer, it has never been shown that the composition of the soil influences in any perceptible degree the susceptibility of the foliage and fruit to attack of the scab except as it affects the amount of moisture. Whether the ability of the foliage and fruit to resist the scab may be increased by the application of a certain class of fertilizers to the soil, or whether by the use of certain other kinds of fertilizers the liability to injury from this disease may be increased, are questions which have perplexed the minds of thoughtful fruit growers. Joseph Harris brought up this question in a paper on fertilizers at the 1891 meeting of the Western New York Horticultural Society.* He said: "I cannot but think that anything calculated to increase the growth, vigor and luxuriance of the trees will render them less liable to injury from fungous diseases. If this is true then fertilizers will help us."

In a discussion in the same society† in 1893 the idea was advanced that trees may be fed so as to fit them to resist fungi; that too liberal use of highly nitrogenous fertilizers, such as stable manure, fosters conditions which render the trees more liable to injury from fungous diseases, and that such tendencies may be corrected by the use of plant food containing more potash and phosphoric acid. Some were inclined to think that the application of hard-wood ashes to the soil increased the ability of the tree to resist the scab. In order to discover whether liberal applications of hard-wood ashes to the soil would have any perceptible influence on the immunity of the foliage and fruit from the scab fungus, an investigation was started at this Station in 1893 which has continued to the present time. The results are here offered as a contribution to our knowledge on this subject.

*Proc. W. N. Y. Hort. Soc., Rochester, 1891, p. 100.
†Proc. W. N. Y. Hort. Soc., Rochester, 1893, pp. 19, 140, 141.

## PLAN AND CONDITIONS OF THE EXPERIMENT.

### PLAN.

In any orchard the amount of injury from scab is liable to vary considerably with different trees of the same variety in the same season. It may also vary greatly with the same tree in different seasons, being influenced by the conditions of light, temperature and moisture. The investigation was planned on an extensive scale, so that the peculiar environment of individual trees and the varying influences of different seasons might not lead to erroneous conclusions. Some sections of the orchard in which the experiment was conducted were annually fertilized with liberal applications of wood ashes and corresponding sections received no ashes. As many trees of a kind as possible were included in each of the two classes, the treated and the untreated, and the experiment has continued five years. Fortunately for the experiment, the scab was unusually abundant one season, 1894, and did an enormous amount of injury to apple foliage and fruit throughout the State. The period of the experiment also covers the seasons of 1895 and 1896 in which the climatic conditions were generally favorable to the production of foliage and fruit free from the scab.

To guard against the possibility of having the test ruined by insects, the orchard was sprayed each year with arsenites and the insects were thus kept under control, excepting plant lice. No fungicides were used.* Since all sections were treated alike the spraying did not lessen the value of the records for comparing sections which were treated with ashes with corresponding untreated sections. The trees were annually pruned for the purpose of removing weak or dead branches and keeping the tops open so that spraying could be done readily. The fruit was not thinned, because more scabby fruit might thus be taken from treated than from untreated sections or *vice versa*.

*The insecticides which were used were London purple, Scheele's green and Paris green. Lodeman has shown that Paris green has slight fungicidal value. Cornell Exp. Sta. Bull. 48, pp. 272-273. In his tests London purple showed no fungicidal value. Cornell Exp. Sta. Bull. 86, p. 60.

Under the conditions which have been described above it is clear that the effect of the variation in the amount of scab on trees of the same variety in different locations, and on the same tree in different seasons, may be largely corrected by averaging the results of a large number of trees for a period of several years. The results which are set forth on the following pages, therefore, form a reliable basis for conclusions as to the influence which the use of wood ashes as a soil fertilizer may have on the immunity of apples from the scab fungus so far as the particular soil is concerned on which this experiment was made. The extent to which such conclusions may be accepted for other localities must be determined by further observations. It is believed that they will hold true generally except possibly in localities where the soil is notably deficient in potash.

An old apple orchard belonging to the Station was selected for this investigation in the spring of 1893. It is located about a mile and a half west of Seneca Lake, mostly on upland, but extending at one side down a short southern slope and including a small portion of Castle Creek bottom land. The soil is a rather heavy clay loam, quite well adapted to the apple, but not equal in this respect to the best apple lands of western New York.

The oldest trees were planted in 1850, making them forty-three years planted when the experiment was begun. They were root-grafted trees from the nursery of T. C. Maxwell & Bros., Geneva, N. Y. Nearly half of the trees which were first planted are gone and their places are now filled with trees varying in size from those recently planted to mature trees which have been in full bearing for many years. The orchard does not form as uniform a block of trees as could be desired for the experiment, but it is readily accessible and under the Station's control. Taking all things into consideration, it was the best one available for the investigation.

Prior to 1893, the year the experiment was inaugurated, the orchard had been in meadow for several years. During the winter of 1892-3 it was given a heavy application of stable manure and the following spring it was plowed. Since then it has either been used for soiling crops or has been given clean cultivation till about August 1 and then seeded to some cover crop.

### THE APPLICATION OF WOOD ASHES TO TREATED SECTIONS.

The orchard was divided into eight sections, four of which have had an annual application of wood ashes at the rate of one hundred pounds per tree, and the remaining four sections have received none. No other fertilizer has been applied to any part of the orchard during the experiment except within two or three feet of trees which have been newly planted to fill vacancies. The ashes have been weighed separately for each tree and spread broadcast to the line midway between adjacent rows. They were thoroughly mixed and carefully sampled before being spread in the orchard. The analyses given herewith show the percentage of potash in each application.

| | | |
|---|---|---|
| First application | 4.13 | per cent, $K_2O$ |
| Second " | 3.89 | " " |
| Third " | 5.71 | " " |
| Fourth " | 5.71 | " " |
| Fifth " | 1.38 | " " |

Since one hundred pounds of ashes were applied to each tree annually the above figures show the number of pounds of potash per tree in each application. The trees are thirty feet apart each way making forty-eight trees per acre. The amount of actual potash which has been applied to the treated sections during the five years is 20.82 pounds per tree or 999.36 pounds per acre, an average of 200 pounds per acre annually. The amount of potash commonly recommended for apple orchards varies from 50 to 100 pounds per acre annually. The amount of potash which was applied in this experiment is exceedingly liberal, being twice as great as the highest amount commonly recommended for apple orchards.

The amount of phosphoric acid in the ashes which were used in this experiment was not determined. Dr. Van Slyke* states that the amount of phosphoric acid in wood ashes varies from

*N. Y. Agl. Exp. Sta. Bull. 94, p. 323.

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1 to 2 per cent. At the lower estimate one pound of phosphoric acid per tree was applied each year in this experiment, or 48 pounds per acre. The application of from 30 to 60 pounds of available phosphoric acid per acre is commonly recommended for apple orchards. The phosphoric acid in the ashes is mostly insoluble and becomes available slowly. It may possibly become available as readily as the phosphoric acid of coarsely powdered bone.

### EXPLANATION OF DIAGRAM.

Baldwin, treated, Nos. 10, 101, 102, 108, 109, 125, 126, 127, 128.

Baldwin, untreated, Nos. 81, 111, 133, 136, 137, 207.

Fall Pippin, treated, Nos. 31, 33, 34, 35, 37, 38, 39.

Fall Pippin, untreated, Nos. 1, 4, 5, 6, 8, 9.

R. I. Greening, treated, Nos. 50, 51, 52, 54, 55, 56, 58, 70, 105, 107, 129, 146.

R. I. Greening, untreated, Nos. 24, 25, 26, 27, 28, 29, 42, 43, 46, 48, 62, 69, 82, 83, 162, 165, 184, 185.

Roxbury Russet, treated, Nos. 143, 145, 147, 149.

Roxbury Russet, untreated, Nos. 150, 153, 161, 175.

Northern Spy, treated, Nos. 74, 75, 76, 77, 202, 205, 210, 212, 213, 215, 221, 223, 224, 225, 245.

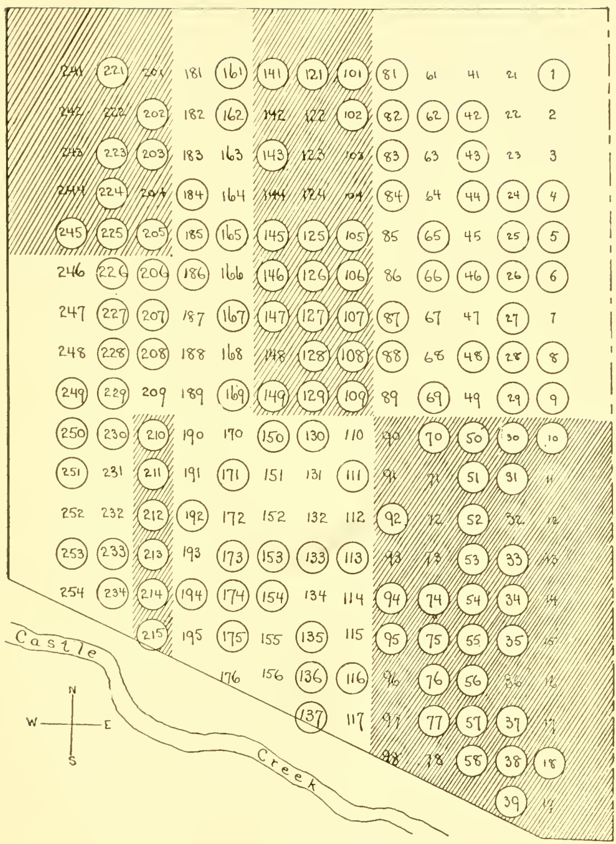
Northern Spy, untreated, Nos. 116, 206, 208, 227, 228, 229, 230, 233, 234, 249, 250, 251, 253.

The shaded portions indicate sections which were treated with ashes.

The old trees are indicated by the circles.

### THE VARIETIES.

The orchard was divided into eight sections as already described. For convenience these are numbered consecutively from 1 to 8. Sections 2, 4, 6 and 8 received annual applications of ashes while the others received none. The accompanying plan gives the relative positions of the sections and the varieties of trees included in them. The following list shows the number of treated and untreated trees of each variety which were of bearing age.




PLAN OF THE EXPERIMENT ORCHARD.

| | Treated with ashes. | Untreated. | | Treated with ashes. | Untreated. |
|---|---|---|---|---|---|
| Baldwin | 9 | 6 | Golden Russet | .... | 7 |
| Fall Pippin | 7 | 6 | Keswick. | .... | 1 |
| R. I. Greening | 12 | 18 | Peck Pleasant | .... | 1 |
| Roxbury Russet | 4 | 4 | Maiden Blush | .... | 1 |
| Northern Spy | 15 | 13 | Talman. | .... | 1 |
| Esopus Spitzenburg | 3 | 4 | Vandevere | .... | 1 |
| Tompkins King | 6 | 1 | Summer Pippin | 1 | ..... |
| Reinette Pippin | 2 | 1 | Baldwin (young) | 12 | 17 |

This list includes 153 bearing trees. Without the young Baldwins there are 124 mature trees in full bearing. Several varieties are not well enough represented in both classes to permit them to be used in comparing treated and untreated sections. Excluding these there still remain forty-seven treated and forty-seven untreated trees, mature and in full bearing, whose records for the five years may be used for determining the results of the experiment. These belong to the following varieties: Baldwin, Fall Pippin, Rhode Island Greening, Roxbury Russet and Northern Spy.

## RESULTS OF THE EXPERIMENT.

Records were kept of the September condition of the foliage in 1894-5-6-7 and of the condition June 23, 1894. A careful estimate of the condition of the foliage of each tree was made by two persons and the average of the two estimates was recorded. For obvious reasons it was impossible to examine carefully every leaf and note whether or not it was injured by the scab. Therefore the chief means of determining whether treating the soil with ashes had any influence on the prevalence of the scab was by careful examination of every fruit with reference to this point. During the first three years the fruit was classified with reference to the scab into four classes: (1) free; (2) slight and considerable, averaging about 20 per cent injury if 100 per cent represents a fruit rendered totally worthless by the scab; (3) bad, averaging about 55 per cent injury, and (4) unmarketable, averaging about 85 per cent injury. In 1896 and 1897 the fruit was sorted into the ordinary commercial grades of first, seconds and culls, but separate account was kept of those which were thrown out of the firsts on account of the scab injury and of those which were thrown out of the seconds for the same reason. These records concerning the foliage and fruit were kept for all trees in the orchard, but only the five varieties mentioned above are reported for the reasons already given.

Observations were also made on the color, keeping qualities and yield of the fruit from treated and untreated sections, although these have no bearing on the subject under investigation.

## THE FOLIAGE.

In estimating the condition of the foliage the complete loss of leaves was rated as 100 per cent injury. No record of the condition of the foliage in 1893 was kept. In 1894 observations were made not only in September but also in June, following three weeks of rainy, dark weather, unfavorable to healthy growth of foliage and favorable to the spread of the scab. The average condition of the foliage in treated and untreated sections is shown in Table I.

In 1896 the foliage on both treated and untreated trees was practically perfect, even Fall Pippin showing but a very slight injury. In 1894 and 1897 the treated Baldwin ranked slightly better than the untreated and the two classes graded about alike in 1895. In the treated sections Fall Pippin showed a gain every year. Rhode Island Greening showed a slight improvement each year, Roxbury Russet showed no improvement and Northern Spy ranked about the same in both classes, except that in 1894 the condition of the foliage in the untreated sections averaged somewhat better than in the treated sections. The most marked improvement in the treated sections appears when the June and September condition of the foliage in 1894 are compared. From May 16 to June 5, a period of twenty-one days, it rained every day. During this time there was less than the normal amount of sunshine and the temperature was lower than the average. The trees were sprayed with London purple, 1 pound to 180 gallons. The spray injured the foliage considerably, although lime was added to the mixture to prevent such injury. Under the existing conditions the foliage was unusually susceptible to injury from this cause. It was also very much injured by disease.

From June to September, as shown by Table I, the treated Baldwin gained five points, the untreated lost two; the treated Fall Pippin gained twenty-six, the untreated but eighteen; the treated R. I. Greening gained eleven points, the untreated twelve; the treated Roxbury Russet lost one point, the untreated lost four; the treated Spy lost four points, while the untreated lost nine points. Many of the injured leaves dropped in June and new ones replaced them to a considerable extent, so that in some instances the condition of the foliage in September was much better than it was on the same trees in June, and the sections which received the ashes showed a gain in every instance when compared with the untreated sections.

Taking all years and all varieties into consideration, whenever there was any marked difference in the September condition of the foliage it was in favor of the sections which had received the ashes. Since the estimates include the loss or injury from all causes, including not only the effects of the scab but also of other diseases, insect depredation, etc., they do not necessarily show that the improvement in the foliage on treated sections was due to increased ability to resist the scab as a result of the use of ashes as a fertilizer. The most that can be said is that in many cases there was better foliage where the ashes were used.

## The Fruit.

It was very easy to identify the scab on the fruit. During the first three years of the experiment each fruit was graded according to the amount of scab, and a separate record was kept of the number of specimens in each grade for each tree. The first grade contained fruit absolutely free from the disease. If the slightest speck of scab was discovered the fruit was put into the second grade. Fruit which had enough scab to affect its ordinary commercial grade was put into the third grade and the fourth grade contained all fruits which had enough scab to ren-

TABLE I — CONDITION OF FOLIAGE.

| NAME. | JUNE 23, 1894. | | SEPTEMBER, 1894. | | 1895. | | 1896. | | 1897. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Treated. | Untreated. | Treated. | Untreated. | Treated. | Untreated. | Treated. | Untreated. | Treated. | Untreated. |
| | Per cent. | Per cent. | Per cent | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| Baldwin | 26.0 | 23.0 | 21.0 | 25.0 | 2.5 | 2.2 | * | * | 6.7 | 7.8 |
| Fall Pippin | 53.0 | 56.0 | 27.0 | 38.0 | 4.6 | 8.5 | 1.0 | 1.0 | 10.7 | 14.7 |
| R. I. Greening | 24.0 | 26.0 | 13.0 | 14.0 | 4.4 | 5.5 | * | * | 7.9 | 8.6 |
| Roxbury Russet | 19.0 | 16.0 | 20.0 | 20.0 | 3.0 | 2.5 | * | * | 1.2 | 1.0 |
| Northern Spy | 17.0 | 17.0 | 21.0 | 26.0 | 2.7 | 2.2 | * | * | 2.8 | 2.6 |

*Almost perfect.

TABLE II — AVERAGE INJURY TO THE FRUIT BY THE SCAB.

| NAME. | 1893. | | 1894. | | 1895. | | 1896. | | 1897. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Treated. | Untreated. | Treated. | Untreated. | Treated. | Untreated. | Treated. | Untreated. | Treated. | Untreated. |
| | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| Baldwin | * | * | 28.30 | 27.05 | 6.00 | 6.92 | 1.24 | 0.84 | 1.82 | 0.83 |
| Fall Pippin | 43.08 | 40.79 | 69.59 | 68.21 | 31.41 | 40.96 | 13.04 | 8.14 | 13.72 | 11.15 |
| R. I. Greening | 26.30 | 31.01 | 58.08 | 62.06 | 12.85 | 11.83 | 9.66 | 6.06 | 7.14 | 0.57 |
| Roxbury Russet | 27.10 | 29.82 | 45.15 | 42.75 | 3.52 | 2.98 | 0.54 | 0.30 | 1.56 | 0.69 |
| Northern Spy | 26.47 | 26.21 | 38.04 | 33.21 | 13.62 | 12.52 | 0.53 | 0.08 | 3.23 | 1.86 |

*In 1893 the treated Baldwins yielded but few fruits and the untreated yielded none.

der them unmarketable. All these grades were made solely on the basis of the amount of scab and the size of the fruit was not considered. Letting 20 per cent represent the average injury from scab in the second class, 55 per cent in the third class and 85 per cent in the fourth class, the percentage of injury which the scab caused to the entire yield of the tree may be computed, thus furnishing a statement by which different trees may be compared as to the amount of injury to the fruit by the scab.

In 1896 and 1897, the fruit was sorted into the ordinary commercial grades of firsts, seconds and culls and the amount of fruit in each grade was recorded for each tree in pounds instead of recording the number of fruits in each grade. The firsts were required to be at least 2½ inches in diameter. An account was kept in each cases of the number of pounds of fruit which were thrown out of the first grade on account of the scab and of those which were thrown out of the second grade for the same cause. This method does not give as accurate a record of the amount of scab on the fruit as the method used in 1893-4-5, for if the fruit was too small to be marketable no account of the scab was kept, nor was any record made of those cases in which the injury from scab was not severe enough to affect the ordinary grading of the fruit. The method does, however, give important testimony on the practical question of the influence which the use of ashes as a fertilizer in the orchard may be expected to have on the relative amounts of firsts, seconds and culls so far as its effect on the scab is concerned. In order to find an expression for each tree for comparing the amount of scab on the different varieties in 1896 and 1897, the average injury to the fruit which was thrown out of the first grade on account of the scab is reckoned at 40 per cent and of that which was thrown into the culls on account of the scab at 90 per cent.

The records which were obtained in the manner just described form a reliable account of the amount of scab on the fruit and a satisfactory basis for comparing the treated and untreated sections. Computing the amount of scab in the way which has already been explained the averages are found which are shown in Table II.

This table shows a slightly greater injury in 1895 with the untreated Baldwins, a greater injury with untreated Fall Pippins in 1895, with untreated R. I. Greenings in 1893 and 1894 and with Roxbury Russett in 1893 than with the treated trees of the same varieties. With these exceptions these varieties show on the average every year greater injury from scab where the ground was fertilized with ashes than on corresponding sections which received no ashes.

In 1896 the season was unusually favorable to the development of perfect fruit, yet with every one of these varieties, the records show a greater average injury from scab on treated than on untreated sections. If apple trees ever needed to be fortified against conditions unfavorable to healthy growth it was in the early summer of 1894, yet in that year, with the exception of R. I. Greenings, every variety named in the table had a higher rate of injury where ashes were used than where they were not used.

This orchard had been sprayed with London purple only, and even in sections treated with the ashes had in some cases lost over half of its foliage from an epidemic of fungous diseases and other injuries following the long period of dark, cool, wet weather. In marked contrast was an adjoining orchard that had been treated with Bordeaux mixture to prevent the scab and whose foliage had been kept in good condition by this means. In the orchard where the ashes were used much of the fruit dropped in June as a result of the loss of the foliage, while the trees which were sprayed with Bordeaux mixture held both the foliage and the fruit and matured a fairly good crop. The great superiority of the Bordeaux mixture for preventing the scab under most unfavorable conditions, as compared with fertilizing the soil with ashes for the same purpose, was thus clearly shown.

## CONCLUSIONS.

The investigation has extended over a period of five years, it has included forty-seven trees in full bearing in the treated sections, comparable with the same number of trees representing the same varieties in the untreated sections. The results show that with the conditions under which this investigation was made liberal applications of hard wood ashes to the soil do not increase the immunity of the apples from the scab.

Whether the result would be the same on soil which is naturally very deficient in potash remains to be demonstrated. The soil in the orchard which was used for this investigation has a fair amount of potash and also of nitrogen and phosphoric acid as shown by the following analyses.

At the close of the experiment samples of soil to a depth of nine inches were taken in each of the eight sections of the orchard. A composite sample was made of the soils which had been treated with ashes and one of the untreated soils. The Chemist reports the following analyses of the air dried samples:

| | Treated with ashes. Per cent. | Untreated. Per cent. |
|---|---|---|
| Nitrogen | 0.186 | 0.214 |
| Phosphoric acid | 0.112 | 0.128 |
| Potash | 0.400 | 0.480 |

This shows the percentage of potash which was soluble in hydrochloric acid and not the total percentage in the soil. There was 16.9 per cent of moisture in one case and 17.5 per cent in the other. As far as these analyses go they indicate a fairly uniform condition of fertility in both treated and untreated sections of the orchard.

Some persons have expressed surprise that after the application of potash amounting to 1,000 pounds per acre in five years an analysis of the treated soil does not show a more marked increase in the percentage of potash. Assuming that the soil in this case contains 3,000,000 pounds per acre with 17 per cent of moisture, one analysis shows 9,960 pounds of potash per acre and the other analysis 11,950 pounds per acre in the first nine inches of the soil. An application of 1,000 pounds of potash per acre, supposing that none of it has passed below a depth of nine inches, which is not probable, would not equal the difference which naturally exists in the amount of potash per acre in different parts of the orchard. Moreover, the errors of sampling and analysis might obscure the effect on the soil, of an application of 1,000 lbs. of potash per acre.

There is one difference which should be noticed when comparing the potash which is applied in the ashes with the potash already in the soil, and that is that the potash in the ashes is soluble in water, while that in the soil is largely insoluble in water and is but slowly available to the plant.

## SOME RESULTS FOLLOWING THE APPLICATION OF ASHES IN THE APPLE ORCHARD.

Although the use of ashes as a fertilizer did not increase the immunity of the apples from the disease, it showed results in some other ways which interest the orchardist. Observations were made on the color and keeping qualities of the fruit and the productiveness of the trees. The general tendency to more abundant and vigorous foliage on trees in the treated sections has already been noticed.

### COLOR OF THE FRUIT.

Where the soil was treated with ashes, the color of the fruit was much improved with some varieties in some seasons. In 1893 the improvement in the color of the fruit on treated sections was noticeable with all varieties which were represented in treated and untreated sections. The only exception was with one crate of drops from an untreated section which were more highly colored, no doubt because the fruit had been lying on the ground; for it is well known that the color of apples may sometimes be increased by leaving them on the ground exposed to the light. Even the Roxbury and Golden Russets were smoother and higher colored on treated than on untreated sections in 1893.

In 1894 the results were not so uniform. On the treated sections Fall Pippins were smoother and fairer than on the untreated sections. Tompkins Kings were more highly colored on the treated sections than on the one tree on untreated soil. Baldwins showed but little difference, except that in a few cases fruit from the untreated trees was more highly colored than on corresponding treated trees. The reverse was true of the R. I. Greening, for where any difference was noticeable the treated trees had higher colored fruit, with a riper appearance, more yellow color and a tinge of red. With these exceptions, but little difference could be seen in the treated and untreated sections in 1894 so far as color of fruit is concerned.

In 1895 the results were no more uniform than in the previous year. Remembering that the even numbers represent treated sections, the rank as to color is shown in the following lists where sections are arranged in order according to color of fruit, those having the highest colored fruit being ranked first:

R. I. Greening—Sections 1, 5, 2, 3, 8.

Baldwin—Sections 8, 1, 3, 4, 2, 7.

Roxbury Russet—Sections 2, 3, 7.

Northern Spy—Sections 3, 5, 6, 4, 7.

The Tompkins King had much finer red color where the soil was treated, and on treated soil Spitzenburgs were somewhat superior in color to the same variety on untreated soil.

In 1896 and 1897 there was no noticeable difference in the color of fruit from treated and untreated sections.

The results show that an abundant supply of readily available potash in the soil influences the brilliancy of the color in the fruit. On soil which is naturally well supplied with potash, as this is, and in seasons which are very favorable to the perfect development of foliage and fruit, as was the case in 1896, the colors may develop as perfectly without the application of potash to the soil as with it. In one portion of the original orchard, which has been in sod for years without the application of either stable manures or commercial fertilizers, Northern Spy fruit was produced in 1896 which exceeded in brilliancy of color the Northern Spys which were grown in the cultivated sections where for four years wood ashes had been applied to the soil in liberal quantities. A careful study of the data which have been obtained during the course of this investigation, and which are mostly set forth on previous pages, leads to the conclusion that when the fruit is ready to be gathered the degree of color which it has attained is the result of a combination of various conditions in the environment of the tree at different periods in the development of the fruit. The character and quantity of available plant food, the moisture, texture and mechanical conditions of the soil are some of these conditions. The amount of light and its intensity at different periods in the season, the atmospheric temperature and humidity and the amount of sound foliage are others. Possibly the amount of reserve food material which was stored in the tissues during the previous season may also influence the final result. This idea is suggested by the fact that the foliage during the summer and autumn of 1895 was unusually perfect and the trees were consequently able to store up an exceptionally abundant supply of reserve food material, as is shown by the very abundant crop of the following year. In the early summer of 1896, shortly after the fruit was set, even before it had attained a diameter of an inch, the red color began to show on the red varieties and when mature the fruit was exceptionally well colored.

## KEEPING QUALITIES OF THE FRUIT.

For the purpose of comparing the keeping qualities of fruit from treated sections with fruit of the same variety from untreated sections, samples from different sections were put in the fruit house and records were kept of the length of time the fruit kept in good condition. The fruit was sorted over as often as was deemed necessary; those fruits which had begun to decay or had become withered and unfit for market were discarded and a record was kept of the number discarded at each date of sorting. Knowing the date when the fruit was put into the fruit house, it was easy to determine the average length of time during which the apples kept in good condition. These records show that the character of the season has considerable influence in determining the keeping qualities of the fruit. The following table gives the records for 1894, 1895 and 1896. The records for 1897 are not yet complete, while in 1893 the conditions for making comparisons on this point was not satisfactory.

TABLE III. — KEEPING QUALITIES OF FRUIT.

| NAME. | AVERAGE NUMBER OF DAYS AFTER OCTOBER 29, DURING WHICH SAMPLES OF FRUIT KEPT IN GOOD CONDITION. | | | | | |
|---|---|---|---|---|---|---|
| | 1894–5. | | 1895–6. | | 1896–7. | |
| | Treated. | Untreated. | Treated. | Untreated. | Treated. | Untreated. |
| Baldwin | 172 | 144 | 173 | 154 | 203 | 206 |
| Fall Pippin | * | * | * | * | 96 | 96 |
| Roxbury Russet | 68 | 107 | 70 | 106 | 172 | 188 |
| R. I. Greening | 104 | 91 | 122 | 91 | 138 | 166 |
| Northern Spy | 86 | 85 | 86 | 92 | 126 | 125 |
| Tompkins King | 78 | 79 | 103 | 79 | 116 | 153 |
| Esopus Spitzenburg | 124 | 90 | 112 | 90 | 163 | 153 |
| Reinette Pippin | * | * | * | * | 102 | 132 |

* No record.

The table shows that the effect of the use of ashes on the keeping qualities of the fruit varies with different varieties. In each season the Roxbury Russet from untreated sections kept longer than those from the treated sections. Northern Spy showed but little difference in this respect, while Esopus Spitzenburg from treated sections kept better than from the untreated.

No attempt was made to determine whether there are any differences in structure or composition of the fruit which kept well as compared with that which did not. When mature fruit keeps exceptionally well it may be said to have reached perfect development, whatever that may be. That the season of 1896 especially favored the perfect development of the fruit is shown by the following statement of the average number of days after October 29, during which all varieties mentioned in the table, except Fall Pippin and Reinette Pippin, kept in good condition.

| | 1894-5. | 1895-6. | 1896-7. |
|---|---|---|---|
| Treated | 105 | 111 | 153 |
| Untreated | 99 | 102 | 164 |

This also shows that the season of 1896 was exceptionally favorable, while 1894 was not favorable to the perfect development of the fruit. It appears, therefore, that the keeping qualities of the fruit are modified by the character of the season.

Table IV, which is derived from Table III, shows the differences in the number of days during which fruit from treated and untreated sections kept in good condition. When the difference is in favor of the treated sections the + sign is used but when it is in favor of the untreated sections the — sign is used.

Table IV.—Difference in Number of Days During Which Fruit Kept in Good Condition.

| Name. | 1894-5. | 1895-6. | 1896-7. |
|---|---|---|---|
| Baldwin | +28 | +19 | — 3 |
| Fall Pippin | * | * | — 0 |
| Roxbury Russet | —39 | —36 | —16 |
| R. I. Greening | +13 | +31 | —28 |
| Northern Spy | + 1 | — 6 | + 1 |
| Tompkins King | — 1 | +24 | —37 |
| Esopus Spitzenburg | +34 | +22 | +10 |
| Reinette Pippin | * | * | —30 |

* No record.

The fruit from treated sections generally kept better than that from untreated sections in 1894-5 and 1895-6, the Roxbury Russet being a marked exception. In 1896-7 the fruit from the treated sections kept longer than in the two previous seasons, but it did not generally keep so long as did the corresponding fruit from untreated sections. These considerations lead to the opinion that the perfect development of the fruit was hastened by applying the ashes to the soil. In a season which, like 1896, favors the perfect development of the fruit, the ripening process may be carried too far where ashes are used, and consequently the fruit may not keep so well as it does where no ashes are used. In a season like 1894, unfavorable to the perfect development of the fruit, the use of ashes, on the contrary, may tend to bring a larger proportion of fruit to perfect maturity, or may tend to bring all the fruit more nearly to perfect maturity and thus improve its keeping qualities.

## Avepage Yield per Tree.

This experiment was not undertaken primarily as a fertilizer experiment and it cannot be claimed that its evidence is conclusive as to the effect on the yield of applying wood ashes to the soil in liberal quantities. It cannot be assumed that trees of the same variety, in the same orchard, have equal capabilities for producing fruit even when they are of the same age and have been propagated, planted and cultivated in the same way. With the data now available no rigid comparisons should be made of the treated and untreated sections for the purpose of drawing definite conclusions as to the influence of the treatment on the yield. It is hoped that the investigation may be continued so as to secure more evidence on this subject.

Table V shows the average yield per tree for each variety from 1893 to 1897, and the annual average per tree for the whole period.

TABLE V.—AVERAGE YIELD PER TREE IN BUSHELS.

| YEAR. | Baldwin. | | Fall Pippin. | | Roxbury Russet. | | R. I. Greening. | | Northern Spy. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Treated. | Untreated. | Treated. | Untreated. | Treated. | Untreated. | Treated. | Untreated. | Treated. | Untreated. |
| | Bushels. | Bushels. | Bushels. | Bushels. | Bushels. | Bushels. | Bushels. | Bushels. | Bushels. | Bushels. |
| 1893. | * | ...... | 0.08 | 2.01 | 1.57 | 0.50 | 2.58 | 2.72 | 5.98 | 0.14 |
| 1894. | 2.57 | 2.94 | 0.74 | 0.58 | 6.44 | 2.80 | 5.41 | 4.11 | 8.64 | 5.85 |
| 1895. | 6.88 | 9.81 | 5.43 | 3.94 | 6.89 | 7.52 | 8.31 | 5.55 | 6.47 | 6.35 |
| 1896. | 25.56 | 24.10 | 20.64 | 19.77 | 30.56 | 21.37 | 19.14 | 23.78 | 19.87 | 13.40 |
| 1897. | 3.29 | 2.69 | 1.41 | 1.52 | 12.47 | 11.24 | 2.06 | 1.09 | 8.68 | 6.93 |
| Annual average per tree...... | 7.66 | 7.91 | 5.66 | 5.56 | 11.59 | 8.69 | 7.50 | 7.45 | 9.93 | 6.53 |

* A few fruits.

The annual average shows an increased average yield per tree with Fall Pippin, Roxbury Russet, R. I. Greening and Northern Spy, and a decrease in the case of the Baldwin. The trees are 30 x 30 feet, making 48 to the acre. The average annual increase per acre for the first four varieties named is shown below. The untreated Baldwins averaged 13.44 bushels more fruit per acre annually than did the treated Baldwins.

TABLE VI.—INCREASED YIELD ON TREATED SECTIONS.

| NAME. | Annual average increase per tree. | Rate per acre. |
|---|---|---|
| | Bushels. | Bushels. |
| Fall Pippin | 0.10 | 4.8 |
| Roxbury Russet | 2.90 | 139.2 |
| R. I. Greening | 0.05 | 2.4 |
| Northern Spy | 3.40 | 163.2 |
| Baldwin | —0.28 | —13.4 |

An examination of Table V shows that the sections which received no ashes on the whole increased in yield from 1893 to 1896, and in 1897, after the exceedingly heavy crop of the previous year, the yield exceeded that of either of the first two years the orchard was put under experiment. The sum of the average yields of the varieties named in that table are shown below.

| | 1893. | 1894. | 1895. | 1896. | 1897 |
|---|---|---|---|---|---|
| Treated, bushels | 10.21 | 23.80 | 33.98 | 115.77 | 28.59 |
| Untreated, bushels | 5.37 | 16.28 | 33.17 | 102.42 | 23.47 |

This shows an increase in the average yield even where no ashes were used, which may be explained by the fact that prior to the spring of 1893 the orchard was in sod, but since that time it has been kept under cultivation.

## SCAB RESISTANT VARIETIES.

The data which have been gathered during this experiment throw some light on the question of the variation of different varieties in their natural ability to resist the attacks of the scab fungus. Fall Pippin makes itself conspicuous each year by taking front rank among the varieties which are susceptible to this disease, while Maiden Blush, even in a most unfavorable season, has comparatively little of the disease. In 1894, as shown in Table VII, the average injury by scab to the fruit of six Fall Pippin trees was 68.2 per cent. An untreated Maiden Blush averaged but 11.74 per cent.

Mr. Paddock has recently examined for me a few varieties of apples to see whether or not there are any structural differences in the epidermis and cuticle of scab resistant varieties like Ben Davis, Grimes Golden and Talman Sweet as compared with susceptible varieties like Fameuse, Esopus Spitzenburg and Rhode Island Greening. So far as he has made examination the resistant varieties have thicker cuticle and thicker walled epidermal cells. This, if it holds true generally, means that the power to resist attacks of the scab fungus is correlated with structural peculiarities and it is quite reasonable to suppose that these scab-resistant characteristics may be intensified by breeding and selection. Work in this direction has already been undertaken with the orange by Mr. H. J. Webber of the Division of Vegetable Pathology, United States Department of Agriculture, in connection with his work for the Division in Florida. He writes under date of January 7, 1898: " In the case of the orange we have found very marked differences in the resistance of certain varieties to disease; for instance, foot rot, the most serious disease with which orange growers have to contend, is controlled mainly by grafting or budding the varieties desired on sour orange stock, which is practically immune from the disease. Again, the sour and bitter-sweet oranges are practically immune to blight, which is also one of the very serious diseases.

" It is not alone fungous diseases, however, that may be treated in this way. The orange rust, which is caused by a surface-feeding Phytops, I feel confident could also be controlled by breeding resistant sorts."

This line of work which Mr. Webber has undertaken in Florida, namely, the breeding of varieties resistant to the attacks of certain insects and diseases, if followed in connection with some of the cultivated fruits of this region might be productive of results

TABLE VII.—INJURY TO UNTREATED TREES.

(Amount of injury to foliage from all causes and injury to fruit by scab; 100 indicating complete loss or injury.)

| Number of trees. | NAME. | 1893. | | 1894. | | 1895. | | 1896. | | 1897. | | Average for fruit, five years. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Foliage. | Fruit. | Foliage. | Fruit. | Foliage | Fruit. | Foliage. | Fruit. | Foliage. | Fruit. | |
| | | Per cent. | Per cent | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| 6 | Baldwin | * | † | 25.0 | 27.05 | 2.2 | 6.92 | ‖ | 0.84 | 3.8 | 0.83 | 8.91 |
| 6 | Fall Pippin | * | 40.79 | 38.0 | 68.21 | 8.5 | 40.96 | 1.0 | 8.14 | 14.7 | 11.15 | 33.85 |
| 18 | R. I. Greening | * | 31.01 | 14.0 | 62.06 | 5.5 | 11.83 | ‖ | 6.06 | 8.6 | 0.57 | 22.31 |
| 4 | Roxbury Russet | * | 29.82 | 20.0 | 42.75 | 2.5 | 2.98 | ‖ | 0.30 | 1.0 | 0.69 | 15.31 |
| 13 | Northern Spy | * | 26.21 | 26.0 | 33.21 | 2.2 | 12.52 | ‖ | 0.08 | 2.6 | 1.86 | 14.78 |
| 4 | Esopus Spitzenburg | * | † | 31.0 | 36.30 | 4.0 | 51 00 | 3.0 | 2.24 | 5.8 | 0.80 | 22.58 |
| 1 | Tompkins King | * | † | 20.0 | ‡ | 3.0 | 8.08 | ‖ | 0.12 | 5.0 | 1.99 | 3.40 |
| 1 | Reinette Pippin | * | 48.05 | 20.0 | 56.40 | 3.0 | 8.48 | ‖ | 0.00 | 8.0 | 7.19 | 30.03 |
| 7 | Golden Russet | * | 24.26 | 21.0 | 40.57 | 2.4 | 2.24 | ‖ | 0.20 | 1.3 | 1.58 | 13.77 |
| 1 | Peck Pleasant | * | 41.21 | 40.0 | 8.12 | 2.0 | † | ‖ | 3.38 | 1.0 | 2.04 | 13.69 |
| 1 | Maiden Blush | * | 16.66 | § | 11.74 | 2.0 | 8.76 | ‖ | 3.55 | 1.0 | 0.03 | 8.15 |
| 1 | Vandevere | * | 34.10 | 55.0 | 60.70 | 3.0 | † | ‖ | 11.53 | 5.0 | ...... | 35.44 |
| 17 | Baldwin (young) | * | 23.50 | 26.0 | 30.10 | 2.5 | 5.92 | ‖ | 0.08 | 4.7 | 1.56 | 12.23 |

* No estimate made. † No fruit. ‡ But little fruit. § Almost perfect. ‖ Trace.

of great value to New York fruit-growers. With varieties of fruit like the apple, which require several years after the seed is planted before coming into bearing, progress by systematic breeding in this direction must be quite slow. In the meantime there appears to be no way of protecting the orchards against the attacks of the apple scab fungus which is so certain to give satisfactory results as spraying thoroughly with the Bordeaux mixture.

# REPORT

OF THE

# DEPARTMENT OF VEGETABLE PATHOLOGY.

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# REPORT OF THE MYCOLOGIST.

F. C. STEWART.

## I. THE DOWNY MILDEW* OF THE CUCUMBER; WHAT IT IS AND HOW TO PREVENT IT.†

### SUMMARY.

The 1896 crop of late cucumbers in southeastern New York was unusually small—from 17 to 25 per cent of a full crop. The chief cause of the short crop was a disease which caused the leaves to turn yellow and die prematurely. This disease, which is known as downy mildew, was first observed in this country in 1889, since which time it has been rapidly spreading and has become very destructive to cucumbers, muskmelons and watermelons.

In an experiment made at Woodbury, Long Island, the disease was successfully prevented by spraying once every ten days with Bordeaux mixture. Sprayed plants remained green and continued to produce cucumbers for four weeks after unsprayed plants in the same field had lost their foliage and ceased to produce fruit. The net profit from spraying on the experimental plat of one and three-fourths acres was more than one hundred and sixty dollars per acre.

It is probable that the same treatment will protect muskmelons and watermelons against the disease.

There is no good reason for believing that the disease will disappear; on the contrary, it is likely to become more widespread and more destructive. Therefore, it is earnestly recommended that farmers prepare to fight the disease as follows: Beginning when the plants are very small, spray thoroughly with Bordeaux mixture (1-to-8 formula) once every eight or ten

* *Plasmopara cubensis* (B. & C.) Humph.

† Reprint of Bulletin No. 119.

days until frost. The Bordeaux mixture can be satisfactorily applied with a knapsack sprayer, but it may, perhaps, be less expensive to use a barrel spray-pump mounted on a one-horse cart which is hauled through the field along blank spaces felt for the purpose.

## INTRODUCTION.

In southeastern New York, particularly in Westchester county and on Long Island, the crop of late cucumbers in 1896 was unusually small. Farmers estimated that cucumbers grown for pickles produced only about one-fourth of a crop; and statistics furnished by the proprietors of various pickle factories on Long Island show that this estimate is very nearly correct. One firm of pickle manufacturers having six salting houses in different parts of Long Island, contracted with farmers to purchase the entire crop of cucumbers on 817 acres at a stipulated price per thousand. From these 817 acres the firm received 15,759,200 cucumbers, which gives an average of 19,288 per acre. In Westchester county the yield was still smaller. A firm having four factories in that county reports that receipts would place the average yield per acre at 13,000.

A fair average crop is considered to be 75,000 cucumbers per acre, and this is the number used by picklemen in computing the acreage capacity of their factories. Until within a few years 125,000 per acre was not an unusual yield; but during the past five or six years the yield has decreased rapidly, reaching so low a point in 1895 and 1896 that the crop ceased to be a profitable one. In spite of the poor crop of 1895, farmers continued to plant heavily in 1896, being loth to give up a crop so admirably adapted to their soil and climate. Moreover they believed that the season of 1895 was exceptional, and that with the return of normal weather conditions the cucumber disease would disappear and the crop continue to be as profitable as it had been in the past. But when the disease reappeared in 1896, more virulent than ever, they became discouraged and many of them decided that they must quit growing cucumbers. Some of the picklemen, too, feared that they would be obliged to close their factories.

## CAUSE OF THE FAILURE OF THE CUCUMBER CROP.

It should be borne in mind that what is said under this head does not apply to cucumbers in general but only to late cucumbers, which are grown chiefly for pickling. Such sucumbers are planted from about June 20 to July 4, and commence bearing about August 1. During the picking season all cucumbers more than about one and one-quarter inches long are gathered every other day so that none are allowed to become large and seedy. These cucumbers are universally called "pickles," the name cucumber being applied only to those which are allowed to become nearly or quite full-grown. The latter are sold in the city markets while "pickles," for the most part, are sold under contract to the local pickle factories. The contract binds the farmer to grow a definite number of acres of "pickles" and sell the entire product to the factory at a stipulated price. The customary price for 1896 was one dollar per thousand. Sometimes they are sold by weight. The pickle industry on Long Island is a large and important one.

During the month of August, 1896, the writer visited a large number of cucumber fields in various parts of Long Island for the purpose of ascertaining the cause of the cucumber failure of which farmers were complaining. As there are several fungus and insect enemies of the cucumber, we expected to find that the trouble was not in all cases due to the same cause. It seemed likely that in different fields different causes would be found doing the work of destruction. Such was, in fact, the case, but to a much smaller extent than might be expected.

The striped cucumber-beetle* was found to be doing very little, if any, damage. This insect seldom does serious injury to late cucumbers.

In a few fields the melon-louse† was present in destructive numbers. This is a small, greenish insect, which feeds on the leaves and roots of cucumbers, muskmelons, squashes and various other wild and cultivated plants. Cucumber plants in-

* *Diabrotica vittata* Fabr.

† *Aphis gossypii* Glover.

fested by it can be readily detected by the curling of the leaves. On the under surfaces of the curled leaves the insect may be found in immense numbers sucking the juice from the plant. It is to be observed that the melon-louse generally works from the edges of the field toward the center. The explanation is this: The insect feeds upon quite a variety of weeds, such as the dandelion, dock, shepherd's purse, plantain, etc., which are abundant along the margins of cultivated fields. When the cucumber plants appear the lice leave the weeds and go to feed upon the cucumber leaves which are more to their liking, and thus it is that they work from the edges of the fields to the center.

In the vicinity of Huntington some damage was done by the boreal lady-bird beetle* which is a hard-shelled beetle, about three-eighths of an inch long and nearly as wide, and very convex. Its color is dirty yellow with black spots. Both the beetle and its larva feed upon the cucumber leaves—the beetle from the upper surface and the larva from the under surface. Their work is conspicuous and readily recognized as insect work.

A disease which did more damage that all the above named insects is a mysterious wilt disease which is characterized as follows: At almost any time after the plants have commenced to run they suddenly wilt without any apparent cause. In some cases the whole plant wilts; in others a portion of the plant or, perhaps, a single leaf, while the remainder remains healthy. Healthy plants and diseased plants may be frequently found in the same hill. A casual examination of plants recently wilted reveals nothing which could cause the death of the plant and so this disease is indeed a puzzle to the farmer. But in the later stages of the disease a rotten spot may generally be found at the base of a wilted leaf or somewhere on the main stem. Microscopic examination shows that in the neighborhood of the rotten spots the tissues are swarming with exceedingly minute germs called bacteria, and these are the cause of the trouble. Dr. Halsted, who has given considerable study to the wilt disease of

* *Epilachna borealis* Fabr.

cucumbers, melons, etc., is of the opinion that the bacterium which causes this disease of cucurbitaceous plants is identical with the one which causes a wilt disease of potatoes and tomatoes, common in the Southern States and not infrequently found as far north as the latitude of New York City. But recent investigations made by Dr. Erwin F. Smith* show that the wilt disease of potatoes and tomatoes has no connection whatever with the cucumber wilt. He attempted to transmit the disease from the cucumber to the tomato and potato by artificial inoculation but failed in every case. Moreover, he comes to the conclusion† that there are two distinct wilt diseases of the cucumber. Which one of these caused the wilting of Long Island cucumbers the past season we do not know. Along what is known as the Port Jefferson Branch of the Long Island Railroad the loss from the cucumber wilt was considerable, although not so great as the loss from downy mildew to be mentioned later.

In the present state of our knowledge of the wilt disease no remedy for it can be recommended. Rotation of crops has been suggested as a remedy and probably it does tend to lessen the virulence of the disease, but it cannot be relied upon. The past season we found a bad case of cucumber wilt in a field that had been in grass for twelve years. It seems probable that the disease can be communicated by means of cucumber seed.

It is well known that the white grubs (larvæ) of the striped cucumber-beetle feed upon the roots of cucumber plants, and when present in large numbers they may cause the plants to wilt. When present they are readily detected. It is safe to say that almost none of the wilt of late cucumbers on Long Island in 1896 was due to this cause.

We now come to the consideration of the chief cause of the "poor pickle crop" of 1896; namely, the downy mildew. The symptoms of this disease are as follows: The leaves show yellow spots which have no definite outline. If the weather is warm and favorable for the disease these spots enlarge rapidly and run

* Smith, Erwin F.—A Bacterial Disease of the Tomato, Eggplant and Irish Potato. Bull. No. 12 U. S. Dept. of Agriculture, Division of Vegetable Physiology and Pathology. Issued Dec. 19, 1896.

† Loc. cit. p. 6.

together so that the whole leaf becomes yellow and soon dies and shrivels like a leaf killed by frost. If the weather is cool the yellow spots spread less rapidly. In the latter case the central portion of the yellow spots becomes dead and brittle and of a light-brown color. For an illustration of this see Plate X. The disease invariably begins with the oldest leaves and proceeds toward the tips of the vines. Hence the disease appears to proceed from the center of a hill outward. In a field recently attacked, the center of every hill will be clearly marked by a cluster of yellow leaves, so that the rows may be plainly seen clear across the field, even though the plants are large and cover the ground. Affected plants continue to grow at the tips and put out new leaves, and it is interesting to note how the disease follows at a distance of about four or five leaves behind the growing tip. After the disease is once thoroughly established, very few cucumbers are produced although the plants may continue to flower profusely. The few cucumbers which are formed grow slowly and become misshapen so that they are unsalable.

Besides the downy mildew there are several other fungous diseases which sometimes do damage to cucumbers, but the downy mildew was the only one which did serious harm to late cucumbers on Long Island in 1896. The anthracnose, *Colletotrichum lagenarium* (Pass.) Hals., has recently done much damage to cucumbers in New Jersey, but it has not been destructive on Long Island during the past season. Of the total shortage of 75 per cent in the Long Island cucumber crop of 1896 it is safe to say that 55 per cent was due to the downy mildew, while the remaining 20 per cent was due to all other diseases and insects. In the vicinity of Hicksville and Central Park practically all of the damage was done by the downy mildew.

## STRUCTURE OF THE CUCUMBER LEAF.

In order that the nature of the downy mildew and its method of killing the leaves may be better understood, it is perhaps best to first describe the structure of the cucumber leaf.

Plate X.—A Cucumber Leaf Affected with Downy Mildew.

To the naked eye a piece of cucumber leaf is structureless; but if a very thin cross-section is cut and placed under a compound microscope which magnifies about 390 diameters, it is found to be made up of numerous compartments or cells, some of which contain many green bodies, the chlorophyll grains. Fig. 1, Plate XI, is a drawing of a small portion of such a cross-section. Above and below there is a layer of colorless cells (*a*, *á*) called the epidermis (*a* is on the upper face of the leaf, *á* on the lower). The epidermis is an impervious protective covering for the leaf. Between *a* and *á* we find cells of various shapes. Near the upper surface of the leaf they are much elongated and are called palisade cells (*b*, *b*). Toward the lower surface they are more nearly spherical. In each of these cells there are several small green bodies (*c*) the chlorophyll grains which give the green color to the leaves. Fig. 2 of the same plate is a drawing of a portion of the epidermis or skin, peeled from the lower surface of the leaf. The elliptical objects (*s*), are stomata (sing. stoma). Between the two cells composing a stoma there is a narrow slit (*r*) which opens into an intercellular passage on the interior of the leaf. At *m* in Fig. 1, there is shown a cross-section of the two cells of a stoma, just beneath the intercellular passage (*i*). On the under surface of the leaf the number of stomata to the square inch is more than 400,000, while on the upper surface there are about 165,000 per square inch. The epidermis of the upper surface of the leaf resembles closely that of the lower surface, except that there are fewer stomata. On both surfaces of the leaf there are hairs which can be seen with the naked eye. These hairs are of two kinds: (1) long, tapering hairs like the one shown in Fig. 2, and (2) short hairs with large, swollen tips, called glandular hairs.

## NATURE OF THE DOWNY MILDEW.

The symptoms of this disease have been given on a previous page. The naked eye can detect nothing about the diseased leaves which could cause the yellow spots and consequently they are a puzzle to farmers. As in the case of many other plant diseases, the cause of which is not known, the blame had been laid upon the weather. Fortunately the compound microscope comes to our aid here and makes the whole matter perfectly plain. If a fragment of leaf taken from one of the yellow spots is magnified about 390 diameters, there will be seen a large number of such things as are figured in Plate XII. These constitute the downy mildew fungus, *Plasmopara cubensis*, which is the real cause of the yellow spots. It is not an insect. It is a vegetable growth and is just as truly a plant as is the cucumber plant itself. At Fig. 1 there is shown a branched sporophore (*s*) bearing several young spores (*sp*). The sporophores are nearly colorless and come out through the stomata on the under surface of the leaf, the branched tops hanging downward. Fig. 3 shows one young and one mature sporophore* coming through a stoma (*st*). When the spores are mature they are violet colored and usually have the form shown in Figs. 2, 2′ and 2″. These spores are readily carried by the wind for a long distance. Should one chance to fall upon a cucumber leaf and find there a drop of dew or other moisture, it will germinate in a few hours by discharging several small protoplasmic bodies called zoöspores. Each of the zoöspores may put out a germ-tube which finds it way through a stoma to the interior of the leaf, where it forms a net-work of colorless fungus threads (hyphae) which run here and there among the cells. At frequent intervals the hypae put out knob-like outgrowths which penetrate into the cells and feed upon the cell contents. See Fig. 7, Plate XII. The fungus is, therefore, a parasite, appropriating to its own use the nourishment which the cucumber plant has prepared. Besides abstracting nourishment, the fungus probably does further injury by poisoning the cells and causing them to die quickly. After the fungus has vegetated within the leaf for a while it forms sporophores which push out through the stomata and produce another crop of spores. The length of time required for the completion of this life cycle is not known, but it is certainly short, probably less than twenty-four hours. Thus

*The number of sporophores which proceed from a single stoma is small, usually one or two; but it is not uncommon to find as many as five, and even larger numbers are occasionally seen.

the disease spreads from plant to plant with great rapidity. In what form the fungus passes the winter is not known. The ordinary conidal spores, described above, retain their germinating capacity for a short time only. Some species of closely related fungi produce, in addition to these ordinary spores, thick walled resting spores, which retain their power of germination for a long time and serve to carry the fungus over the winter or other unfavorable period. No such spores have been found in connection with *Plasmopara cubensis*.

The large, short-stalked spores* shown in Figures 4, 5 and 6 are a modified form of the ordinary conidia. Spores of this character are known to occur occasionally in a few other species of Peronosporae, the family to which *Plasmopara cubensis* belongs; but it is unusual for them to occur in such large numbers as we have found them in this species.

The downy mildew fungus likes hot weather and a moderate rainfall. The time of worst attack is generally in August. During the first half of last August there was a period of ten days of excessively hot weather. The disease spread with such alarming rapidity that by August 20 the majority of cucumber fields were ruined. The influence of moisture is seen when diseased cucumber leaves are placed for about twenty-four hours in a tight tin box containing blotting paper saturated with water. In this moist atmosphere the sporophores attain a greater length and produce myriads of spores which give to the diseased spots a decided violet tinge. The spores are so numerous that when a leaf is suddenly jarred they fall like a cloud of violet-colored dust. Under the microscope the fungus is seen to be in a state of active

*These peculiar spores do not seem to have been previously observed as they are not mentioned in the literature of this species. The writer found them in abundance during August on field-grown cucumbers and muskmelons. On both of these plants one or more such spores might be found on nearly every surface section taken from the under surface of the leaves. They closely resemble the ordinary conidia except that they are considerably larger. The sessile form (Fig. 5) is much more common than the stalked form (Fig. 4). On page 311 of the *Botanical Gazette* for 1883, Dr. Farlow mentions having seen similar spores in *Peronospora graminicola*, Pk. and *Peronospora violae*, DBy; and Dr. Max Cornu has described and figured such spores found in connection with *Plasmopara viticola*. See his article, *Le Peronospora des Vignes*.

In the opinion of the writer these spores should be considered abnormal and due to some unfavorable condition, probably insufficient moisture. As previously stated, they were found in abundance on leaves collected in dry weather; but they were rarely found on leaves collected on damp days or on leaves kept in a moist chamber.

growth—spores may be found attached to the sporophores and in all stages of growth; and the bases of the sporophores are surrounded by huge masses of protoplasm like the one shown at Fig. 1, Plate XII. Whereas, on leaves taken from the open in dry weather, the fungus does not produce spores in such profusion as to color the leaf spots; no masses of protoplasm are to be found at the bases of the sporophores; and it is rare that immature spores can be found attached to the branches of the sporophores.

## BOTANICAL RELATIONSHIP OF THE DOWNY MILDEW FUNGUS.

Botanists have grouped the higher plants into families and given these families Latin names. For example, we have the Gourd Family or Cucurbitaceae, which contains the gourd, muskmelon, watermelon, cucumber, squash, pumpkin and other similar plants. The numerous species of fungi have been grouped into families in the same manner, and so we have the family of smuts or Ustilagineae, which contains all the species of smut fungi, such as corn smut, oat smut, onion smut, etc.; the family of Rusts or Uredineae, which contains the various species of rust fungi, and many other families.

The cucumber downy mildew fungus has the Latin name, *Plasmopara cubensis*, and it belongs to the family of Downy Mildews or Peronosporeae. This is a family which contains many species of fungi injurious to cultivated plants. Some well known examples are: The dreaded potato-blight, *Phytophthora infestans*, the downy mildew of the grape, *Plasmopara viticola*, the spinach mildew, *Peronospora effusa*, and the onion mildew, *Peronospora schleideni*. But the downy mildews should not be confused with the powdery mildews, such as gooseberry mildew and the common rose mildew. These are quite different in structure and belong to the family Erysipheae.

## HOST PLANTS.

The plant upon which a fungus lives is called its host plant. *Plasmopara cubensis* has several host plants, all of which belong to the Cucurbitaceae. It was originally discovered on a wild plant in Cuba; and has since been found on the cucumber (*Cucumis sativus*), the muskmelon (*Cucumis melo*), the watermelon (*Citrullus vulgaris*), the squash (*Cucurbita maxima*), the pumpkin (*Cucurbita pepo*) and the gherkin gourd (*Cucumis anguria*). It is likely that when the fungus becomes better known it will be found on still other cucurbitaceous plants. During an outbreak of the disease in New Jersey in 1891, Dr. Halsted* sought for it on the star cucumber (*Sicyos angulatus*) and the wild cucumber (*Echinocystis lobata*) but failed to find it.

On both field-grown and hot-house cucumbers it is exceedingly destructive. The muskmelon, too, suffers severely from its attacks. Muskmelon plants attacked by the disease lose their leaves in much the same manner as do cucumber plants, except that the yellow discoloration is less marked in the muskmelon and the dead spots are dark colored. The diseased plants may continue to produce melons but they are of a very inferior quality. The watermelon is affected in the same way. Dr. Halsted attributes† the partial failure of the New Jersey watermelon crop in 1891 to this fungus. On the squash and pumpkin the disease presents the same general appearance as on the cucumber, but as yet it has not done much harm to these plants. However, it seems to be on the increase and it is not improbable that in the near future Long Island squash growers will have to fight this disease or abandon the crop just as cucumber growers are doing now.

## HISTORY OF THE DISEASE.

The disease with which we are dealing has a comparatively short history. It was originally discovered on a wild plant in Cuba and the fungus causing it was first described‡ in 1869 by Berkeley and Curtis, who gave it the name *Peronospora cubensis*. For the next twenty years nothing was heard of it and then in 1889 it suddenly appeared in Japan and in New Jersey. The first announcement of its occurrence in this country is to be found on page 152 of the *Botanical Gazette* for June, 1889. Dr. Halsted,

*Halsted, B. D. Notes upon Peronosporeae for 1891. Ann. Rept. New Jersey Agricultural Experiment Station for 1891, p. 218.

†Loc. cit.

‡Journal Linnaean Society, Botany, Vol. 10, p. 363.

the author of that article, states that he found the fungus on cucumber leaves growing under glass at New Brunswick, N. J. Subsequently, he reported* that it had been found abundantly in various parts of New Jersey in 1889, not only on forced cucumbers but also on squashes, pumpkins and field-grown cucumbers. In the *Botanical Gazette* for August, 1889, Dr. Farlow gave a detailed account of the fungus and stated that it had been found in Japan a few months before by Prof. Miyabe. In the same year, 1889, Prof. Galloway† reported having received specimens from Anona, Fla., and College Station, Texas, in both of which localities it was abundant.

In 1890 Dr. Humphrey‡ studied the fungus at the Massachusetts Experiment Station. He made the first drawings of the spores§ and sporophores, and the hyphae penetrating the cells of the leaf; and because of the manner in which the spores germinate he changed the name to *Plasmopara cubensis*.

Following this, the fungus was reported from various parts of the country. It began to do serious injury to muskmelons and watermelons, and has now become so injurious to cucumbers and melons that it must be placed in the front rank of destructive fungous diseases. According to Ludwig|| it has not yet been found in Europe.

It is a curious freak of nature that a fungus which had not been observed for twenty years should appear almost simultaneously in two widely separated portions of the earth and so suddenly spring into prominence as a destructive disease.

## AN EXPERIMENT ON THE PREVENTION OF THE DISEASE BY SPRAYING WITH BORDEAUX MIXTURE.

In the season of 1896, the Station made arrangements with Mr. R. C. Colyer, of Woodbury, N. Y., to make a spraying experiment

* Halsted, B. D. Some Notes upon Economic Peronosporeae for 1889 in New Jersey. Journal of Mycology, Vol. V., p. 201.

† Galloway, B. T. New Localities for *Peronospora Cubensis*. Journal of Mycology, Vol. V, p. 216.

‡ Humphrey, J. E. Eighth Ann. Rept. Mass. Agl. Exp. Sta., 1890, pp. 210-212.

§ He did not, however, illustrate the germination of the spores although he distinctly states that the method of germination is by zoöspores and because of this character places the fungus in the genus *Plasmopara*. Dr. Halsted, also, has observed that the germination is by means of zoöspores, but no one has ever figured them.

|| Ludwig, F. Lehrbuch der Niederen Kryptogamen, p. 150.

on one of his fields of late cucumbers. This field had an area of about one and three-fourths acres, and was planted about July 1, in forty-two rows, each containing one hundred and three hills, the rows being five feet apart and the hills four feet apart in the row. It was planned to spray a part of the field with Bordeaux mixture and leave another part unsprayed for comparison. Bordeaux mixture was selected for use in the experiment because it is known to be a preventive of the downy mildew of the grape, the late blight of potatoes and other diseases caused by fungi belonging to the family of downy mildews. The downy mildew of the grape is caused by the fungus *Plasmopara viticola* which is a near relative of the cucumber downy mildew fungus. Grape growers no longer fear this once troublesome disease because they know that Bordeaux mixture applied at the proper time will certainly prevent it.

The writer, knowing the nature of the cucumber disease and the value of Bordeaux mixture for such diseases in general, was confident that the cucumber crop could be saved by spraying the plants with Bordeaux mixture before the disease made its appearance. Acting upon this idea we prepared a brief newspaper article in which the nature of the cucumber disease was explained and an outline given of what seemed likely to be a successful method of treating it. This article was published in June in some of the local newspapers, viz., the *Island*, published at Floral Park; the *Enterprise*, published at East Norwich; and the *Long Islander*, published at Huntington. It appears that no attention was paid to this article. We know of no instance in which any attempt has been made on Long Island to prevent the cucumber disease by the use of Bordeaux mixture, excepting, of course, our own experiment and the cases of three or four farmers who, having seen the results of this experiment, made an attempt to save their cucumbers after the disease had attacked them. The Bordeaux mixture has been used on Long Island very little for any purpose. The past season several farmers sprayed potatoes and a few have sprayed their orchards, but this excellent fungicide should be better known here.

Humphrey,* Lodeman† and some other writers have suggested spraying for cucumber downy mildew, but we believe that the only record experiment is one made by Halsted‡ who reports that cucumber plants sprayed with Bordeaux mixture held their leaves longer than unsprayed plants. The results of that experiment were somewhat complicated by the fact that the unsprayed plants suffered severely from attacks of anthracnose§ as well as downy mildew. Hence it seemed desirable to have more experimental evidence of the efficiency of Bordeaux mixture as a preventive of cucumber downy mildew.

Let us now return to our own experiment: The forty-two rows of cucucmber plants were divided into five plats as shown in the accompanying diagram.

PLAN OF EXPERIMENTAL FIELD.

| |
|---|
| *Plat I.* 10 rows; sprayed 7 times. |
| *Plat II.* 6 rows; not sprayed. |
| *Plat III.* 10 rows; sprayed 7 times. |
| *Plat IV.* 6 rows; center 2 rows sprayed four times, the other four not sprayed. |
| *Plat V.* 10 rows; sprayed 7 times. |

*Humphrey, J. E. Tenth Ann. Rept. Mass. Agr. Exp. Sta., 1892, p. 227.

†Lodeman, E. G. The Spraying of Plants, p. 315.

‡Halsted, B. D. Experiments with Cucumbers, Rept. of the New Jersey Agricultural College Experiment Station for 1895, p. 203.

§*Colletotrichum lagenarium* (Pass.) Hals.

## CHRONOLOGICAL RECORD OF THE FIELD.

July 13. *First Spraying.* The plants were well up, the majority of them having two leaves besides the seed-leaves. Plats I, III and V were sprayed with Bordeaux mixture (1-to-7 formula). Thirty-six gallons of Bordeaux mixture were used and the time consumed in making and applying it was about three hours. Plats II and IV not sprayed.

July 24. *Second Spraying.* The plants had been growing very rapidly and appeared to be in perfect health. Plats I, III and V sprayed again (1-to-7 formula). Bordeaux mixture used, 58 gallons. Time, 5 hours. Plats II and IV not sprayed.

July 30. On the plants in Plats I, III and V many leaves were yellow around the margins, while the plants in Plats II and IV were in perfect health and showed none of the yellow leaves. Thus it appeared that the injury was due to the Bordeaux mixture applied on July 24. Two questions now arose, viz.: Had the Bordeaux mixture been improperly prepared? or, Had it been used in a too concentrated form?

August 3. *Third Spraying.* The plants on Plats I, III and V still showed decided injury. Plats II and IV were perfectly healthy. Plats I, III and V sprayed again. Fearing that the Bordeaux mixture had been too strong in the first two sprayings, the 1-to-11 formula was used this time. Bordeaux mixture used, 75 gallons. Time, 6 hours. In order to determine whether the injury from Bordeaux mixture in the second spraying was due to a too concentrated mixture, the center two rows in Plat IV (which up to this time had not been sprayed at all) were treated as follows: One row was sprayed with carefully prepared Bordeaux mixture of the 1-to-7 formula and the other row with Bordeaux mixture of the 1-to-11 formula. Hereafter, these two rows will be referred to as "test rows."

August 7. The first appearance of the yellow spots of the downy mildew.

August 8. The first picking was done on this date.

August 12 and 13. *Fourth Spraying.* The third spraying did no injury to the plants. Neither had there been any injury to either of the two test rows in Plat IV. The unsprayed plants in Plats II and IV were now severely attacked by the downy mildew—every hill showed the characteristic yellow spots. While on Plats I, III and V only an occasional yellow spot could be found. The test rows in Plat IV showed more disease than Plats I, III and V but considerably less than the unsprayed plants in Plats II and IV. The test rows were again sprayed as on August 3. Plats I, III and V sprayed again (1-to-11 formula). Bordeaux mixture used, 105 gallons. Time, 9 hours.

August 21. *Fifth spraying begun.* On this date the contrast between the sprayed and the unsprayed plats was very striking. Plats I, III and V were perfectly green, in excellent health and producing an abundance of cucumbers; while Plat II and the unsprayed rows on Plat IV were yellow throughout, many leaves were completely dead and picking was practically finished. The test rows in Plat IV showed no injury from spraying, and they were not nearly so badly diseased as the unsprayed rows beside them. Plat V and two rows of Plat III were again sprayed. This time it was thought best to use the 1-to-8 formula. A close examination of the sprayed plants showed that the disease was getting started among them and it was feared that the Bordeaux mixture used in the last two sprayings might not have been strong enough to check the disease. The experiment on the test rows in Plat IV showed that the stronger mixture could be safely used if it were properly prepared. The quantity of Bordeaux mixture used this time was 50 gallons and the time required to apply it, 4 hours. On the night of August 21st, there was a heavy rain and on the 22d and 23d drizzling rains fell so that no more spraying was done until the 24th.

August 24 and 25. *Fifth spraying finished.* The heavy rains had washed off so much of the Bordeaux mixture that it was deemed advisable to re-spray the plants sprayed on August

21. Plats I, III and V were, therefore, given a thorough spraying on August 24 and 25. Quantity of Bordeaux mixture used, 150 gallons. Time, 10 hours. The test rows were again sprayed.

September 2 and 3. *Sixth spraying.* At this time the unsprayed plants had no green leaves except a few at the ends of the vines. The sprayed plants, on Plats I, III and V were considerably diseased but continued to yield about 30 baskets of cucumbers every other day. They were again sprayed with the 1-to-8 formula. Bordeaux mixture used, 100 gallons. Time, 6 hours. Less Bordeaux was required this time because there had been very little rain since the last spraying. Time was saved by using two nozzles, instead of one, as in all previous sprayings. The test rows were again sprayed.

September 8 and 9. *Seventh spraying.* Among the sprayed plants the disease was slightly worse than on September 2; but, in spite of this, two pickings had been made during the week, the one made September 7 yielding 40 baskets of cucumbers. The test rows on Plat IV, were now little better than the unsprayed rows. Plats I, III and V, sprayed again (1-to-8 formula). Bordeaux mixture used, 100 gallons. Time, 6 hours. Two nozzles were used as in the sixth spraying.

September 21. The vines were badly diseased but still retained considerable of their foliage. As late as September 19, eleven baskets of cucumbers were taken at one picking.

September 23. Five baskets of cucumbers were picked on this date. The vines were killed by frost during the night of September 23-24.

## HOW THE SPRAYING WAS DONE.

Thirty rows were sprayed seven times and two rows four times with Bordeaux mixture made by the potassium ferro cyanide test and applied with an Eclipse knapsack sprayer. Spraying was begun July 13, when the plants had but two leaves, and continued, at intervals of from six to eleven days, until September 9. The remaining ten rows were not sprayed at all.

## THE EXTENT TO WHICH SPRAYING PREVENTED THE DISEASE.

The downy mildew first appeared on the unsprayed plants August 7, and by August 21 it had injured the foliage to such an extent that scarcely any cucumbers were produced after this date. The damage was done almost wholly by the downy mildew. The thirty-two rows of plants which had been sprayed were in perfect health and vigor on August 21, and *after this date produced two hundred sixty dollars* worth of cucumbers* which represents approximately the benefit resulting from spraying.

This benefit would, without doubt, have been considerably larger if no unsprayed plants had been left. On the unsprayed plants in Plats II and IV, the fungus was allowed to grow unchecked and produce immense number of spores which the wind scattered broadcast over the sprayed plants. These spores could not attack the leaves from the upper side because of the Bordeaux mixture. Probably they dropped to the ground and were carried to the undersurfaces of the leaves by the spattering of rain drops. Here there was no Bordeaux mixture to hinder them and so they readily gained access to the tissues of the leaf. As a result, about August 21, the yellow disease-spots could be occasionally found on the leaves of sprayed plants and from this time on the disease gradually spread and shortened the crop considerably. Had all the plants in the field been sprayed, the disease could not have obtained a start. The soil on which the plants grew could not have been originally infested by the fungus because no cucumbers had been grown on it for several years. Hence, the only source from which the plants could receive infection would be the spores coming from the neighboring fields, the nearest of which was one-fourth mile away. Under these conditions comparatively few spores would have fallen upon our experimental field and it is very probable that we could have kept the plants in perfect health until frost.

*The actual amount was more than this, but exactly how much we do not know, and desiring to be strictly within the limits of truth we will place it a little low and call it two hundred sixty dollars. It is to be regretted that an exact record of the yield on the different plats was not kept. The cucumbers were sold in the Wallabout Market, Brooklyn, and because of the scarcity of cucumbers, they brought, on an average, nearly four times the price which picklemen were paying for cucumbers raised on contract.

The experimental field, being near a public highway, attracted a great deal of attention. Some who knew nothing of its history, were much puzzled by its appearance and stopped to inquire why it was so "streaked." Such was the interest in it that farmers who had heard of the experiment came from several miles around to see what had been accomplished by spraying. The contrast between the sprayed and unsprayed portions of the field was very striking. See Plate XIII.

### EXPENSE OF THE TREATMENT.

The items of expense are as follows:

| | |
|---|---|
| Seven hundred and six* gallons of Bordeaux mixture at an average cost of two-thirds of a cent per gallon.... | $4 71 |
| Forty-nine hours labor applying the Bordeaux mixture at 15 cents per hour.............................. | 7 35 |
| Expense of carting 706 gallons of water, about........ | 2 25 |
| Total.................................... | $14 31 |

The thirty-two rows sprayed contained 3,296 hills and covered an area of a trifle more than one and one-half acres. The expense per acre was, therefore, $9.50. Spraying increased the crop on this one and one-half acres by the amount of $260, which is at the rate of $173 per acre. Deducting from the latter amount the expense of spraying one acre, $9.50, we have left *$163.50 net profit per acre.*

### STRENGTH AND QUANTITY OF BORDEAUX MIXTURE USED IN THE EXPERIMENT.

It will be observed that in the course of the experiment three different strengths of Bordeaux mixture were used. The experiment would have been more satisfactory if a single strength could have been used throughout the season. But the second spraying injured the plants and it was suspected that the Bordeaux mixture used (1-to-7 formula) had been too strong. Accordingly, the next two sprayings were made with weaker mixture (1-to-11 formula). At the time of the fifth spraying it was

*This includes the 674 gallons used on Plats I, III and V, and 32 gallons used on the two test rows in Plat IV.

discovered that the disease was beginning to attack the sprayed plants and it was feared that the mixture used in the third and fourth sprayings had not been strong enough to prevent the germination of the fungus spores; and in the meantime it had been ascertained that the injury done by the second spraying was due to the Bordeaux mixture having been improperly prepared. So in the fifth, sixth and seventh sprayings we used Bordeaux mixture of the 1-to-8 formula.

Further experiments are necessary to determine what strength of Bordeaux mixture will be the most satisfactory. The weaker the mixture the less will be the expense of spraying, but, of course, it must be strong enough to kill the fungus spores. Judging from the behavior of the two test rows in Plat IV, one of which was sprayed with 1-to-11 Bordeaux and the other with 1-to-7 Bordeaux, it seems probable that Bordeaux of the 1-to-11 formula will prevent the disease just as effectually as stronger mixtures. This opinion is strengthened by the fact that the grape downy mildew is readily controlled by 1-to-11 Bordeaux.

The quantity of Bordeaux mixture which it is necessary to use at each application depends upon the size of the plants, the amount of rainfall and the frequency with which the plants are sprayed. The quantity required for the first spraying is small as compared with the quantity required when the plants are full grown. If the plants are sprayed once a week and there is little rain between the sprayings, the quantity required each time will not be nearly as great as when the plants are sprayed at longer intervals and heavy rains occur.

In the experiment, the quantity of Bordeaux mixture used in the several sprayings was as follows:

| | |
|---|---|
| First spraying | 25 gallons per acre. |
| Second spraying | 41 gallons per acre. |
| Third spraying | 53 gallons per acre. |
| Fourth spraying | 74 gallons per acre. |
| Fifth spraying | 141 gallons per acre. |
| Sixth spraying | 71 gallons per acre. |
| Seventh spraying | 71 gallons per acre. |
| Total of seven sprayings | 476 gallons per acre. |

### Time Required to Apply Bordeaux Mixture.

Applying Bordeaux mixture with a knapsack sprayer is hard work; hence the amount of work done depends largely upon the strength of the laborer. Experience gained from this experiment and potato spraying experiments, shows that an active man of average strength can make and apply from 125 to 150 gallons of Bordeaux mixture in a day of ten hours, using an Eclipse knapsack sprayer with a single Vermorel nozzle. This quantity can be increased to from 150 to 175 gallons per day by using two nozzles, but when two nozzles are used it is necessary to keep the pump handle working almost constantly, which makes the work harder. In spraying cucumbers two nozzles can be advantageously used in the later sprayings, provided the laborer is strong and willing to work.

### Mr. Colyer's Opinion of the Experiment.

The following statement from Mr. R. C. Colyer, of Woodbury, L. I., N. Y., on whose premises the experiment was made, explains itself. Mr. Colyer writes as follows:

" The unsprayed vines were a failure—the blight affected them before they commenced to pick. The pickles grew crooked and pointed so that when they were counted about one-fourth of them had to be thrown out and the balance were unsatisfactory at the salting-house. The blight affected them so fatally that in about two weeks they ceased picking. The sprayed vines grew vigorously—the blight did not affect them apparently. The pickles grew perfect and all were salable. The spraying preserved the vines until they were killed by the frost, September 24th. The vines were yielding fairly well when the frost came. This experiment with Bordeaux mixture on the pickle vines was a success. The crop from the vines sprayed was very profitable to me. The blight was general last year, the main part of the crop being destroyed about the middle of August. Very few farmers were picking as late as September 1. The pickles that grew on these vines preserved by the application of the Bordeaux mixture, sold in Wallabout market, Brooklyn, at an average price of about four dollars per thousand for the large ones and three dollars per thousand for the small ones, giving me more than $260 profit from the sprayed vines after the unsprayed vines were dead.

"I have been growing pickles for the New York market and for salting-houses for the past sixteen years; for the first ten years the vines grew vigorously and yielded pickles until the vines were killed by frost (usually the last of September in this section), yielding from 100,000 to 150,000 per acre, which made them a very profitable crop. During the last six years the yield has been growing less, apparently from some disease unknown to us, the disease spreading and becoming more fatal every year. Last year, 1896, the crop did not pay for the cost of the fertilizer and cultivation. Many large growers have ceased to plant them and unless a remedy had been found the crop must soon have been abandoned here on Long Island.

"Yours truly,

"R. C. COLYER."

## SPRAYING MUSKMELONS AND WATERMELONS.

Both muskmelons and watermelons suffer severely from the attacks of downy mildew. There is every reason to believe that Bordeaux mixture, properly applied, will as effectually protect these plants as it does the cucumber. As in the case with the cucumber, the spraying should be commenced when the plants are small and continued at intervals of about ten days until frost. Some of the Bordeaux mixture will, of course, fall upon the melons and spot them, but this will do no harm since the spots can be readily removed, when it is time to market the melons, by rubbing them with a cloth moistened with vinegar.

In this connection it may be of interest to some to know how the unsightly Bordeaux stains can be removed from the hands. In making and applying Bordeaux mixture one can hardly escape staining the hands badly, especially if the potassium ferrocyanide test is used in making the Bordeaux. By washing the hands in vinegar most of the stain can be removed.

## ARE SPRAYED CUCUMBERS AND MELONS POISONOUS?

The question has been asked, may not sprayed cucumbers be poisonous? They who ask this question reason, that, as the cucumber gets its nourishment from the vine which takes its food through the roots and leaves, if the leaves and the soil about the roots are coated with a poisonous substance the plants may absorb the poison and store it in the cucumber. This is an objection which has often been raised against the spraying of plants, but it has been shown to be without foundation. It is true that plants may take up copper compounds from the soil, but not in sufficient quantity to make the fruit poisonous. Likewise, the leaves of land plants under certain conditions can absorb liquids, but only to a very limited extent.

A greater source of danger lies in the Bordeaux mixture which falls on the fruit itself and is eaten with it. However, expert chemists who have made analyses of sprayed grapes and other fruits state that the amount of fruit which it would be necessary to eat in order to get a poisonous dose of Bordeaux mixture is so large that there is no danger. And since copper, the poisonous property of Bordeaux mixture, is not a cumulative poison there is no danger from small doses.

But the most convincing proof that sprayed fruit is not poisonous, is the fact that although the spraying of potatoes, grapes, apples, pears and other fruits is quite a general practice in some parts of our country, no cases of poisoning have resulted therefrom. It will be remembered that when farmers first began to use Paris green for the Colorado potato-beetle there were many people who feared to eat the tubers of the treated plants. Now, Paris green is almost universally used on potatoes without evil consequences to consumers.

Sprayed cucumbers and melons are certainly not poisonous.

## THE PREPARATION OF BORDEAUX MIXTURE.

The ingredients used in the preparation of Bordeaux mixture are copper sulphate, fresh lime and water, which are combined in different proportions for use on different plants. For spraying cucumbers and melons we recommend the use of a mixture containing one pound of copper sulphate, two-thirds of a pound of fresh lime and eight gallons of water. This formula is known as the "1-to-8 formula," which means that each eight gallons of Bordeaux mixture contains one pound of copper sulphate. In a 1-to-11 formula, one pound of copper sulphate is contained in eleven gallons of Bordeaux mixture, and so on. This simple method of designating the strength of Bordeaux mixture was devised by Beach.*

## COPPER SULPHATE.

Blue vitriol and blue stone are other names for copper sulphate. It is put on the market in three forms: (1) in large crystals, (2) in granulated form, and (3) in powdered form. The granulated form is the most satisfactory because it is cheaper than the powdered form and dissolves more readily than the large crystals.

Copper sulphate, in quantities of from fifty to one hundred pounds ought not to cost more than five cents per pound. In barrel quantities it can be purchased in New York city for four and one-half cents per pound and perhaps less. Since it will keep indefinitely it is advisable to buy in large quantities in order to get wholesale rates. It is poisonous.

## DISSOLVING THE COPPER SULPHATE.

Select a wooden vessel (never use an iron vessel) and put into it a quantity of water equal to about one-half the quantity of Bordeaux mixture desired. A barrel having a capacity of about fifty gallons is excellent for the purpose and, in fact, this is the vessel most generally used. See that the inside of the barrel is free from sticks, dirt or anything else which might clog the nozzles of the spray-pump. Fill the barrel about one-half full of clean water. Weigh out the required amount of copper sulphate, six pounds

*See New York Exp. Sta. Bulletin No. 84, p. 3.

for cucumbers, put it into a loose bag (a fertilizer bag is good) and suspend it in the barrel in such a manner that the copper sulphate will be near the top of the water. If allowed to rest on the bottom of the barrel it will require longer to dissolve.

### Preparing the Lime.

Take four pounds or more of the best unslaked lime obtainable (air-slaked lime should not be used), put it into a separate vessel and slake it as for whitewash. It is well to have this vessel of good size so that after the lime is slaked considerable water may be added to dilute and cool it. Formerly, the amount of lime required was determined by weighing, but we now have a chemical test called the potassium ferrocyanide test (to be described presently) which does away with the necessity of weighing the lime.

### Mixing the Copper Sulphate and Lime Water.

When the copper sulphate is dissolved and the lime slaked, fasten a fertilizer bag or other coarse cloth over the top of the barrel for a strainer. Have at hand a small bottle containing a little potassium ferrocyanide (yellow prussiate of potash) dissolved in water. Now, strain the lime water into the copper sulphate solution until a considerable quantity has been added. Next, remove the strainer and give the mixture in the barrel a thorough stirring; then add a drop of the potassium ferrocyanide solution. If enough lime has been added no change of color will take place when the drop of potassium ferrocyanide strikes the mixture, but if more lime is needed the drop will change to a reddish brown color. Continue to add lime until the mixture does not change color when tested, being careful to stir thoroughly each time before testing; and after the test shows that there is enough lime add yet a little more lime in order to be *sure* that there is enough. If too little lime is used the plants will be injured in the manner described on page 359, but an excess of lime will do no harm.

Potassium ferrocyanide can be purchased at any drug store. The quantity needed for a season's spraying should cost but a few cents. It is a poison.

Bordeaux mixture must be freshly prepared each time it is needed for use. If allowed to stand longer than a few hours it begins to deteriorate in value.

## PREPARING STOCK SOLUTIONS OF COPPER SULPHATE AND LIME.

Where large quantities of Bordeaux mixture are required it will be found advantageous to prepare stock solutions of copper sulphate and lime.

Dissolve one hundred pounds of copper sulphate in fifty gallons of water. Each gallon of the solution will contain two pounds of copper sulphate. When it is desired to prepare Bordeaux mixture, three gallons of this stock solution will be sufficient to make a barrel of the mixture. In this way the time consumed in weighing and dissolving the copper sulphate can be saved. The stock solution can be kept any length of time provided it is kept tightly covered to prevent evaporation.

A stock solution of lime can also be prepared. Lime can be slaked in quantity and kept in a concentrated form if care is taken to keep it covered with water so that it can not harden. When needed for use the required quantity can be taken and diluted to the desired consistency.

## SPRAYING MACHINERY.

In the spraying experiment reported in this bulletin the Bordeaux mixture was applied with a knapsack sprayer like the one shown in Fig. 17. The following discussion of knapsack sprayers is copied from Bulletin No. 75 of this Station:

"Knapsack sprayers, as the name indicates, are machines designed to be carried on the back. These are manufactured by a number of firms; the later patterns differ from each other only in small, but occasionally very essential details. In general, knapsacks consist of a copper tank holding from three to five

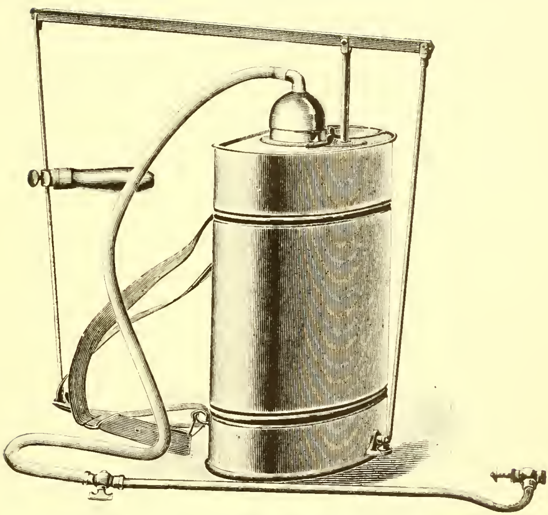


FIG. 17.—KNAPSACK SPRAYER.

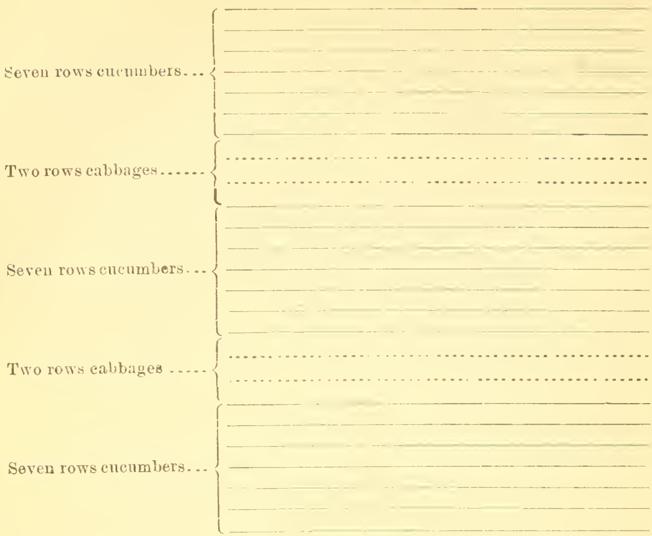
gallons, being held in place on the back by straps over the shoulders. They are furnished with force pumps that have a large air-chamber, making the discharge constant. In the later patterns the pump handle is so arranged that it can be made to work over either shoulder, so that the pumping may be done by either hand.

"In purchasing a knapsack care should be taken to select one in which the discharge pipe enters the tank at the top. If it enters at the bottom it invariably becomes clogged in a short time where heavy mixtures are used, so that it is a constant source of annoyance. . . . . . . . When furnished with a Vermorel nozzle the knapsack is a very efficient sprayer. They can be obtained of most dealers in spraying apparatus at a price ranging from ten to fifteen dollars."

Spraying with a knapsack sprayer is hard work and slow, but the knapsack can be used in a great many cases where it would be inconvenient and perhaps impossible to use either a barrel spray-pump or a power sprayer. On account of the habit of growth of cucumbers and melons, a sprayer on wheels can not be used for spraying these plants except, perhaps, in the manner to be described a little later; hence the knapsack sprayer, in spite of its tediousness, is sure to find favor among those who grow cucumbers and other vines which require spraying. It is so useful for applying fungicides and insecticides to various field and garden plants that every farmer should have one even if he has also a barrel spray-pump.

Some of the large growers insist, however, that an easier and more rapid method should be found. To such persons we make the following suggestions:

Plant the cucumbers in strips of from six to nine rows each, leaving between the strips open spaces of from twelve to thirteen feet in width. In the center of each open space plant two rows of late cabbage, cauliflower, or some other low-growing plant. The following diagram shows the plan of a field planted in this manner:




Buy a good spray-pump (there are several good ones which sell for about ten dollars), mount it in a fifty-gallon barrel and place the barrel on some kind of a cart, which is to be hauled along the open spaces by one horse. The heavy, two-wheeled, dump carts used by market gardeners will answer this purpose very well. The horse walks between the cabbage rows and the wheels which are about six feet apart, run between the cabbages and the outside rows of cucumbers. From the spray-pump let a lead of hose several feet in length extend on either side. At the end of each lead of hose attach a piece of gas-pipe* about eight feet in length and carrying at its extremity two or more spraying nozzles. The two-discharge and three-discharge Vermorel nozzles† are as good as any.

Three men will be required to operate the sprayer—one to drive and work the pump and one on either side to manage the nozzles. A fourth man and a team can, with advantage, be used to haul water and prepare the Bordeaux mixture. If the strips each con-

*What is known as the bamboo extension rod will serve the same purpose admirably.
†For sale by the Gould Manufacturing Co., 16 Murray St., New York City.

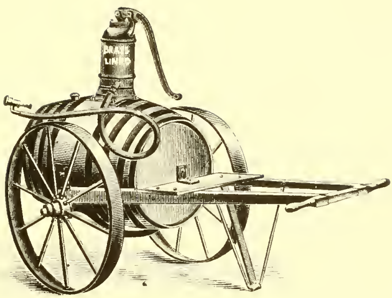


FIG. 18.—SPRAYER ON WHEELS.

tain seven rows (which number seems to us to be the most convenient one, all things considered) five feet apart, it will be necessary for each of the men who carry the nozzles to spray three and one-half rows at each passage. With the aid of the eight feet of gas-pipe they should be able to spray all of the plants on the three and one-half rows without trampling the vines to any extent.

A spraying outfit of this kind will cost from $17 to $20 in addition to the cart. It can be used for spraying potatoes in the same manner as cucumbers.

For the first two or three sprayings, when the plants are small, it is doubtful if this method will be more economical than spraying with a knapsack, but after the plants cover the ground it will probably be found very satisfactory.

If it is desired to omit the cabbage rows and make the open spaces as narrow as possible, a cart of narrow tread will be needed. The Myers' spraying outfit, shown in Fig. 18, has the merit of being very compact. Its tread is but three feet and one-half inch and it can be hauled by one horse or pushed by hand. The capacity of the barrel is forty-five gallons. Price, $25. Manufactured by F. E. Myers & Bro., Ashland, Ohio. For sale by J. S. Woodhouse, 191 Water Street, New York City. We have not tested this sprayer in the field, but it has the appearance of being both durable and effective.

It is not likely that a power sprayer can be used at all.

## BRIEF DIRECTIONS FOR SPRAYING CUCUMBERS AND MELONS.

Beginning when the plants are very small, spray thoroughly with the Bordeaux mixture (1-to-8 formula), once every eight or ten days until frost. When heavy rains occur it may be necessary to spray oftener. The leaves should be kept constantly covered with the Bordeaux mixture.

## CONCLUSION.

It is, indeed, very gratifying to us to be able to report that a remedy has been found for so destructive a disease as this downy mildew. There are few plants which give such bountiful returns for spraying as do cucumbers. It is to be hoped that farmers will at once apply the remedy as recommended and thereby make cucumber growing as profitable as it was before the disease appeared; but, judging from the history of the treatment of plant diseases in this country, it seems probable that it will be several years before the spraying of cucumbers will become anything like a general practice. In the meantime those who do spray will reap a harvest, for, in all probability, the disease will continue to spread and become so destructive as to drive many growers out of the business, and thus keep up prices. While, in any given locality, the disease may fluctuate in virulence from year to year with the weather conditions, it is undoubtedly in America to stay and may be expected to cause heavy losses in every year.

## EXPLANATION OF PLATE XI.

Fig. 1. Cross-section of a cucumber leaf.

*a.* Epidermis of the upper surface.

*a'.* Epidermis of the under surface.

*b.b.* Palisade cells.

*c.* A chlorophyll grain.

*m.* Cross-section of a stoma.

*i.* Intercellular passage.

Fig. 2. Surface section from the under surface of a cucumber leaf.

*s.* A stoma.

*r.* The rift or opening between the two crescent-shaped guard-cells of the stoma.

Fig. 3. A plant hair (trichome) from the under surface of a cucumber leaf.

NOTE.—All the figures on this plate were drawn with the aid of an Abbé camera lucida under a magnification of 700 diameters and afterwards reduced by the engraver to the present magnification, viz.: 465 diameters.

## EXPLANATION OF PLATE XII.

The cucumber downy mildew (*Plasmopara cubensis*).

Fig. 1. A vigorous sporophore grown on a cucumber leaf which had been kept twenty-four hours in a moist chamber. (Original.)


PLATE XI.—THE STRUCTURE OF A CUCUMBER LEAF.

PLATE XIII.—VIEW OF A PORTION OF THE EXPERIMENTAL FIELD AT WOODBURY. TAKEN AUGUST 27.

*s.* The sporophore proper.

*sp.* Immature spore.

*p.* Mass of protoplasm.

Figs 2, 2′ and 2″. Mature spores of the ordinary normal form. (Original.)

Fig. 3. Shows how the sporophores come out through the stomata. (Original.)

*s.* Portion of a mature sporophore.

*y.* A young sporophore.

*st.* The stoma.

*m.* A fragment of the mycelium.

Fig. 4. A cluster of sporophores taken in dry weather from a cucumber leaf grown out of doors. (Original.)

*s*, *s*′, *s*″, *s*‴. Four stunted sporophores of the normal branched form.

*u.* An abnormal unbranched sporophore bearing a monstrous spore.

*t*, *t*′, *t*″. Transition forms between *s* and *u*.

Fig. 5. A cluster of very short-stalked spores from a cucumber leaf. (Original.)

Fig. 6. A short-stalked spore from a muskmelon leaf. (Original.)

Fig. 7. Four cells of a cucumber leaf with the mycelial threads of the fungus running between them and sending into them the haustoria (*h*, *h*′, *h*″). (Copied after Humphrey in 8th Ann. Rept. Mass. Exp. Sta.)

Fig. 8. A rare form of short-stalked spore from a cucumber leaf. (Original.)

Fig. 9. A monstrous pear-shaped spore which was found attached to a well-developed sporophore after the manner of the ordinary spores. Two other spores of this character have been observed. (Original.)

NOTE.—All figures on this plate are equally magnified, viz.: 665 diameters; and with the exception of Fig. 7 all were drawn with the aid of an Abbé camera lucida in the same manner as the figures on Plate XI.

# II. SPRAYING POTATOES ON LONG ISLAND IN THE SEASON OF 1896.*

F. C. STEWART.

## SUMMARY.

(1) Potatoes on Long Island in 1896 were unusually free from disease. In spite of this fact, spraying five times with Bordeaux mixture increased the yield on Victor Rose $4\frac{3}{4}$ bushels, on White Elephant $60\frac{1}{2}$ bushels, on Green Mountain 62 bushels, on Defender 16 bushels, and on Late Blush 28 bushels per acre.

(2) The total expense of spraying 8.58 acres of potatoes five times, including all labor and cost of chemicals and an allowance for the wear of machinery, was $34.25, or $4 per acre.

(3) The expense of applying Paris green twice to 1.09 acres of potatoes, by means of the Leggett powder-gun, was $1.65, or $1.51 per acre.

(4) Comparing the value of the increase in yield due to spraying, with the outlay required to produce that increase, it was found that spraying had been profitable on all varieties except Victor Rose. On the variety Green Mountain there was a net profit of $13 per acre, allowing potatoes to be worth 25 cents per bushel. Spraying, being profitable in such a season as 1896, must be profitable in almost any season on Long Island.

(5) Fungiroid, applied dry, was found to be so much inferior to the wet Bordeaux mixture that its use as a substitute for Bordeaux mixture is not to be recommended.

(6) The "Lion Brand" Bordeaux mixture, likewise, proved to be of practically no value.

(7) Bordeaux mixture (1-to-7 formula) used without any Paris green, gave considerable protection against insects but not enough to warrant the recommendation of its use. Paris green should always be added to the Bordeaux mixture whenever either flea-beetles or Colorado potato-beetles are numerous.

* Reprint of Bulletin No. 123.

(8) It appears that three applications of Bordeaux mixture are not sufficient for potatoes on Long Island. In the early part of the season it is necessary to fight flea-beetles and Colorado beetles, in midsummer the early blight must be kept in check, and in the latter part of the season late blight and flea-beetles make their appearance. The plants need protection throughout the season.

(9) One-to-eleven Bordeaux gave slightly better results than 1-to-7 Bordeaux. As a repellent of insects the weak mixture seems to be fully as effective as the stronger mixture. Had blight been prevalent the results might have been different. The use of the weak mixture cannot be recommended without further trial.

(10) Plants sprayed five times with Bordeaux mixture at the rate of 100 gallons per acre, yielded in one case 15 bushels per acre and in another case 27 bushels per acre more than plants sprayed at the rate of 50 gallons per acre.

(11) A trial of the Hudson Special Bordeaux Sprayer showed it to be an efficient sprayer for applying Bordeaux mixture to potatoes.

## INTRODUCTION.

It is a well-known fact that the ravages of the late blight or rot blight (*Phytophthora infestans*) of the potato can be prevented by spraying the plants with Bordeaux mixture. Many carefully conducted experiments have been made, both in this country and in Europe, and in almost every one of these experiments the late blight and potato rot have been successfully controlled by spraying. The amount of evidence is so great that we are obliged to accept it as an established fact that late blight can be prevented by spraying.

The disease makes its appearance in midsummer during warm, moist weather and rapidly destroys the plants, whole fields sometimes being ruined in the space of three or four days. At digging time many of the tubers are found to be rotten. Spraying should be commenced before the disease makes it appearance and two or three applications made at intervals of about two weeks. In cases where the disease has been severe this treatment has sometimes saved almost an entire crop at an expense of two or three dollars per acre, which shows that, at times, spraying is exceedingly profitable. It is quite generally conceded that it will pay to spray potatoes in those seasons in which late blight occurs.

The late blight, however, does not occur every season. In some portions of the United States it never occurs. On Long Island it probably occurs destructively about one year in four, on the average. Now, spraying is preventive, not curative, and so must be commenced before it is known whether the disease will appear. Accordingly, farmers have come to look upon spraying as a form of insurance, and some have raised the question, "Can we not better afford to lose a crop occasionally than to bear the expense of spraying every season?" Those who ask this question assume that spraying is of no value except to prevent the late blight. But that is not true; spraying benefits the potato plant in other ways:

(1) Spraying protects it against the attacks of early blight (*Macrosporium solani*), a disease which attacks the leaves, producing circular or elliptical, dead, brittle spots which are marked with dark colored rings arranged concentrically, like the rings on the ball of the thumb. This disease is not as conspicuous as the late blight but, on the whole, is perhaps fully as destructive since it is more widely distributed and occurs to some extent every season.

(2) Spraying, if done thoroughly, will prevent the greater part of the damage done by flea-beetles (*Crepidodera* [*Epitrix*] *cucumeris*).

(3) The plants can be more completely protected against the attacks of Colorado potato-beetles (*Doryphora decemlineata*), than is possible by any method in which Paris green is used alone.

(4) The danger of injury to the foliage from Paris green poisoning is avoided.

(5) Some of the best authorities on the spraying of plants hold that Bordeaux mixture has a beneficial influence on potato foliage even when no insects or diseases are present. The nature of this influence has not yet been satisfactorily explained.

All of the above-mentioned advantages of spraying must be taken into consideration when discussing the question, Will it pay to spray every season?

In most of the recorded experiments on potato spraying, the late blight has been an important factor, and hence these experiments do not furnish a complete answer to the present question. It is necessary to know not only the benefit to be derived from spraying in seasons when late blight is prevalent, but also the benefit to be derived from spraying in seasons when there is *no* late blight. Fortunately, the conditions have been such that our experiments on Long Island during the past two seasons have thrown considerable light on this very point.

## SPRAYING EXPERIMENT AT FLORAL PARK.

In 1895 we made a spraying experiment* at Floral Park, Long Island. A field of potatoes containing four and one-half acres was divided into three equal plats. One plat was sprayed five times with Bordeaux mixture, one plat was sprayed three times with Bordeaux mixture and the remaining plat was not sprayed. With the exception of spraying, the three plats were treated as nearly alike as was possible in every respect. The Colorado potato-beetles were kept under control by the use of Paris green. On the sprayed plats the Paris green was applied with the Bordeaux mixture in the first two applications. On the unsprayed plat the same quantity of Paris green was used and was applied in water by means of the spraying machine at the same time the sprayed plats were treated the first two times.

Throughout the entire season there was no trace of late blight, even on the unsprayed plat, and so it might be thought that our spraying had been unnecessary. But the early blight had been prevalent and there had also been some flea-beetles on the unsprayed plat. Spraying with Bordeaux mixture had prevented these enemies from doing much damage to the sprayed plats and as a consequence these plats gave a considerably larger yield than the unsprayed plat. The plat sprayed three times yielded 52 bushels of merchantable tubers per acre more than the un-

*For the details of this experiment see N. Y. Agrl. Exp. Sta. Bul. No. 101, pp. 73-76.

sprayed plat, and the plat which had been sprayed five times yielded 62 bushels per acre more than the unsprayed plat. No record was kept of the expense of the spraying but there was certainly considerable profit.

## FIRST SPRAYING EXPERIMENT AT EAST WILLISTON.

There being a demand for some definite information as to the expense of spraying potatoes on Long Island, the Station, in 1896, undertook an experiment along this line. The season was remarkably favorable for the potato crop, as very little disease of any kind appeared. This fact made our results exceptionally valuable since they show what spraying will do for potato plants which are apparently healthy.

From Mr. R. H. Robbins, we obtained the privilege of using for the experiment a potato field containing about nine and two-thirds acres on his farm near East Williston, Long Island. The field was in the form of a parallelogram, 48 rods long and about 32 rods wide, the rows running the short way. The soil was practically uniform and had been fertilized alike all over the field. In 1895 the entire field was planted to cabbage. In 1896 four varieties of potatoes were planted — 64 rows of Victor Rose, 93 rows of White Elephant, 53 rows of Green Mountain and 73 rows of Defender. Care was taken that the field should receive the same cultivation throughout.

Each variety was divided into two plats, one of which was sprayed with Bordeaux mixture five times according to the approved method, and the other was not treated at all, except that Paris green was applied twice with Leggett's powder-gun according to the common practice of Long Island farmers. At the close of the season the potatoes on these two plats were dug and weighed separately.

The accompanying diagram shows the relative size and position of the sprayed and unsprayed portions of the field.

*How the spraying was done.*— It being desired to ascertain the expense of spraying potatoes as it should be practiced by the average grower of late potatoes on Long Island, every part of the work was put upon a practical basis. All of the methods used


Plate XIV.—The Spraying Outfit Used in the Experiment at East Williston.

were such as we would recommend for actual farm practice. We sprayed five times* with Bordeaux mixture, 1 to 8 formula, commencing when the plants were about six inches high and repeating the treatment at intervals of about two weeks. Whenever Colorado potato-beetles or flea beetles became numerous, Paris green was added to the Bordeaux mixture at the rate of three-fourths of a pound of Paris green to 50 gallons of the Bordeaux mixture. The copper sulphate was purchased directly from the manufacturer in New York in quantity (450-pound-barrel), at 4½ cents per pound. The spraying outfit used is shown in Plate XIV. It consisted of an Eclipse No. 2 spray-pump† mounted in a 70-gallon barrel which was put on a stout two-wheeled cart‡ having wheels five feet eight inches apart and hauled by one horse. By means of a rubber hose the spray-pump communicated with a three-fourths-inch iron pipe to which were attached eight Deming-Vermorel nozzles, arranged in such a manner that each of

*The dates of spraying were June 4, June 19, July 2, July 17 and July 31.

†Manufactured by Morrill & Morley, Benton Harbor, Mich.

‡The cart and barrel were obtained from a Callister Paris green sprinkler, manufactured and sold by Thomas Callister, Queens, N. Y. Many Long Island farmers are familiar with this sprinkler. An ordinary 50-gallon barrel will answer the purpose just as well except that it will require filling oftener. Any stout two-wheeled cart having a tread of about six feet can be used. A two-wheeled dump-cart will answer the purpose.

Victor Rose.—56 rows; sprayed.
1.9382 acres.

Victor Rose.—8 rows; not sprayed. 0.2758 acres.

White Elephant.—84 rows; sprayed.
2.8817 acres.

White Elephant.—9 rows; not sprayed. 0.3073 acres.

Green Mountain.—48 rows; sprayed.
1.6318 acres.

Green Mountain.—5 rows; not sprayed. 0.1694 acres.

Defender.—63 rows; sprayed.
2.1261 acres.

Defender.—10 rows; not sprayed. 0.3358 acres.

*Diagram of Experiment Field at East Williston.*

four rows received the spray from two nozzles. Thus, four rows were sprayed at each passage. One man (an ordinary farm laborer) worked the pump and did the driving. This same man prepared the Bordeaux mixture and did all work connected with the spraying. The water used in the Bordeaux mixture was obtained at a farm-house which was 40 rods from the nearest point of the field. Therefore, it was necessary to haul the water from 40 to 88 rods. The Bordeaux mixture was prepared at the farmhouse and taken to the field in the spray-barrel.

*Expense of the spraying.*—The items of expense are as follows:

| | |
|---|---|
| 240 pounds copper sulphate at 4½ cents per pound | $10 80 |
| Freight on 240 pounds copper sulphate | 25 |
| 1 barrel unslaked lime | 1 40 |
| Carting sulphate and lime from railroad station | 50 |
| Potassium ferrocyanide | 10 |
| 25 pounds Paris green at 20 cents per pound | 5 00 |
| 44 hours labor for man at 15 cents per hour | 6 60 |
| 44 hours labor for horse at 15 cents per hour | 6 60 |
| Total | $31 25 |

This $31.25 covers all labor and cost of chemicals but does not include any allowance for the wear of machinery. The latter, however, is a part of the necessary expense of spraying and must be taken into consideration; but the amount can only be estimated. Considering that the first cost of the spraying outfit, exclusive of the cart, was less than $25, and that it was in use only about one-tenth of the time it might have been used, it would seem that $3 is sufficient to allow for the wear of the machine. Three dollars added to $31.25 (cost of labor and chemicals) makes *the total expense of spraying 8.58 acres, $34.25; or the total expense of spraying one acre five times, $4; or the total expense per acre for each spraying, 80 cents.*

Any farmer can spray potatoes as cheaply as this, provided he goes about it in the right way and is not obliged to haul water too far. The ease with which water can be obtained has an important bearing on the expense of spraying. Where water can be obtained easily and does not require hauling more than a few rods, spraying can be done for less than $4 per acre. In our experiment the water was pumped by hand and hauled from 40 to 88 rods, which consumed considerable time. We have also placed the value of labor, for both man and horse, a trifle high. Thirty cents per hour or three dollars per day for a man and horse is more than they will cost the average farmer.

The total quantity of Bordeaux mixture used in the experiment was 1,975 gallons, or 46 gallons per acre for each application. The quantity of Bordeaux mixture required depends largely upon the kind of nozzle used. The nozzle should throw a mist-like spray, the finer the better. Nozzles which throw a coarse spray waste the Bordeaux mixture. Deming-Vermorel nozzles were used in the experiment.

*Treatment of the unsprayed plats.*—As previously stated, a few rows of each variety were left unsprayed in order that the benefit from spraying might be definitely determined by comparing the yield of the sprayed plat with the yield of the unsprayed plat. These unsprayed plats were treated as the average farmer would treat his crop.

On Long Island it has become very popular to combat the Colorado potato-beetles with Paris green applied dry by means of Leggett's powder-gun. The Paris green is diluted with a considerable quantity of flower or air-slaked lime, preferably the latter, since the lime prevents the Paris green from "burning" the foliage. So we planned to treat the unsprayed or check plats in this manner.

The owner of the field was asked to notify us when he thought it was necessary to begin fighting the Colorado potato-beetles. On June 26 he notified us that the potato beetles were beginning to do damage to the unsprayed plats and should be poisoned. The same day we applied Paris green with Leggett's powder-gun under what we considered favorable circumstances. On the 1.09 acres there were used 1.5 pounds of Paris green mixed with 13 pounds of air-slaked lime. There was very little wind and the morning had been misty so that the foliage was wet. The Paris green and lime adhered well to the foliage and most of the beetles were killed.

On July 11 it was thought necessary to apply Paris green again. This time three pounds of Paris green were applied with lime in the same manner as before. The day, however, was not so suitable for the work. There was no wind but the foliage was dry. Most of the beetles were killed and they did not again become sufficiently numerous to seem to require another treatment.

The expense of treating the 1.09 acres with Paris green was as follows:

| | |
|---|---|
| 4½ pounds Paris green at 20 cents per pound | $0 90 |
| 5 hours labor at 15 cents per hour | 75 |
| Total | $1 65 |

This makes the expense per acre $1.51, which is undoubtedly somewhat greater than it is in ordinary farm practice. The powder-gun was rusty and did not work well, which resulted in a loss of time and waste of Paris green.

*The results.*—In the case of each of the four varieties the sprayed plat and the unsprayed plat were dug and weighed separately. The product of each plat was also divided into "merchantable tubers" and "culls," the latter class including not only the small tubers but also those which had been mutilated by the potato digger. The accompanying table presents the results in a condensed form:

EFFECT OF SPRAYING WITH BORDEAUX MIXTURE UPON YIELD OF POTATOES.

| VARIETY AND TREATMENT. | | YIELD PER ACRE. | | | | | | Increase in total yield per acre due to spraying. | | Increase in yield of merchantable tubers per acre due to spraying. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Merchantable. | | Culls. | | Total. | | | | | |
| | | Bu. | Lbs. | Bu. | Lbs. | Bu. | Lbs. | Bu. | Lbs. | Bu. | Lbs. |
| Victor Rose | Sprayed | 167 | 17 | 15 | 44 | 183 | 1 | 10 | 55 | 4 | 47 |
| | Unsprayed | 162 | 30 | 9 | 36 | 172 | 6 | ...... | | ...... | |
| White Elephant | Sprayed | 185 | 21 | 14 | 49 | 200 | 10 | 63 | 31 | 60 | 34 |
| | Unsprayed | 124 | 47 | 11 | 52 | 136 | 39 | ...... | | ...... | |
| Green Mountain | Sprayed | 253 | 38 | 13 | 21 | 266 | 59 | 63 | 50 | 62 | 5 |
| | Unsprayed | 191 | 33 | 11 | 36 | 203 | 9 | ...... | | ...... | |
| Defender | Sprayed | 194 | 29 | 8 | 47 | 203 | 16 | 19 | 14 | 16 | 6 |
| | Unsprayed | 178 | 23 | 5 | 39 | 184 | 2 | ...... | | ...... | |

No trace of late blight appeared in any part of the field. There was some early blight on the unsprayed plats but not as much as usual. The average observer would have said that the plants on the unsprayed plats were free from disease throughout the season and that it would certainly have been a wase of labor to spray them. Flea-beetles and Colorado potato-beetles were abundant.

In spite of the fact that the plants appeared to be free from disease of all kinds, spraying increased the yield sufficiently to pay all of the expense of spraying and a fair profit besides. The fact must not be overlooked that had these potatoes not been sprayed, Paris green must have been applied to them with a powder-gun or in some other way to keep the Colorado potato-beetles in check. Practically speaking then, the expense of spraying is not $4 per acre but $4 minus the expense of applying Paris green alone, which, in the experiment, was $1.51. We admit that $1.51 is probably high but in the absence of more accurate information we are obliged to use this sum. The difference between $4 and $1.51 is $2.49 which is the amount of extra expense per acre caused by spraying.

By consulting the table it may be seen that spraying increased the yield of merchantable tubers per acre on the four varieties as follows:

| | |
|---|---|
| Victor Rose, 4 bushels and 47 pounds; value at 25 cents per bushel. | $1.19 |
| White Elephant, 60 bushels and 34 pounds; value at 25 cents per bushel ........ | 15 14 |
| Green Mountain, 62 bushels and 5 pounds; value at 25 cents per bushel ........ | 15 52 |
| Defender, 16 bushels and 6 pounds; value at 25 cents per bushel... | 4 02 |

Comparing the values in the last column with $2.49, the expense of producing them, it is seen that:

| | |
|---|---|
| Spraying Victor Rose resulted in a loss of.............. | $1 30 per acre. |
| Spraying White Elephant resulted in a profit of.......... | 12 65 per acre. |
| Spraying Green Mountain resulted in a profit of......... | 13 03 per acre. |
| Spraying Defender resulted in a profit of............... | 1 53 per acre. |

Even if the comparison is made with $4, the total expense of spraying, there will still be a profit on all the varieties except Victor Rose—$2.81 loss on Victor Rose, $11.14 profit on White Elephant, $11.52 profit on Green Mountain and 2 cents profit on Defender.

The results of this experiment tend to show that it will pay to spray potatoes on Long Island every season; for if it has been profitable the past season it will be profitable any season. The season of 1896 was certainly an unusually favorable one for potatoes on Long Island. It is rare that potato plants are so generally free from the various blights.

## THE REQUISITES OF A POTATO SPRAYING EXPERIMENT.

The spraying of potatoes has never been practiced to any great extent on Long Island. Last year several farmers tried it for the first time and on account of the lack of blight they failed to obtain the striking results which they had expected. They saw no marked contrast between their fields which had been sprayed and their neighbors' fields which had not been sprayed. In some cases the unsprayed fields made the better appearance. Some of the more careful ones took the precaution to leave an unsprayed strip through the center or along one side of the sprayed field in order to make the test a fair one. They who did this must have observed a difference between the sprayed and unsprayed plants, but probably considered the difference so slight as to be of no practical importance. Had they completed the experiment by carefully measuring the land and measuring the potatoes on the sprayed and unsprayed portions of the field they would, most likely, have been astonished. A difference of from 15 to 20 bushels per acre can scarcely be detected while the crop is growing or even after the tubers have been thrown out by the potato digger, and yet this quantity is ordinarily sufficient to pay the expense of spraying.

To those persons who doubt that spraying pays, we suggest that they give it a fair test. A fair test requires that care be taken to avoid all unnecessary expense and that the sprayed and unsprayed plants shall be under practically the same conditions.

They must be of the same variety, planted at the same time, in the same manner, on the same kind of soil, treated with the same kind and quantity of fertilizer and given the same cultivation. The spraying must be properly done, the land accurately measured and the crop weighed. Failure to comply with any one of these conditions makes the test an unfair one.

## THE PHILOSOPHY OF SPRAYING.

It is believed that, in some unexplained way, the Bordeaux mixture has a direct beneficial influence on potato foliage, in addition to its value as a fungicide and repellent to insects. Its chief value, however, lies in the protection which it affords the leaves against the attacks of parasitic fungi and insects. The leaves of the potato plant are very essential organs and it is of the greatest importance that they should be perfect in order that they may do their work properly. The inorganic food substances which the plant absorbs from the soil through its roots are transferred to the leaves and by them assimilated, or in other words, transformed into starch and certain other organic substances which pass down the stem and are stored up in the tubers. The size and quality of the tubers are, therefore, directly dependent upon the activity of the leaves. If portions of the leaves are eaten away by insects or destroyed by disease their capacity for assimilation is lessened and the tubers are correspondingly smaller.

The truth of this is recognized when there is great destruction of foliage such as is caused by a severe attack of late blight or by hordes of Colorado potato-beetles, but it seems certain that the amount of damage done by leaf-eating insects and parasitic fungi is greatly underestimated. This is proven by the results of the spraying experiment reported in the previous pages. In that case, spraying increased the yield on one variety by the amount of 62 bushels per acre, chiefly by protecting the leaves in the following three ways: (1) from the apparently slight injury of the early blight fungus; (2) by affording partial protection from the injury caused by flea-beetles; and (3) by preventing the attacks of Colorado potato-beetles more thoroughly than could be done by means of Paris green applied with a powder-gun. No one of these three kinds of injury appeared great but the sum of the three was sufficient to make spraying very profitable.

The fungi which cause the diseases early blight and late blight, propagate themselves by means of minute spores which may be carried from plant to plant by the wind. When one of these spores falls upon a potato leaf and finds there a drop of dew or other moisture it germinates and grows into the leaf, producing a new disease-spot. If the leaf is covered with a thin coating of Bordeaux mixture the spore is unable to germinate and in this way spraying prevents fungous diseases. It is evident that any leaf which has none of the Bordeaux mixture will not be protected.

Bordeaux mixture will not kill either flea-beetles or Colorado potato-beetles, but it is very distasteful to them. They will not feed upon leaves covered with Bordeaux mixture if they can avoid it; and when Paris green is added to the Bordeaux mixture we have the best known remedy for both these insects. The Bordeaux mixture, being very adhesive, holds the Paris green on the leaves through quite heavy rains which would wash off Paris green applied in any other way. For flea-beetles, Paris green applied by the ordinary methods seems to be almost without avail. It is a mistaken notion, however, that Paris green is not poisonous to flea-beetles. It certainly will kill them if they eat it, and it is probably that a goodly number of them are actually killed by the Paris green applied in the ordinary way for potato-beetles. But flea-beetles are very cautious insects and shun the poison. If the Paris green is mixed with Bordeaux mixture and applied in the form of a fine spray, the poison will reach nearly every leaf and stick there for a long time, keeping the flea-beetles at bay.

From this discussion it will be seen that the degree of success attained in fighting flea-beetles by spraying depends upon the thoroughness with which the spraying is done. Leaves which are kept well covered with Bordeaux mixture and Paris green will suffer very little from flea-beetle attacks. Such leaves will suffer slightly from attacks made on the undersides, for flea-beetles feed to some extent from the under sides of the leaves where it is difficult to reach them with Bordeaux mixture. But all leaves which do not receive the Bordeaux mixture will be attacked by flea-beetles and also by fungi. In spraying, then, care must be taken that each and every leaf receives a little of the Bordeaux mixture. With a knapsack sprayer this is easily accomplished. There is no danger of getting on too much—the more the better. Where the spraying is done with stationary nozzles it is more difficult to reach all of the leaves. Experience has shown that one nozzle per row (no matter of what kind the nozzle may be) is insufficient. Two good nozzles per row will cover the foliage fairly well.

While it is impossible to state with accuracy what degree of protection against flea-beetles will be afforded by Bordeaux mixture and Paris green applied every two weeks by means of two stationary nozzles per row, observation leads us to estimate it at from 25 to 50 per cent ; that is, plants sprayed in this way would be injured by flea-beetles from one-half to three-fourths as much as plants not sprayed. In view of the results of the experiment reported on page 397 of this Report, we are of the opinion that it will pay to use three nozzles per row in the last two sprayings.

## SECOND SPRAYING EXPERIMENT AT EAST WILLISTON.

The following spraying experiment was made in the season of 1896 on a farm managed by C. Burkard and located near East Williston, N. Y.

*Objects of the experiment.*—The experiment was designed to furnish information on several points of interest in regard to the spraying of potatoes.

During the past two years the Station has received numerous inquiries concerning the value of the so-called dry Bordeaux mixture patented under the name "Fungiroid." This is manufactured and sold by Leggett & Brother, 301 Pearl Street, New York. It is claimed to be a remedy for potato blight and some other fungous diseases and is to be applied in dry form with a powder-gun sold by the same firm. The powder-gun is much used by Long Island farmers for applying Paris green to potatoes and the question is often asked, Will not the Fungiroid and Paris green applied together with the powder-gun produce as good results as the wet Bordeaux mixture applied with a spraying machine? An answer to this question was one of the objects of the experiment.

James A. Blanchard, 4 and 6 Gold Street, New York, has patented and placed upon the market a concentrated form of Bordeaux mixture, which is known as the "Lion Brand" Bordeaux mixture. It is sold in tin cans containing one gallon of a thick, slate colored liquid. This quantity is to be added to forty-nine gallons of water and applied with a spraying machine in the ordinary way. This mixture also was tested in the experiment.

In some sections of the United States three applications of Bordeaux mixture to potatoes are considered sufficient. In other sections it seems necessary to make five applications. In our experiment at Floral Park, in 1895, one plat was sprayed three times and another five times, the first three applications on the two plats being made on the same dates. The plat sprayed five times yielded ten bushels per acre more than the plat sprayed three times. It was thought that the three sprayings might have given better results if they had been made at sufficiently long intervals to cover the entire season of growth. It was planned to test this in the experiment.

The Bordeaux mixture used for spraying orchards and vineyards is made after the 1-to-11 formula, in which one pound of copper sulphate is required to make eleven gallons of Bordeaux mixture. But for spraying potatoes a more concentrated form of Bordeaux mixture has generally been used; namely, Bordeaux mixture made after the 1-to-7 formula, in which one pound of copper sulphate is required to make seven gallons. The weaker mixture is, of course, the cheaper and consequently the more desirable to use provided it is equally efficient. To determine the relative efficiency of these two strengths of Bordeaux mixture was one of the objects of the experiment.

In the experiment at Floral Park, in 1895, it was observed that Colorado potato-beetles shunned plants which had been sprayed with Bordeaux mixture containing no Paris green.* This suggested the idea that perhaps Paris green might be dispensed with and the Bordeaux mixture alone used for both "bugs" and blight. The experiment was planned to test the value of Bordeaux mixture used without Paris green.

*Plan of the experiment.*—In an experiment in which the character of the soil is an important factor, long narrow plats are likely to give more reliable results than square plats or plats in which the length and breadth are nearly equal. The narrower the plats the less is the liability to error arising from non-uniformity of soil. The experiment under consideration was so planned that differences in soil conditions were practically eliminated and this adds much to the value of the results.

The experiment included fourteen rows, 920 feet, or nearly fifty-six rods in length, of the variety Late Blush.

The rows were numbered consecutively and two separated rows received similar treatment in each case.

Rows 1 and 8 were treated five times with Fungiroid and Paris green, half and half, applied dry with a Leggett powder-gun according to the directions given on the can.†

Rows 2 and 9 were treated five times with Paris green in lime water. The lime water was used to prevent the free arsenious acid in the Paris green from injuring the foliage.

Rows 3 and 10 were sprayed five times—the first time with Paris green in lime water the same as was used on rows 2 and 9, and the last four times with "Lion Brand" Bordeaux mixture‡ and Paris green.

Rows 4 and 11 were sprayed four times with Bordeaux mixture (1-to-7 formula) and Paris green. It was the original intention to spray these rows only three times, but it was found absolutely necessary to make a fourth application.

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*N. Y. Agrl. Exp. Sta. Bul. No. 101, p. 75.

† Fungiroid may be purchased separately or mixed with Paris green, half and half, in pound cans ready for use. We used the latter form.

‡ It was planned to use "Lion Brand" Bordeaux mixture for all five applications but the can of Bordeaux designed for use in the first application was stolen. The contents in one of the two cans subsequently used was so thick that it could not be gotten out of the can through the three-fourths inch hole provided for that purpose. It was necessary to cut out the top of the can. The other can was better in this respect, but still it was difficult to empty out the contents through the hole.

Rows 5 and 12 were sprayed five times with Bordeaux mixture (1-to-7 formula) and Paris green.

Rows 6 and 13 were sprayed five times with Bordeaux mixture (1-to-7 formula) alone.

Rows 7 and 14 were sprayed five times with Bordeaux mixture (1-to-11 formula) and Paris green.

The several applications were made to all fourteen rows on the same dates, namely, June 11, June 26, July 10, July 24 and August 7. The last application was omitted from Rows 4 and 11. All liquids were applied with a knapsack sprayer and care was taken that each row received practically the same quantity. In all cases where Paris green was used (except on Rows 1 and 8), it was used at the rate of one ounce of Paris green to four gallons of liquid. The first application was made when the plants were about six inches high.

*Prevalence of insects and disease.*—No trace of late blight appeared and only a small amount of early blight. Flea-beetles were moderately abundant and Colorado potato-beetles very abundant. For a few days after the first treatment, June 11, the potato-beetles were scarce, but by the time of the second treat-

COMPARATIVE EFFECT OF DIFFERENT FUNGICIDES AND INSECTICIDES UPON YIELD OF POTATOES.

| KIND OF TREATMENT RECEIVED. | PRODUCT OF THE TWO ROWS. | | COMPUTED YIELD PER ACRE. | | | Increase in yield of merchantable tubers per acre using the two rows treated with Paris green in lime-water as a basis of comparison. |
|---|---|---|---|---|---|---|
| | Merchantable tubers. | Culls. | Merchantable tubers. | Culls. | Total. | |
| | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. |
| Fungiroid and Paris green, 5 times | 7.25 | 3.00 | 62.50 | 25.75 | 88.25 | — 6.25 |
| Paris green in lime-water, 5 times | 8.00 | 2.50 | 68.75 | 21.50 | 90.25 | |
| Paris green in lime-water, once; "Lion Brand" Bordeaux + Paris green, 4 times | 8.38 | 1.75 | 72.25 | 15.00 | 87.25 | + 3.50 |
| 1-to-7 Bordeaux+Paris green, 4 times | 10.63 | 1.50 | 91.50 | 12.75 | 103.25 | + 22.75 |
| 1-to-7 Bordeaux+Paris green, 5 times | 11.00 | 1.25 | 94.75 | 10.75 | 105.50 | + 26 |
| 1-to-7 Bordeaux, 5 times | 8.75 | 1.50 | 72.25 | 13.00 | 88.25 | + 6 50 |
| 1-to-11 Bordeaux + Paris green, 5 times | 11.25 | 1.00 | 97.00 | 8.50 | 105.50 | + 28.25 |

ment, June 26, they were again abundant. The second treatment disposed of them again, but they became numerous by the time of the third treatment, July 24. The third treatment, however, finished them for the season. They gave no trouble after July 24. In this experiment the fight was chiefly against the Colorado potato-beetles, and it was a hard fight. Throughout the whole season it was noticed that they were the most numerous on Rows 1 and 8, treated with Fungiroid and Paris green. Rows 2 and 9 seemed to suffer to about the same extent as Rows 3 and 10. The rows to which ordinary Bordeaux mixture had been applied did not suffer nearly so much as the other rows, and among the Bordeaux rows it was noticeable that the beetles had a decided preference for those which had received no Paris green.

All of the plants dried up somewhat sooner than they should have done. They did not, however, die from any disease, but from lack of proper cultivation.

*Results.*—The results of the experiment are tabulated on the preceding page.

The seven kinds of treatment arranged in the order of their value would, therefore, stand as follows:

(1) Bordeaux mixture (1-to-11 formula) and Paris green, five times.

(2) Bordeaux mixture (1-to-7 formula) and Paris green, five times.

(3) Bordeaux mixture (1-to-7 formula) and Paris green, four times.

(4) Bordeaux mixture (1-to-7 formula) alone, five times.

(5) Paris green in lime water, once; "Lion Brand" Bordeaux mixture and Paris green, four times.

(6) Paris green in lime water, five times.

(7) Fungiroid and Paris green dry, five times.

*Comments on the results.*—We can see no reason why 1-to-11 Bordeaux should give better results than 1-to-7 Bordeaux. It was expected that the position of these two treatments would be reversed. It should be borne in mind, however, that the fight was chiefly against insects and, consequently, the value of the Bordeaux mixture lay, for the most part, in its adhesive property which caused it to hold the Paris green on the leaves. The 1-to-11 Bordeaux adheres just as well, but no better, than 1-to-7 Bordeaux. The difference (2.25 bushels per acre) is so slight as to make them practically equal. Had late blight been prevalent the results might have been different. In a season when potatoes blighted badly, Prof. L. R. Jones* of the Vermont Station found strong Bordeaux decidedly preferable to weak Bordeaux, but he did not use the same formulæ used in this experiment.

It was found wholly impracticable to get along with three applications of Bordeaux mixture. If any one of the first three treatments had been postponed the plants would certainly have been seriously injured by Colorado potato-beetles. And it would not have been prudent to omit the fourth treatment which was made July 24, because the plants would then have been unprotected against late blight which was liable to appear any time after July 15.

With Paris green, 1-to-7 Bordeaux mixture produced 19½ bushels per acre more than the same mixture *without* Paris green. This shows that Bordeaux mixture falls far short of furnishing complete protection against insects. Paris green must be used with it. It is to be noted, however, that Bordeaux mixture alone gave better results than Paris green in lime water, Fungiroid and Paris green applied dry, or the "Lion Brand" Bordeaux mixture and Paris green; and this, too, when insects were the chief enemies. Bordeaux mixture certainly has considerable value as a repellent of insects.

The "Lion Brand" Bordeaux mixture with Paris green was a failure, giving but 3½ bushels per acre more than Paris green in water. The experiment does not prove that it may not have some value as a fungicide, because very little fungus was encountered in the experiment; but the experiment *does* prove that as a spraying mixture for potatoes it is decidedly inferior to ordinary Bordeaux mixture. It lacks the adhesive property of Bordeaux mixture.

Fungiroid with Paris green made an even worse showing. The rows treated with Fungiroid and Paris green yielded 6.25 bushels

*Vt. Agrl. Exp. Sta. Ninth Ann. Report, 1895, p. 97.

per acre less than the rows treated with Paris green in lime water. There being but little fungus, this difference represents the difference between applying Paris green dry and applying it in lime water. The Fungiroid and Paris green were applied according to directions on the can, namely, at the rate of two pounds per acre, applied on dry foliage with a Leggett powder-gun, and when there was but little wind. Although this experiment furnishes no information as to the fungicidal value of Fungiroid we do not hesitate to state that, in our opinion, the value of Fungiroid is so small as compared with liquid Bordeaux mixture that it has no claim to consideration from potato growers. Our opinion is based: (1) On the fact that Fungiroid lacks the adhesive property of Bordeaux mixture; (2) on the results of experiments at other experiment stations in which the merits of Fungiroid and Bordeaux mixture have been compared; (3) on the opinions of eminent authorities on plant diseases. Prof. L. R. Jones, botanist of the Vermont Experiment Station, experimented with Fungiroid and other forms of dry Bordeaux mixture on potatoes for two seasons. From the results of these experiments he draws the following conclusion:* "When these powders were applied dry, even in the most liberal amounts, they gave so little protection that their substitution for the ordinary or wet mixture is not to be recommended under any circumstances." In an experiment made by Mr. H. P. Gould† at the Maine Experiment Station, Fungiroid applied to potatoes increased the yield 10 per cent, while wet Bordeaux mixture increased the yield 31 2-3 per cent under parallel conditions. Prof. Galloway,‡ Chief of the Division of Vegetable Physiology and Pathology, United States Department of Agriculture, considers powder fungicides as a class much inferior to liquid fungicides.

The small yield on all parts of the experiment field was due to poor cultivation. The experiment furnishes a striking example of the fact that spraying cannot be made to take the place of cultivation.

* Loc. cit., p. 98.

† Me. Agrl. Exp. Sta. Bul. No. 28.

‡ *Rural New Yorker*, Vol. LV, Aug. 8, 1896, p. 528.

## ONE HUNDRED GALLONS OF BORDEAUX MIXTURE PER ACRE VS. FIFTY GALLONS PER ACRE.

The following experiment was conducted on the farm of Mr. H. L. Hallock, near Jamesport, N. Y.:

Seven rows, 636 feet in length, were planted with potatoes of the variety White Elephant. Considerable care was taken to apply the fertilizer uniformly over the seven rows and to cut the seed potatoes in such a way as to leave two eyes to each piece. They were planted with a potato-planter. This was on land which had grown corn the previous season.

During the season they were sprayed five times with Bordeaux mixture, Paris green being added in the first two sprayings. The dates of spraying were June 9, June 22, July 8, July 22 and August 6. The Bordeaux mixture was applied with a Hudson Special Bordeaux Sprayer, a cut of which may be seen in Fig. 11. This sprayer is arranged to spray four rows at a time with two nozzles to each row, so that in going across the field and back again eight rows are sprayed. But instead of spraying eight rows we sprayed only seven and were thus enabled to double spray the center row; in other words, the center row received at each spraying exactly twice as much Bordeaux mixture as each of the other six rows. Since the sprayer applies Bordeaux mixture at the rate of about 50 gallons per acre, the six single sprayed rows received Bordeaux mixture at the rate of 50 gallons per acre and the double sprayed row or center row at the rate of 100 gallons per acre.

At digging time the tubers on the center row were weighed by themselves. The tubers on the other six rows were also weighed.

The double sprayed row yielded $430\frac{1}{2}$ lbs. mechantable tubers, 35 lbs. culls.

The six single-sprayed rows averaged $390\frac{1}{2}$ lbs. merchantable tubers, $52\frac{2}{3}$ lbs. culls per row.

Difference in yield of merchantable tubers, 40 lbs. per row or 15 bu. 13 lbs. per acre.

The experiment was repeated on seven other rows of potatoes 536 feet long, planted on clover sod. The treatment was the same and the result was as follows:

The double-sprayed row yielded 463¾ lbs. merchantable tubers, 22 lbs. culls.

The six single-sprayed rows averaged 403 11/12 lbs. merchantable tubers, 21 lbs. culls per row.

Difference in yield of merchantable tubers, 59 5/6 lbs. per row or 27 bu. per acre.

To recapitulate, potatoes sprayed five times with Bordeaux mixture at the rate of 100 gallons per acre outyielded potatoes sprayed at the rate of 50 gallons per acre. The amount of the difference was in one case 15 bu. 13 lbs. of merchantable tubers per acre, and in another case, 27 bu. of merchantable tubers per acre.

As in the experiments at East Williston, the fight here was chiefly against flea-beetles and Colorado potato-beetles. There was very little disease of any kind to contend with.

The result of this experiment confirms us in a previously formed opinion based upon general observation, namely, that heavy applications of Bordeaux mixture give much better results than light applications, and that it will pay to use at least three nozzles per row in the last two sprayings.

## A TEST OF THE HUDSON SPECIAL BORDEAUX SPRAYER.

Quite recently Long Island potato growers have begun to take considerable interest in the spraying of potatoes, and one of the greatest obstacles to progress in the practice of spraying is the difficulty of obtaining suitable machinery for applying the Bordeaux mixture. For gardens and small fields of from one to two acres the knapsack sprayer answers very well; but for the large fields of those farmers who make potatoes their chief farm crop, the knapsack is too tedious. In our opinion the most economical method of spraying these large fields is by means of a home-made outfit similar to the one shown in Plate XIV. There are, however, many farmers who object to the labor required to operate such an outfit. They desire a sprayer so arranged that all of the work is done by horse power. Sprayers of this description are necessarily somewhat complex and consequently expensive. Several different kinds have been placed upon the market, but they have been so defective in various ways that farmers have become suspicious of this class of sprayers. The perfect power sprayer for potatoes has not yet appeared.

In the spring of 1896, the Riverhead Agricultural Works, Riverhead, N. Y., put out a new Hudson Special Bordeaux Sprayer. This machine having certain new, and, apparently, desirable features, and being manufactured and sold by a firm located in the potato growing section of Long Island, it seemed necessary for us to test it so that we might be able to answer correctly the inquiries which are certain to arise concerning it.

We used it throughout the season of 1896 for spraying about seven acres of potatoes near Jamesport, Long Island, and found it quite satisfactory. One of the strong points of the sprayer is the manner in which the nozzles are arranged. There are two nozzles to each row, and they can be readily adjusted to suit the size of the plants. We are thoroughly convinced that one nozzle per row is entirely insufficient, except, perhaps, for the first spraying.

We experienced very little difficulty from clogging of the nozzles. The Bordeaux mixture is drawn from the bottom of the barrel and this is generally considered an objectionable feature, since there is more liability of the nozzles clogging than there is when the escape tube leaves the barrel from the top. But in the Hudson sprayer the agitation of the liquid is so thorough that this difficulty is overcome, provided a reasonable amount of care is used in straining the Bordeaux mixture and in rinsing out the barrel. The ease with which the barrel can be filled is another good feature of the machine.

This sprayer should give excellent satisfaction, if in operating it the following rules are heeded:

(1) *The Bordeaux mixture must be thoroughly strained.*— The strainer furnished with the sprayer is entirely sufficient. Everything that goes into the barrel should be passed through this

strainer. There need be no difficulty in getting Bordeaux mixture through the strainer if the Bordeaux is properly made. First of all, see that the barrel in which the Bordeaux is to be mixed is free from sticks and dirt — rinse it well. Always strain the lime water and if there is dirt in the water, strain it also. With proper management this straining process need not consume much time and in the end there will be a great saving of time. Avoid a great excess of lime in the Bordeaux.

(2) *At the close of each day's work pass a small quantity of clean water through the nozzles and rinse the barrel.*—This should always be done but is most important when Paris green is used with the Bordeaux mixture.

## DIRECTIONS FOR SPRAYING POTATOES ON LONG ISLAND.

Spray every season. Begin when the plants are from six to eight inches high and spray once every two weeks as long as the plants continue green. If heavy rains occur it may be necessary to spray somewhat oftener, particularly in seasons when late blight is prevalent. Use Bordeaux mixture of the 1-to-8 formula; that is, use one pound of copper sulphate for every eight gallons of Bordeaux mixture. When Colorado potato-beetles or flea-beetles are abundant add Paris green to the Bordeaux mixture at the rate of three-fourths of a pound of Paris green to 50 gallons of Bordeaux mixture. Spray thoroughly. If a sprayer with stationary nozzles is used there should be two nozzles per row in the first three spraying and three nozzles per row in all subsequent sprayings. It is, however, sometimes difficult to arrange the nozzles so that three per row can be used with advantage. In such cases it may be advisable to use, instead, two nozzles per row and go over the plants twice in opposite directions. By all means, spray thoroughly in the latter part of the season.

This treatment can be depended upon to prevent early blight and late blight or rot, keep off Colorado potato-beetles and considerably reduce the amount of damage done by flea-beetles.

Plate XV.—Young Sweet Corn Plant Affected with Bacterial Disease. About Three-fourths Natural Size.

# III. A BACTERIAL DISEASE OF SWEET CORN.*

F. C. STEWART.

## SUMMARY.

In the market gardens of Long Island, early varieties of sweet corn are much subject to a wilt disease in which the fibro-vascular bundles of the plant are gorged with multitudes of short, yellow bacilli. The disease is certainly different from Burrill's corn disease and is one which has not heretofore been reported. The yellow bacillus found in the fibro-vascular bundles is undoubtedly the cause of the disease and brings about the death of the plant by cutting off the supply of water. It has been artificially cultivated on various culture media and its behavior recorded. The disease seems to be confined to sweet corn and is most destructive to early varieties. Field corn and pop corn are entirely exempt. Outside of Long Island it is positively known to occur only in Iowa, but, probably, careful search will show that it is widely spread. It is disseminated chiefly by means of the germs which cling to the seed, but also by manure, implements and washing of the soil. As for remedial measures, the principal things to be observed are: (1) Care in the selection of seed and (2) the planting of resistant varieties. Lime and sulphur, applied to the soil have been tried and proven unsuccessful.

## INTRODUCTION.

During the past three years the writer has had under observation a bacterial wilt disease which has done considerable damage to sweet corn in the market-gardens of Long Island. The disease was originally discovered at Queens, N. Y., on a very early, dwarf variety of sweet corn named Manhattan. It has since been found affecting many different varieties and in all parts of Long

* Reprint of Bulletin No. 130.

Island. Certain varieties have been much more severely attacked than have others, but the disease has been widespread on Long Island and, in several instances, destructive, particularly in the season of 1897. Occasionally, an entire crop has been ruined and losses of from 20 to 40 per cent have been frequent; but in the majority of cases the loss has been so slight as to pass unnoticed by the farmer, although one familiar with the disease could readily detect it in almost any field of early sweet corn on Long Island during the past season.

Although we had here to deal with a disease of considerable economic importance, it soon became evident that it is an undescribed disease caused by a species of bacterium which is probably unknown to science. Previous to the discovery of this disease, the only known bacterial disease of corn (*Zea mays*) was one described by Burrill* in 1889. Burrill's disease affects field corn and differs so widely from the disease under consideration that there is no doubt that the two are entirely distinct.

## SYMPTOMS OF THE DISEASE.

Some bacterial diseases of plants are very difficult to diagnose. They have no characters by which they can be readily identified without the aid of a compound microscope, and for some diseases the revelations of the microscope must be supplemented by information obtained from the study of cultures. Fortunately, this disease of sweet corn has some distinguishing characters by which it can be identified with certainty and without the aid of a microscope.

The affected plants wilt and dry up without any apparent cause. This may occur at any stage of growth but it is most likely to occur about the time of flowering. The past season it was observed to be very prevalent as early as June 12, among plants which were from eight to ten inches in height. The leaves wilt and then gradually wither. The time which elapses between the first appearance of the disease and the death of the plant varies greatly. In some cases it may be no more than four days, while in others it may occupy a month. Sometimes an affected

*Burrill, T. J. A Bacterial Disease of Corn. Ill. Agl. Exp. Sta. Bul. No. 6.

plant will completely recover, or it may recover for a time and succumb to the disease later. Occasionally, all of the leaves of a plant will wilt simultaneously (this is most likely to happen with small plants), but more often they die one after another so that wholly dry leaves and green leaves may be seen on the same plant. There is no abnormal coloration — it is simply a drying up of the tissues. There is nothing abnormal about the roots and the subterranean portion of the stem appears sound and normal except in the case of plants which have been dead for some time. Such plants may show black decay spots on the subterranean stem; but decay does not set in until the whole plant is dead and even then progresses slowly. The fact that the whole interior of the lower end of the stem is brown signifies nothing. This browning is found in healthy plants as well as in the diseased ones.

The most distinctive character of the disease is revealed when the stem is cut lengthwise. The fibro-vascular bundles appear as yellow streaks in the white parenchyma; but in the stems of plants which have been dead for some time some of the bundles may be black instead of yellow. If the stem is cut crosswise and the cut surface exposed to the air for about five minutes, a yellow, viscid substance exudes in drops from the ends of the vessels. This yellow substance in the fibro-vascular bundles is composed of bacteria. It is an invariable accompaniment of the disease and in plants which have died from the disease it will be sufficiently abundant to be seen easily with the naked eye. Thus we have in this yellow substance a character by which the disease may be readily identified. It should be stated, however, that in very young plants the yellow substance is detected less easily than in large ones with well-developed vascular systems; and, also, that the microscope will show its presence in the vessels of the plants before it can be detected with the naked eye and before there is any outward manifestation of the disease except in the dwarfed condition of the plants.

Fields of sweet corn affected with the disease are very uneven, particularly at the time when the ears are forming. Plants in various stages of the disease are intermingled with apparently healthy plants of different sizes. It is a common thing to find diseased plants in the same hill with healthy ones which may continue in good health to the end of the season. There are no indications that the disease is communicated from one plant to another. It does not spread from an initial center, but is scattered all through the field. Usually, the small plants are the first to succumb to the disease, which fact suggests that the disease may be the cause of their slow growth. This suspicion was confirmed by microscopic examination. Plants green and apparently healthy, except for their small size, were found to contain a considerable quantity of the bacterium in their vessels, while in the larger, more vigorous plants the bacterium could not be found. However, in wet weather the bacterium may sometimes be found in quite vigorous plants. This feature of the disease will be discussed more fully on a subsequent page.

The bacterium invades the vessels of all parts of the plant, including the roots. Plants which did not succumb to the disease until after the ears had commenced to form were examined after they were dead but before they were completely dry, and the bacterium was found in abundance in the vessels of all parts of the stem clear up to the tassel and in the ear, where it oozed out onto the kernels and the inner husks. The ears showed no tendency to rot.

## BACTERIA THE CAUSE OF THE DISEASE.

Since affected plants behave very much like plants suffering from lack of moisture, except that there is little or no "rolling" of the leaves, careless observers are liable to think that dry weather is the cause of the trouble. This theory is at once rendered untenable by the fact that plants die from the disease in wet weather as well as in dry weather. Some have attributed the trouble to the fertilizer used, but one does not have far to seek to remove suspicion from the fertilizer. It is also easily demonstrated that insects are not responsible for it. Various species of fungi may be found on the roots of dead plants but no species is constantly associated with the disease and fungous hyphæ are to be found on the interior of the stem only in decayed specimens. A pink Fusarium grows in great profusion on the sheathing bases of the leaves and *Epicoccum neglectum* Desm. is common on the dead leaves, but both of these fungi are saprophytes and do not appear until the leaves are dead.

The yellow mass of bacteria in the vascular system becomes an object of suspicion as soon as it is observed. These bacteria make their appearance before the plant commences to wilt and by the time the plant is wholly dead the vessels are gorged with them. If the bacteria have nothing to do with the disease how can their presence be explained? Russell* has shown that " normally, the healthy plant, with intact outer membranes, is free from bacteria within its tissues." Concerning the possibility of saprophytic bacteria gaining access to healthy plant tissue through the medium of wounds, the same author reports experiments† in which it was shown that, although certain saprohytic species are capable of spreading through healthy tissue, they do not penetrate to any great distance nor multiply rapidly. Therefore, on account of the immense numbers of the corn bacterium which may be found throughout the vascular system of every affected plant, even in the early stages of the disease, and its scarcity in the tissues of vigorous, healthy plants, coupled with the fact of the absence of any other sufficient cause, it is safe to assume that the yellow bacterium is the cause of the trouble. Conclusive proof of this, however, is to be obtained only from inoculation experiments.

## ISOLATION OF THE GERM.

Pure cultures of the germ are easily obtained. It grows readily, at a temperature of from 21° to 28°C., on neutral beef agar, neutral potato agar or neutral gelatin. By carefully splitting open the stem of a freshly wilted plant and touching a sterilized platinum needle to one of the bacteria-laden vessels it is quite

*Russell, H. L. Bacteria in Their Relation to Vegetable Tissue. A dissertation presented to the Board of University Studies of the Johns Hopkins University for the degree of Doctor of Philosophy. Friedenwald Company, Baltimore, 1892, pp. 3-6.

†Non-Parasitic Bacteria in Vegetable Tissue. Bot. Gazette, Vol. XVIII, pp. 93-96.

easy to obtain a Petri-dish culture which is almost entirely free from foreign germs. This can be done with small plants but it is more easily accomplished if the plants are large and have well-developed stems. Unless there is an undue amount of moisture on the surface of the medium the colonies show no tendency to spread and run together.

## INOCULATION EXPERIMENTS.

Attempts to inoculate field-grown plants of sweet corn have been unsatisfactory because it has been practicably impossible to obtain plants which were known to be free from the disease. Susceptible varieties have been quite generally affected, and since the disease is one which acts slowly it is not possible to get results of much value from inoculation experiments made upon plants among which the disease previously existed, even to a slight extent. Only one of the field experiments is worth reporting in detail. It is as follows: In 1896 thirteen hills of Manhattan sweet corn were planted in one row. In each of the first seven hills there was placed, at time of planting, a handful of dirt taken from soil in which the disease was prevalent the preceding season. The remaining six hills were left untreated for comparison. When the plants were a few inches high they were thinned to four in a hill. A few of the plants in the inoculated hills began to wither before they were a foot high and from this time on they withered one by one, until on July 20th, when the kernels were "in the milk," all of the inoculated plants except two were either dead or dying. At this date, not a single plant in any of the uninoculated hills showed any symptoms of the disease; but later in the season several of the plants became affected. How they came to be affected is not known. While this experiment was not wholly satisfactory the results tend to show that the disease is communicable.

Several attempts were made to inoculate sweet corn by puncturing the stem near the ground and inserting a small quantity of the diseased tissue of an affected plant. In some of the large varieties the inoculated plants remained healthy to the end of the season. In the smaller varieties the disease usually appeared in from two to four weeks after inoculation, but the uninoculated plants used as a check, likewise, invariably became affected to a considerable extent so that no trustworty information could be obtained from such experiments.

Finally it became evident that the plants must be grown in pots of sterilized soil if the inoculation experiments were to furnish results of any value. A quantity of soil was thoroughly sterilized in steam sterilizers and placed in large pots. On July 3 Early Cory sweet corn (grown in Iowa) was planted in the pots and inoculation experiments with pure cultures of the yellow germ were started. The pots were allowed to remain uncovered; otherwise, all precautions were taken to prevent contamination. Nevertheless, an undoubted case of the disease was found in one of the check pots on August 3d, and later several others were found. This meant that diseased seed had been used and the experiment was worthless except to prove that infection may be brought about by the germs which cling to the seed.

Three unsuccessful attempts were made to produce the disease in yellow dent field-corn by inoculation. On August 28th, 1895, ten plants of yellow dent corn (variety unknown) were inoculated by puncturing the stem at the surface of the soil with a sterilized scalpel and then inserting into the puncture a small quantity of the yellow substance taken directly from the interior of the stem of a diseased sweet corn plant. These plants were under observation until frost (about October 7th) but none of them showed any symptoms of the disease. On July 12, 1897, twenty plants of yellow dent corn, variety Golden Dent, were inoculated in the same manner as in the experiment of 1895. None of these plants developed outward symptoms of the disease, but a month after inoculation it was found that in several of the plants the yellow bacillus had ascended a few of the fibro-vascular bundles where it was visible to the naked eye as far as the third node above the point of inoculation. It was noticeable, however, that it occurred only in bundles which had been ruptured by the needle used in inoculation. In 1897 a 50-foot row of the same Golden Dent corn was inoculated by placing in the drill, at the time of planting, a liberal quantity of soil in which diseased plants had grown the preceding season. Not a single plant developed the disease.

Pop corn, also, has resisted all attempts at inoculation. In 1897 a 50-foot row of pop corn, variety Maple Dale, was inoculated by putting diseased soil in the drill at time of planting. None of the plants became diseased. On July 8, 1897, twenty plants of the same variety of pop corn were inoculated by puncturing the stem and inserting diseased tissue into the wound as in the experiments with sweet corn and field corn. None of the plants became diseased, but as in the case of field corn the germ could be seen in some of the bundles up to the third node.

Oats inoculated by means of diseased soil, and teosinte (*Euchlœna luxurians*), inoculated both by puncture and diseased soil gave negative results.

## DESCRIPTION OF THE GERM.

*Morphology.*—A short bacillus with rounded ends; usually occurring in pairs with a plain constriction between the members. A pair varies in length from 2.5 microns to 3.3 microns, and in width or diameter from .65 micron to .85 micron. (See Plate XVI, fig. 1.) No spores have been observed, but since an extended examination of old cultures has not been made it can not be stated with certainty that spores are not formed. The organism is plainly motile but not actively so.

*Growth on agar.*—The organism grows readily on neutral agar of the following composition: Finely chopped beef, 500 grams; Witte's peptonum siccum, 5 grams; agar, 15 grams; water, 1 liter; made neutral with sodium carbonate. In Petri-dish cultures on this medium the colonies become plainly visible within forty-eight hours at a temperature of 22° to 25° C. The buried colonies soon become spindle-shaped, while the surface colonies are circular and with nearly smooth outline. From the very start the colonies have a light yellow color which deepens to light orange-yellow in the course of about a week. The surface colonies are smooth and shining and show no tendency to spread


PLATE XVI. FIG. 1.—VARIOUS FORMS OF THE SWEET CORN BACILLUS GROWN ON POTATO AGAR; *a* AND *b* ARE TYPICAL FORMS. MAGNIFICATION, 1,875 DIAMETERS.

PLATE XVI. FIG. 2.—PETRI-DISH CULTURE OF THE SWEET CORN BACILLUS SHOWING EFFECT OF EXPOSURE TO SUNLIGHT.

widely over the surface of the agar. In streak cultures there is considerable growth at the end of twenty-four hours at the room temperature. This growth is at first dirty yellowish-white, but gradually changes to a deep yellow (a color expert pronounced it "raw sienna"). The margins of the growth are quite strongly lobulated, but well defined. The surface is at first smooth and shining, but as the water evaporates from the agar granulation takes place, commencing in the upper part of the tube. It does not grow down into the agar nor color the agar. No odor is produced. In stab cultures there is considerable growth along the needle-track. The "nail-head" growth is thick, its margin is slightly irregular and of a deeper yellow than the interior. For a considerable length of time the surface is smooth but eventually it becomes granular as in streak cultures.

The organism grows readily, also, on potato agar which is prepared by adding ten grams of agar to one liter of potato broth. The color and habit of growth are practically the same as on beef agar.

*Growth on gelatin.*—The gelatin used was the following comcomposition: Beef, 500 grams; Witte's peptonum siccum, 10 grams; gelatin (Compte Fils à Madgebourg, first quality), 150 grams; water, 1 liter; neutralized with sodium carbonate. On this medium, at the same temperature, the organism grows less rapidly than on agar. In streak cultures the growth is narrow, quite thick, smooth and shining on the surface and smooth along the margins. The color is a trifle lighter than on agar, and there is no granulation until the seventh or eighth week. There is no growth down into the agar. In stab culture the "nail-head" growth is of small diameter, thick, smooth and shining, smooth around the margin and of orange-yellow color. Along the needle-track there is considerable of a dirty yellowish-white growth. The needle-track does not become funnel-shaped. There is no liquefaction of the gelatin.

*Growth on potato.*—On sterilized slanted potato cylinders the organism grows very rapidly. Potato seems to be its favorite culture medium. At a temperature of 26°C. there is a copious growth in twenty-four hours. It spreads irregularly over the slanted surface, is smooth, and for three or four days has the same color as on agar, but at the end of a week it is slightly iridescent. In 48 hours the potato cylinder begins to turn brown and in a week it is decidedly brown. A yellowish-white precipitate forms in the water at the bottom of the tube. No gas bubbles are formed.

*Growth in bouillon.*—It grows in bouillon, either neutral or made quite strongly acid with malic acid, but the growth is not conspicuous. In bouillon containing 500 grams beef and ten grams Witte's peptonum siccum per liter it produces, in twenty-four hours, a slight cloudiness which increases very slowly. At the end of three weeks some flocculent white precipitate is formed, the liquid is moderately cloudy, and, if the tube has remained quiet for several days, the surface will be covered by a thin film bearing raised, yellow colonies of the size of a pin-head.

*Growth in peptone solution.*—The peptone solution of Dunham was used. The formula is as follows: Distilled water, 1 liter; peptone (Witte's peptonum siccum in the present case), ten grams; sodium chloride, 5 grams. In twenty-four hours there is a slight turbidity which becomes quite pronounced at the end of a week. There is a small quantity of dirty-white precipitate in the bottom of the tube, but no membrane forms on the surface. With age, the precipitate becomes light yellow in color.

*Growth in milk.*—Sterilized skimmed milk is changed very slowly by the germ. By the fourth week there is usually a thin layer (5 to 8 millimeters thick) of clear liquid in the upper part of the tube, while the remainder appears unaltered.

*Chemical reactions produced by its growth.*—The pale rose color of peptone-rosolic-acid solution is slightly intensified, indicating the presence of a small amount of some alkali, but if this is the case the quantity produced is not sufficient to overcome the slight acidity of the water in the bottoms of tubes containing sterilized potato cylinders. And the behavior of tubes of litmus milk inoculated with the germ indicate the production of acid rather than alkali. During the first three weeks the color of litmus milk becomes just a shade lighter blue, but during the following three weeks the blue color entirely disappears, leaving the milk very nearly the color of normal milk and with no precipitation of the casein. The cause of this peculiar behavior of litmus milk is not known to the writer.

Peptone-rosolic-acid solution is prepared by adding to 100 cubic centimeters of Dunham's peptone solution (see formula previously given), 4 cubic centimeters of the following solution: Rosolic acid, 0.5 grams; alcohol (80 per cent), 100 cubic centimeters.

The litmus milk was prepared as follows: One cubic centimeter of a saturated aqueous solution of Trommsdorf's litmus was put into a test-tube containing ten cubic centimeters of sweet skimmed milk and the whole sterilized. After sterilization the contents of the tube were of a pale blue color. It was tested with malic acid and potassium hydrate and found to react properly.

*Growth on acid and alkaline media.*—The organism appears to grow best on neutral or slightly acid media. A comparatively slight degree of alkalinity is sufficient to prevent growth wholly, but on the acid side there is a wider range. It grew very feebly on 10 c. c. of agar containing 0.05 c. c. of a saturated solution of sodium carbonate. However, on agar containing 0.02 c. c. of a saturated solution of sodium carbonate per 10 c. c. of agar it grew readily and with the same color and habit of growth as on neutral agar. In sterilization, the agar containing the larger amount of sodium carbonate browned slightly. The tests with acid media were made in bouillon acidified with malic acid. The germ grew readily in bouillon containing as much as 1 c. c of a 1 per cent solution of malic acid per 10 c. c. of neutral bouillon. When double this amount of malic acid was used no growth was obtained.

*Gas production.*—The organism does not produce gas by the fermentation of grape sugar, cane sugar or milk sugar. Tubes of neutral agar containing two per cent of these sugars were inoculated, thoroughly shaken and cooled quickly. Numerous small colonies of the germ developed throughout the medium but in no case were any gas bubbles formed. In fermentation tubes containing two per cent of the above sugars in bouillon there was an abundant growth but no gas was formed.

*Need of oxygen.*—The organism is a facultative anaerobe, growing almost, if not quite, as readily in air which has been robbed of its oxygen by Buchner's pyrogallic acid method as it does in normal air. The color, however, is a lighter shade of yellow.

*Temperature relations.*—Under this head it can only be said that it grows vigorously at all temperatures between 21° and 30° C. The thermal death-point has not been determined.

*Behavior toward stains.*—It takes the basic aniline stains readily, staining uniformly throughout.

*Relation to light.*—It is not injuriously affected by diffused light but exposure for a few hours to direct sunlight kills it. Over the cover of an ordinary Petri-dish containing a culture of the organism on potato agar, there was pasted a piece of black cloth which had at the center a circular hole of 1.8 cm. in diameter. The Petri-dish was then placed in bright sunlight for three hours, after which it was incubated for 96 hours at a temperature of about 23° C. The yellow bacterial colonies came up thickly all over the agar except at the center, directly underneath the hole in the black cloth. Here there were just a few colonies, most of the germs* on this area having been killed by exposure to the sun.

Plate XVI, fig. 2, is from a natural-size photograph of the culture with the cover removed. It will be seen that the circular area over which the bacteria are killed has a diameter somewhat greater than that of the hole in the cloth. This is due to the fact that the rays of sunlight did not strike the cover at right angles.

## PATHOLOGICAL HISTOLOGY.

As already stated, the organism occurs in the vascular system throughout the entire plant. It is never found in the parenchyma cells, but in the fibro-vascular bundles exclusively, and is there probably confined to the vessels. There is no disorganization or discoloration† of any of the tissues.

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*Prof. H. Marshall Ward has published a very interesting paper entitled, Action of Light on Bacteria, III. Philosophical Trans. of the Soc. of London. Vol. 185, Part II, pp. 961-986. 1894. On page 964 he makes some suggestions as to why (in experiments like the above) the germs on the exposed area are not *all* killed.

†The blackening of the fibro-vascular bundles, a not uncommon occurrence, is not due to the action of the corn bacterium.

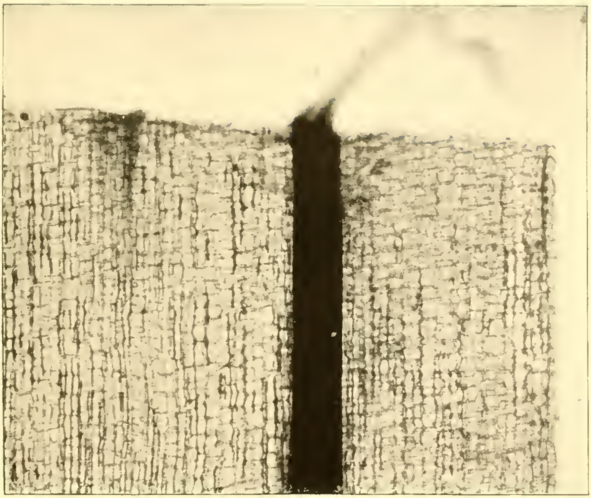

PLATE XVII.—PHOTOMICROGRAPH OF A LONGITUDINAL SECTION OF A DISEASED SWEET CORN STEM MOUNTED IN WATER, SHOWING THE BACTERIA SWARMING FROM THE END OF A FIBRO-VASCULAR BUNDLE.

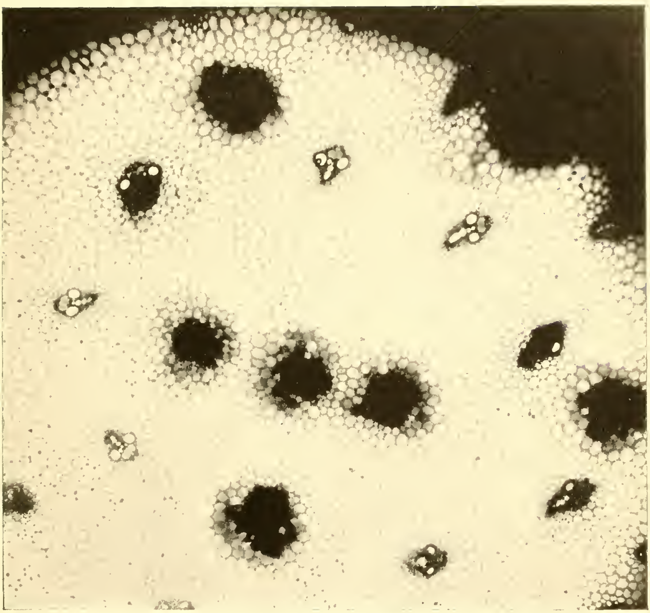

Plate XVIII.—Photomicrograph of a Cross-section of a Diseased Sweet Corn Stem Mounted in Water. The Structure of the Fibro-vascular Bundles in which the Bacteria Occur is Often Entirely Obscured by the Bacteria.

While it is undoubtedly true that the germ robs its host of a great deal of nourishment, the death of the host-plant seems to be due, chiefly, to the cutting off of the water supply. This view is supported by the fact that in dry weather plants growing in moist situations suffer less from the disease than plants growing in drier situations; and while plants may die from the disease in wet weather it is most virulent in dry weather. If plants are examined in periods of wet weather it will be found that the amount of the yellow substance which they may contain in their vessels without showing outward symptoms of the disease is much greater than it is in dry weather. Ordinarily, it is not easy to detect the germ in plants which show no outward symptoms, either by wilted leaves or dwarfed size; but in very wet weather plants seemingly in perfect health will be found to contain a considerable quantity of the germ. It is interesting to observe the effect of alternating periods of wet and dry weather. For about one month preceding July 12, 1897, it was very dry on Long Island — so dry that in the latter part of the period some crops suffered severely. During this time the corn disease was very destructive. Then came about three weeks of rainy weather followed by a short period of dry weather. Many plants which were partially dead revived during the rainy season and promised to outgrow the disease, but as soon as the rains ceased they suddenly collapsed.

The vessels, which constitute the chief avenue for the ascent of water, are so thoroughly plugged with millions upon millions of bacteria that it is indeed no wonder that the plant dies from lack of water. A good idea of the immense numbers of bacteria which throng the vessels may be obtained by examining Plate XVII, which is a photomicrograph of a longitudinal section of a diseased corn stem. The bacteria swarm out of the ends of the vessels like smoke out of a chimney. In cross-section (See Plate XVIII), they ooze out in such numbers as to obscure the structure of the fibro-vascular bundles.

The germ seems to have no power to pass through the walls of the parenchyma cells. This was especially noticeable in field corn and pop corn plants artificially inoculated by puncture. The germ was to be found only in the bundles which had been ruptured. It was unable to gain access to the vessels of unruptured bundles because of its inability to pass through the intervening parenchyma.

## IDENTITY OF THE GERM.

It is by no means certain that this germ has not been previously described and named. Systematic bacteriology is, at present, in such a state of confusion that, even with access to all of the literature, one can scarcely avoid frequently falling into error. The writer, unfortunately, has had access to only a small part of the systematic literature and, therefore, it would be manifestly injudicious for him to give the organism a name which may, perhaps, only serve to burden the synonymy. Hereafter it will be referred to simply as the sweet corn bacillus. It is hoped that the foregoing description is sufficient for the complete identification of the organism, so that one having the necessary facilities may find no difficulty in referring it to its proper species if it has already been described.

While it is possible that the organism has been previously described, its habit of producing disease in sweet corn has surely not been reported heretofore. Burrill's corn germ, *Bacillus cloacæ** Jordan, the only other bacterium described as producing disease in *Zea mays*, is undoubtedly different. It attacks field corn while the sweet corn bacillus attacks only sweet corn; plants attacked by the sweet corn bacillus do not turn yellow and there is no moist rot of the ears; the sweet corn bacillus is conspicuous in the fibro-vascular bundles and exudes in yellow, viscid drops from the cut ends of stems, while neither is true of Burrill's germ; on agar, the sweet corn bacillus is yellow, while Burrill's germ on this medium is grayish. There are still other points of difference but those mentioned are sufficient to show that the two organisms belong to different species.

*It appears that Burrill never gave his corn germ a name and yet Ludwig (Lehrbuch der niederen Kryptogamen, p. 95) calls it *Bacillus secales* (Burrill), and Russell (Bacteria in their Relation to Vegetable Tissue, p. 36) uses the name *Bacillus zeæ* Burrill. The studies of Dr. Theobald Smith (The Wilder Quarter-Century Book, 1893, p. 214) and of Dr. V. A. Moore (Agricultural Science, VIII, pp. 368-385) have shown that it is identical with *Bacillus cloacæ* Jordan (Report Mass. State Board of Health; Water Supply and Sewerage, Part II, 1890, p. 836) which is probably the proper name to apply to it.

## DISSEMINATION OF THE GERM.

The chief method of dissemination of the germ is, probably, by diseased seed. That seed from diseased plants may contain the germs, usually in great number, is certain, and we have proven by experiment that some, at least, of these germs retain their vitality long enough to infect the plants of the new crop. Plants of the variety Early Cory were grown in pots of sterilized earth which were watered, when the rain-fall was insufficient, with sterilized water. Every precaution, except that the pots were not covered, was taken to prevent contamination and yet several of the plants developed the disease. In this case, the infection must have been brought about by germs which clung to the seed. As an item of contradictory evidence, it should be mentioned that a pure culture of the germ on potato agar was found to be dead at the end of eleven months.

Another common way in which the germ is disseminated is in the use of stable manure made by animals which have been fed on the diseased corn stalks. It may also be disseminated by means of the implements used in cultivation and by the washing of the soil during heavy rains.

## GEOGRAPHICAL DISTRIBUTION.

The disease occurs in abundance throughout Long Island. The only other locality in which it is positively known to occur is in Iowa, and the proof of its existence there is based upon the experiment above mentioned, in which Iowa-grown seed planted in pots of sterilized earth produced plants which developed the disease. A wilt disease of early sweet corn has been reported to us from Madison, N. J., but no specimens were sent. In view of the fact that the disease may be disseminated by means of the seed, it is impossible to believe that it is confined to Long Island. In all probability it is widespread.

## REMEDIES.

Since the cause of the disease is entirely within the tissues and probably gains entrance through the subterranean parts of the plant, the application of fungicides to the parts above ground must be absolutely without avail. In the application of fungicides to the soil there is a possibility of success but it can scarcely be said that this line of treatment is a promising one. Soil treatment for the fungous and bacterial diseases of plants has been successful in only a few instances. Lime is known to be a remedy for the club-foot disease of cabbage and the experiments of Thaxter* indicate that sulphur applied to the soil is a preventive of onion smut; but neither of these substances seems to have any beneficial effect on the sweet corn disease. Two rows of sweet corn (one row of Manhattan and one row of Early Cory) fifty feet in length were treated with air-slaked lime by scattering the lime, at the rate of 900 pounds per acre, in the drills with the seed. Two other rows of sweet corn (same varieties) were treated in the same manner with flowers of sulphur applied at the rate of 300 pounds per acre. Every plant in the four rows died from the disease, in most cases without forming ears. In the case of the lime it may be that better results would have been obtained if the lime had been applied to the soil several months before planting.†

The planting of non-susceptible varieties, as far as practicable, is, of course, to be recommended. There are marked differences of susceptibility among varieties, and this fact can often be turned to good advantage. In case it is necessary to plant susceptible varieties it may be found advantageous to soak the seed before planting in some germicide; for example, a weak solution of corrosive sublimate. However, treatment of the seeds with chemicals must be made with caution as there is danger of injuring the germination. The ears of diseased plants should never be used for seed.

*Thaxter, R. Conn. Agl. Exp. Sta. Ann. Rept., 1889, pp. 146-152.

†If air-slaked lime is applied the fall before the spring in which the cabbages are set it prevents the club-foot to a great extent, but if applied at the time of setting it has but little effect. A notable example of this was observed at Woodbury, N. Y., the present season. A large seed-bed for cabbage and cauliflower was given a heavy application of air-slaked lime just before the seeds were sown. Nearly all the plants became affected with club-foot.

# IV. EXPERIMENTS AND OBSERVATIONS ON SOME DISEASES OF PLANTS.*

F. C. STEWART.

## SUMMARY.

I. The popular opinion that green manuring with rye will prevent potato scab has been found, by experiment, to be without foundation in fact. Of the six plats employed in the experiment three were green manured with rye, while the remaining three (alternating with the rye plats) were used as checks. On all six plats the tubers were badly scabbed, the rye plats being even worse than the check plats.

II. An attempt to communicate the potato stem-blight by means of diseased "seed" failed. Unsuccessful attempts were made, also, to inoculate tomatoes, peppers, egg-plants, petunias and Chinese lantern plants by placing pieces of diseased tubers about their roots. The conclusion is that the disease is purely physiological and that there is no danger of spreading it by planting diseased tubers.

III. It has been shown by experiment that common salt solution applied to the foliage of carnations or to the soil in which they are grown will neither prevent rust nor give the plants a more vigorous growth.

IV. On Long Island it is unnecessary to commence spraying cucumbers (no matter what the date of planting) until the middle of July. In an experiment at Floral Park spraying increased the yield of early cucumbers at the rate of 30,450 fruits per acre.

Downy mildew is easier to control by spraying than is anthracnose.

*Reprint of Bulletin No. 138.

On Long Island downy mildew appeared earlier and was more destructive in 1896 than in 1897, although the rainfall for July and August was much heavier in the latter season. The high temperature of August 1-15, 1896, was probably responsible for the virulence of the disease in that year.

In an experiment at Woodbury an acre of late cucumbers which were sprayed eight times with Bordeaux mixture yielded 101,960 "pickles." The average yield of unsprayed cucumbers in this section was probably less than 20,000 per acre.

*Plasmopara cubensis* has been found on *Cucumis moschata* (winter crook-neck squash), which is a new host for this fungus.

## I. PLOWING UNDER GREEN RYE TO PREVENT POTATO SCAB.

There appears to be a quite widespread notion among farmers that potatoes will be free from scab (*Oöspora scabies*) if grown on soil in which green rye has been plowed under just before planting. Some even assert that this method will insure a smooth crop of tubers on land which has produced a scabby crop the previous season.

It is highly important to know if this opinion has any foundation in fact, because at the present time there is no thoroughly practical method known for circumventing the evil influence of scab-infested soil. Halsted* has advocated the use of flowers of sulphur, applied to the "seed" and in the drills at the rate of about 300 pounds per acre, but for some reason farmers are unable, in practice, to confirm the results of his experiment.

Why green rye should have any power to prevent potato scab is not clear. Flagg,† assuming the rye theory to be true, has suggested, as a possible explanation, that the rye brings about an acid condition of the soil which is well known to be unfavorable to the growth of the scab fungus.

Although there appeared to be no good reason why green rye should possess the merits claimed for it, it was deemed worth while to test the matter by experiment; for experience has shown

*Halsted, B. D. Field Experiments with Potatoes. N. J. Agl. Expt. Stas. Bul. 112; and N. J. Agl. Expt. Stas. Rept. 1896, pp. 309-318.

†Flagg, C. O. Green Manuring and Potato Scab. *Cult. and Country Gent.*, Vol. LXI, p. 779.

that the popular opinions of the people concerning agricultural practice are usually based upon fact. Empiricism has often led science.

The experiment was made in coöperation with Messrs. White and Rice, of Yorktown, N. Y., and much credit is due these gentlemen for the painstaking manner in which they carried out the details of the experiment. The land used for the experiment was in a young plum orchard and was fairly, though not absolutely, uniform. In 1896 it had grown potatoes which were so scabby that a large part of the crop was unmerchantable. In October, 1896, the land was plowed and harrowed, and divided into six plats, lying side by side, as shown in the accompanying diagrammatic table. On October 12, rye was sown on three alternating plats, three other plats being left as checks. In spite of the lateness of seeding, the rye made a good growth, being about six inches high when plowed under, April 26, 1897. No fertilizer was used on any of the plats. The plats were planted April 28. Four rows were planted in each plat and exactly 175 pieces of "seed" (cut to two eyes) in each row. The "seed" consisted of slightly scabby tubers grown on the same land, and was of the variety Carman No. 1. In each plat two of the four rows were planted with tubers which had been soaked one and one-half hours in corrosive sublimate solution, containing $2\frac{1}{4}$ ounces of corrosive sublimate in 15 gallons of water. The remaining two rows in each plat were planted with untreated tubers.

YIELD OF SOUND AND SCABBY POTATOES ON RYE PLATS AND CHECK PLATS.

| Plats. | Manuring. | No scab. | Scabby but merchantable. | Unmerchantable. | Total. |
|---|---|---|---|---|---|
| | | Lbs. | Lbs. | Lbs. | Lbs. |
| I. | Check | 308 | 263 | 236 | 807 |
| II. | Rye | 211 | 162 | 321 | 694 |
| III. | Check | 248 | 216 | 319 | 783 |
| IV. | Rye | 154 | 198 | 248 | 600 |
| V. | Check | 229 | 182 | 134 | 545 |
| VI. | Rye | 161 | 212 | 224 | 597 |
| | Total check plats | 785 | 661 | 689 | 2,135 |
| | Total rye plats | 526 | 572 | 793 | 1,891 |

On all of the plats the potatoes came up well and produced a luxuriant growth of foliage. When the crop was harvested it was found that some of the tubers had rotted although the plants had received two applications of Bordeaux mixture, but the loss from rot was too small to materially affect the results so far as amount of scab is concerned.

It was found that the total yield of the three plats on which rye had been plowed under was 1891 pounds, while the total yield of the three plats which had no rye was 2135 pounds. The smaller yield on the rye plats appears to have been due to the rye. At least, it is safe to say that the rye had no tendency to *increase* the yield.

With reference to the amount of scab, the tubers were sorted into three classes: (1) Those entirely free from scab, (2) those which were scabby but merchantable, and (3) those which were so scabby as to be unmerchantable. The total yield of 1891 pounds on the rye plats was divided among these three classes as follows: No scab, 526 pounds; scabby but merchantable, 572 pounds; unmerchantable, 793 pounds. Classified on the same basis the yield of the plats without rye was distributed as follows: No scab, 785 pounds; scabby but merchantable, 661 pounds; unmerchantable, 689 pounds. From these figures it will be seen that plowing under rye did not decrease the amount of scab in the least, but on the contrary apparently *increased* it considerably.

From the results of this experiment, then, it appears that the practice of plowing under green rye to prevent potato scab is not to be recommended, inasmuch as it tends to increase rather than decrease the amount of scab and may, perhaps reduce the yield.

Concerning the value of the corrosive sublimate treatment, different plats gave different results, but on the whole the treated were fully as scabby as the untreated. This has been the almost universal experience and our experiment only serves to emphasize the uselessness of treating the " seed " with corrosive sublimate, if it is to be planted in scab-infested soil. The corrosive sublimate treatment did not reduce the yield.

## II. THE COMMUNICABILITY OF POTATO STEM-BLIGHT.

The potato stem-blight herein discussed is the one described by the writer in Bulletin No. 101 of this Station, pp. 83-84. The symptoms of the disease, as there given, are as follows: "First, there is a cessation of growth. The topmost leaves take on a yellowish, or in some varieties a purple color, and roll inward from the edges and upward, exposing the under surfaces. This condition is followed by wilting and complete drying up of the entire foliage, the process taking from one to three weeks. The tubers appear to be sound, but, when cut at the stem-end, blackened fibers are seen penetrating the flesh to a considerable distance materially injuring it for cooking purposes. No rot develops in the tubers. The stem just beneath the surface of the soil first shows discolored spots and later becomes dry and shriveled."

This disease has continued to be destructive in 1896 and 1897, but the cause of it is still unknown. Formerly, a species of Oöspora was suspected of having some connection with it, but it is now very doubtful if any organism is responsible for the trouble. The portion of the stem which is below ground is quite evidently the seat of the disease, but no fungus hyphæ can be found in the tissues of this part of the plant in the early stages of the disease; neither are bacteria abundant, and the few which are found in the tissues may easily have gained entrance after the death of the stem. Numerous Petri-dish cultures of tissue from the interior of diseased stems were made with varying results. Because of the nature of the disease and the position of the diseased part it is very difficult to prevent the intrusion of foreign germs. While these cultures were in progress portions of diseased tubers were placed in moist chambers, but without exception they failed to develop any growth whatever. This gave rise to the suspicion that the disease may not be due to any organism but is purely physiological. It was, therefore, deemed advisable to determine, by experiment, whether the disease is communicable.

A quantity of badly diseased tubers was obtained and planted on land which had not grown potatoes for at least ten years. The tubers were cut with two eyes to each piece and care was taken that every piece planted showed some of the disease. Nearly every piece of "seed" produced a plant, but many of them were very slow about coming up. They appeared weak, were of divers sizes and, up to the time of blossoming, were considerably smaller than plants from healthy "seed" planted at the same time.

It was late in July before any of the plants showed symptoms of the disease, and at the close of the season only a few had had even a mild attack. When the tubers were dug just a few showed the characteristic blackening of the fibro-vascular bundles at the stem-end.

In spite of their slow growth in the early part of the season they yielded well. Five rows fifty feet long yielded 275 pounds of merchantable tubers which is equivalent to a yield of 266 bushels per acre. It is evident that they were not badly diseased.

Were the disease due either to fungi or bacteria, diseased tubers would, most likely, produce diseased plants. Since the disease is located in the subterranean stem, and to some extent in the tubers themselves, it is in the highest degree probable that the germs of the disease would become attached to the tubers and be distributed with them. The results of this experiment furnish strong evidence that the disease is not communicable, which is equivalent to saying that it is not caused by any vegetable organism. That the weather conditions were not unfavorable to the disease is shown by the fact that a potato field about thirty rods from the experimental potatoes was badly affected and the disease was common in various localities on Long Island. It should be stated, however, that the plants were thoroughly sprayed with Bordeaux mixture (eight or nine times in the course of the season); but it is scarcely possible that spraying could prevent a disease like this in which the seat of the trouble is certainly below the surface of the soil. Moreover, we observed, in 1896, a potato field which had been sprayed five times and yet it was estimated that 33 per cent of the plants were affected by the disease.

Although the experiment shows that a fair yield of healthy tubers may be obtained from diseased "seed," we cannot recommend the practice of planting such "seed." Six 50-foot rows planted with healthy "seed" of the same variety and grown under parallel conditions, yielded 379 pounds of merchantable tubers, or at the rate of 305 bushels per acre, which is 39 bushels per acre above the yield from the diseased "seed."

Attempts were made to inoculate the disease upon other solanaceous plants. Badly diseased tubers were finely chopped and put into the soil close about the roots of 28 young tomato plants, 25 young egg-plants, 10 younger pepper plants (*Capsicum*), 10 young plants of the Chinese lantern plant (*Physalis franchetti*) and 6 young petunias. These plants were kept under observation throughout the season, but none of them showed any symptoms of a disease like the potato stem-blight. In fact, all of them except the petunias were remarkably healthy and productive. They, too, were occasionally sprayed with Bordeaux mixture.

## III. EFFECTS OF COMMON SALT ON THE GROWTH OF CARNATIONS AND CARNATION RUST.

Some florists have advocated the use of an aqueous solution of common salt (sodium chloride) on carnation foliage. The salt solution is to be applied in the form of a fine spray, and it is believed that the plants are benefited in two ways; (1) by preventing the attacks of rust (*Uromyces caryophyllinus*), and (2) by giving the plants a more vigorous growth.

Some experiments which we have conducted during the past three years lead us to believe that salt solution is worthless for either of the above purposes. In a previous bulletin* we have reported a spraying experiment on carnations in which salt solution (8 lbs. to 45 gals. of water) applied once a week, failed to prevent rust in the least, every plant showing rust at "lifting" time; neither did the plants seem to be any more vigorous or

* New York Agl. Exp. Sta. Bul. 100, pp. 56-62.

to have made any better growth than unsprayed plants of the same variety standing beside them. This experiment was made in 1895. In 1896 it was repeated, but no rust appeared on any of the plants, not even on the unsprayed ones, so that this season's experiments gave no additional evidence as to the value of salt spray as a preventive of rust; but it was again observed that the sprayed plants made no better growth than the unsprayed ones.

In addition to the spraying experiment in 1896, another experiment was made to determine the effect of adding salt to the soil in which carnations are grown. On May 18, 1896, 50 rooted cuttings, of the variety Uncle John, were potted in six-inch pots which were sunk in the soil out of doors. They were divided into five lots of ten plants each and treated, at intervals of about two weeks, with different quantities of a two and one-half per cent salt solution as follows:

Lot I. 10 c. c. salt solution, or 0.25 gram of salt per plant;
Lot II. 40 c. c. salt solution, or 1 gram of salt per plant;
Lot III. 80 c. c. salt solution, or 2 grams of salt per plant;
Lot IV. 200 c. c. salt solution, or 5 grams of salt per plant;
Lot V. Check. Not treated.

The salt solution was poured upon the surface of the soil in the pot around the base of the plant and allowed to soak down. The dates of application were as follows: June 2, 16, 30, July 14, 29, August 24, September 9 and 26.

As in the spraying experiment of the same season, no rust appeared. At the conclusion of the experiment the plants were examined by an expert carnationist who did not know how the different lots had been treated and hence could not possibly have been prejudiced. He decided that the plants in Lot V had made considerably the best growth; that Lots I and II were about equal and second best; while Lots III and IV were about equal and poorest. It was very evident that the salted plants had made a less vigorous growth.

In 1897 the experiment was repeated. As before, the plants were of the variety Uncle John, potted on May 18 in six-inch pots which were sunk in the soil out of doors; there were ten plants in each lot; and the same quantities of a two and one-half per cent solution were used. This time, however, Lot I was omitted.

The dates of applying the salt solution in this experiment were as follows: May 18, 28, June 11, 25, July 9, 23, August 7, 20, September 3.

All of the salted plants were again smaller than the unsalted ones. On August 27 four average plants of each lot, still in the pots, were removed to the greenhouse. Up to this date no rust had appeared, but on September 17, when the plants were next examined, every one was found to be rusty. From this time on the rust made rapid progress and became even worse on the salted plants than on the unsalted.

These experiments show that it is useless to try to prevent rust by the use of salt solution, applied either to the soil or to the foliage, and, also, that salt is not an aid to the growth of carnations.

## IV. FURTHER EXPERIMENTS ON SPRAYING CUCUMBERS.

### Spraying Early Cucumbers.

In the Long Island market gardens cucumbers are divided into two classes—early cucumbers and late cucumbers. The former are planted as soon as danger of frost is past in spring, and the fruits, which are allowed to attain a length of from five to seven inches, are sold in the city markets to be eaten fresh. Late cucumbers are planted from June 25 to July 4, and the fruits are gathered when they are from two and one-half to three and one-half inches in length. They are used for pickling purposes, and for the most part are sold directly to pickle manufacturers who have established salting houses at various points in the farming districts.

The spraying experiment reported in Bulletin No. 119 of this Station was made on late cucumbers. In 1897 the following experiment was made on early cucumbers. Eight rows of 25 hills each were planted early in May. The rows were five feet apart and the hills four feet apart in the row. The variety was White

Spine. When the plants were well started they were thinned to four in a hill. Throughout the whole season four of the eight rows were kept well covered with Bordeaux mixture (1-to-8 formula) by frequent sprayings, while the other four rows were not sprayed at all. Spraying was commenced almost as soon as the plants were out of the ground, in order, if possible, to prevent the ravages of the striped cucumber beetle, *Diabrotica vittata*. For this reason Paris green was added to the Bordeaux mixture used in the first three sprayings. The dates of spraying were: May 28, June 1, 11, 22, July 2, 12, 16, 23, 30, August 7, 13, 20, 27, and September 7. In all, the plants were sprayed fourteen times and each time carefully so that the spraying was of the most thorough kind.

The weather was unfavorable for cucumbers, still they grew fairly well. The first disease to make its appearance was a bacterial wilt disease which commenced its ravages about August 2, and during the two weeks following killed perhaps 50 plants on the unsprayed plat and only five or six on the sprayed plat. On August 11 there were traces of anthracnose, *Colletotrichum lagenarium*, on the unsprayed plat and from August 24 to the end of the season this disease was very destructive on the unsprayed plat and also did some damage on the sprayed plat, particularly toward the close of the season. The downy mildew made its first appearance August 24 on the unsprayed plat where it spread rapidly and did much damage, but it did not attack the sprayed plat.

A careful record was kept of the number and weight of the fruits produced on the two plats. At each picking only those fruits which were more than three inches long were gathered. In other words, the fruits were allowed to attain a considerable size and most of them would pass in the market for " cucumbers " as the large fruits are called to distinguish them from " pickles " which are the small fruits used for pickling. The sprayed plat yielded 3,263 fruits which weighed 1,159 pounds; while the unsprayed plat yielded 1,866 fruits, having a weight of 590 pounds. Expressed in more familiar terms, the yield per acre on the sprayed plat was at the rate of 71,100, weighing 25,265 pounds;

on the unsprayed plat at the rate of 40,650, weighing 12,860 pounds. Hence, the increase in number of fruits per acre due to spraying was 30,450, and the increase in weight 12,405 pounds.

The following table gives the number and weight of the fruits gathered at each picking:

Yield of Cucumbers from Sprayed and Unsprayed Plats.

| Date. | Sprayed. | | Unsprayed. | |
|---|---|---|---|---|
| | Number. | Weight. | Number. | Weight. |
| | | Lbs. | | Lbs. |
| July 26 | 16 | 3.25 | 31 | 9.50 |
| August 2 | 89 | 22.25 | 112 | 28.25 |
| August 7 | 184 | 60.25 | 155 | 57.25 |
| August 11 | 184 | 60.50 | 158 | 54 |
| August 16 | 378 | 139.75 | 269 | 109.50 |
| August 20 | 256 | 96 | 220 | 70.50 |
| August 24 | 322 | 99 | 236 | 72 |
| August 27 | 234 | 73 | 124 | 32 |
| August 31 | 370 | 157 | 241 | 80 |
| September 4 | 298 | 117 | 108 | 32 |
| September 8 | 300 | 128 | 87 | 17 |
| September 10 | 151 | 38 | 43 | 8 |
| September 14 | 288 | 105 | 44 | 11 |
| September 18 | 193 | 60 | 38 | 9 |
| Totals | 3,263 | 1,159 | 1,866 | 590 |

It is important to observe that in the first two pickings the unsprayed plants yielded more than the sprayed. This shows that at the beginning of the experiment the unsprayed plants had at least an equal chance with the sprayed, so that the differences which appeared later may be justly attributed to the spraying. Moreover, it shows that up to the close of July there was no appreciable benefit from spraying, and this means that the six applications made prior to July 15 were unnecessary. Spraying deterred the striped cucumber beetles but slightly and this small benefit was counterbalanced by the injurious effect of the Bordeaux mixture on the growth of the young plants. There was no discoloration of the foliage such as occurs when the Bordeaux is improperly prepared, but the sprayed plants were somewhat smaller for a considerable length of time. All observations go to show that spraying (on either early or late cucumbers) need not be commenced until after July 15. The past season there was scarcely a trace of anthracnose on cucumbers anywhere on

Long Island until after August 1, and downy mildew did not appear until three weeks later. The time of appearance of both these diseases is more dependent upon the weather conditions than upon the stage of growth of the plant. Both early and late cucumbers are attacked at about the same time.

The very thorough spraying which the plants received gave complete protection against downy mildew but only partial protection against the anthracnose. In the latter part of the season there was sufficient anthracnose among the sprayed plants to seriously affect the yield. By consulting the table on page 427, it may be seen that the last picking was made September 18, whereas there was no frost until September 28. After September 18, the anthracnose became so severe on the sprayed plat that the plants dried up and produced thereafter only deformed fruits or "nubbins." From this it appears that anthracnose is more difficult to manage than downy mildew, and that to prevent it the spraying must be done very thoroughly and repeated at short intervals. Of course this test was a severe one because of the close proximity of the diseased plants on the unsprayed plat.

An unexpected result of the experiment was the influence which the spraying *seemed* to have in checking the wilt disease. The wilt disease killed about fifty plants on the unsprayed plat and only five or six on the sprayed plat. Considering the small size of the plats this difference is worthy of note.

Until near the close of the season the percentage of deformed fruits produced by the sprayed plants was very small—much smaller than in the case of the unsprayed plants.

## WHY *Plasmopara cubensis* WAS MORE ABUNDANT IN 1896 THAN IN 1897.

Halsted* has published observations which indicate that the Peronosporeæ, in general, thrive best in wet seasons. For *Plasmopara cubensis* no such observations have been recorded, but from the following it appears that this fungus is influenced more by temperature than by rainfall.

*Halsted, Byron D. Downy Mildews in a Dry Season. Bulletin from the Botanical Department of the Iowa Agricultural College, 1888; and, Peronosporeæ and Rainfall. Journ. Myc., Vol. V, pp. 6-11, 1889.

In 1896, *Plasmopara cubensis* made its first appearance on Long Island about August 7. In 1897 it did not appear until August 24, and was not nearly so destructive as in 1896. Without doubt this difference was due to some difference in the weather conditions prevailing during the two seasons, and inasmuch as August is the month in which the fungus commences its ravages, it is likely that the variable factor should be sought in the weather records of that month. The New York State Weather Bureau has stations on Long Island at Brooklyn, Willets Point, Brentwood and Setauket. A comparison of the records of these stations for August, 1896, with the records of the same stations for August, 1897, shows that the only important difference is in the temperature for the first fifteen days of the month. This difference is brought out in a striking manner in the following table of daily mean temperature* which shows that the average temperature for the first half of August, 1896, was 7° higher than for the same period in 1897.

TEMPERATURE RECORD, AUGUST 1–15, 1896 AND 1897.

| DATE. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| August, 1896 | 67° | 72° | 72° | 78° | 80° | 78° | 81° | 81° | 83° | 83° | 83° | 83° | 82° | 76° | 75° |
| August, 1897 | 72° | 74° | 73° | 72° | 66° | 70° | 71° | 70° | 69° | 71° | 73° | 71° | 69° | 72° | 76° |

The rainfall for August was somewhat greater in 1897 than in 1896, and this alone should be sufficient evidence that the rainfall is not the controlling factor in the development of downy mildew. However, if it is desired to go back to the month of July we find that 1897 was much the wetter. The records are as follows:

RAINFALL RECORD, JULY AND AUGUST, 1896 AND 1897.

| | July 1896. | August 1896. | July 1897. | August 1897. |
|---|---|---|---|---|
| | Inches. | Inches. | Inches. | Inches. |
| Brooklyn | 4.23 | 3.22 | 11.06 | 4.10 |
| Willets Point | 5.79 | 1.64 | 9.75 | 2.26 |
| Brentwood | 4.70 | 4.20 | 10.00 | 2.10 |
| Setauket | 2.74 | 2.35 | 18.18 | 5.03 |

*Computed from records published in Report of the New York State Weather Bureau, Vol. VIII, No. 8, p. 8, and Vol. IX, No. 8, p. 8.

## ONE HUNDRED THOUSAND CUCUMBERS FROM AN ACRE OF SPRAYED PLANTS.

In the spraying experiment against the downy mildew made at Woodbury, Long Island, in 1896, and reported in Bulletin No. 119, the protection against the disease was not complete. Toward the close of the season the downy mildew became quite abundant on the sprayed plats. The infection came, of course, from the badly diseased plants in the adjoining rows which had not been sprayed. In practice, no unsprayed rows would be left and it is reasonable to expect even better results than were obtained in that experiment.

For the purpose of ascertaining to what extent the disease can be controlled when an entire field is sprayed, the following experiment was made at Woodbury, on the farm of Mr. R. C. Colyer, the gentleman who coöperated with us in the experiment made in 1896. In a meadow of clover and timothy, equal parts, an exact acre of land was selected. The grass was removed about June 20 and the land immediately plowed and spread with barnyard manure. It was then thoroughly harrowed with a disc harrow and marked out 3½ by 4 feet. Next Mapes' Fruit and Vine fertilizer, 1,000 pounds, was drilled into the rows, 400 pounds of kainit sown on broadcast and the field again harrowed.* The seed, which was of the variety Early Cluster, was planted June 26th. On account of heavy rains it was necessary to do considerable replanting, some hills being replanted twice, but eventually nearly a full stand was obtained. The acre was sprayed eight times with Bordeaux mixture (1-to-8 formula), applied with a knapsack sprayer. The dates of spraying were as follows: July 22, 30, August 7, 16, 25, September 4, 13, and 20. A killing frost occurred on the night of September 28.

The cucumbers were contracted to the H. J. Heinz Company, which has a factory at Hicksville, at $1.50 per thousand for the larger ones and 75 cents per thousand for the small ones, or gherkins. Below is the factory record of receipts from the experiment acre:

*It should not be assumed that the Station recommends this method of manuring. The manuring and preparation of the land were left entirely to the judgment of Mr. Colyer, who was instructed to " put the land in proper condition to grow a good crop of cucumbers."

CUCUMBERS FROM SPRAYED ACRE, SOLD TO PICKLE FACTORY.

| DATE. | Number of fruits of the proper size for pickles. | Number of small fruits or gherkins. |
|---|---|---|
| August 14 | 80 | 50 |
| August 16 | 200 | 300 |
| August 18 | 400 | 75 |
| August 20 | 750 | 650 |
| August 23 | 2,050 | 1,225 |
| August 25 | 2,225 | 1,335 |
| August 28 | 2,925 | 1,220 |
| August 30 | 5,040 | 1,655 |
| September 1 | 3,575 | 1,000 |
| September 3 | 3,900 | 1,450 |
| September 6 | 7,350 | 3,025 |
| September 9 | 3,230 | 1,410 |
| September 11 | 6,400 | 1,600 |
| September 14 | 4,700 | 2,065 |
| September 16 | 2,350 | 1,590 |
| September 18 | 3,900 | 1,900 |
| September 21 | 4,160 | 2,000 |
| September 23 | 1,675 | 6,075 |
| September 27 | 700 | 3,225 |
| Total | 55,610 | 31,850 |

To the above number must be added 1,500 large ones and 13,000 small ones which were gathered on September 29th, the day after the frost. These were sold in Wallabout market, Brooklyn, because no cucumbers would be received at the factory after frost. They brought $19.

Summarized, the results are as follows:

| | | |
|---|---|---|
| 55,610 large "pickles" at $1.50 per thousand | | $83 40 |
| 31,850 small "pickles" at 75 cents per thousand | | 23 85 |
| 13,000 small "pickles" <br> 1,500 large "pickles" | Sold at Wallabout for | 19 00 |
| 101,960 | | $126 25 |

When frost came the plants were entirely free from downy mildew and anthracnose, although both of these diseases were abundant in most of the cucumber fields in the vicinity. The nearest source of infection was an unsprayed muskmelon patch about thirty rods distant.

Ordinarily, 100,000 cucumbers per acre would not be considered a large yield but for the past season it is uncommonly large. The average yield per acre of cucumbers on Long Island in 1897 was smaller than in 1896, when it was about 20,000 per acre. In some sections the crop was almost a total failure. In 1896 the downy mildew was by far the principal enemy, but in 1897 it seemed as if all of the enemies of the cucumber had combined for its destruction. The weather was very unfavorable, and downy mildew, anthracnose and the bacterial wilt disease were all destructive. Indeed, it was impossible to determine which of these four causes was responsible for the most damage.

## SHADE AS A PREVENTIVE OF DOWNY MILDEW.

It is a matter of common observation that down mildew is less destructive to cucumber plants which are partially shaded; for example, plants growing under trees or in weeds and particularly portions of vines which run out into the grass and tall weeds at the borders of the field.

It was attempted to make a practical application of this fact by planting rows of sweet corn alternately with rows of cucumbers. Rows of sweet corn were planted five feet apart, and when the corn was a few inches high rows of cucumbers were planted between the corn rows. On the same date other hills of cucumbers without the corn were planted close by for comparison.

As might have been expected, the unshaded plants made considerable better growth than the shaded. There seemed to be no difference in the amount of anthracnose, only a slight difference in the amount of downy mildew, and the bacterial wilt disease was decidedly more destructive among the shaded plants.

It seems improbable that shade can be advantageously employed as a preventive of down mildew.

## A NEW HOST FOR *Plasmopara cubensis*.

The recorded hosts of *Plasmopara cubensis* are as follows:

(1) "On leaves of some cucurbitaceous plant"* (from Cuba);

(2) *Cucumis sativa* L. (cucumber);†

* Berkeley, Rev. M. J. and Curtis, Dr. M. A. Fungi Cubenses. Journ. of the Linnaean Soc. Botany X, p. 363, 1869.

† Farlow, W. G. Notes on Fungi. Bot. Gaz., XIV, p. 189, Aug., 1889.

(3) *Cucurbita maxima* Duchesne (squash);*

(4) *Cucurbita pepo* L. (pumpkin);†

(5) *Citrullus vulgaris* Schrad. (watermelon);‡

(6) *Cucumis melo* L. (muskmelon);§

(7) *Cucumis anguria* L. (gherkin gourd).||

To this list of hosts must now be added *Cucumis moschata* Duchesne (winter crook-neck squash) on which the fungus was found in abundance at Floral Park, N. Y., during the past season.

*Halsted, Byron D. Some Notes upon Economic Peronosporeæ for 1889 in New Jersey. Journ. of Myc., 5, p. 201.

†Halsted, Loc. cit.

‡Halsted, Byron D. Notes upon Peronosporeæ for 1891. Bot. Gaz., XVI, p. 339. Dec., 1891.

§Halsted, B. D. Report of the Botanist. Fourteenth Ann. Rept. N. J. State Agr. Exp. Sta. and the Sixth Ann. Rept. of the N. J. Agr. Coll. Exp. Sta. for the year 1893, p. 352.

||Swingle, W. T. Some Peronosporaceæ in the Herbarium of the Division of Vegetable Pathology. Journ. of Myc., VII, p. 125, 1892.

# REPORT

OF THE

# DEPARTMENT OF ENTOMOLOGY.


**Entomologists.**

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# REPORT OF THE ENTOMOLOGISTS.

## I. INSPECTION OF NURSERIES AND TREATMENT OF INFECTED NURSERY STOCK.*

V. H. LOWE.

### SUMMARY.

Most of the nurseries inspected have been found practically free from insect pests of a serious nature. Ten important species have been found at different times, however, in sufficient numbers to do serious injury. In all cases efforts were at once made to clean out the stock thus infested. The most important insect which attacks nursery stock in this State is the San José scale. It is important to nurserymen not only because of the injury which it may do to the infested stock, but because it is greatly dreaded by both dealers and fruit growers alike. Hence, stock from a nusery which is known to have been once infested does not find a ready sale.

Experiments in dipping and spraying young nursery trees indicate that plant lice may be controlled in the nursery by dipping the curled tips of infested trees in a solution of whale oil soap, one pound to seven gallons of water. The work should be done early in the season. Flea beetles attacking young pear and apple trees may be held in check by spraying with green arsenite, one pound to 100 gallons of water, and the canker worm will succumb to the same treatment.

The experiments in fumigating nursery stock with hydrocyanic acid gas, when the stock is piled in the cellar for winter storage, indicate that this method may prove practical, thus avoiding the necessity of building special fumigating houses.

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*Reprint of Bulletin No. 136.

## INTRODUCTION.

In the spring of 1896, the Maryland Legislature passed a law providing that all nursery stock shipped into that state must be accompanied by a certificate. This certificate must state that the stock has been duly inspected by an authorized official and pronounced by him free from indications of the presence of dangerously injurious insects and plant diseases. It is stated that this law was for the especial purpose of protecting Maryland fruit growers from the further importation into their State of that much-dreaded pest, the San José scale. Other States followed suit until seven now have similar laws and the question of similar legislation is being agitated in as many more.

Owing to this agitation and also to the fact that much has been said and written about the San José scale, its rapid work as a destroyer of fruit trees and shrubs and the ease with which it can be transported on nursery stock, Western New York nurserymen soon found themselves in a position where it was necessary to have their nurseries inspected or be seriously handicapped by the inspection laws of other states.

Although there was no evidence of an organized effort on the part of the nurserymen to have the work of inspection put upon a proper basis, the Station at once undertook to accommodate them and has endeavored to do so as far as possible during the past two years.

That there will be still further need of nursery and orchard inspection in the State seems very probable. The San José scale has been found in abundance in some sections of the State and has already shown that it can thrive in Western New York. The fact, also, that a small nursery has been found in the western part of the State and others in the southeastern, in which the scale has been thriving for several years, indicates that this insect may have a much wider distribution within our borders than is at present suspected. This seems all the more probable when we reflect that just over the line in Canada the scale has been found in a number of orchards and it is known to occur in states bordering New York on the east, south and west. At present there is no law to hinder the importation of infested stock from all of these directions and no provision made for a systematic effort to prevent the further spread of this and similar pests within the State.

The insects discussed in this bulletin have been found in more or less abundance in the nurseries from time to time. All of them are readily transported on nursery stock and hence are of importance to the nurseryman as well as the fruit grower.

The problem of how best to control the numerous species of insects which attack the growing plants in the nursery is a very important one. The few experiments noted in this bulletin are incomplete, but it is expected that as opportunity is afforded they will be continued until more definite results are reached. This work will be greatly aided by the increased facilities at the Station.

## INSPECTION OF NURSERIES IN WESTERN NEW YORK.

### Method of Inspection.

The immediate surroundings of the nursery were first noted and any old neglected orchards bordering on the nursery, or neglected blocks of stock were first carefully examined. On several occasions neglected apple orchards or a few old neglected apple trees were found badly infested with various species of injurious insects, principally the woolly aphis. Further examinations showed that many of the nursery trees in the immediate vicinity were infested with the same species, the indications being that the insects had originally come from the old trees. After the orchard trees were examined the condition of the more immediate surroundings of the blocks, such as the fence corners, etc., were noted and any suspicious looking shrubbery subjected to a careful scrutiny. The nursery rows were next examined, the usual method being to go back and forth across the rows a number of times until the general appearance of the trees was well noted. All suspicious looking trees were, of course, carefully examined. Where possible, the examination was repeated two or three times during the season.

## VALUE OF INSPECTION.

It is a difficult matter to estimate the real value of nursery stock inspection. Very much depends upon the care with which the work is done. Judging from our own experience and from the work that is being done in other states, inspection which includes not only the nursery but the orchard as well, properly carried out, can be depended upon to bring to light the worst cases, at least, of infestation by the San José scale and other insects and plant diseases of a seriously injurious nature. Judging from our observations one of the chief benefits which has thus far resulted from nursery stock inspection in this State, is to make the growers and dealers more careful as to the condition of the stock sent out. It is probably not overestimating the value of nursery and orchard inspection to say that, properly carried out, it will be a constant stimulus to the production of clean, healthy stock, and will result in effectually holding in check such dreaded pests as the San José scale.

## THOSE BENEFITED BY INSPECTION.

If inspection has a tendency to bring a better class of nursery stock on the market, then it is evident that not only the nurserymen, but all interested directly and indirectly, in the growing of trees, shrubs and vines are more or less benefited thereby. Where the inspection is extended to the orchard the benefit is much greater. Farmers should keep this in mind and note carefully the condition of the trees when they come from the nursery and watch for the development of injurious insects and diseases. In this way each farmer can be the inspector for his own premises. Nurserymen have usually considered inspection something of an annoyance but cheerfully take the necessary steps for their own benefit and to satisfy their customers.

## A GROWING DEMAND FOR INSPECTION.

As previously stated, several states have recently passed inspection laws similar to the Maryland law. Hence all nurserymen doing business in these states require certificates in order to prevent serious interference with their business. These restrictions to the trade have created a demand for nursery stock inspection which is far too great for a station entomologist to meet properly without aid if he expects to carry on his regular work. We found the demands for this kind of work so heavy during the past season that, in order to prevent a too serious interference with other duties, it was necessary to restrict our inspection for the most part to Ontario County alone. As yet no provision has been made either by State or federal law to meet this urgent demand of a highly important industry.

### Varieties of Trees, Shrubs and Vines Examined.

It is not necessary to give a list here of the varieties of trees, shrubs and vines examined. It is safe to say that practically all the varieties of plants grown as nursery stock in Western New York, both in the field and under glass, were examined on different occasions. By far the greater part of the stock inspected, however, consisted of the various varieties of fruit trees.

### Varieties of Trees Most Commonly Infested.

These were the apple, peach and pear trees. The apple and pear trees were most commonly infested with the woolly aphis, and this pest was most often found on the Ben Davis and Yellow Transparent apples and upon the standard pears. In most cases of infested pear trees, the blocks were next to blocks of infested apples, the indications being that the insects had come from the apples to the pears. The peach trees were infested with the peach-tree borer.

### Species of Insects Included in this Report.

Only the more important species which are readily transferred on nursery stock are included in this report. No account is taken of the large number of species which attack the stock during the growing season but which do not remain on the trees after the leaves are taken off and hence are not readily scattered over the country by means of nursery stock.

For convenience the species herein discussed may be grouped under four heads as follows:

I. Insects which secrete or otherwise produce a scale-like covering .................................... SCALE INSECTS, including the oyster-shell bark-louse, scurfy bark-louse, the New York plum lecanium, the oak scale and the San José scale.

II. Insects which secrete honey dew or a bluish-whie flocculent substance .................................... PLANT LICE, including the woolly aphis of the apple.

III. Insects which bore into the trees ............... BORERS, including the peach-tree borer.

IV. Insects which feed on the buds and leaves and which hibernate on the twigs in protective cases ............ CASE-BEARERS, including the pistol-case-bearer and the cigar-case-bearer. Although not a true case-bearing insect the bud moth may for convenience be included under this head.

## SCALE INSECTS.

Scale insects are among the most common of the insect pests. The group includes a large number of species. As destructive insects they rank among the first and are to be dreaded, not only because of the great injury which they can inflict, but because most species are very hard to eradicate from a nursery or an orchard after they have once become well established. As a rule, however, scale insects need not become abundant in the nursery if the stock is carefully watched and the first few trees found infested are either treated or burned. The most important species found are discussed in detail as follows:

### THE OYSTER SHELL BARK LOUSE.

*Mytilaspis pomorum* Bouché.

This insect is so commonly found in the orchard that it is liable to be considered of little importance. It is less harmful than many other scale insects yet it is capable of doing very serious injury, especially in the young orchard, and for this reason should be considered an important pest in the nursery, even though the nursery trees themselves do not usually become badly infested.

*History.*—But little is known of the early history of this species. According to our best authorities it is undoubtedly of European origin but was introduced very early into this country. It was first described in 1738 by a Frenchman named Reaumer who found specimens on an elm in his native country. According to Dr. Howard* it was known in this country as early as 1794.

The earliest account which we have seen relating to the insect in this State was published by Dr. Asa Fitch in 1856 in his first report as State Entomologist (p. 31). Dr. Fitch states that the insect was then known "everywhere through the northern states . . . infesting the orchards to a grievous extent, causing the death of many trees and impairing the health and vigor of many more." The same writer quotes a Wisconsin correspondent who states that the insect was evidently introduced into Wisconsin as early as 1840. It is thus shown that the species had a wide distribution in this country at an early date.

*Present distribution.*—The oyster-shell bark-louse is known all over the world. It occurs in more or less abundance wherever apples and pears are grown. In the United States it is reported from Maine to California, although it is not so well known in many of the western states as in the east and south. It is widely distributed throughout this State. While we are receiving specimens from new localities every year, up to the present time specimens have been received from the following counties: Erie, Niagara, Monroe, Wayne, Ontario, Yates, Schuyler, Seneca, Cayuga, Onondaga, Cortland, Jefferson, Lewis, St. Lawrence, Columbia, Kings, Queens and Suffolk.

*Food plants.*—The list of food plants for this insect includes a large number of our common trees and shrubs. In the nursery it is especially abundant upon fruit trees, such as apple and pear, but it should be watched for on other stock such as currant, gooseberry, blackberry and raspberry, also on ornamentals such as maple, birch, elm and lilac.

*Descriptions and life history.*—The life history of the oyster-shell bark-louse is very similar to that of many other species of scale insects. If an infested tree is examined in the winter the

* Year Book U. S. Dept. Agr. 1894, p. 255.

scales will be found to present the appearance shown in Plate XIX, fig. 1, which is from a photograph of an infested apple twig, natural size. It will be observed that although differing in shape, being longer and narrower, the scales bear a slight resemblance to an oyster-shell, hence the name. If one or two of these scales are turned over [Fig. 2.] they will be found to be well filled with creamy white eggs. If, however, the eggs are not observed until nearly ready to hatch they will have turned to a dark reddish-brown color. There are usually between forty and fifty, although the number may vary greatly. We have found as few as thirty and more than sixty under different scales. The shriveled body of the female scale will be found occupying a portion of the smaller end. The eggs vary in shape as shown at Fig. 3, which is from a photomicrograph showing a number of the eggs greatly enlarged, but in general appearance slightly resemble miniature hens' eggs. They also vary in size, but from a number of measurements we found that an egg of average size would measure about 0.3 mm. by 0.18 mm.

The eggs remain protected by the scales all winter. In this climate most of them have hatched by the first of June. In some seasons they hatch earlier than others. Last year many newly hatched lice were observed on apple trees in the vicinity of the Station as early as May 7.

The newly hatched lice are very small, measuring only about 0.4 mm. in length and half as broad. A good idea of their shape is given in Plate XX, fig. 1, *c*. Their bodies are nearly flat and light yellow in color. They wander about for a short time, varying from a few hours to a day or more, finally settling down, most of them on the new growth, where they begin to suck the sap by means of their sharp, thread-like mouth parts. They probably never go to the leaves and only one or two cases have been reported where the scales were found on the fruit. It is probable that when once settled on the bark the females never move.

The scales grow rapidly and by the latter part of July are mature. Most of the scales grow to have the appearance already referred to and shown at Plate XIX, fig. 1. These are the female scales and they are in a very large majority. The male scales are much smaller, and more regular in outline. The posterior portion of the scale is also very different in that it is hinged so as to allow the mature male to escape.

In color, the male and female scales are similar, both finally becoming an ash gray tint. The mature male is a delicate two-winged insect very different in appearance from the female. A mature male is shown in Plate XX, fig. 1, *a*, and a mature female, with her scale removed, at *e*.

The eggs are laid during the middle of the summer, the body of the female growing smaller as each one is produced until finally there is little left but a withered skin. The eggs remain under the scales all winter, finally hatching in the spring as previously stated.

*Means of distribution.*—As the scale passes the fall, winter, and part of the spring in the egg stage, the eggs being protected by the scales, it is evident that the insect may be easily distributed by means of infested stock. When the trees are not badly infested the scales are easily overlooked, and thus as each scale protects thirty or forty eggs, a nursery tree even slightly infested may finally harbor enough scales to do very serious injury in the orchard.

*Remedial measures.*—Badly infested nursery trees should be dug up and burned. Where especially choice trees or shrubs are infested they may be successfully treated either by applying a wash during the winter or by spraying in the spring while the young lice are active. For a winter wash either kerosene emulsion or whale oil soap may be used. The kerosene emulsion should be diluted with three parts of water, and the whale oil soap* used at a strength of one pound to two gallons of water.

Before applying the wash the infested parts should either be scraped gently or rubbed with a stiff scrubbing brush to loosen the scales. This allows the insecticide to reach the eggs which would otherwise be protected by the scales. For spring treat-

*In buying whale oil soap much pains should be taken to get a good article. Much of the soap on the market is very poor. The Leggett brand has proven of good quality, also that manufactured by Jas. Good, Philadelphia, Pa.

ment, spray the trees as soon as the young lice appear. Either kerosene emulsion or whale oil soap solution may be used. The former should be diluted with seven parts of water and the latter used at a strength of one pound to seven gallons of water.

Where practical the winter treatment is preferable, as many of the young scales may be easily missed. In case of badly infested trees, however, both the winter and spring treatment may be given with excellent effect.

### THE SCURFY BARK-LOUSE.

*Chionaspis furfurus* Fitch.

Like the oyster-shell bark-louse, this species occasionally becomes sufficiently abundant to do serious injury. We have seen it in the nursery as often as the other species, and have found it doing very serious injury in at least one large pear orchard in the State.

*History.*—Although this species is less frequently mentioned in the writings of early American entomologists, it was well known at an early date as an injurious species. B. D. Walsh and other writers on American entomology mentioned it as early as 1860. Since that time it has been frequently mentioned by American writers.

*Present distribution.*—According to Dr. Howard* this species is now known to occur in the District of Columbia and twenty states, including Massachusetts on the east, Georgia on the south and southern California on the west. The same writer also states that it has been recently reported in England. It is undoubtedly widely distributed in this State. Up to this date we have received specimens from Erie, Niagara, Monroe, Wayne, Ontario, Yates, Schuyler, Seneca, Cayuga, Onondaga, Columbia, Queens and Suffolk counties.

*Food plants.*—The most common food plants for the scurfy bark-louse are apple and pear. In the nurseries we have found it more abundant on pear trees than on any other stock. In one instance nearly all the trees in a small block of standard pears

*Year Book U. S. Dept. Agr. 1894, p. 259.

were very badly infested, a majority of them being seriously injured. We have found it upon apple, pear, crab apple and quince. In addition to these food plants Dr. Howard* gives black cherry, choke cherry, currant, mountain ash, Japan quince and peach, the last named having been sent from two localities in Georgia.

*Descriptions and life history.*—The general appearance of the mature female scales is shown in Plate XIX, Fig. 4, which is from a photograph of an infested pear twig. They are dirty white in color. The life history of this species is very similar to that of the oyster-shell bark-louse. The eggs are found under the scales during the winter, but usually in less numbers than in the preceding species; also, instead of being cream white, they are purplish red. The young scales hatch in the spring at about the time the young oyster-shell bark-lice appear, which they resemble very closely. The male scales are much smaller than the female scales, and, unlike them, are brilliant white. They are also quite different in shape, the sides being nearly parallel with two longitudinal ridges extending along the upper surface.

*Means of distribution.*—This insect is distributed by means of infested nursery stock in the same manner as the preceding species. Owing to their lighter color, however, they are more easily seen, and hence there is less excuse for sending out infested stock.

*Remedial measures.*—The treatment recommended for the oyster-shell bark-louse will prove equally effective for this insect.

## THE NEW YORK PLUM LECANIUM.

*Lecanium cerasifex* †Fitch(?).

The sudden appearance of this insect three years ago in overwhelming numbers in some of the large plum orchards of western New York is, doubtless, fresh in the memory of orchardists and nurserymen throughout the State. Very little is heard of this scale now, however, owing to the fact that it disappeared almost as suddenly as it came. But it may still be seen occasion-

*Year Book U. S. Dept. Agr. 1894, p. 260.

†Identified by Mr. Th. Pergande.

ally in most plum orchards and during the past season we found it scattered in several nurseries, hence it may yet be considered a pest which should be carefully watched with a view to preventing other serious outbreaks.

*History.*—Previous to 1893 but little was known of this insect in this State, although it seems to be the prevailing opinion among prominent fruit growers that the insect has been in the plum orchards of western New York for twenty years or more, but not in sufficient numbers to cause special comment. During the seasons of 1893 and 1894 the insect did great damage to western New York plum orchards, but in the spring of 1895 comparatively few of the scales could be found, most of them having succumbed to the attacks of parasites, predaceous insects and climatic changes.

*Present distribution.*—Accurate data as to the present distribution of this insect is wanting. This or a very similar species, however, is known in the south and a species which is probably identical is reported from England. Judging from our observations during the past season, the scale is at present scattered through many of the larger plum orchards in western New York and may be occasionally seen in the nurseries, but in only a few cases have we found it in sufficient numbers to do serious injury. We have observed the species in the following counties: Niagara, Orleans, Genesee, Monroe, Ontario, Seneca, Cayuga, Onondaga, Richmond and Queens.

*Food plants.*—As its name indicates, this species is especially injurious to the plum. It has also been reported upon apple, pear, maple, *Cissus*, cherry and peach. In addition to these food plants the writer has found a very closely allied if not identical species upon quince, apricot, cultivated blackberry, cultivated grape, honey locust, black ash and iron wood [*Ostryia*].

*Descriptions and life history.*—A detailed account of this insect is given in the Fourteenth Annual Report of this Station, pages 574-593. As comparatively few of the reports are left for distribution, however, it may be well to repeat the life history of the insect substantially as given therein.

The general appearance of the insect is shown at Plate XIX, fig. 5. At *a* the mature scales are shown enlarged and at *b* the mature and young hibernating scales, natural size. Unlike the two preceding species, this scale passes the winter in the larval state. After the first few warm days of spring, the young scales begin to move about, but soon find a suitable place to settle down to again suck the sap of their host plant. They soon begin to grow with astonishing rapidity. Previous to this time the male and female scales are very much alike, but as the season advances the female scales are seen to grow to large oval fleshy scales, while the males are much smaller, oblong and slightly oval in shape. A delicate white waxy scale is their only protection. The mature male is a delicate two-winged insect, in general appearance resembling the males of the two preceding species. Under this delicate covering the male undergoes its transformations, finally, about the time the female becomes full grown, emerging as a mature insect.

About the middle of May or early in June the females are mature and egg laying begins. The eggs are oblong oval in shape, pearly white and have smooth shells. They are laid under the mother shell, which is only the hardened integument of the parent insect, the mother scale herself literally turning into a mass of eggs. The number of eggs produced by a single scale varies greatly, probably from five or six hundred to over two thousand, the writer having counted over twenty-one hundred under a single female.

The newly hatched scales remain under the mother shells for a time varying from a few hours to two or three days. At this time they vary in size from 0.5 to 0.75 mm. in length and are a little more than half as broad as long. Their bodies are also very thin and slightly curved above.

As would be supposed, a swarm of little scales is produced from a single mother. After leaving the mother shell they travel about apparently aimlessly for a time, but within a few days settle down, most of them upon the under surface of the leaves along the mid ribs and larger veins, although many may be found upon the upper surface as well. Still others, however, may be found scattered about promiscuously on both surfaces of the leaves, and it is not unusual to find some that have remained behind on the new and tender twigs. When attacking the leaves of the quince, they seem to prefer the upper surface, for out of a large number of quince leaves examined only an occasional scale could be found on the under surfaces, while the upper surfaces were moderately infested. It should be remembered that these young scales are very small at this time, and as they closely resemble the leaf in color and are almost semi-transparent, they are easily overlooked. Hence in examining the leaves for them it is well to use a small magnifying glass.

The scales grow slowly during the summer and gradually change to a dark, reddish brown color. During all of this time, however, they suck the sap vigorously and secrete much honey dew, causing the leaves, branches and fruit to become sticky and unsightly.

During the latter part of August or early in September the young scales migrate to the twigs and branches and even the trunk to seek shelter for the winter. On badly infested trees they may frequently be found overlapping one another and in sheltered places, as in crevices in the bark, it is not unusual to find them two or three deep. In this condition they remain until spring, when activity is again renewed and the life cycle completed.

*Means of distribution.*—The hibernating scales are easily carried about on nursery stock. Young nursery trees probably seldom become badly infested. All of the infested trees which we have seen had but comparatively few scales on them and these were scattered about on the trunks and branches and were usually hidden in scars on the trunks and near the buds so effectually that they were easily overlooked. Thus the young scales, although not protected by a scaly covering, are not easily rubbed off and hence may remain on trees shipped long distances without injury.

*Remedial measures.*—In the report above referred to we have given a detailed account of a series of experiments with kerosene emulsion as a remedy for this species. It was found that kero sene emulsion, diluted with from four to six parts of water, could be depended upon to kill the hibernating scales when applied to the infested trees in the form of a spray. When the spray is to be directed against the newly hatched lice, the emulsion should not be diluted with more than nine parts of water.

## THE OAK SCALE.

*Asterodiaspis quercicola* Bouché.

There are but few references to this insect in the writings of American entomologists. In his report for 1880, p. 330, Prof. J. H. Comstock, who was then Entomologist of the United States Department of Agriculture, published a description of the male and female, the former being taken from Signoret. Another reference is in Insect Life, Vol. II, p. 41, in which Dr. L. O. Howard states that this scale is found almost solely upon American oaks in a grove in the Department grounds, previously referred to by Professor Comstock in his report for 1880. In Insect Life, Vol. VII, p. 120, Mr. C. L. Marlatt gives the result of experiments against this insect. He found that the newly hatched young could be killed by spraying the infested trees with kerosene emulsion, one part to thirteen parts of water. In the same volume, page 428, a brief reference is made to a note by Mr. R. Newstead in the Entomologist's Monthly Magazine for April, 1895, in which he states that, although birds are not usually supposed to feed on scale insects, he had found that the blue tit and longtailed tit feed on this and certain other species.

It is probable that, except in isolated cases, the species has never been a serious pest in this country.

As its name implies, this scale attacks the oak. Some idea of its general appearance can be had by referring to Plate XIX, fig. 6. This figure is from a photograph of an infested twig, natural size. The female scales are nearly circular and somewhat conical. They are dark or yellowish green in color. When one of the mature scales is removed, it will be found to have made a pit-like depression in the bark. The mature female scales will measure from 1 mm. to nearly 2 mm. in diameter. According to Sig noret, as quoted by Comstock, the male scales are oval and usually smaller than the females, measuring but 1 mm. in length. But little is known of the life history of this species.

We have seldom found this scale in the nursery. It may do serious injury on large trees, however. A good illustration of this is on one of the principal streets of Geneva, where most of the English oaks, *Quercus robar*, which line the streets for two or three blocks on either side, have been either killed or nearly so by this scale. So far as we know its only food plant is the oak.

### THE SAN JOSÉ SCALE.

*Aspidiotus perniciosus* Comst.

At present this is the most important of all the species of insects which attack nursery stock. It is important, not only because of the injury to the trees which it is capable of doing, but because nurserymen and fruitgrowers are afraid of it, and hence hesitate to buy stock from a nursery in a locality where the scale is known to exist. It is also of especial interest to nurserymen and fruit growers in this State because it is being found each season in new localities within our borders. The finding of the scale in a small nursery near Union Springs probably means that it has been sent to numerous localities within the State. Much has been written about it and it has been described and its life history written over and over again. Yet a very large majority of the nurserymen and fruit growers of the State seem to have but little idea of the true nature of the insect. It may be well, therefore, to give a somewhat detailed account of it in these pages.

*History.*—The original home of the San José scale is not positively known. Some writers think that it originally came from South America while others believe that its native home may have been Japan or possibly Australia. But wherever its original home may have been it is said to have been known in the San José Valley, California, as early as 1870. In 1880 Prof. J. H. Comstock described it and gave it its scientific name. It was not discovered in the east until 1893 when a few trees in an orchard at Charlottesville, Va., were found infested. Subsequent investigations showed that these trees came originally from a New Jersey nursery. In 1894 the scale was found on Long Island and other points in this State.

*Present distribution.*—According to Messrs. Howard and Marlatt* the scale was known in 1896 in Alabama, Arizona, California, Delaware, Florida, Georgia, Idaho, Indiana, Louisiana, Massachusetts, Maryland, New Jersey, New York, New Mexico, Ohio, Oregon, Pennsylvania, Virginia, Washington, West Virginia and British Columbia. In addition to the above states it is now known to occur in several localities in Michigan and in the provinces of Canada. In this State it has been found in the following counties: Suffolk, in several orchards; Queens, in three nurseries; Kings, in one small orchard near Brooklyn; Orange, in an orchard at New Milford (Dr. Lintner); Dutchess, in an orchard near Poughkeepsie; Columbia, in an orchard near Germantown and two at Kinderhook; Tompkins, on ornamentals on the campus of Cornell University; Seneca, two trees, which have been burned, in an orchard near Farmer; Cayuga, in an old nursery near Union Springs.

*Food plants.*—The following list of food plants, which includes those observed up to 1896, is given by Dr. J. B. Smith.† It will be of especial interest to nurserymen and hence is given here in full. Linden, enonymus, almond, peach, apricot, plum, cherry, locust, spiræa, raspberry, blackberry, rose, hawthorne, cotoneaster, pear, apple, quince, flowering quince, gooseberry, currant, flowering currant, persimmon, acacia, elm, osage orange, English walnut, pecan, hickory, alder, chestnut, oak, birch, weeping willow, laurel leaved willow, Kilmarnock willow, sumach and grape. A list published in July, 1897, by Prof. F. M. Webster‡ includes black walnut, Carolina poplar, lombardy poplar, golden leaf poplar, European willow, cut leaf birch, flowering peach, flowering cherry, American linden, European linden, hardy catalpa and mountain ash in addition to those given above.

*U. S. Dept. Agr. Div. Ent. Bul. 3, new series.
†N. J. Agl. Exp. Stas. Rept. 1896, p. 547.
‡Ohio Agl. Exp. Sta. Bul. 81, p. 184.

From the above lists it will be seen that the scale may be found on practically all classes of nursery stock grown in the east. It is not known to attack citrus fruits.

*Descriptions and life history.*—A good idea of the general appearance of the scale is given in Plate XXI, figs. 1 to 4. Here the scales are shown natural size and enlarged on both twigs and fruit. The female scales are greatly in excess of the males, which is the case with most other scale insects. The following description is taken from Bul. 3 (new series), U. S. Department of Agriculture Division of Entomology, by Howard and Marlatt, p. 46: "The scale of the female is circular, very slightly raised centrally, and varies in diameter from 1 to 2 mm., averaging about 1.4 mm. The exuviæ is central or nearly so. The large well-developed scales are gray, excepting the central part covering the exuviæ, which varies from pale to reddish yellow, although in some cases dark colored. The scale is usually smooth exteriorly or sometimes slightly annulated, and the limits of the larval scale are always plainly marked. The natural color of the scale is frequently obscured by the presence of the sooty fungus [*Fumago salicina*].

The microscopic characteristics of the mature female are shown at Plate XX, fig. 2. At *b* the ornamentation of the anal plate is shown. This is of especial value in determining the species. Those who wish to make microscopical examination of the insect to determine the species, will find that the characteristics of the anal plate can be brought out by boiling the insect for a few minutes in a weak solution of caustic potash, then washing, then, after placing in alcohol for a short time, cleaning in oil of cloves or other convenient cleaning solution. The specimen should then be mounted in balsam. The *male scale* is darker than the female scale, "oblong oval" in shape, "nearly twice as long as wide and about half the diameter of the female scale." (Howard and Marlatt.) The mature male is a delicate two winged insect, orange yellow in color excepting the head, which is somewhat darker.

The main points of the insect's life history may be briefly stated as follows: In this climate, if an infested tree is examined during the winter the scales will be found varying in size from less than half grown to fully matured. On badly infested trees they are crowded in great numbers very close together. On trees not badly infested they will be found in groups of from two or three to many more with numerous individuals scattered about on the bark. The writer has not had an opportunity of studying the life history of the scale in western New York until within the past few weeks, and hence no observations have been made as to the time the females first begin producing young in the spring. On Long Island, however, the males mature in April and during the following month the females begin giving birth to young. Unlike most scale insects, the young are brought forth, in nearly all cases, alive. According to Howard and Marlatt the average number of young produced by a single female is 400. The period during which an individual female will continue producing young lasts for six or seven weeks. The newly born scales are nearly microscopic in size, with bodies oval in shape, when viewed from above, and orange yellow in color. They remain under the mother scale for a short time, finally coming forth to wander about until a suitable place is found to insert their sharp thread-like setæ by means of which they suck the sap. By this time thread-like waxy secretions have begun to appear on the back of each little scale. These waxy secretions together with the cast skins form the scales. At first there is no difference in appearance between the male and female scales, but according to Howard and Marlatt* the difference becomes apparent after the first molt. Owing to the comparatively long period during which young are produced it is difficult to ascertain the number of generations. Judging from the scales, as they appear in the winter, however, it is probable that young are produced until the latter part of the summer or early in the fall. After all their young have been brought forth the old females die, the young surviving to continue the species.

*Means of distribution.*—Locally the active scales are undoubtedly carried about by birds; insects, such as beetles; and probably on the clothing of persons working in the infested nursery

*U. S. Dept. Agr. Div. Ent. Bul. 3, new series, p. 46.

or orchard. An illustration of this was noticed in one of the nurseries previously referred to. In this nursery it is evident that the scales were first introduced on a few trees. These are very badly infested, those in their immediate vicinity less so and those four or five rods away still less. Along the road bordering this nursery and about forty rods away are a dozen or more pear trees which have been in bearing about two years. These are healthy, vigorous trees and are only very slightly infested having evidently become infested only within the past year. It seems very probable that the only way the scales could have been brought to these trees was by some of the means above referred to.

It is undoubtedly safe to say that the scale is sent broadcast over the country by means of nursery stock more than in any other way. It is true that infested pears from California have frequently been found on fruit stands in some of our eastern cities, but there is very much less chance of spreading the scale in this way than by infested nursery stock. Infested trees dug either in the fall or spring will carry dormant scales.

*Remedial measures.*—Various insecticides have been tested in the east against this insect. Eight of the most important of these are discussed in Bulletin No. 87 of this Station. The insecticide which has proved the most successful in the east is whale oil soap. This should be applied at least twice to the infested trees in the fall after the leaves have fallen, at a strength of two pounds to a gallon of water. Another application should be made in the spring before the buds begin to swell. A portion of an infested plum orchard which was carefully sprayed with whale oil soap at this strength was practically freed from the scale after two applications. It is important to have good whale oil soap. That manufactured by Leggett Bros., 301 Pearl Street, New York, and by James Good, 514-518 Hurst Street, Philadelphia, is highly recommended. Dr. J. B. Smith* recommends a fish oil soap, which can be made after the following formula:

| | |
|---|---|
| Concentrated lye | 3½ pounds. |
| Water | 7½ gallons. |
| Fish oil | 1 gallon. |

*N. J. Agr. Exp. Stas. Rept. 1896, p. 559.

The lye should be dissolved in boiling water and the fish oil at once added. This mixture should be kept boiling for two hours and then allowed to cool. This soap should be used at a strength of one pound to one gallon of water.

Pure kerosene oil has been used as a winter application with varying degrees of success. It will kill all the scales with which it comes in contact, but unless the tree is very hardy or the conditions are just right it is liable to kill the tree also. It should not be used except in extreme cases.

When the trees or nursery stock are to be fumigated with hydocyanic acid gas, the gas may be generated after the following formula:

| | |
|---|---|
| Fused cyanide of potassium (98 per cent) | 1 oz. |
| Sulphuric acid, commercial | 1 oz. |
| Water | 3 ozs. |

Pour the water and the sulphuric acid into a glass or glazed earthenware dish. When this is placed where it is to remain add the cyanide of potassium. This will generate enough gas for 150 cubic feet of space. Much care should be taken that the operator does not breathe any of the fumes.

Fumigation is not considered the most practical method of treatment for infested orchard trees here in the east, but it may be used for infested nursery stock. On another page reference is made to treating nursery stock in large cellars. A convenient house for fumigating a small amount of nursery stock is shown at Plate XXII. These may be built any convenient size. They are built of a double thickness of boards with building paper between to make them as nearly air tight as can be conveniently done. The door is made to fit very tight. The stock is piled in the house in such a manner as to allow the gas to circulate freely. One generator with enough material to fill the space is placed about the middle of the floor and as soon as the cyanide is added, the door is shut and the stock left for an hour. When the fumigating is done on a cool, cloudy day or at night, there is practically no danger of injuring the stock as shown by the fact that various varieties of fruit trees, also currants and gooseberries, have been exposed in the building shown in the plate and in others in their immediate vicinity, all night without the least apparent injury.

*A closely allied species common in New York.*—This insect, *Aspidiotus ancylus* Putn., resembles the San José scale in general appearance and is frequently mistaken for it. It is not a serious pest in this State, however, but in the south it may occur in sufficient numbers to do serious injury to the infested plants. Its life history has not been worked out for this locality.

We have frequently found this species in the nursery, usually on young plum trees, but in no instance were the scales in sufficient numbers to injure the trees to an appreciable extent.

According to Prof. T. D. A. Cockerell* this scale is found upon ash, maple, beech, linden, oak, osage orange, peach, hackberry, bladder nut and water locust.

## PLANT LICE.

The nature of these insects in general need not be enlarged upon here as the principal prints in their development will be touched upon in another bulletin. These insects were unusually abundant last year in both nurseries and orchards. One of the species, *Hyalopterus pruni*, which was abundant on the plum last season is shown at Plate XXIV, fig. 5. This species was also very abundant in some of the nurseries examined last season but will be discussed more in detail in the bulletin above referred to.

### THE WOOLLY LOUSE OF THE APPLE.

*Schizeneura lanigera* Hausm.

The writer has found this species more common in New York nurseries than any of the other injurious insects. As a rule apple trees were the worst infested, but blocks of pears or quince trees growing next to blocks of infested apples, were also usually infested.

The life history and habits of this insect together with its importance as a nursery stock pest are discussed by the writer in the Annual Report of the Station for 1896, pages 570-577, and hence it will be unnecessary to discuss these points in detail here.

*U. S. Dept. Agr. Div. Ent. Bul. No. 6, technical series, p. 20.

It may be stated, however, that in some sections of the State this species of woolly aphis is doing very serious injury every year both in the nurseries and young orchards. The insect and its work are illustrated at Plate XXIII, figs. 1 to 5. All of the photographs for this plate were made from an infested apple tree taken from a nursery at Geneva. The insect works on both roots and branches. Those infesting the former are referred to as the root inhabiting form and those on the branches as the aerial form. The injury to the roots caused by the lice is shown at Fig. 3. The larger roots are more or less deformed and are covered with galls. A nearer view of some of the galls is shown at Fig. 4. Fig. 1 shows the appearance of a badly infested twig. The lice collect on the under sides of the limbs and twigs and secrete a bluish white cottony substance which completely covers them. If these lice are removed it will be found that they have formed numerous galls and pits on the bark. At Fig. 2 one of these galls and some of the lice, with most of the cottony substance removed, are shown enlarged to about four times natural size.

The lice are distributed in the nursery or orchard by means of the migrating females, but they are distributed over the country by means of infested nursery stock. Many trees with infested roots are shipped, but the lice are frequently found in the scars along the trunks of the young trees as shown at Fig. 5. The lice hibernate in these scars and other similar places on the trees. The winter eggs may also be frequently found among these hibernating lice. In a large majority of cases the infested trees found on the packing grounds during the past two seasons by the writer, were harboring the lice in these scars on the trunks only, very few of them having infested roots. It is important that nurserymen and buyers take pains to avoid selling or planting stock thus infested. The lice can be easily and quickly killed by touching these infested scars with a cloth saturated with kerosene oil.

This insect is widely distributed throughout the United States and is well known in Europe. It is probably found in this State wherever apples are grown. Our records show that it has been either observed by the writer in injurious numbers or reported to the Station from the following counties: Chautauqua, Monroe, Wayne, Ontario, Yates, Seneca, Cayuga, Columbia, Dutchess, Queens and Suffolk.

## BORERS.

This group includes a number of the most serious pests in nursery and orchard trees. By "borers" is usually meant those insects which bore into the roots, trunks or branches of the infested plant. As the larvæ are most active in the injurious work the term refers especially to them. The only species of borer which was found doing serious injury in the nurseries is the peach tree borer.

### THE PEACH TREE BORER.

*Sannina exitiosa* Say.

This insect is also discussed at length in the Annual Report of this Station for 1896, pp. 559-567, and hence need be only briefly mentioned here.

The nature of the insect is shown at Plate XXIV, figs. 1 to 3. The injury is done by the larvæ which bore into the trunk or roots, feeding largely on the sapwood. One of the larvæ is shown at Fig 1. At Fig. 2 the pupa (*a*) and male (*b*) and female (*c*) moths are shown. Both figures are from photographs showing the originals natural size. At Fig. 3 an upper and side view of one of the larvæ slightly enlarged is shown.

In some sections of the State this insect is usually very abundant. The borers were much less frequently found the past season than the season previous.

This insect has also a wide distribution and is well known in all parts of the State. We have found it especially abundant in Monroe, Wayne, Ontario, Seneca and Cayuga counties.

## CASE-BEARING INSECTS.

Under this head may be included two species of insects which have done serious injury in the nurseries and orchards, especially the latter, in this State during the past two seasons. These are commonly known as the pistol-case-bearer and the cigar-case-bearer. They are called case-bearers because the caterpillars construct cases for themselves which they carry on their backs and which serve as protection to the owners.

### THE PISTOL-CASE-BEARER.

*Coleophora malivorella* Riley.

This insect should receive the careful attention of both nurserymen and fruit growers as it is becoming a very serious pest. It is especially injurious to the apple and pear and is known to attack the quince. The principal injury is done to the buds and expanding leaves. The young caterpillars construct pistol-shaped cases soon after hatching. They hibernate in these and during the winter the cases may be seen attached to the twigs, as shown at Plate XXIV, fig. 4. The case-bearers are more noticeable during the spring or early summer as their cases are much larger and their injurious work more apparent. This insect is discussed in detail in Bulletin No. 122 of this Station.

The pistol-case-bearer is probably distributed over a considerable area in the eastern states. It is especially injurious in the apple orchards of western New York. The writer has observed it in seriously injurious numbers in some of the large orchards in Orleans, Monroe, Wayne, Ontario and Seneca counties.

### CIGAR-CASE-BEARER.

*Coleophora fletcherella* Fernald.

A closely allied species is the cigar-case-bearer. The case of the mature caterpillar resembles a miniature cigar, hence the name. The writer has not observed this species in the nursery as frequently as the other, but it is well known as a serious pest in the apple orchards, especially in the western part of the State. The hibernating case-bearers of this species are not as easily detected as those of the other. Their cases are smaller, usually a little lighter colored and bent in the shape of a crescent moon. They are usually found close beside the winter buds or partially hidden in a fold in the bark or the angle made by a branching twig. It is as widely distributed as the former species and is found on the same food plants.

### THE BUD MOTH.

*Tmetocera ocellana* Schif.

Although not a case-bearing insect the discussion of the species may be placed here for convenience.

*History.*—This species is probably of European origin. It was known as a serious pest in this country nearly fifty years ago. Since then it has been recorded as a serious pest in various parts of the eastern states.

*Present distribution.*—It is probably well distributed throughout the eastern states. It is also well known in Canada. It has been found in Missouri and as far west as Idaho.

*Food plants.*—The writer has observed this insect upon apple, pear, plum and peach trees. According to Prof. M. V. Slingerland,* who has made a careful study of this species, it also attacks the cherry, quince and blackberry.

*Descriptions and life history.*—The life history of this insect has not been studied out by the writer. As given by Prof. Slingerland, in the bulletin above referred to it is briefly, as follows: Usually the nurseryman or fruit grower is not aware that this insect is injuring his trees until he finds that many of the leaf buds fail to produce leaves in the spring. Upon examination the little brown caterpillars may be found eating out the tender centers of the swelling buds. Later in the season they attack the unfolding leaves, drawing them together with silken threads as shown at Plate XXIV, fig. 6. By June the caterpillars are full grown. The pupa stage is passed in these nests, "in a tube of dead leaves," and lasts about ten days. The parent insects are dark ash gray moths marked with a cream white band across the front wings. In three or four days after emerging the moths lay their eggs. The eggs resemble minute drops of water and are laid singly or in clusters on the leaves. The eggs hatch in from seven to ten days. The young caterpillars soon begin to feed on the skin of the leaf. They also make for themselves tubes of silk usually along the midrib of the leaf. They continue to feed during July and part of August, devouring only the soft parts of the

*Cornell Univ. Agl. Exp. Sta. Bul. 107, p. 57.

leaf. During August the caterpillars migrate to the twigs where they spin silken cases on which to pass the winter. These cases are about one-eighth of an inch long, and as they lie close to the bark and resemble it in color are not readily detected.

The writer has quite frequently found these cases with their hibernating caterpillars on nursery trees about to be shipped from the packing grounds. It is in this manner that the insect is most readily distributed over the country.

*Remedial measures.*—Where practicable the trees should be thoroughly sprayed with Paris green, 1 pound to 150 gallons of water, before the buds open in the spring. Two applications will be found better than one, the object being to keep the buds coated with the poison so that the first meal of the caterpillars in the spring will be a poisoned one. Experiments at this Station have shown that the bud moth can be held in check in this way.

In nurseries and in orchards, also, serious injury may be prevented by cutting out the nests which are rendered conspicuous by the partially dead leaves. This should be done before the moths come forth, thus reducing the numbers of the next brood.

## EXPERIMENTS IN TREATING INFESTED NURSERY STOCK.

### Dipping Young Stock Infested with Plant Lice.

As noted on a previous page, plant lice have been unusually abundant during the past season. Their injurious work has been especially evident in the nurseries. The greatest injury was usually caused to seedling and one-year-old fruit trees. The lice attacked the tender leaves at the tips of the young trees soon causing them to curl so badly that the insects could not be reached with a spray. In the nursery in which the experiments were made the infested trees, principally sweet cherry, apple and pear trees, showed serious injury from the effects of the lice The experiments were undertaken with a view to determining a practical method of checking the injurious work of the lice. It was evident that spraying would not be a success and so dipping the infested trees in a solution of whale oil soap and water was resorted to. It might at first seem that this method would be impractical because of the time and labor involved, but it should be remembered that the lice appear on comparatively few trees first, others becoming infested from these later in the season, and hence if they are successfully treated more serious injury by the lice may be prevented.

All of the trees used in the experiments were seedlings, one-year-olds and two-year-olds. As the lice were congregated on the leaves at the tips it was necessary to wet only this portion of the tree. The dipping of the stock was found to be a very simple matter. Three or four men carrying pails filled with the solution passed through the blocks and, picking out the infested trees, bent them over carefully and dipped their tips into the solution, taking care to hold them long enough to wet all of the lice. It was found unnecessary to spend more than two minutes to a tree.

*Experiments.*—About a thousand trees were used in experiments, which for convenience may be divided into six blocks. Blocks I and II were sweet cherries badly infested with the black cherry aphis, *Myzus cerasi*. Blocks III and IV were apples also badly infested, but with the apple aphis, *Aphis mali*. Blocks V and VI were standard pears infested with a species of plant lice, *Aphis* sp. Blocks I, III and V were treated the same day, a bright, warm day about the middle of July, with a solution of whale oil soap, 1 pound to 3 gallons of water. Blocks II, IV and VI were treated within two days of this time, under practically the same weather conditions, with a solution of whale oil soap, 1 pound to 7 gallons of water. But one application was made in each case.

*Results.*—In nearly every case where the stronger soap solution, 1 pound to 3 gallons, was used, the leaves were more or less injured. The pears were injured most while there was not much difference between the apples and cherries. So far as could be ascertained, all of the lice on these trees were killed. The weaker solution, 1 pound to 7 gallons, did not injure the foliage in any instance, but proved fully as effectual as the stronger solution in killing the lice. These treated trees were not seriously infested again during the season.

*Conclusions.*—The above experiments indicate that, when young nursery trees become so badly infested with plant lice as to make spraying impractical, they may be successfully treated by dipping the curled tips in a solution of whale-oil soap, one pound to seven gallons of water. The expense and labor were so slight as to be factors of but little importance. When thoroughly done but one treatment is necessary under ordinary circumstances.

## SPRAYING YOUNG GRAFTS.

Most of these experiments were conducted against a large species of flea-beetle, *Systena hudsonias* Forst. The beetles were very abundant during June and July on apple and pear grafts in a nursery near the Station. The beetles fed voraciously on both upper and under surfaces of the leaves, eating away the tender tissue and causing them to wither and die. About twenty-five per cent of the grafts were killed before the experiments were commenced, and a whole block of 20,000 apple grafts was seriously threatened. The beetles were also doing serious injury in a small block of two-year-old apples and a large block of two-year-old pears in the same nursery. Green arsenite was used in all the experiments, and in each case sufficient lime was used to make the mixture "milky" in appearance. A barrel and pump, mounted on a small stone boat which could be easily hauled between the rows by one horse, was used. To each lead of hose a Y was attached so as to support two short lengths of hose. Two men followed the pump, spraying two rows at a time, thus requiring three men to do the work. Improved Vermorel nozzles were used.

*Experiments.*—Block 1; one-year-old apple grafts sprayed June 16, with green arsenite, 1 pound to 150 gallons of water. June 18 this block was again sprayed, but the poison was used at a strength of one pound to 100 gallons of water. June 25 a third application was made, the poison being used at the same strength.

Block II; two-year-old apple trees sprayed June 18 and again June 25, with green arsenite, one pound to 100 gallons of water.

Block III; two-year-old pear trees sprayed June 18 and again June 25 with green arsenite as in Block II.

Block IV; one-year-old apple grafts badly infested with canker worms. This block was sprayed early in June with the green arsenite, one pound to 100 gallons of water. A second application of the poison was unnecessary.

*Results.*—The green arsenite at one pound to 150 gallons of water had but little effect on the beetles. Where the stronger mixture was applied the effect was very apparent, after the second application. But few live beetles could be found, and after the third application no further injury to the stock was noticed. Although most of the spraying was done on a bright warm day, the most tender leaves did not show the slightest indications of having been burned by the green arsenite.

Block IV was freed from canker worms by one application of the poison at the strength stated.

*Conclusions.*—While these experiments should be carried further before final conclusions are reached, the results indicate that young grafts may be safely sprayed with the green arsenite, one pound to 100 gallons of water, provided enough lime is added to give the mixture a "milky" appearance. It may be here stated that it is important to add the lime as it not only makes the mixture spread and adhere to the leaf better, but prevents burning the foliage.

### SPRAYING CUT-LEAVED BIRCH.

These trees constituted a small block in one of the Geneva nurseries. Nearly all of the trees were badly infested with thrips [*Thrips* sp.] These are very small, almost microscopic insects, which feed on the soft parts of the leaves, soon causing them to wither and die. They are frequently very injurious, and are well known to both gardeners and fruit growers. They are hard to reach with insecticides, as they fly away as soon as disturbed by the spray mixture. The trees in question were beginning to show the injury which the insects were causing before the spraying was done. In all cases much pains was taken to wet both upper and under surfaces of the leaves.

*Experiments.*—About the middle of June the block was sprayed with a solution of whale-oil soap, one pound to seven gallons of water. After waiting two days no beneficial results were apparent. The block was again sprayed with whale-oil soap, one pound to four gallons of water. This had the effect of keeping the insects away for a few days, but injured the foliage slightly during one or two warm bright days which followed the application of the soap. In about six days from this last application the trees were again sprayed, this time with whale-oil soap, one pound to seven gallons of water, with the addition of flowers of sulphur, one ounce to each gallon of solution. This proved much more effectual than either of the other applications. Another application of the soap solution with the sulphur added was made a week later. Although this species of thrips continued abundant throughout the season on other ornamentals in the immediate vicinity of the block of birch, no further injury of a serious nature resulted to the sprayed trees.

*Conclusions.*— These experiments indicate that thrips can be held in check by a whale-oil soap solution, one pound to seven gallons of water, with the addition of one ounce of flowers of sulphur to each gallon of the solution when attacking trees similar to the cut-leaved birch. It should be remembered that it is important that the leaves should be drenched on both upper and under surfaces.

### Experiments in Fumigating Nursery Stock.

These experiments have only just begun, and hence require but brief mention here. Fumigating nursery stock is usually done for the purpose of killing the San José scale. If fumigation can be made practical in the large cellars used by nurserymen it will be an inexpensive way to treat a large amount of stock, and a preventive to the spread not only of the San José scale, but other insects, such as the woolly aphis, bud moth, pistol-case-bearer and other injurious species. Experiments along this line are being conducted in the insectary at the Station and in one of the large frost proof cellars of the Chase Nursery Co., at Rochester. The cellar is 80 feet long, 40 feet wide and 16 feet high. This was filled with fruit trees of all varieties and fumigated with hydrocyanic acid gas. Before the gas was generated, twigs infested with the woolly aphis and the pistol-case-bearer were placed in different parts of the cellar including the remotest parts and under some of the piles of trees. The trees were exposed all night, fourteen hours. The temperature in the cellar was a little above freezing. The twigs were carefully examined and all of the lice were dead. The pistol-case-bearers are apparently dead, but are being kept in the insectary awaiting results when it becomes time for them to revive.

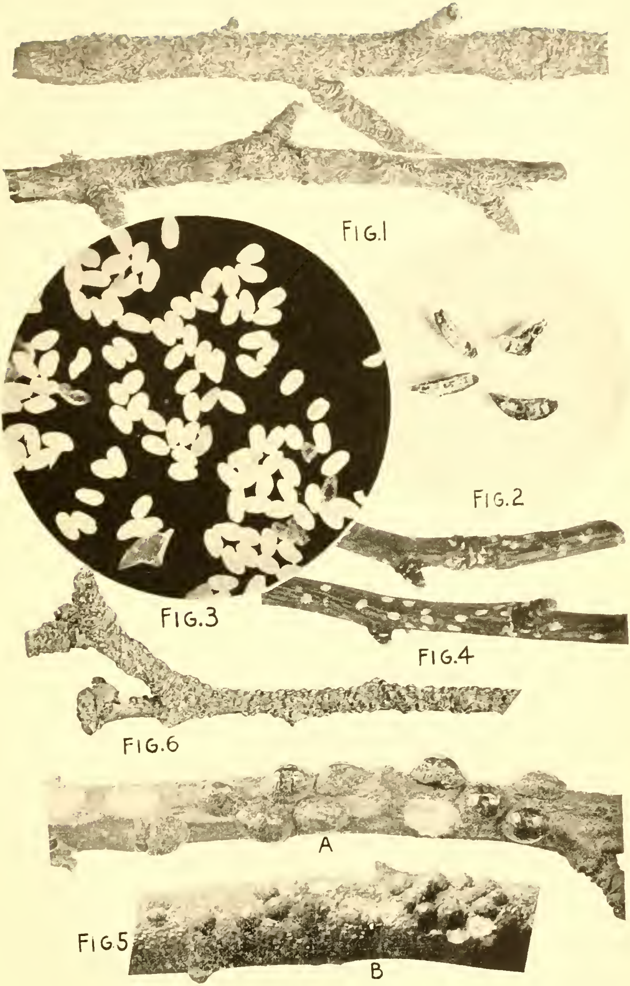


PLATE XIX.

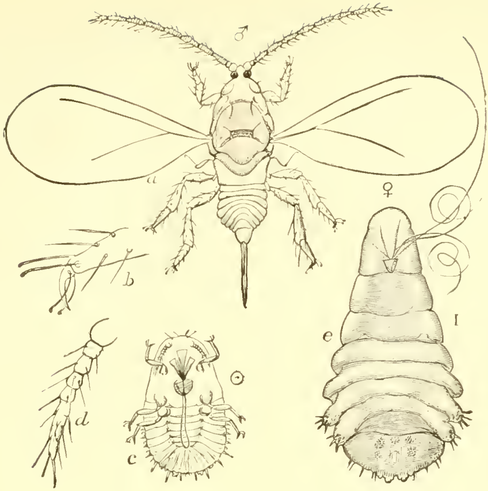


PLATE XX. FIG. 1.

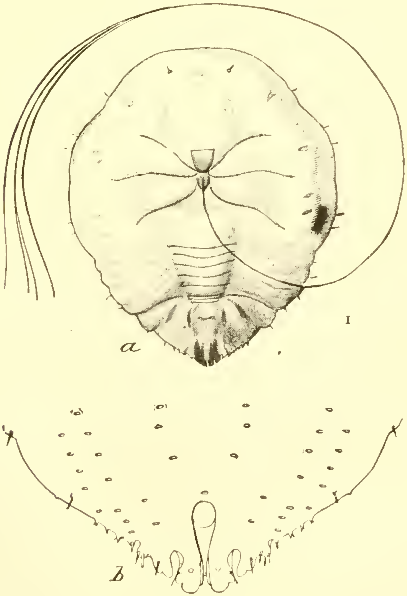


PLATE XX. FIG. 2.

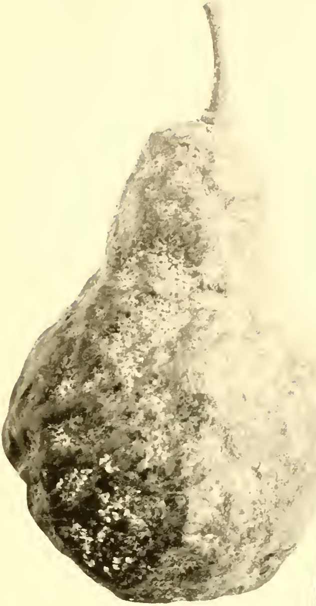

FIG 1

FIG. 3

FIG. 4

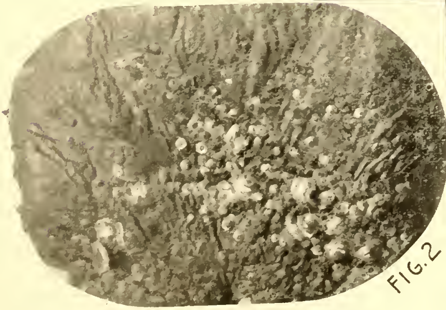

FIG. 2

PLATE XXI.

PLATE XXII.

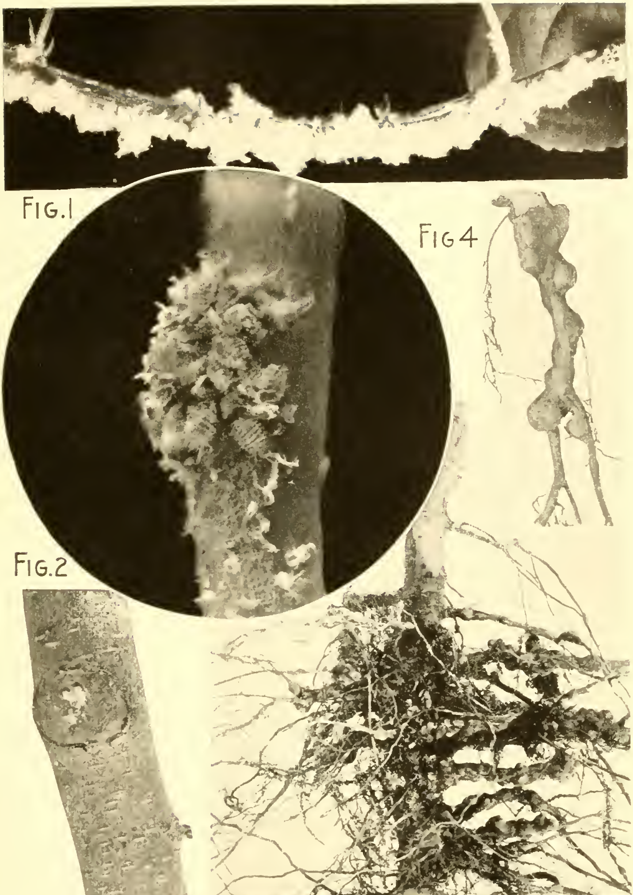


PLATE XXIII

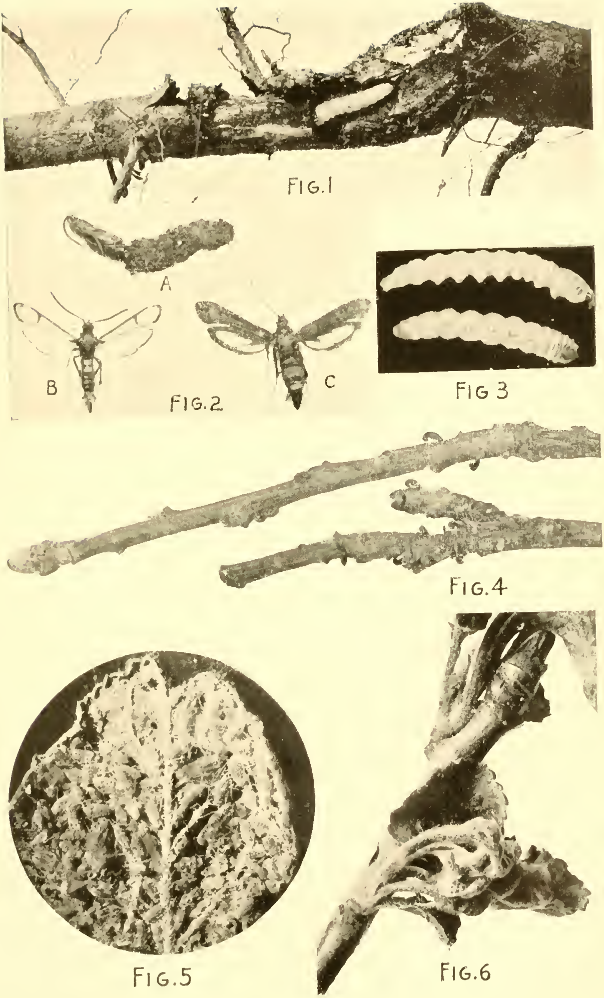


PLATE XXIV.

## EXPLANATION OF PLATES.

Plate XIX. Fig. 1, the oyster-shell bark-louse, natural size; 2, view of under surface of some of the scales showing eggs, enlarged; 3, photomicrograph of some of the eggs; 4, scurfy bark-louse, natural size; 5, plum lecanium, *a*, enlarged, *b*, natural size; 6, the oak scale, natural size.

Plate XX. Fig. 1, the oyster-shell bark-louse; *a*, adult male; *b*, foot of same; *c*, young larva; *d*, antenna of same; *e*, adult female taken from scale—*a*, *c*, *e*, greatly enlarged, *b*, *d*, still more enlarged.

Fig. 2. The San José scale, adult female before development of eggs; *a*, ventral view showing very long sucking setæ; *b*, anal plate, showing characteristic ornamentation of edge, greatly enlarged.

(L. O. Howard and C. L. Marlatt, United States Department of Agriculture, Division of Entomology.)

Plate XXI. The San José scale. Fig. 1, infested pear [Duchess d'Angouleme]; 2, portion of the pear enlarged, showing scales about four times natural size; 3, infested pear twig, natural size; 4, section of the same, enlarged.

Plate XXII. Small house for fumigating nursery stock.

Plate XXIII. The woolly louse of the apple. Fig. 1, infested apple twig, natural size; 2, section of the same twig enlarged, showing gall and lice; 3, roots of young apple, showing galls made by the lice; 4, some of the galls, natural size; 5, scar on trunk of young apple tree in which lice have congregated.

Plate XXIV. Fig. 1, plum root showing work of peach tree borer; 2, *a*, pupa case with chrysalis emerging; *b* and *c*, male and female moths; 3, larva, two views. [Fig. 2, natural size; Fig. 3, slightly enlarged. From photographs by Mr. F. A. Sirrine.] 4, pistol-case-bearers hibernating on apple twig, natural size; 5, plant lice, *Hyalopterus pruni*, on under surface of plum leaf, enlarged; 6, young apple leaves drawn together by larva of bud moth.

# II. PLANT LICE: DESCRIPTIONS, ENEMIES AND TREATMENT.*

V. H. LOWE.

## SUMMARY.

Plant lice are among the most important of the injurious insects. They may be found every year in the orchard and garden, but seldom in such numbers as during the past season.

Plant lice do not devour the tissue of the host plant, but suck the sap by means of their tube-like mouth parts. They swarm upon the open leaf-buds and on the under surfaces of the leaves, causing them to curl and to become otherwise distorted. These insects multiply with great rapidity, but are held in check to a certain degree by numerous predaceous and parasitic insects. In most species the young are born alive during the spring and summer, eggs not being produced until fall.

As plant lice suck their food, Paris green and similar poisons cannot be depended upon when used in the ordinary manner. Some external irritant must be used instead. Numerous insecticides of this nature are recommended. One of the most important is good whale-oil soap. Experiments during the past season show that one pound of whale oil soap to seven gallons of water will kill plum and currant lice. The solution should be applied in a fine spray to the under surface of the leaves. It is important that the work be done very thoroughly. The first application should be made as soon as the lice appear in the spring, which will be soon after the leaf-buds open. A second or third application may be made, as occasion demands.

*Reprint of Bulletin No. 139.

## INTRODUCTION.

Plant lice are among the most important of the injurious insects. They infest all kinds of fruits, vegetables and ornamental plants. Although present every year, some seasons are more favorable for their development than others. The past season has been one of this kind, and various species of plant lice have caused serious injury throughout the State, especially to orchard and bush fruits. The large number of inquiries received at the Station asking for information concerning the nature and habits of these insects, together with the best-known methods of combating them, indicate the wide-spread injury caused by the lice and the need of information concerning them.

Plant lice are also among the most difficult insects to study. To work out all the details concerning the life history of any one species would, under ordinary circumstances, require more than a summer's work for a single individual. Observations on the species referred to in this bulletin were not begun, systematically, until last spring. The work is, therefore, necessarily incomplete; yet the existing circumstances are such that it seems best to publish a portion, at least, of the results thus far obtained.

## PLANT LICE.

### CLASSIFICATION.

Plant lice are true bugs. They belong to one of the largest and, from an economic standpoint, one of the most important orders of insects, namely, the *Hemiptera*. The mouth parts of insects of this group are modified into beak-like tubes, by means of which they suck their food. They are thus also classed with the suctorial feeders, as distinguished from those insects which masticate their food.

### HOW PLANT LICE OBTAIN THEIR FOOD.

By carefully observing a plant louse when feeding, either from directly in front or from the side, it will be observed that the beak is extended so as to touch the surface of the leaf or is thrust slightly into it. The beak incloses the thread-like mouth parts which the louse forces from the apex into the tissue, producing a wound which causes the sap to flow. This liquid food is pumped through the beak into the insect's body by means of suctorial muscles. Thus each plant louse is literally a minute pump, which robs the host plant of a portion of its sustenance.

## NATURE OF THE INJURY CAUSED BY PLANT LICE.

Although all plant lice suck the sap of the host plant, the direct injury which they do may be manifest in different ways. Thus in some cases galls or pit-like depressions are formed on the parts attacked, as is the case with the woolly aphis, and certain species which produce galls on the leaves. Most species, however, which attack the leaves of cultivated fruits, cause them to curl, and, if the lice are very abundant, to wither and finally drop off.

An indirect injury caused by these insects is through the honey dew which they secrete. On badly infested trees the branches, leaves and fruit become coated with this sweet liquid, which, in the process of drying, becomes sticky. This sticky coating soon turns black, because of a black fungus which readily grows in it. Thus both the trees and fruit soon become unsightly, and, not infrequently, the latter is made unfit for market.

## LIFE HISTORY.

As the life history of these interesting insects is not usually well understood by those not especially interested in the study of insects, it may be well to state briefly the main points in their development. The life history of different species varies, but the following will serve as a general illustration:

If a colony of plant lice is examined in the late spring or early summer it will be found to consist of winged and wingless females in all stages of development, from the newly born larvæ to the full grown individuals. The mature females give birth to living young with astonishing frequency. All of the young of these broods are females which mature in an incredibly short time, giving birth, in turn, to female young at an equally rapid rate with their parents. Winged females are produced from time to time, apparently as occasion demands, for the dissemination of the species. These winged lice fly to other food plants or to other leaves on the same plant and start new colonies. This is continued during the summer. In many cases the lice migrate to new food plants for a portion of the summer. In the fall they may return to food plants of the same species as the original. These migratory broods consist of winged females. A generation of sexual forms, true males and females, is produced sometime during the fall. After pairing, each female produces one or more eggs. The eggs are usually placed on the twigs near the buds. They remain dormant all winter, hatching early in the spring into agamic females which, as they start the first broods of the season, are known as "stem mothers." It will be noticed that no male insects are produced throughout the season until fall. Reproduction is by a process known as budding. The following forms enter into the life cycle of a species during the season. The wingless and winged agamic female, the sexual female, the male, the winter egg and the "stem mother."

## THE PRINCIPAL INSECTICIDES USED IN COMBATING PLANT-LICE.

These kill by contact. Internal poisons, such as Paris green and London purple, will not kill plant-lice when sprayed upon the leaves. The reason for this will be apparent when it is remembered that these insects suck the sap from beneath the surface of the leaf instead of devouring the leaf itself. The insecticides used for this purpose include kerosene emulsion, the kerosene-water mixture, whale-oil soap, tobacco in various forms, pyrethrum powder and hot water.

*Kerosene emulsion.*—This insecticide may be made after the following formula:

| | |
|---|---|
| Water | 1 gallon. |
| Soap, whale-oil soap preferred | ½ pound. |
| Kerosene oil | 2 gallons. |

Dissolve the soap in the water by heating to the boiling point. When all the soap is dissolved remove from the fire and, while the solution is boiling hot, add the oil and agitate violently. This may be conveniently done by pumping the mixture through a small force pump. When sufficiently emulsified the mixture will have the appearance of milk. If allowed to cool it becomes thick like loppered milk. This is standard emulsion and may be diluted with water as desired. For ordinary use against such soft bodied insects as plant lice, 1 part of emulsion to from 10 to 15 parts of water is strong enough.

*The kerosene-water mixture.*—This is the simple mixture of kerosene and water without the use of soap or oil. The mixing is done in the pump and nozzles of the spraying outfits prepared especially for this purpose. The kerosene is held in one tank and the water in another. The pump draws from both tanks. The proportions of water and oil can be regulated at will.

The kerosene-water mixture has been used with good results against both plant-lice and scale insects. When applying the mixture to the foliage, care should be taken that injury to the tender leaves does not result from the separation of the oil and water.

*Whale-oil or fish-oil soaps.*—These soaps, when properly made, are among the most valuable of this class of insecticides. They may be made from any of the numerous fish oils on the market, but are usually sold under the name of whale-oil soap. The value of the soap as an insecticide lies, largely, in the caustic it contains.

Whale-oil soap was first used as an insecticide in this country nearly sixty years ago. It was recommended as a remedy for the rose bug and was used for this purpose at a strength of 1 lb. to 7½ gals. of water. The success which has attended its use against the San José scale in the east, has brought it into quite general use during the past few years. It now bids fair to take the place of kerosene emulsion.

One of the principal difficulties in the way of obtaining good results with the so called whale-oil soaps, is the fact that much of the soap of this nature sold on the market is of little or no value as an insecticide. Among the brands of whale-oil soap which have proven satisfactory in the hands of careful experimenters is that known as Good's Caustic Potash Whale Oil Soap No. 3, manufactured by James Good, 514-518 Hurst Street, Philadelphia, Pa. Also Leggett and Brother's Anchor Brand whale oil soap, manufactured by Leggett and Brother, 301 Pearl Street, New York. The price of strictly first class whale-oil soap varies from 3½ to 4 cents per pound in wholesale quantities.

It is sometimes desirable to make the soap at home. According to Lodeman* a good fish-oil soap may be made after the following formula:

| | |
|---|---|
| Crystal potash lye | 1 pound. |
| Fish oil | 3 pints. |
| Soft water | 3 gallons. |

"Dissolve the lye in the water, and when boiling add the oil and boil for two hours."

*Tobacco.*—As an insecticide tobacco has a wide range of usefulness. It may be used dry or in the form of a decoction. If used dry it should be finely powdered, the finer the better. Tobacco decoction may be made after the following formula:

| | |
|---|---|
| Refuse tobacco | 1 pound. |
| Water | 2 to 3 gallons. |

The mixture should boil for thirty minutes or more, or until a dark brown tea results. It should be kept covered until cool and may be sprayed, undiluted, upon the infested plants.

*Concentrated extract of tobacco.*—There are several preparations of this nature now on the market each of which is sold under a different name. A brand called "Nikoteen," manufactured by the Skabcura Dip Co., Ninety-ninth Street and Torrence Avenue, Chicago, Ill., has been used at the Station with excellent results. This insecticide may be used either in the form of a vapor or as a spray. For use in the latter form against plant lice, 1 part nikoteen to 600 parts water is recommended.

*Spraying of Plants, p. 146.

*Pyrethrum.*—This is sold under the name of "Persian insect powder" or "buhach." It is a valuable insecticide and is especially adapted for use against plant lice and similar insects. It is one of the most powerful contact poisons and may be applied pure or mixed with two or three times its own bulk or diluent. When used in this way it is especially adapted to small conservatories.

Pyrethrum has also been used with kerosene emulsion either as a kerosene extract or mixed directly with the emulsion.

*Hot water* has been successfully used against plant lice. Its use is considered practical only on a small scale. Most plants will not be injured by the application of water heated to 130° F. This treatment is fatal to the lice. Where practical, the whole plant may be dipped.

## EXPERIMENTS AGAINST PLANT LICE.

### SPRAYING EXPERIMENTS WITH WHALE-OIL SOAP.

These experiments were conducted in the Station plum orchard and in the garden on red currant bushes. The principal object of the experiments was to demonstrate whether whale-oil soap could be depended upon to check plant-lice when used as a spray, and thus avoid the necessity of preparing kerosene emulsion. Both the plum trees and currant bushes were badly infested, the former principally with *Hyalopterus pruni* and the latter with *Myzus ribis*. Both of these species are treated in detail on subsequent pages. The currants were sprayed first as follows:

On May 15, with a solution of whale-oil soap, 1 pound to 10 gallons of water. Although much pains was taken to apply the spray so as to reach all of the lice, there was but little noticeable effect from the application.

On May 30 the currants were again sprayed but with a stronger solution of soap, 1 pound to 7 gallons of water. The leaves were badly curled, but by drenching them with the spray directed from below most of the lice were reached. The effects of this application were soon apparent.


PLATE XXV.—WORK OF PLANT LICE ON CURRANTS.

During the first week of June the bushes were sprayed again with the same solution of whale-oil soap, with the effect that they were practically freed from the insects.

Had the first solution been stronger, two applications would probably have been sufficient. Two rows were left unsprayed with the result shown at Plate XXV. At the time the photograph was taken, in early June, but few leaves were left on the bushes as a result of the work of the lice. The treated rows showed much less injury from the insects.

The plum trees were not sprayed until June 4. They were badly infested at this time, and the young leaves were so badly curled as to make it very difficult to reach all of the lice. The whale-oil soap solution, 1 pound to 7 gallons of water, was used on all of the trees. The effects of this treatment were at once apparent. Practically all the lice were killed on the leaves which were not so badly curled as to prevent the spray from reaching the insects.

Before the trees were sprayed a second time, about a week later, some of the worst infested trees were trimmed. The tips of the branches having the most curled leaves were cut off. This removed large numbers of lice and left but little refuge for those that remained. The trees were again sprayed with the whale-oil soap solution, as in the first instance, immediately after being trimmed, with the result that, in a short time, but comparatively few live lice could be found.

## Recommendations.

Do not wait for the leaves to become curled, but spray thoroughly as soon as the first few lice are observed. Much depends upon the thoroughness of the first application.

Direct the spray from below so as to drench the under surface of the leaves.

Use a solution of good whale-oil soap, not weaker than 1 pound to 7 gallons of water.

When the spraying has been neglected until the leaves have become badly curled, trim off the curled tips and spray at once with the whale-oil soap solution. This applies especially to fruit trees.

In the case of currants and gooseberries, it will sometimes be found practical to pick off and destroy the leaves which are first infested in the spring.

## NATURAL ENEMIES OF PLANT LICE.

Plant lice are preyed upon by both predaceous and parasitic insects. These insects may be classed among those friendly to the farmer, because of the good they do by checking the increase of noxious species.

Among the most prominent of the predaceous insects which feed upon plant-lice are the lady bird beetles. Both the larvæ and mature insects devour the lice. These insects will always be found where plant-lice are abundant. The following are among the species observed during the past season:

### PREDACEOUS INSECTS.

*Anatis ocellata* Linn. (*15-punctata* Oliv.).—This insect undoubtedly feeds on various species of plant lice. Although common on the currant bushes, the writer found it much more common during the past year upon the plum trees. During the latter part of May and until the middle of July, the insects could be found upon the trees in all stages of development. At Plate XXVI, fig. 7, the larva is shown natural size and enlarged, the pupa at Fig. 8 and the mature insect, natural size, at Fig. 10. Fig. 9 is from a photograph of a plum with one of the pupæ attached. These pupæ do not seriously injure the fruit. The skin of the plum is not broken, as the larva, when about to pupate, attaches itself to the fruit merely by a gummy secretion from the tip of the abdomen.

There are a number of other species of lady-bird beetles which attack both plum and currant plant lice. The following are among those which were observed as being most common last season: The nine-spotted lady-bird beetle, *Coccinella 9-notata* Hbst.; the two-spotted lady-bird beetle, *Adalia bi-punctata* Linn.; a small reddish brown or brick red species having a black dot in

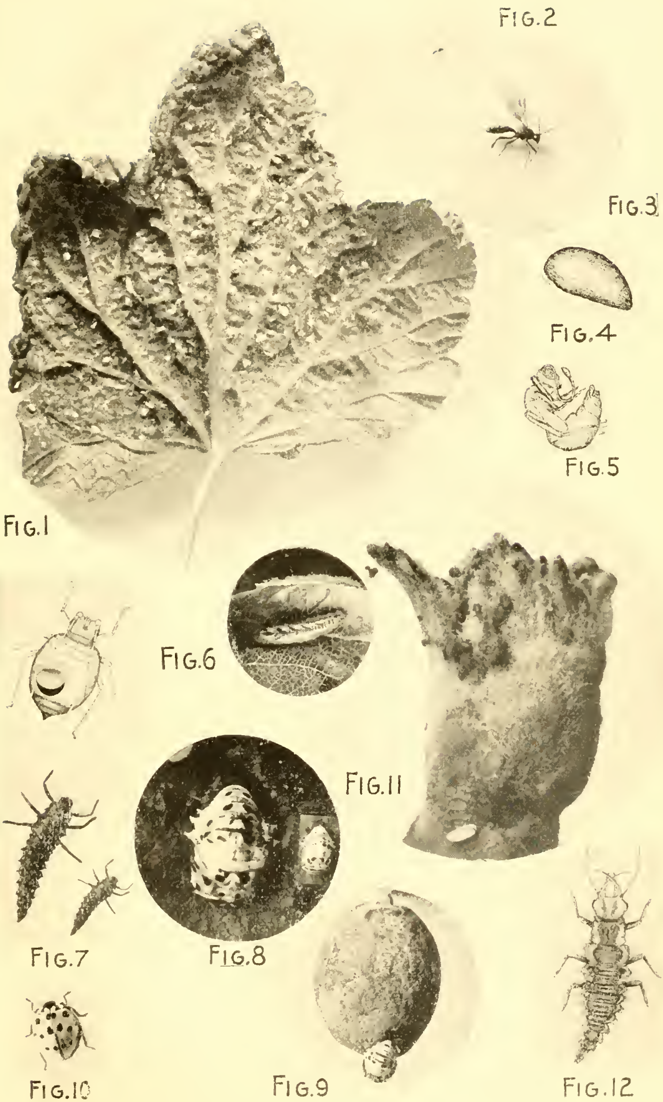


PLATE XXVI.—ENEMIES OF PLANT LICE.

each elytra; the ten-spotted lady-bird beetle, *Megilla maculata* DeG. This species is red with ten black spots on the elytra.

Plant lice are also preyed upon by syrphus fly larvæ. A photograph of a common species, natural size, is shown at Plate XXVI, fig. 11. The egg, attached near the base of an opening apple leaf bud, is also shown, enlarged to about four times natural size. These larvæ suck the juices from the bodies of the plant lice, thus quickly causing their death. When full grown the larva forms an oblong green or brown puparium, larger at one end, and usually attached to the under surface of the leaf. In a few days a two-winged fly emerges. This is the mature insect which lays the egg.

Another species of syrphus-fly larva which has been much more common on the plum trees during the past season than the species referred to, is smaller and of a yellowish brown color. Specimens which appeared to be about full grown were measured July 20. The average dimensions were 2.4 mm. by 0.78 mm. Eggs were also found on this date. They were pearly white, oblong, slightly oval, rounded at each end and measured 0.87 mm. by 0.33 mm.; the shell brittle, and sculptured with heavy parallel, longitudinal lines of a dull white crossed by oblique parallel lines of the same shade. Every attempt to breed this species in the laboratory failed and neither pupæ nor the mature insects were observed. The larvæ were very abundant. From May until October a few of them could be found upon almost every infested leaf. Frequently they were entirely hidden from view by the large number of plant lice and the white powdery substance with which the lice are dusted so that the only indication of their presence was the brown, shriveled skins of the dead lice. It is probably within bounds to say that these larvæ destroyed nearly forty per cent of the plum lice in the Station orchard last season.

There are still other kinds of insects which feed upon plant lice. Among them the most common are the aphis lions. These ferocious creatures are the larvæ of delicate winged insects known as the lace-winged flies. The mature insects are very delicate and have finely veined green wings. The eggs are laid singly on the tips of stiff stalks of silk which are fastened to the leaf in an upright position. The stalks are about half an inch high. When full grown the larva rolls itself into a little ball of white silk from which the mature insect finally emerges. These voracious larvæ suck the juices from their victims, holding the plant louse or other prey at the tips of their long jaws and sucking the liquid by means of their peculiarly arranged mouth parts. A drawing of one of these larvæ, greatly enlarged, is shown at Plate XXVI, fig. 12. When about full grown a larva of this species measures about 4.4 mm.

## PARASITIC INSECTS.

The work of these little insects was much more apparent upon the currant plant lice than upon those under observation on the plum trees. No parasites were reared from the latter.

*Aphidius polygonaphia** Fitch.—This minute insect belongs to a large group of beneficial insects which are classified in the same order with the wild and tame bees, namely, the *Hymenoptera*. This parasite seems to have a special liking for the currant plant louse, *Myzus ribis*, although it is a common parasite on other species. The egg of the parasite is laid on or just under the skin of the plant louse, and when this is once done the unfortunate louse is doomed. The egg soon hatches and the minute larva feeds upon the tissue just beneath the skin, taking care at first not to touch a vital organ. By the time it has become full grown, however, nothing remains of the host but the integument. The larva transforms to the pupa within its host, the mature insect cutting its way out. A parasitized plant louse soon becomes inactive, and swells up until it is somewhat larger than the largest of its fellows. The integument becomes hard, finally almost brittle, and turns pearly white. At Plate XXVI, fig. 1, some of the parasitized lice are shown on the under surface of a currant leaf.

Although present during the entire time that the plant lice were common upon the currant, they were especially abundant

*Identified by Mr. William Ashmead.

during the latter part of May and the middle of June. June 17, the writer had a good opportunity to watch some of these minute parasites in the act of oviposition. They were flying or walking nervously about the infested leaves as if looking for just the right lice upon which to deposit their eggs. The female apparently selects a suitable part of the body of her victim upon which to place an egg, straightens her legs somewhat so as to raise her body, and brings the tip of the abdomen forward between them as far as necessary. In doing this the abdomen may be lengthened to twice its natural length and extended half its length or more beyond the head. The lice usually place the eggs upon the abdomen of the plant louse, but this is not always the case. Upon one occasion out of six parasites under observation, four placed the egg upon the abdomen, one upon the thorax and one upon the head. In all of these and many other cases under observation the plant lice upon which the eggs were laid were not more than half grown.

The time required for the eggs to hatch and the insect to mature was not observed. Both larvæ and pupæ were dissected out of parasitized lice. A drawing of the former, greatly enlarged, is shown at Plate XXVI, fig. 4; of the latter at fig. 5; and photographs of the mature insect at figs. 2 and 3.

June 18, a number of the parasites hatched from specimens kept in the laboratory. In all the cases observed the developed parasite was on its back within the body of the louse, with the head near the posterior extremity. When ready to emerge the imprisoned insect begins to cut through the walls of the abdomen with its jaws, cutting a round opening large enough to admit its body. As a rule the piece is not cut clear around, thus leaving a hinge as shown at Plate XXVI, fig. 6. It takes but a very short time for the parasite to make its way to liberty, about four minutes being the time required for those under observation.

Other species bred from *Myzus ribis* by the writer are *Isocratus vulgaris* Walk. and *Pachyneuron aphidivorus** Ashm. These species were not abundant.

*Identified by Mr. William Ashmead.

## SPECIES OF PLANT LICE UNDER OBSERVATION.

These include two, *Hyalopterus pruni* Fab., which has been very abundant on the plum during the past season, causing serious injury to the trees, and *Myzus ribis*, which has been equally abundant and injurious on the currant.

### ATTACKING THE PLUM.

### *Hyalopterus pruni* Fab.

This species attacks the leaves of the plum, collecting in large numbers on the under surfaces. The lice multiply rapidly, becoming so thick as to cover the entire under surface of the leaves (Plate XXVII, fig. 10), causing them to curl and wilt. Their bodies are covered with a bluish-white, mealy powder. Much injury was caused in both orchards and nurseries by these lice last season. In the Station orchard all of the varieties of plums were attacked during the time when the lice were naturally most numerous, but toward the latter part of the season but few could be found excepting on the native varieties.

*History and present distribution.*—So little attention has been given this insect by writers on economic entomology that it is difficult to learn its history. It is probably of European origin. It was first described by Fabricius who lived in the latter part of the seventeenth century. According to Bucton this species was also mentioned by several early European writers.

The insect is now known to occur in Germany, England, Australia and New Zealand, and is probably distributed over a considerable portion of the eastern United States. It has been found as far west as Iowa. It occurs in abundance in the western part of this State.

*Food plants.*—The plum seems to be the principal food plant of this species. It is said to infest the leaves of the grape, peach, nectarine and apricot in Europe. It is known to migrate from the plum to a species of grass, *Phragmitis communis*. According to H. Osborne and F. A. Sirrine* it also infests the choke cherry.

*Insect Life, Vol. I, p. 235.

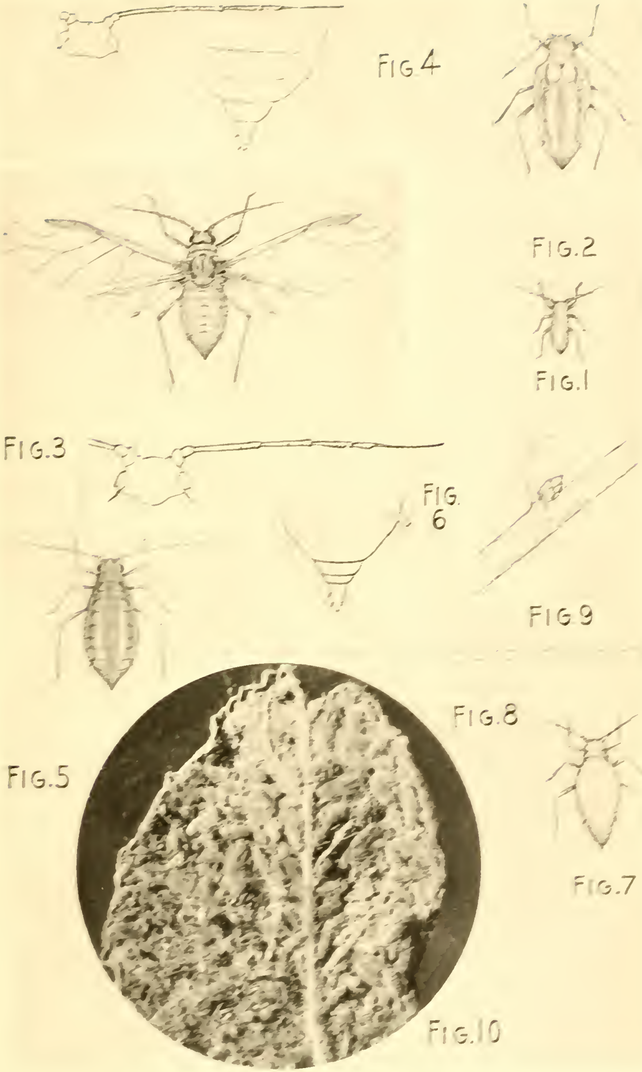

FIG. 4
FIG. 2
FIG. 1
FIG. 3
FIG. 6
FIG. 9
FIG. 8
FIG. 5
FIG. 7
FIG. 10

*Descriptions and notes on life history.*—The writer's attention was first called to this species early in June. At this time most of the plum trees in the Station orchard were very badly infested with this and other species of plant lice. Most of the lice of this species were wingless and were present in all stages of development. Pupæ and winged forms were much less numerous.

*The larva.*—The very young larva of average size measures about 0.5 mm. in length. The lateral margins of the body are nearly parallel, but the body is usually slightly broader near the posterior extremity. The general color is pale green with a slightly bluish tinge. The antennæ are six-jointed. Joints I, II, are shorter and sub equal in length. Eyes red, legs stout, nectaries about as long as thick. The larvæ, like the mature lice, are covered with a bluish white powder. (Plate XXVII, fig. 1.)

*Apterous viviparous female.*—Size of body 2.67 mm. by 0.99 mm. General color pale or yellowish green, with slightly darker green mottling. A medio-dorsal line of darker green, widest at about the middle, extends from the head to the cauda. Eyes dark reddish brown. All appendages nearly colorless or very light green, with the exception of the anterior half of the fifth and the entire sixth joints of the antennæ, the tips of the posterior tibiæ and the tarsi, which are dusky. Rostrum reaches nearly to the second coxæ. Antennæ slender, about two-thirds length of body. Joints III, IV and V sparsely tuberculated. Length 1.77 mm. Joints I, II and VI shortest (III, 0.45 mm.; IV, 0.3 mm.; V, 0.25 mm.; VI, 0.125 mm.; VII, 0.45 mm.). Nectaries dusky; very short, 0.09 mm. in length, about half as broad, and slightly restricted at base. Legs slender, cauda prominent, slightly curved upward, 0.18 mm. in length by 0.12 mm. at base, tapering toward the tip and furnished on either side with two slender backward curved hairs. (Plate XXVII, figs. 5 and 6.)

The apterous females were found on the native plums in the Station orchard until the latter part of September, when only an occasional individual could be found.

*Winged viviparous female.*—Body more slender than apterous female. Size of body 2 mm. by 0.74 mm. General color the same as the apterous female. Head and prothorax usually somewhat darker green. Antennæ slender, slightly dusky with the exception of the basal third of the third joint, which is pale green. Prothorax and thoracic lobes darker green. Apical third of femora and tibiæ, entire tarsi and nectaries slightly dusky. Abdomen pale yellowish green with four to six triangular medio-dorsal green marks ranged transversely. Front of head not conical. Measurements of antennæ about the same as in apterous female. Wings hyaline, expanse 6.9 mm., veins yellowish green; stigma narrow. Nectaries and cauda as in apterous viviparous female. (Plate XXVII, figs. 3 and 4; pupa shown at fig. 2.)

The winged females were on the plums in more or less abundance during the entire summer. During the latter part of July, August and most of September but few winged females were found and most of these were on the native plums with colonies of young.

During the early part of September (September 8) the lice were observed to be more abundant in the Station orchard. A few scattering colonies of winged females and young were found on all varieties of plums. These colonies evidently became more numerous toward the middle and latter part of the month. Oviparous females were first observed about the middle of October, and could occasionally be found on the trees until the first of December. The males were not positively identified. The first winter eggs were found November 11. They were on the twigs, most of them near the winter buds as shown at Plate XXVII, fig. 9.

*Oviparous female.*—Body oblong, rounded above and tapering to posterior extremity. Size of body 1.33 mm. by 0.5 mm. General color pale green. A medio-dorsal line of darker green extends from the head to about two-thirds the entire length of the abdomen and two faint, green sub-dorsal lines close to the lateral margin, extend the entire length of the abdomen. Antennæ six-jointed; length 0.72 mm. (III, 0.05 mm.; IV, 0.23 mm.; V, 0.05 mm.; VI, 0.22 mm.) Plate XXVII, figs. 7 and 8.

*Winter egg.*—Color pale green at first, varying to darker shades. Measurements 0.6 mm. by 0.25 mm. Oblong oval in shape, slightly curved and obtusely rounded at the ends.

*Partial bibliographical list:*

1857. Koch, C. L. Die Pflanzenlause—Aphiden, pp. 22-23. Descriptions of larva and apterous and winged viviparous females. Figures of apterous and winged viviparous females.

1877. Bucton, G. B. Monograph of British Aphides, Vol. II, pp. 110-111. Descriptions and figures of apterous and winged viviparous females.

1892. Herbert Osborne and F. A. Sirrine. Insect Life, Vol. V, p. 236. *Hyalopterus arundinis* Fab. (equals *pruni* Fab.) on plum and choke cherry.

*Other species attacking the plum.*—Six or more species are known to attack the plum. Among those observed by the writer last season are the following:

*Hyalopterus arundinis* Fab. This species closely resembles the preceding. According to Bucton, it differs in both size and habits

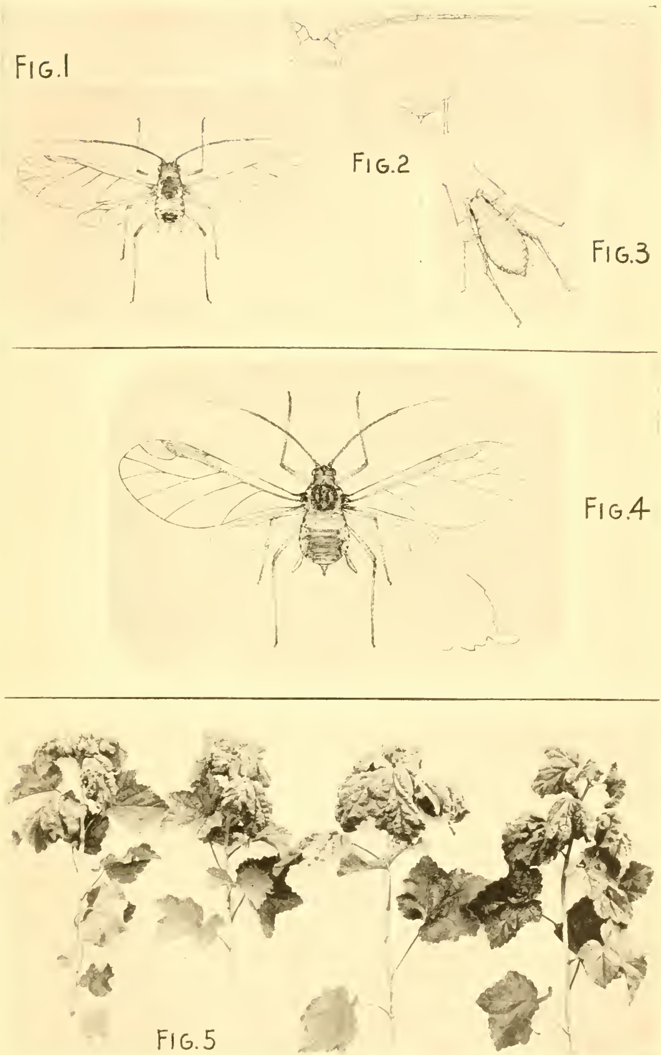


PLATE XXVIII.—PLANT LICE OF CURRANT.

from *H. pruni*, being smaller and more active. Other structural differences are very slight, if any. The markings on the thorax are slightly different. This species was found closely associated with *H. pruni*.

*Aphis pruni** Fab. A common species on the plum. Numerous early in the season. Winged females (migratory brood) with young scattered through the Station orchard during the latter part of September and early in October.

*Phorodon humuli*. During August, September and October occasional individuals were found in the plum orchard. August 26 a few apterous and winged females with larvæ were found on the plum leaves.

### Attacking the Currant.

#### *Myzus ribis* Linn.

This species is especially injurious to the red currant. The lice cause red bladder-like galls to form on the leaves. A badly infested leaf becomes greatly distorted and curled as the result of these gall formations, as shown in Plate XXVIII, fig. 5. The degree to which the leaves are distorted by the lice seems to be influenced by the variety of currants. In the Station garden the leaves of Fay and Cherry currants were distorted by the lice much more than those of the London Red, although all three were infested equally and by the above species.

The injury caused by the lice was very apparent in the Station garden. The leaves dropped from the bushes and the fruit was injured both by premature ripening and by the black fungus which grows in the honey dew secreted by the lice.

*History and present distribution*.—This species is probably of European origin. It is widely distributed throughout the eastern part of the United States, occurring from Maine to Illinois and probably further west. It is also well known in Canada.

*Food plants*.—Besides the red currant, it infests the black currant and gooseberry.

*Descriptions and notes on life history*.—The winter eggs hatch soon after the leaves open. Last year by May 13 the lice had be-

*Identified by Mr. Th. Pergande.

come quite numerous on the currant bushes in the Station garden. The galls had just begun to form and some of them were tinged with red. Each of the galls was occupied usually by but one female with three or four young. The lice were multiplying very rapidly at this time and toward the latter part of May had become sufficiently abundant to do serious injury.

The apterous and winged viviparous females have been described by Bucton* as follows:

*Apterous viviparous female.*—Size of body 2.14 mm. by 1.01 mm.; length of antennæ 2.27 mm.; length of cornicles 0.37 mm. Long oval, shining green, with darker green mottlings. Front flat, garnished with short bristles, as also are the sides. Antennæ long and very fine. Cornicles cylindrical and pale green. Eyes bright red. Cauda obtuse. Legs yellow or greenish. Bristles capitate.

*Winged viviparous female.*—Expanse of wings 7.62 mm.; size of body 2.54 mm. by 1.13 mm.; length of antennæ 2.27 mm.; length of cornicles 0.50 mm. Bright greenish yellow. Head pale olive. Eyes red. Three ocelli obvious. Antennæ fixed on small tubercules. Prothorax with an indented olive band. Thoracic lobes brown. A stellate spot is seen on the post thorax, succeeded by six or seven irregular transverse bands on the abdomen of varying thickness; four or five spots on each lateral edge. Cornicles green or olive, cylindrical, or at least very slightly lavate. Legs green, with olive femoral points and tarsi. Wings broad with yellow insertions, greenish cubitus and veins.

During the latter part of July nearly all the lice disappeared from the currants and gooseberries. There still remained, however, an occasional apterous female on the old leaves.

These females could be occasionally found as long as the leaves remained on the bushes and were always accompanied by from two to four or five larvæ. They were very light green in color and about two-thirds as large as the apterous viviparous females found earlier in the season. (Plate XXVIII, fig. 3.)

The male lice were first observed toward the latter part of October (Oct. 21).

*The male.*—Size of body 1.15 mm. by 0.45 mm.; expanse 5.95 mm. Yellowish green. Head dark or olive green. Meso-thorax mottled with irregular dark green spots, and the abdomen with from three to six dark spots along the lateral dorsal margins, and a broad, broken transverse dorsal band of the same color on the posterior half.

* Monograph of British Aphides, Vol. I, pp. 180, 181.

Antennæ olive green, slender, 2.85 mm. in length (Joint III, 0.65 mm.; IV, 0.4 mm.; V, 0.4 mm.; VI, 0.125 mm.; VII, 1.1 mm.). Third, fourth and fifth joints tuberculate. Sensoria very numerous. Eyes deep red. Legs yellowish green with the exception of the anterior third of the femora, tips of the tibiæ and the tarsi, which are dusky. Nectaries yellowish green, cylindrical, slightly dilated, 0.22 mm. in length. Veins dark, stigma light yellow or yellowish green, 8 mm. in length. (Described from one specimen in balsam.) Plate XXVIII, figs. 1 and 2.

The eggs are shining black. A few were found on the twigs during the latter part of October. They were much more numerout about a month later.

*Partial bibliographical list:*

1857. Koch, C. L. "Die Pflanzenlause—Aphiden," pp. 39-40. (*Rhopalosiphum ribis* Linn.) Descriptions. Ill. apterous and winged viviparous females.

1867. Walsh, B. D. Practical Entomologist, Vol. II, p. 106. Method of work.

Ibid, pp. 109-110. Gives account of work of Coccinellidæ against plant lice.

Riley, C. V. Prairie Farmer, Vol. V, n. s., p. 69. Means against.

1869. Walsh, B. D. American Entomologist, Vol. I, p. 250.

1870. Riley, C. V. Second Missouri Report, p. 110.

1873. Riley, C. V. Sixth Missouri Report, p. 46.

1876. Bucton, G. B. Monograph British Aphides, Vol. I, pp. 180-181. Descriptions apterous and winged viviparous females and pupa. Illustrations of apterous and winged viviparous females.

1878. Thomas, Cyrus. Third Report (Eighth Annual Report of the Entomologist of Ill.) pp. 76-78. Gives Bucton's descriptions with notes on possible varieties of *M. ribis*.

1883. Saunders, J. H. Insects Injurious to Fruits, p. 351. Brief notes.

1887. Oestlund, O. W. Synopsis of the Aphididæ of Minn., p. 73 (Bul. No. 4 Geological and Natural History Survey of Minn.) Technical descriptions.

1894. Harvey, F. L. Annual Report Maine Agricultural Experiment Station, 1894, p. 109. Notes, injury caused to gooseberry bushes.

*Other species attacking the currant.—Rhopalosiphum ribis** Linn. This species is especially common on the black currant.

It also attacks the red currant. The black currants in the Station garden were badly infested last season. During the latter part of July the lice left the currants. Return migrants (Plate XXVIII, fig. 4), appeared on the bushes early in October. The

* Identified by Mr. F. A. Sirrine.

oviparous females and the males were first observed October 21, and the former were found until late in November.

Several females of this migratory brood were measured with the following results: Size of body 2.05 mm. by 1 mm. Expanse 8.9 mm.; length of antennæ 2.95 mm.; cornicles 0.45 mm. The markings on the thorax and abdomen vary. In some instances the spots are more irregular and broken than shown in the figure. The lateral dorsal edges of the abdomen are also marked with small, irregular black spots.

*Oviparous female.*—Size of body 1.6 mm. by 0.7 mm. General color dull or olive green. Tips of femora, tibia and the tarsi reddish brown. Antennæ 1.9 mm. (Joint III, 0.52 mm.; IV, 0.3 mm.; V, 0.25 mm.; VI, 0.1 mm.; VII, 0.6 mm.) Eyes red. Cornicles, 0.45 mm.; dilated near middle, restricted at base, dusky on extreme tips. Cauda prominent, light green, 0.15 mm. in length. (Described from specimen in balsam.)

*Male.*—Size of body 1.55 mm. by 0.85 mm. General color yellowish green. Head dark green or brown. Meso and meta thorax and abdomen mottled with darker brown or black. From three to four dark spots on lateral dorsal margins of abdomen. Eyes red, antennæ on slightly raised tubercules. Length, 3.05 mm. (Joint III, 0.75 mm.; IV, 0.5 mm.; V, 0.4 mm.; VI, 0.15 mm.; VII, 0.95 mm.) Legs yellowish or light green with the exception of the anterior third of the femora, tips of tibiæ and the tarsi, which are dark brown or black. Cornicles yellowish or light green, dilated, restricted at base, 0.45 mm. in length. Cauda same color as cornicles, 0.15 mm. in length, tapering, obtusely rounded at apex. (Described from specimen in balsam.)

The eggs are shining black and are placed on the twigs.

Several other species occasionally occur on the currant, but none of them were noticed during the past season in sufficient numbers to do serious injury.

# REPORT

OF THE

# Department of Animal Husbandry.

W. H. JORDAN, Director.

WILLIAM P. WHEELER, First Assistant.

C. G. JENTER, Assistant Chemist.

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## Table of Contents.

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# REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY.

## PART I.

### I. THE SOURCE OF MILK FAT.*

W. H. JORDAN AND C. G. JENTER.

#### SUMMARY.

(1) A cow fed during ninety-five days on a ration from which the fats had been nearly all extracted, continued to secrete milk similar to that produced when fed on the same kinds of hay and grain in their normal condition.

(2) The yield of milk fat during the ninety-five days was 62.9 lbs. The food fat eaten during this time was 11.6 lbs., 5.7 lbs. only of which was digested, consequently at least 57.2 lbs. of the milk fat must have had some source other than the food fat.

(3) The milk fat could not have come from previously stored body fat. This assertion is supported by three considerations: (1) The cow's body could have contained scarcely more than 60 lbs. of fat at the beginning of the experiment; (2) she gained 47 pounds in body weight during this period of time with no increase of body nitrogen, and was judged to be a much fatter cow at the end; (3) the formation of this quantity of milk fat from the body fat would have caused a marked condition of emaciation, which, because of an increase in the body weight would have required the improbable increase in the body of 104 lbs. of water and intestinal contents.

*Reprint of Bulletin No. 132.

(4) During fifty-nine consecutive days 38.8 lbs. of milk fat was secreted and the urine nitrogen was equivalent to 33.3 lbs. of protein. According to any accepted method of interpretation, not over 17 lbs. of fat could have been produced from this amount of metabolized protein.

(5) The quantity of milk solids secreted bore a definite relation neither to the digestible protein eaten nor to the extent of the protein metabolism. In view of these facts it is suggested that the well-known favorable effect upon milk secretion of a narrow nutritive ratio is due in part to a stimulative, and not wholly to a constructive, function of the protein.

(6) The composition of the milk bore no definite relation to the amount and kind of food.

(7) The changes in the proportion of milk solids were due almost wholly to changes in the percentage of fat.

## INTRODUCTION.

Among the problems important in agriculture that are most difficult of solution are those which pertain to animal metabolism They are difficult because the field of chemical activity where the processes of digestion and reconstruction of compounds occur is inaccessible to the ordinary direct means of study and observation. For this reason such questions as the sources of the fats and other compounds that are formed in the animal body are still only partially answered. Especially inconclusive is the knowledge pertaining to the formation of milk fats. A widespread popular belief is that they as well as other fats must first exist in the food, the function of the animal organism being merely to collect and transfer them into the adipose tissue or milk. Apart from certain experimental evidence which proves the possible formation of animal fats in other ways, there is one fact that appears to render this view untenable, which is that great unlikeness exists in the mixtures of fats that different species construct from the same foods. There seems to be no possibility, either, of simply transferring from any ordinary ration a mixture of fats similar in kind and proportions to that found in tallow, lard or milk. Moreover, the construction of animal body fats from the carbohydrates of the foods is now experimentally established beyond reasonable doubt. The investigations of Lawes & Gilbert, Henneberg, Soxhlet, B. Schulze, Tscherwinsky, Chaniewski, E. Voit, Lehmann, Munk and Rubner, show most clearly that with sheep, pigs, geese and dogs the body fat accumulated could not have come wholly from the protein and fats in the food eaten, and, therefore, must have been formed in part, at least, from starch and similar compounds.

It should be said, however, that neither these nor other experiments demonstrate that food protein and fat may not take part in the construction of body fat, but prove simply that carbohydrates do. The possibilities of food protein and fat in their relation to fat formation in the animal body are not yet clearly understood.

Concerning the sources of milk fat our knowledge is less definite. The experiments of Boussingault, Voit, Wolff, G. Kuhn and M. Fleischer are the ones that have been so far carried on for the purpose of obtaining information upon this particular point. The evidence which they furnish is entirely negative, because in all cases the fat of the foods plus the possible fat from the metabolized protein was, according to the interpretations of the several investigators, wholly or nearly sufficient to account for all the fat in the milk. In fact, none of these experiments was so planned or so long continued as to make safe conclusions possible. Soxhlet has recently declared his belief that under certain conditions milk fat may in part be formed from body fat, but his conclusion must be regarded as inferential, for he presents no experimental proof of his theory.

It must be admitted that the production of milk fat involves some conditions not pertaining to the formation of body fat. The former is, according to the general concensus of opinion, the peculiar product, like all other milk solids, of specialized tissues called the mammary glands, the immediate location in these glands of these particular metabolic changes being the epithelial cells of the alveoli. A histological study of these cells when in a state of activity has led some physiologists to believe, not without a show of reason, that milk is the result of the breaking down or liquefaction of proteid tissue in the udder, the food serving merely to rebuild this tissue. Certainly such a theory cannot be regarded as unreasonable in view of the observations which appear to show the formation of beeswax from protein, the fatty degeneration of proteid tissue under the influence of phosphorus poisoning and the apparent production of fat from protein by fly maggots. We have, besides, the generally observed and well-established fact that an increase in the supply of protein in the ration of milch cows often stimulates the secretion of milk in a marked manner, even though there is no increase in the total digestible food consumed.

It must be confessed, however, that the data so far recorded concerning the source of fat are confusing and inconclusive when we attempt to apply them to the narrower question of the formation of milk fat.

It has been for some time the opinion of the writer that in order to reach definite conclusions as to the source of milk fat through experiments conducted without the use of a respiration apparatus, the following conditions, among others, must be secured:

(1) The use of foods either fat-free or containing such small percentages of fat that, if the milk was formed in the usual quantity, a large balance must come either from the cow's body or from the other two classes of food compounds, viz.: protein and carbohydrates.

(2) The continuation of the experiment over so long a period of time as to show conclusively whether, in the absence of food fat, the cow did or did not draw upon a previous store of body fat for the production of milk fat.

(3) The variation of the protein of the food from a quantity below to one above the actual needs of the animal in order to discover, if possible, the minimum protein metabolism necessary to the maintenance of a given production of milk fat.

(4) The observation through this entire long period of time of such data as would enable the experimenter to keep nitrogen and fat balances, which of necessity would include a determination of the urea nitrogen or the amount of metabolized protein.

## THE PLAN, MATERIALS AND PROCEDURE OF THE EXPERIMENT.

During the past year an attempt was made at this Station, with a gratifying degree of success, to conduct an experiment in accordance with the conditions previously outlined, the main object of which was to discover the necessary relation which may exist between any class of compounds in the food and the production of milk fat.

### The Plan of the Experiment.

The plan of the experiment, as finally executed, involved the following:

(1) The feeding of normal foods for a period of about two weeks, followed by the same foods from which the fats had been extracted during ninety-five days, all of which were weighed and analyzed especially for nitrogen and fats.

(2) Changes in the rations from a minimum of 15 lbs. of air-dry food to a maximum of 22½ lbs., and from a minimum of 1.3 lbs. of total protein to a maximum of 3.06 lbs. These changes were so arranged that during a certain period a decrease of protein was accompanied by an increase of carbohydrates.

(3) The analysis of the milk for one hundred and two days.

(4) The collection and analysis of the urine and feces from the experimental animal for sixty-six days, this being done continuously during fifty-nine days of the time in which extracted foods were fed.

(5) A study of the distribution of certain mineral constituents of the food in the milk, urine and feces. (Incidental and not completed.)

(6) A study of the distribution of the energy of the food in the milk, urine and feces. (Incidental and not completed.)

The experimental animal stood in a stall the floor of which was covered with metal, the trench behind being practically a metal lined box, this construction making it possible to recover any excreta that through accident might fall to the floor.

The daily ration was fed in three equal portions, morning, noon and night. Water was offered at stated times, and the animal was weighed at the same hour each day. Two men were employed for the collection of the urine and feces, one during the night and the other during the day. The excreta were caught in tin vessels, the one used for the urine being so constructed as to prevent loss of the liquid by spattering. As far as known there was loss of these materials in but a single instance and that was small.

The weights of urine and feces represent that which was voided during twenty-four hours from six o'clock a. m.

## THE FOODS.

The first matter requiring attention in the experiment herein reported was the selection or preparation of foods containing small quantities of fat. In certain grain foods, such as rice, barley and peas, the percentages of fat are comparatively low, and if these could have been fed unaccompanied by any coarse fodder the selection of a ration would have been a much simpler matter. Under the circumstances, it was decided to attempt to extract the fats from some of the ordinary cattle foods by treating them with a light benzol. It was clearly impossible to do this by any means at our command, and, therefore, we sought the coöperation of some manufacturer engaged in the extraction of vegetable oils The Cleveland Linseed Oil Company, of Cleveland, Ohio, very kindly undertook to do the work for us, and, consequently, we shipped to their works at South Chicago a thousand pounds of finely chopped hay and about fifteen hundred pounds each of corn meal and ground oats. The extraction of these materials evidently was found to be troublesome, requiring repeated treatment, and while the fats were not entirely removed, this Station is under great obligations to this company for giving the work such faithful and efficient attention as to make our experiment possible.

The following is a statement of the composition of these foods before and after extraction. It is seen that the amount of fat left in the treated materials was so small that it was possible to feed the animal a fairly generous ration that contained not over thirteen hundredths of a pound of petroleum ether extract daily, probably not all of which was pure fat or oil. In order to control the protein supply in the ration, use was made of wheat gluten, which contained, as the analyses show, from seventy-two to seventy-four per cent of protein.

COMPOSITION OF FOODS.

| Laboratory number. | FOODS. | Water. | Nitrogen. | Protein.* | Fat (petroleum ether extract). |
|---|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent. | Per cent. |
| 61 | Timothy hay, normal | 10.46 | 0.99 | 6.24 | 1.62 |
| 70 | Timothy hay, extracted | 8 | .95 | 5.94 | .71 |
| 120 | Timothy hay, extracted | 8.02 | .99 | 6.24 | .75 |
| 261 | Timothy hay, extracted | 7.55 | .91 | 5.69 | .71 |
| 286 | Timothy hay, extracted | 7.79 | 1 | 6.25 | .72 |
| 63 | Corn meal, normal | 14.55 | 1.38 | 8.62 | 4.22 |
| 84 | Corn meal, extracted | 11.23 | 1.48 | 9.25 | .38 |
| 121 | Corn meal, extracted | 10.80 | 1.47 | 9.19 | .38 |
| 211 | Corn meal, extracted | 10.67 | 1.48 | 9.25 | .37 |
| 231 | Corn meal, extracted | 10.79 | 1.52 | 9.50 | .44 |
| 271 | Corn meal, extracted | 10.27 | 1.52 | 9.50 | .40 |
| 287 | Corn meal, extracted | 11.58 | 1.51 | 9.44 | .49 |
| 62 | Oats, normal | 11.89 | 2.04 | 12.24 | 4.20 |
| 80 | Oats, extracted | 8.46 | 2.23 | 13.38 | .65 |
| 122 | Oats, extracted | 8.22 | 2.20 | 13.20 | .61 |
| 212 | Oats, extracted | 9.10 | 2.30 | 13.80 | .66 |
| 232 | Oats, extracted | 9.22 | 2.27 | 13.62 | .65 |
| 272 | Oats, extracted | 8.87 | 2.38 | 14.28 | .65 |
| 288 | Oats, extracted | 9.60 | 2.32 | 13.92 | .63 |
| 64 | Wheat gluten, as received | 6.48 | 12.79 | 72.9 | .87 |
| 85 | Wheat gluten, extracted | 5.09 | 13.07 | 74.5 | .05 |
| 123 | Wheat gluten, extracted | 5.09 | 13.03 | 74.3 | .05 |
| 233 | Wheat gluten, extracted | 4.47 | 12.87 | 73.3 | .04 |
| 273 | Wheat gluten, extracted | 5.01 | 12.68 | 72.3 | .03 |
| 289 | Wheat gluten, as received | 6 | 12.80 | 73 | .61 |

*With hay and corn meal, protein=N×6.25; with oats, protein=N×6; with wheat gluten, protein=N×5.7.

THE ANIMAL.

The animal selected for use in this experiment was a young grade Jersey cow of a vigorous type. When the experiment was begun, she was somewhat thin in flesh and about four months advanced in the period of lactation. The vigorous appetite which she possessed was depended upon to secure entire consumption of the foods which had been treated in such a manner as to render them somewhat less palatable. It is a matter of congratulation that the regular consumption of the rations was accomplished with a very satisfactory degree of success, considering the conditions under which the experiment was carried on. The health of the animal did not appear to be impaired by the food and treatment which she received.

## Composition of the Rations.

The ingredients and quantities of the several rations are given in detail below:

Rations.

| Ingredients. | Normal. | Extracted. | | | |
|---|---|---|---|---|---|
| | No. 1. | No. 2. | No. 3 | No. 4. | No. 5. |
| | Lbs. | Lbs. | Lbs. | Lbs. | Lbs |
| Timothy hay | 10 | 10 | 10 | 10 | 6 2-3 |
| Corn meal | 6 | 6 | 6 | 7½ | 5 |
| Oats, ground | 5 | 5 | 5 | 5 | 3 1 3 |
| Wheat gluten | 1 | 1 | 1½ | ........ | ........ |
| Total | 22 | 22 | 22½ | 22½ | 15 |

## The Sequence and Character of the Rations.

Ration 1. From noon April 12 to morning April 26.
This consisted of normal foods containing all their fats.

Ration 2. From noon April 26 to morning May 11.
This ration was the same in kind and quantity as No. 1, only the fats had been largely extracted from the several foods.

Ration 3. From noon May 11 to morning May 18.
This ration was similar to No. 2, except that ½ lb. more of wheat gluten was fed daily in order to increase the proportion of protein up to or beyond the probable full requirements of the animal for maintenance and milk production.

Transition period. From noon May 18 to morning May 23.
During this period the wheat gluten was decreased $\frac{1}{4}$ lb. per day and the corn meal was increased by the same amount, the purpose being to diminish the amount of protein and to increase the proportion of carbohydrates up to any probable requirements of the animal for maintenance and milk production.

Ration 4. From noon May 23 to morning May 31.
Differed from No. 3 in that the wheat gluten was withdrawn from the ration and $1\frac{1}{2}$ lbs. daily of corn meal was added.

Ration 5. From noon June 1 to morning June 20.
Similar to No. 4 only one-third smaller. It was expected that this ration would be considerably below the needs of the cow.

Transition period. From noon June 20 to morning June 24.
$\frac{1}{4}$ lb. wheat gluten added to No. 5 each day.

Ration 2. From noon June 24 to morning July 30.
During this period the food was the same as during the two weeks succeeding April 26.

THE METHODS OF SAMPLING AND ANALYSIS.

The rations were weighed out at several different times during the course of the experiment, and each time this was done samples were taken of the various foods. The similarity in composition of these several portions indicates that the mixing and sampling were thorough.

The milk, urine and feces were taken directly to the laboratory and immediately weighed and sampled, excepting that the night's milk was kept in an ice box until morning when it was mixed with the morning's milk and a sample was then drawn from the mixture. The feces were thoroughly stirred and samples (4 lbs.) of the fresh material were taken for drying and for the nitrogen determination. The feces were dried over steam coils at a temperature not exceeding 60° C.

In general the methods of the A. O. A. C. were followed in the analyses, the only exception being that petroleum ether was used instead of sulphuric ether in extracting the fats from the foods and feces.

The justification of this change is found in the following figures, the only reasonable explanation of which is that the petroleum ether takes out less material that is not fat or oil than does the sulphuric ether. Certainly the petroleum ether would not fail to remove all the fats or oils, and therefore gives figures nearer the truth than does the usual solvent.

Comparison of Results of Extraction of Fats with Sulphuric and Petroleum Ethers.

| Laboratory number. | SAMPLE. | Sulphuric ether extract. | Petroleum ether extract 40-50°. | Charcoal (sulph. ether) extract. |
|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent. |
| 61 | Timothy hay | 3.29 | 1.77 | 1.85 |
| 62 | Oats | 4.71 | 4.52 | 3.75 |
| 316 | Timothy hay (extracted) | 1.77 | .85 | .63 |
| 317 | Corn (extracted) | .51 | .59 | .47 |
| 309 | Feces (normal ration) | 3.58 | 2.58 | ........ |
| 310 | Feces (normal ration) | 3.58 | 2.75 | ........ |
| 311 | Feces (normal ration) | 3.87 | 2.85 | ........ |
| 312 | Feces (normal ration) | 3.78 | 2.98 | ........ |
| 313 | Feces (normal ration) | 3.87 | 2.67 | 2.97 |
| 314 | Feces (normal ration) | 3.84 | 3 | ........ |
| 315 | Feces (normal ration) | 4.07 | 2.78 | ........ |
| 96 | Feces (extracted ration) | 1.17 | .91 | ........ |
| 99 | Feces (extracted ration) | 1.18 | .85 | ........ |
| 102 | Feces (extracted ration) | 1.18 | .86 | ........ |
| 108 | Feces (extracted ration) | 1.16 | .88 | ........ |
| 124 | Feces (extracted ration) | 1.46 | .93 | .84 |
| 127 | Feces (extracted ration) | 1.32 | .97 | ........ |
| 130 | Feces (extracted ration) | 1.36 | 1.06 | ........ |
| 133 | Feces (extracted ration) | 1.45 | .96 | ........ |
| 136 | Feces (extracted ration) | 1.46 | .85 | ........ |
| 139 | Feces (extracted ration) | 1.41 | .98 | .88 |

Nitrogen was determined directly in fresh samples of the urine and feces. The drying of the feces at a temperature varying from 50° to 60° C. caused a material loss of nitrogen as the results clearly show.

The comparisons given are the first thirty-six or fifty-nine cases in which the nitrogen was determined in both the fresh and the air dry samples. There was but one instance in the fifty-nine comparisons where more nitrogen was not obtained from the fresh sample.

EFFECTS OF DRYING UPON THE NITROGEN CONTENT OF A COW'S FECES.

| Laboratory number. | Nitrogen without drying. | Nitrogen when dried. | Daily loss of nitrogen by drying. | Laboratory number. | Nitrogen without drying. | Nitrogen when dried. | Daily loss of nitrogen by drying. |
|---|---|---|---|---|---|---|---|
| | Per cent. | Per cent. | Grams. | | er cent. | Per cent. | Grams. |
| 96 | 0.589 | 0.546 | 6.9 | 154 | 0.561 | 0.529 | 5 |
| 99 | .589 | .565 | 3.8 | 157 | .525 | .511 | 2.3 |
| 102 | .576 | .548 | 4.8 | 160 | .500 | .494 | 1.1 |
| 105 | 551 | .534 | 2.6 | 163 | .463 | .442 | 3 |
| 108 | .559 | .529 | 4.9 | 166 | .451 | .434 | 3.1 |
| 111 | .570 | .544 | 3.6 | 169 | .445 | .422 | 4.5 |
| 114 | .556 | .517 | 6.5 | 172 | .446 | .432 | 2.3 |
| 117 | .556 | .522 | 5.5 | 175 | .446 | .418 | 5.4 |
| 124 | .542 | .526 | 2.2 | 178 | .430 | .407 | 4.1 |
| 127 | .562 | .552 | 1.7 | 181 | .421 | .413 | 1.4 |
| 130 | .557 | .524 | 5.6 | 184 | .468 | .448 | 2.8 |
| 133 | .582 | .540 | 6.7 | 187 | .458 | .420 | 5.4 |
| 136 | .557 | .520 | 5.7 | 190 | .471 | .446 | 2.5 |
| 139 | .557 | .536 | 2.9 | 193 | .455 | .434 | 3 |
| 142 | .553 | .526 | 4.4 | 196 | .438 | .416 | 4 |
| 145 | .568 | .554 | 1.7 | 199 | .425 | .401 | 4.5 |
| 148 | .563 | .538 | 3.8 | 202 | .418 | .384 | 6.7 |
| 151 | .584 | .562 | 3.2 | 205 | .421 | .407 | 2.8 |

## THE NUMERICAL RESULTS OF THE EXPERIMENT.

A large amount of data was necessarily recorded in an experiment involving such numerous weighings and analysis during nearly three months.

The figures herewith presented have been reduced to those which are essential to a critical analysis of our conclusions.

Those which follow are displayed under several heads:

(1) Periods represented by the several samples of foods.

(2) Daily weights of foods and content of nitrogen and fat.

(3) Daily weights and partial composition of the milk, urine and feces.

(4) Daily composition of milk, and yield of milk and milk solids.

(5) Digestibility of rations and amount of digestible food daily.

(6) Amount of water drank daily.

(7) Daily balance sheet, nitrogen and fat.

(8) Balance sheet, nitrogen, totals by periods.

(9) Balance sheet, protein, daily average for periods.

(10) Balance sheet, fat, totals by periods.

(11) Balance sheet, fat, daily average by periods.

PERIODS DURING WHICH THE SEVERAL SAMPLES REPRESENTED THE MATERIALS FED.

| TIMOTHY HAY. | | CORN MEAL. | | GROUND OATS. | | WHEAT GLUTEN. | |
|---|---|---|---|---|---|---|---|
| Sample number. | When fed. | Sample number. | When fed. | Sample number. | When fed. | Sample number. | When fed. |
| 61 | April 12–26 | 63 | April 12–36 | 62 | April 12–26 | 64 | April 12–26. |
| 70 | April 26–May 18 | 84 | April 26–May 11 | 80 | April 26–May 11 | 85 | April 26–May 11. |
| 120 | May 18–June 25 | 121 | May 11–June 8 | 122 | May 11–June 8 | 123 | May 11–23. |
| 261 | June 25–July 1 | 211 | June 8–16 | 212 | June 8–16 | 233 | June 20–28. |
| 286 | July 1–30 | 231 | June 16–28 | 232 | June 16–28 | 273 | June 28–July 1. |
| | | 271 | June 28–July 1 | 272 | June 28–July 1 | 289 | July 1–30. |
| | | 287 | July 1–30 | 288 | July 1–30 | | |

DAILY WEIGHTS OF FOODS AND THEIR CONTENTS OF NITROGEN AND FAT.

| NUMBER OF RATION. | TIME. | DAILY RATIONS. | | | | Nitrogen in food daily. | Fat in food daily. |
|---|---|---|---|---|---|---|---|
| | | Timothy hay. | Corn meal. | Oats, ground. | Wheat gluten. | | |
| | | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. |
| 1. Normal | April 12–26 | 4536 | 2721.6 | 2268 | 453.6 | 186.8 | 287.7 |
| 2. Extracted | April 26–May 11 | 4536 | 2721.6 | 2268 | 453.6 | 193.3 | 57.4 |
| 3. Extracted | May 11–May 18 | 4536 | 2721.6 | 2268 | 680.4 | *221.8 | †56.62 |
| Transition period | May 18–19 | 4536 | 2835 | 2268 | 567 | 210.4 | 58.9 |
| | May 19–20 | 4536 | 2948 | 2268 | 453.6 | 197.2 | 59.2 |
| | May 20–21 | 4536 | 3062 | 2268 | 340.2 | 184.1 | 59.6 |
| | May 21–22 | 4536 | 3175 | 2268 | 226.8 | 171 | 60 |
| | May 22–23 | 4536 | 3289 | 2268 | 113.4 | 157.9 | 60.4 |
| 4. Extracted | May 23–31 | 4536 | 3402 | 2268 | .......... | 144.8 | 60.7 |
| Extracted | May 31–June 1 | 1512 | 1134 | 756 | .......... | 48.3 | 20.2 |
| 5. Extracted | June 1–7 | 3024 | 2268 | 1512 | .......... | 96.5 | 40.5 |
| | June 7–8 | 3024 | 2268 | 1512 | .......... | 97.4 | 40.8 |
| | June 8–16 | 3024 | 2268 | 1512 | .......... | 98.3 | 41.1 |
| | June 16–20 | 3024 | 2268 | 1512 | .......... | 98.7 | 42.5 |
| Transition period | June 20–21 | 3024 | 2154 | 1512 | 113.4 | 111.5 | 42 |
| | June 21–22 | 3024 | 2041 | 1512 | 226.8 | 124.4 | 41.5 |
| | June 22–23 | 3024 | 1938 | 1512 | 340.2 | 137.3 | 41.1 |
| 2. Extracted | June 23–25 | 4536 | 2721.6 | 2268 | 453.6 | 201.2 | 60.9 |
| | June 25–27 | 4536 | 2721.6 | 2268 | 453.6 | 192.6 | 59.1 |
| | June 27–28 | 4536 | 2721.6 | 2268 | 453.6 | 193.1 | 58.6 |
| | June 28–July 1 | 4536 | 2721.6 | 2268 | 453.6 | 194.2 | 57.9 |
| | July 1–30 | 4536 | 2721.6 | 2268 | 453.6 | 197.2 | 63.1 |

*Nitrogen=222.8 grams on May 17-18. †Fat=57.8 grams on May 17-18.

WEIGHTS AND PARTIAL COMPOSITION OF MILK, URINE AND FECES.

| DATE. | | Milk. Laboratory number. | Milk. Amount daily. | Milk. Nitrogen. | Urine. Laboratory number. | Urine. Amount daily. | Urine. Nitrogen. | Feces. Laboratory number. | Feces. Amount daily. | Feces. Nitrogen. | Feces. Fat. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1897. | | Grams. | Per ct. | | Grams. | Per ct | | Grams. | Per ct. | Per ct. |
| Ration 1. | April 19-20.. | 60 | 8,540 | 0.558 | 65 | 6,761 | 1.123 | 309 | 15,288 | 0.445 | 0.54 |
| | April 20-21.. | 68-69 | 8,144 | .556 | 67 | 6,124 | 1.254 | 310 | 13,098 | .439 | .58 |
| | April 21-22.. | 72-73 | 8,420 | .560 | 71 | 5,472 | 1.368 | 311 | 15,252 | .439 | .60 |
| | April 22-23.. | 75-76 | 8,306 | .568 | 74 | 5,911 | 1.282 | 312 | 13,835 | .403 | .61 |
| | April 23-24.. | 78-79 | 7,966 | .578 | 77 | 3,664 | 1.809 | 313 | 14,288 | .421 | .54 |
| | April 24-25.. | 82-83 | 7,995 | .562 | 81 | 6,124 | 1.357 | 314 | 14,381 | .482 | .64 |
| | April 25-26.. | 87-88 | 8,370 | .563 | 86 | 6,159 | 1.147 | 315 | 14,990 | .450 | .58 |
| Ration 2. | May 3- 4.. | 97 | 6,988 | .574 | 98 | 17,109 | .336 | 96 | 16,025 | .589 | .21 |
| | May 4- 5.. | 100 | 6,811 | .662 | 101 | 21,262 | .255 | 99 | 15,812 | .589 | .20 |
| | May 5- 6.. | 103 | 6,910 | .669 | 104 | 21,744 | .274 | 102 | 17,194 | .576 | .19 |
| | May 6- 7.. | 107 | 6,939 | .656 | 106 | 16,804 | .283 | 105 | 15,068 | .551 | .18 |
| | May 7- 8.. | 110 | 7,045 | .658 | 109 | 16,216 | .333 | 108 | 16,188 | .559 | .20 |
| | May 8- 9.. | 113 | 7,066 | .652 | 112 | 21,064 | .235 | 111 | 14,005 | .570 | .20 |
| | May 9-10.. | 116 | 6,981 | .664 | 115 | 12,708 | .367 | 114 | 16,684 | .556 | .19 |
| | May 10-11.. | 119 | 6,790 | .664 | 118 | 19,476 | .314 | 117 | 16,266 | .556 | .20 |
| Ration 3. | May 11-12.. | 126 | 6,655 | .658 | 125 | 21,319 | .283 | 124 | 14,258 | .542 | .18 |
| | May 12-13.. | 129 | 6,684 | .663 | 128 | 20,525 | .358 | 127 | 16,897 | .562 | .21 |
| | May 13-14.. | 132 | 6,804 | .661 | 131 | 22,510 | .319 | 130 | 16,975 | .557 | .23 |
| | May 14-15.. | 135 | 6,549 | 660 | 134 | 23,438 | .277 | 133 | 15,904 | .582 | .21 |
| | May 15-16.. | 138 | 6,357 | .663 | 137 | 24,353 | .230 | 136 | 15,238 | .557 | .18 |
| | May 16-17.. | 141 | 6,301 | .660 | 140 | 26,280 | .220 | 139 | 13,693 | .557 | .20 |
| | May 17-18.. | 144 | 6,351 | .663 | 143 | 23,516 | .220 | 142 | 16,202 | .553 | .18 |
| Transition period. | May 18-19.. | 147 | 6,287 | 657 | 146 | 23,545 | .239 | 145 | 12,538 | .568 | .19 |
| | May 19-20.. | 150 | 6,421 | .658 | 149 | 29,867 | .192 | 148 | 15,422 | .563 | .18 |
| | May 20-21.. | 153 | 6,457 | .653 | 152 | 27,443 | .189 | 151 | 14,770 | .584 | .20 |
| | May 21-22.. | 156 | 6,386 | .655 | 155 | 20,894 | .236 | 154 | 15,635 | .561 | .21 |
| | May 22-23.. | 159 | 6,209 | .662 | 158 | 23,417 | .172 | 157 | 16,571 | .525 | .20 |
| Ration 4. | May 23-24.. | 162 | 5,875 | .661 | 161 | 17,123 | .229 | 160 | 17,478 | .500 | .16 |
| | May 24-25.. | 165 | 5,776 | .665 | 164 | 20,277 | .182 | 163 | 14,373 | .463 | .17 |
| | May 25-26.. | 168 | 5,571 | .655 | 167 | 19,065 | .204 | 166 | 18,165 | .451 | .16 |
| | May 26-27.. | 171 | 5,053 | .675 | 170 | 11,794 | .312 | 169 | 19,597 | .445 | .15 |
| | May 27-28.. | 174 | 5,344 | .657 | 173 | 4,508 | .687 | 172 | 16,280 | .446 | .15 |
| | May 28-29.. | 177 | 5,245 | .665 | 176 | 10,532 | .274 | 175 | 19,498 | .446 | .15 |
| | May 29-30.. | 180 | 5,160 | .656 | 179 | 6,520 | .436 | 178 | 18,101 | .430 | .16 |
| | May 30-31.. | 183 | 5,096 | .648 | 182 | 8,292 | .331 | 181 | 17,662 | .421 | .18 |
| | May 31-Jun 1 | 186 | 4,897 | .653 | 185 | 10,702 | .242 | 184 | 13,934 | .468 | .13 |

Weights and Partial Composition of Milk, Urine and Feces.—(*Continued*).

| | Date. | Milk. Laboratory number. | Milk. Amount daily. | Milk. Nitrogen. | Urine. Laboratory number. | Urine. Amount daily. | Urine. Nitrogen. | Feces. Laboratory number. | Feces. Amount daily. | Feces. Nitrogen. | Feces. Fat. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1897. | | Grams. | Per ct. | | Grams. | Per ct. | | Grams. | Per ct. | Per ct. |
| Ration 1. | June 1–2.... | 189 | 5,025 | 0.651 | 188 | 11,666 | 0.289 | 187 | 14,175 | 0.458 | 0.17 |
| | June 2–3.... | 192 | 5,110 | .655 | 191 | 14,345 | .212 | 190 | 10,178 | .471 | .15 |
| | June 3–4.... | 195 | 5,372 | .667 | 194 | 6,981 | .405 | 193 | 14,303 | .455 | .13 |
| | June 4–5.... | 198 | 5,401 | .651 | 197 | 8,427 | .374 | 196 | 18,208 | .438 | .13 |
| | June 5–6.... | 201 | 5,450 | .673 | 200 | 13,346 | .232 | 199 | 19,009 | .425 | .13 |
| | June 6–7.... | 204 | 5,301 | .658 | 203 | 5,833 | .541 | 202 | 19,668 | .418 | .13 |
| | June 7–8.... | 207 | 5,344 | .656 | 206 | 8,406 | .350 | 205 | 20,369 | .421 | .14 |
| | June 8–9.... | 210 | 5,117 | .663 | 209 | 7,031 | .436 | 208 | 18,839 | .410 | .13 |
| | June 9–10.... | 215 | 4,862 | .661 | 214 | 7,187 | .415 | 213 | 16,386 | .439 | .14 |
| | June 10–11.... | 218 | 4,749 | .664 | 217 | 8,760 | .327 | 216 | 14,799 | .442 | .15 |
| | June 11–12.... | 221 | 4,869 | .660 | 220 | 11,2[illegible]3 | .276 | 219 | 12,559 | .454 | .14 |
| | June 12–13.... | 224 | 4,635 | .655 | 223 | 7,109 | .417 | 222 | 13,615 | .446 | .15 |
| | June 13–14.... | 227 | 4,713 | .660 | 226 | 9,533 | .281 | 225 | 13,558 | .442 | .15 |
| | June 14–15.... | 230 | 4,671 | .619 | 229 | 16,851 | .178 | 228 | 13,055 | .457 | .15 |
| | June 15–16.... | 236 | 4,642 | .665 | 235 | 9,348 | .270 | 234 | 12,453 | .466 | .18 |
| | June 16–17.... | 239 | 4,564 | .661 | 238 | 13,728 | .219 | 237 | 12,984 | .479 | .15 |
| | June 17–18.... | 242 | 3,154 | .663 | 241 | 26,932 | .114 | 240 | 13,140 | .470 | .15 |
| | June 18–19.... | 245 | 5,308 | .651 | 244 | 6,343 | .356 | 243 | 11,510 | .475 | .16 |
| | June 19–20.... | 248 | 4,770 | .636 | 247 | 19,802 | .146 | 246 | 11,184 | .498 | .20 |
| Transition period. | June 20–21.... | 251 | 4,671 | .660 | 250 | 7,109 | .362 | 249 | 11,602 | .500 | .18 |
| | June 21–22.... | 254 | 4,699 | .664 | 253 | 15,132 | .197 | 252 | 11,300 | .488 | .17 |
| | June 22–23.... | 257 | 4,756 | .661 | 256 | 23,715 | .141 | 255 | 10,539 | .513 | .17 |
| Ration 2. | June 23–24.... | 260 | 4,961 | .656 | 259 | 9,511 | .385 | 258 | 10,589 | .538 | .20 |
| | June 24–25.... | 264 | 5,280 | .640 | 263 | 5,231 | .742 | 262 | 12,602 | .587 | .18 |
| | June 25–26.... | 267 | 5,783 | .635 | 266 | 17,237 | .231 | 265 | 12,814 | .623 | .25 |
| | June 26–27.... | 270 | 6,017 | .623 | 269 | 16,386 | .270 | 268 | 14,416 | .631 | .20 |
| | June 27–28.... | 276 | 6,166 | .642 | 275 | 16,145 | .280 | 274 | 15,380 | .582 | .20 |
| | June 28–29.... | 279 | 5,769 | .666 | 278 | 12,772 | .371 | 277 | 15,522 | .531 | .20 |
| | June 29–30.... | 282 | 5,854 | .689 | 281 | 12,077 | .429 | 280 | 15,748 | .561 | .17 |
| | June 30–July 1 | 285 | 5,798 | .675 | 284 | 2[illegible],198 | .239 | 283 | 15,883 | .531 | .19 |

DAILY COMPOSITION OF MILK AND YIELD OF MILK AND MILK SOLIDS.

| DATE. | Solids. | Casein and albumen. | Sugar. | Fats. | Milk daily. | Total solids daily. | DATE. | Solids. | Casein and albumen. | Sugar. | Fats. | Milk daily. | Total solids daily. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Per ct. | Per ct | Per ct. | Per ct. | Lbs. | Lbs. | | Per ct. | Per ct. | Per ct. | Per ct. | Lbs. | Lbs. |
| April 19–20...... | 14.85 | 3.50 | 5.22 | 5.33 | 18.83 | 2.8 | May 15–16...... | 15.38 | 4.14 | 5.16 | 5.28 | 14.02 | 2.2 |
| April 20–21...... | 14.82 | 3.47 | 5.55 | 5 | 17.96 | 2.7 | May 16–17...... | 15.53 | 4.13 | 5.27 | 5.33 | 13.89 | 2.2 |
| April 21–22...... | 15.32 | 3.50 | 5.23 | 5.79 | 18.57 | 2.8 | May 17–18...... | 15.35 | 4.14 | 5.11 | 5.30 | 14 | 2.1 |
| April 22–23...... | 15.32 | 3.54 | 5.52 | 5.46 | 18.31 | 2.8 | May 18–19...... | 15.48 | 4.11 | 5.16 | 5.41 | 13.86 | 2.1 |
| April 23–24...... | 15.24 | 3.61 | 5.45 | 5.38 | 17.56 | 2.7 | May 19–20...... | 15.06 | 4.11 | 5.25 | 4.90 | 14.16 | 2.1 |
| April 24–25...... | 14.57 | 3.50 | 5.34 | 4.93 | 17.63 | 2.6 | May 20–21...... | 15.32 | 4.08 | 5.15 | 5.29 | 14.24 | 2.2 |
| April 25–26...... | 14.70 | 3.52 | 5.36 | 5.02 | 18.46 | 2.7 | May 21–22...... | 15.80 | 4.09 | 5.15 | 5.76 | 14.08 | 2.2 |
| April 26–27...... | 14.42 | 3.60 | 5.26 | 4.76 | 18.08 | 2.6 | May 22–23...... | 15.59 | 4.14 | 5.30 | 5.35 | 13.69 | 2.1 |
| April 27–28...... | 14.15 | 3.65 | 5.29 | 4.41 | 17.96 | 2.5 | May 23–24...... | 15.71 | 4.13 | 5.52 | 5.26 | 12.95 | 2 |
| April 28–29...... | 14.08 | 3.71 | 5.22 | 4.35 | 17.25 | 2.4 | May 24–25...... | 15.42 | 4.16 | 5.16 | 5.30 | 12.74 | 2 |
| April 29–30...... | 14.19 | 3.80 | 5.24 | 4.35 | 16.60 | 2.4 | May 25–26...... | 15.53 | 4.09 | 5.29 | 5.35 | 12.28 | 1.9 |
| April 30–May 1.. | 13.98 | 3.83 | 5.33 | 4.02 | 13.14 | 1.8 | May 26–27...... | 15.26 | 4.22 | 5.19 | 5.05 | 11.14 | 1.7 |
| May 1– 2...... | 15.99 | 3.77 | 5.18 | 6.24 | 19.24 | 3.1 | May 27–28...... | 16.72 | 4.11 | 5.45 | 6.36 | 11.10 | 2 |
| May 2– 3...... | 14.85 | 4.03 | 5.06 | 4.96 | 15.74 | 2.3 | May 28–29...... | 16 | 4.16 | 5.29 | 5.75 | 11.57 | 1.8 |
| May 3– 4...... | 14.83 | 4.04 | 5.38 | 4.61 | 15.41 | 2.3 | May 29–30...... | 15.68 | 4.10 | 5.35 | 5.43 | 11.38 | 1.8 |
| May 4– 5...... | 14.40 | 4.14 | 5.12 | 4.34 | 15.02 | 2.2 | May 30–31...... | 15.64 | 4.05 | 5.37 | 5.42 | 11.24 | 1.8 |
| May 5– 6...... | 15.16 | 4.18 | 5.37 | 4.81 | 15.24 | 2.3 | May 31–June 1.. | 15.69 | 4.08 | 5.35 | 5.46 | 10.80 | 1.7 |
| May 6– 7..... | 14.91 | 4.10 | 5.24 | 4.77 | 15.30 | 2.3 | June 1– 2....... | 15.64 | 4.07 | 5.31 | 5.46 | 11.08 | 1.7 |
| May 7– 8...... | 15.12 | 4.11 | 5.22 | 4.99 | 15.53 | 2.3 | June 2– 3....... | 15.48 | 4.09 | 5.16 | 5.43 | 11.27 | 1.7 |
| May 8– 9...... | 15.20 | 4.08 | 5.32 | 5 | 15.58 | 2.4 | June 3– 4....... | 15.31 | 4.17 | 5.31 | 5.03 | 11.84 | 1.8 |
| May 9–10...... | 15.39 | 4.15 | 5.27 | 5.17 | 15.39 | 2.4 | June 4– 5....... | 15.53 | 4.07 | 5.42 | 5.24 | 11.91 | 1.8 |
| May 10–11...... | 14.96 | 4.15 | 5.15 | 4.86 | 14.97 | 2.2 | June 5– 6....... | 15.47 | 4.21 | 5.12 | 5.34 | 12.02 | 1.9 |
| May 11–12...... | 15.32 | 4.11 | 5.43 | 4.98 | 14.67 | 2.2 | June 6– 7....... | 15.80 | 4.11 | 5.30 | 5.59 | 11.69 | 1.8 |
| May 12–13...... | 15.84 | 4.14 | 5.27 | 5.63 | 14.74 | 2.3 | June 7– 8....... | 15.18 | 4.10 | 5.25 | 5.03 | 11.78 | 1.8 |
| May 13–14...... | 15.44 | 4.13 | 5.19 | 5.32 | 15 | 2.3 | June 8– 9....... | 15.82 | 4.14 | 5.46 | 5.42 | 11.28 | 1.8 |
| May 14–15...... | 15.32 | 4.13 | 5.15 | 5.24 | 14.44 | 2.2 | June 9–10....... | 15.61 | 4.13 | 5.29 | 5.39 | 10.72 | 1.7 |

DAILY COMPOSITION OF MILK AND YIELD OF MILK AND MILK SOLIDS—(*Concluded*).

| DATE. | Solids. | Casein and albumen. | Sugar. | Fats. | Milk daily. | Total solids daily. | DATE. | Solids. | Casein and albumen. | Sugar. | Fats. | Milk daily. | Total solids daily. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Per ct. | Per ct. | Per ct. | Per ct. | Lbs. | Lbs. | | Per ct. | Per ct. | Per ct. | Per ct. | Lbs. | Lbs. |
| June 10–11 | 15.42 | 4.15 | 5.39 | 5.08 | 10.47 | 1.6 | July 5– 6 | 15.14 | 4.16 | 5.24 | 4.94 | 13.03 | 2 |
| June 11–12 | 15.55 | 4.13 | 5.35 | 5.27 | 10.74 | 1.7 | July 6– 7 | 15.38 | 4.16 | 5.35 | 5.07 | 12.66 | 1.9 |
| June 12–13 | 16.00 | 4.09 | 5.27 | 5.84 | 10.22 | 1.6 | July 7– 8 | 15.41 | ...... | ..... | 5.23 | 13.13 | 2 |
| June 13–14 | 15.13 | 4.13 | 5.31 | 4.89 | 10.39 | 1.6 | July 8– 9 | 15.15 | ...... | ..... | 5.04 | 12.74 | 1.9 |
| June 14–15 | 15.55 | 4.06 | 5.40 | 5.29 | 10.30 | 1.6 | July 9–10 | 15.07 | ...... | ..... | 5 | 12.58 | 1.9 |
| June 15–16 | 15.07 | 4.16 | 5.39 | 4.72 | 10.24 | 1.5 | July 10–11 | 15.28 | ...... | ..... | 5.15 | 12.56 | 1.9 |
| June 16–17 | 15.77 | 4.15 | 5.36 | 5.46 | 10.06 | 1.6 | July 11–12 | 14.99 | ...... | ..... | 4.89 | 12.41 | 1.9 |
| June 17–18 | 15.12 | 4.14 | 5.39 | 4.79 | 6.95 | 1.1 | July 12–13 | 15.30 | ...... | ..... | 4.93 | 12.58 | 1.9 |
| June 18–19 | 17.26 | 4.07 | 5.42 | 6.97 | 11.70 | 2 | July 13–14 | 15.28 | ...... | ..... | 5.12 | 12.58 | 1.9 |
| June 19–20 | 15.92 | 3.97 | 5.33 | 5.82 | 10.52 | 1.7 | July 14–15 | 15.71 | ...... | ..... | 5.20 | 11.84 | 1.9 |
| June 20–21 | 15.60 | 4.13 | 5.45 | 5.22 | 10.30 | 1.6 | July 15–16 | 15.92 | ...... | ..... | 5.74 | 12.60 | 2 |
| June 21–22 | 15.43 | 4.15 | 5.47 | 5.01 | 10.36 | 1.6 | July 16–17 | 15.83 | ...... | ..... | 5.34 | 12.69 | 2 |
| June 22–23 | 15.17 | 4.13 | 5.40 | 4.84 | 10.49 | 1.6 | July 17–18 | 15.27 | ...... | ..... | 4.72 | 12.67 | 1.9 |
| June 23–24 | 15.79 | 4.10 | 5.39 | 5.50 | 10.94 | 1.7 | July 18–19 | 15.13 | ...... | ..... | 4.58 | 13.21 | 2 |
| June 24–25 | 15.25 | 4 | 5.45 | 5 | 11.64 | 1.8 | July 19–20 | 15 05 | ...... | ..... | 4.73 | 12.80 | 1.9 |
| June 25–26 | 15.77 | 3.97 | 5.38 | 5.62 | 12.75 | 2 | July 20–21 | 15.01 | ...... | ..... | 4.74 | 12.83 | 1.9 |
| June 26–27 | 15.78 | 3.89 | 5.44 | 5.65 | 13.27 | 2.1 | July 21–22 | 15.21 | ...... | ..... | 4.97 | 12.38 | 1.9 |
| June 27–28 | 15.64 | 4.01 | 5.42 | 5.41 | 13.60 | 2.1 | July 22–23 | 15.31 | ...... | ..... | 5.14 | 12.60 | 1.9 |
| June 28–29 | 15.42 | 4.16 | 5.64 | 4.82 | 12.72 | 2 | July 23–24 | 15.40 | ...... | ..... | 5.14 | 12.55 | 1.9 |
| June 29–30 | 15.68 | 4.31 | 5.33 | 5.24 | 12.91 | 2 | July 24–25 | 15.27 | ...... | ..... | 5.03 | 11.80 | 1.8 |
| June 30–July 1 | 15.49 | 4.22 | 5.04 | 5.43 | 12.78 | 2 | July 25–26 | 15.63 | ...... | ..... | 5.40 | 11.76 | 1.8 |
| July 1–2 | 15.58 | 4.24 | 5.25 | 5.29 | 12.64 | 2 | July 26–27 | 15.27 | ...... | ..... | 4.96 | 11.10 | 1.7 |
| July 2–3 | 15.80 | 4.13 | 5.01 | 5.86 | 12.85 | 2 | July 27–28 | 15.69 | ...... | ..... | 5.41 | 10.97 | 1.7 |
| July 3–4 | 15.11 | 4.24 | 5.20 | 4.87 | 12.63 | 1.9 | July 28–29 | 15.96 | ...... | ..... | 5.90 | 11.52 | 1.8 |
| July 4–5 | 15.24 | 4.21 | 5.14 | 5.09 | 12.97 | 2 | July 29–30 | 15.92 | ...... | ..... | 5.84 | 11.25 | 1.8 |

NOTE.—The ash is assumed to be 0.80 per cent.

## DIGESTIBILITY OF RATIONS.

| | Dry matter. | Ash. | Protein. | Carbohydrates | Fats. |
|---|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| April 19 to 26 | 68.1 | 28.9 | 66.0 | 70.1 | 70.7 |
| May 3 to 11 | 63.5 | 27.3 | 59.4 | 67.9 | 45.6 |
| 26 to 31 | 60.1 | 21.8 | 44.9 | 63.0 | 52.6 |
| June 10 to 20 | 55.6 | 16.9 | 39.6 | 59.1 | 51.4 |

## AMOUNT OF DIGESTIBLE FOOD DAILY.

| | Dry matter. | Ash. | Protein. | Carbohydrates. | Fats. |
|---|---|---|---|---|---|
| | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. |
| April 19 to 26 | 13.2 | 0.20 | 1.70 | 10.89 | 0.44 |
| May 3 to 11 | 12.7 | .20 | 1.42 | 11.04 | .05 |
| 26 to 31 | 12.4 | .16 | .90 | 11.30 | .07 |
| June 10 to 20 | 7.6 | .08 | .53 | 6.9 | .05 |

## AMOUNT OF WATER DRANK DAILY.

| Date. | Water. | Date. | Water. | Date. | Water. | Date. | Water. | Date. | Water. | Date. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lbs. | | Lbs. | | Lbs. | | Lbs. | | Lbs. | | Lbs. |
| April | | May | | May | | June | | July | | July | |
| 19 | 58.5 | 13 | 99 | 31 | 48 | 17 | 78 | 4 | 102 | 22 | 106.5 |
| 20 | 52.2 | 14 | 98 | June | | 18 | 47.5 | 5 | 118 | 23 | 125.2 |
| 21 | 55.8 | 15 | 104 | 1 | 67.8 | 19 | 80.5 | 6 | 118 | 24 | 96.5 |
| 22 | 58 | 16 | 103 | 2 | 70 | 20 | 42.5 | 7 | 120.5 | 25 | 99 |
| 23 | 37.5 | 17 | 96.2 | 3 | 69.5 | 21 | 69.5 | 8 | 72 | 26 | 82.5 |
| 24 | 85.8 | 18 | 100 5 | 4 | 69 | 22 | 52 | 9 | 117.5 | 27 | 88 |
| 25 | 61 | 19 | 112 | 5 | 86 | 23 | 61.5 | 10 | 119 | 28 | 90.5 |
| May | | 20 | 100 | 6 | 60 | 24 | 62 | 11 | 121.5 | 29 | 95 |
| 3 | 84.5 | 21 | 91 | 7 | 71 5 | 25 | 84 | 12 | 118.5 | 30 | 97 |
| 4 | 97.8 | 22 | 97.5 | 8 | 54.5 | 26 | 71.5 | 13 | 107.5 | ..... | ....... |
| 5 | 98.5 | 23 | 84 | 9 | 49 | 27 | 81 | 14 | 69 | ..... | ....... |
| 6 | 86.5 | 24 | 94.5 | 10 | 53 | 28 | 61.5 | 15 | 96 | ..... | ....... |
| 7 | 91 | 25 | 86 | 11 | 58.5 | 29 | 86.5 | 16 | 136.5 | ..... | ....... |
| 8 | 94.5 | 26 | 68 | 12 | 45.5 | 30 | 100 | 17 | 107.5 | ..... | ....... |
| 9 | 63 | 27 | 54 | 13 | 54.5 | July | | 18 | 99.5 | ..... | ....... |
| 10 | 94 | 28 | 78 | 14 | 72.5 | 1 | 100.2 | 19 | 112.5 | ..... | ....... |
| 11 | 98.8 | 29 | 62.5 | 15 | 53.5 | 2 | 84 | 20 | 169.5 | ..... | ....... |
| 12 | 89.5 | 30 | 77.5 | 16 | 63.8 | 3 | 110 | 21 | 99.5 | ..... | ....... |

BALANCE SHEET OF NITROGEN AND FAT.

| Date. 1897. | Nitrogen income. | Nitrogen Outgo. | | | | Gain of nitrogen by animal. | Loss of nitrogen by animal. | Fat income. | Fat Outgo. | | | Loss of fat by cow. | Weight of cow. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Milk. | Urine. | Feces. | Total. | | | | Milk. | Feces. | Total. | | |
| | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams | Grams. | Grams. | Lbs. |
| *Ration 1.—Normal Foods.* | | | | | | | | | | | | | |
| April 19-20 | 186.8 | 47.7 | 75.9 | 68 | 191.6 | ........ | 4.8 | 287.7 | 455.2 | 82.6 | 537.8 | 259.1 | ........ |
| April 20-21 | 186.8 | 45.3 | 76.8 | 57.5 | 179.6 | 7.2 | ........ | 287.7 | 407.2 | 76 | 483.2 | 195.5 | 868 |
| April 21-22 | 186.8 | 47.2 | 74.8 | 66.9 | 188.9 | ........ | 2.1 | 287.7 | 487.5 | 91.5 | 579 | 291.3 | 867 |
| April 22-23 | 186.8 | 47.2 | 75.8 | 55.7 | 178.7 | 8.1 | ........ | 287.7 | 453.5 | 84.4 | 537.9 | 250.2 | 862 |
| April 23-24 | 186.8 | 46.0 | 66.3 | 60.2 | 172.5 | 14.3 | ........ | 287.7 | 428.6 | 77.1 | 505.7 | 218 | 860 |
| April 24-25 | 186.8 | 44.9 | 83.1 | 69.3 | 197.3 | ........ | 10.5 | 287.7 | 394.1 | 92 | 486.1 | 198.4 | 858 |
| pril 25-26 | 186.8 | 47.1 | 70.6 | 67.5 | 185.2 | 1.6 | ........ | 287.7 | 420.2 | 86.9 | 507.1 | 219.4 | ........ |
| Total | 1,307.6 | 325.4 | 523.3 | 445.1 | 1,293.8 | 31.2 | 17.4 | 2,013.9 | 3,046.3 | 590.5 | 3,636.8 | 1,622.9 | ........ |
| Average | 186.8 | 46.5 | 74.8 | 63.6 | 184.8 | 2.0 | ........ | 287.7 | 435.2 | 84.3 | 519.5 | 231.8 | ........ |
| *Ration 2.—Extracted Foods.* | | | | | | | | | | | | | |
| April 26-27 | 178.9 | ........ | ........ | ........ | ........ | ........ | ........ | 46.7 | 390.3 | ........ | ........ | ........ | ........ |
| April 27-28 | 193.3 | 47.7 | ........ | ........ | ........ | ........ | ........ | 57.4 | 359.1 | ........ | ........ | ........ | ........ |
| April 28-29 | 193.3 | 47.5 | ........ | ........ | ........ | ........ | ........ | 57.4 | 340.4 | ........ | ........ | ........ | ........ |
| April 29-30 | 193.3 | 45.8 | ........ | ........ | ........ | ........ | ........ | 57.4 | 327.4 | ........ | ........ | ........ | ........ |
| April 30-May 1 | 193.3 | 36.5 | ........ | ........ | ........ | ........ | ........ | 57.4 | 239.6 | ........ | ........ | ........ | ........ |
| May 1-2 | 193.3 | 52.6 | ........ | ........ | ........ | ........ | ........ | 57.4 | 544.4 | ........ | ........ | ........ | ........ |
| May 2-3 | 193.3 | 46 | ........ | ........ | ........ | ........ | ........ | 57.4 | 354 | ........ | ........ | ........ | ........ |
| May 3-4 | 193.3 | 40.1 | 57.5 | 94.4 | 192 | 1.3 | ........ | 57.4 | 322.1 | 33.7 | 355.8 | 298.4 | 867 |
| May 4-5 | 193.3 | 45.1 | 54.2 | 93.1 | 192.4 | 0.9 | ........ | 57.4 | 295.6 | 31.6 | 327.2 | 269.8 | 866 |
| May 5-6 | 193.3 | 46.2 | 59.6 | 99 | 204.8 | ........ | 11.5 | 57.4 | 332.3 | 32.7 | 365 | 307.6 | 867 |
| May 6-7 | 193.3 | 45.5 | 47.5 | 83 | 176 | 17.3 | ........ | 57.4 | 331 | 27.1 | 358.1 | 300.7 | 868 |
| May 7-8 | 193.3 | 46.4 | 54 | 90.5 | 190.9 | 2.4 | ........ | 57.4 | 351.5 | 32.4 | 383.9 | 326.5 | 869 |
| May 8-9 | 193.3 | 46.1 | 49.5 | 79.8 | 175.4 | 17.9 | ........ | 57.4 | 353.3 | 28 | 381.3 | 323.9 | 873 |
| May 9-10 | 193.3 | 46.4 | 46.6 | 92.7 | 185.7 | 7.6 | ........ | 57.4 | 360.9 | 31.7 | 392.6 | 337.2 | 872 |
| May 10-11 | 193.3 | 45.1 | 61.2 | 90.4 | 196.7 | ........ | 3.4 | 57.4 | 330 | 32.5 | 362.5 | 305.1 | 870 |
| Total | 1,546.4 | 360.9 | 430.1 | 722.9 | 1,513.9 | 47.4 | 14.9 | 459.2 | 2,676.7 | 249.7 | 2,926.4 | 2,467.2 | ........ |
| Average | 193.3 | 45.1 | 53.7 | 90.4 | 189.2 | 5.9 | 1.8 | 57.4 | 334.3 | 31.2 | 365.8 | 308.4 | ........ |

BALANCE SHEET OF NITROGEN AND FAT — *Continued.*

| Date. 1897. | Nitrogen income. | Nitrogen Outgo. | | | | Gain | Loss | Fat income. | Fat Outgo. | | | Loss of fat by cow. | Weight of cow. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Milk. | Urine. | Feces. | Total. | of nitrogen by animal. | | | Milk. | Feces. | Total. | | |
| | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Lbs. |
| *Ration 3 — Extracted Foods, Maximum Protein Supply.* | | | | | | | | | | | | | |
| May 11-12 | 221.6 | 43.8 | 60.3 | 77.4 | 181.5 | 40.1 | ........ | 56.6 | 331.4 | 25.7 | 357.1 | 300.5 | 873 |
| May 12-13 | 221.6 | 44.3 | 73.5 | 95 | 212.8 | 8.8 | ........ | 56.6 | 376.3 | 35.5 | 411.8 | 355.2 | 870 |
| May 13-14 | 221.6 | 45 | 71.8 | 94.5 | 211.3 | 10.3 | ........ | 56.6 | 362 | 39 | 401 | 344.4 | 868 |
| May 14-15 | 221.6 | 43.2 | 64.9 | 92.5 | 200.6 | 21 | ........ | 56.6 | 343.2 | 33.4 | 376.6 | 320 | 870 |
| May 15-16 | 221.6 | 42.1 | 56 | 84.9 | 183 | 38 | ........ | 56.6 | 335.6 | 27.4 | 363 | 306.4 | 874 |
| May 16-17 | 221.6 | 41.6 | 57.8 | 76.3 | 175.7 | 45.9 | ........ | 56.6 | 335.8 | 27.4 | 363.2 | 306.6 | 876 |
| May 17-18 | 222.8 | 42.1 | 51.7 | 89.6 | 183.4 | 39.4 | ........ | 57.8 | 336.6 | 29.2 | 365.8 | 308 | 875 |
| Total | 1,552.4 | 302.1 | 436 | 610.2 | 1,348.3 | 204.1 | ........ | 397.4 | 2,420.9 | 217.6 | 2,638.5 | 2,241.1 | ......... |
| Average | 221.8 | 43.2 | 62.3 | 87.2 | 192.6 | 29.2 | ........ | 56.8 | 345.7 | 31.1 | 376.9 | 320.1 | ......... |
| *Transition Period—Protein Decreased, Carbohydrates Increased.* | | | | | | | | | | | | | |
| May 18-19 | 210.4 | 41.3 | 56.3 | 71.2 | 168.8 | 41.6 | ........ | 58.9 | 340.1 | 23.8 | 363.9 | 305 | 880 |
| May 19-20 | 196.8 | 42.2 | 57.3 | 86.8 | 186.3 | 10.5 | ........ | 59.1 | 314.6 | 27.8 | 342.4 | 283.3 | 882 |
| May 20-21 | 184.1 | 42.2 | 51.9 | 86.2 | 180.3 | 3.8 | ........ | 59.6 | 341.5 | 29.5 | 371 | 311.4 | 884 |
| May 21-22 | 171 | 41.8 | 49.3 | 87.7 | 178.8 | ........ | 7.8 | 60 | 367.8 | 32.8 | 400.6 | 340.6 | 886 |
| May 22-23 | 157.9 | 41.1 | 40.3 | 87 | 168.4 | ........ | 10.5 | 60.4 | 332.2 | 33.1 | 365.3 | 304.9 | 885 |
| Total | 920.2 | 208.6 | 255.1 | 418.9 | 882.6 | 56.1 | 18.3 | 298 | 1,696.2 | 147 | 1,843.2 | 1,545.2 | ......... |
| Average | 184 | 41.7 | 51 | 83.8 | 176.5 | 7.5 | ........ | 59.6 | 339.2 | 29.4 | 386.6 | 309 | ......... |

BALANCE SHEET OF NITROGEN AND FAT.—*Continued.*

| Date. 1897. | Nitrogen income. | Nitrogen Outgo. | | | | Gain | Loss | Fat income. | Fat Outgo. | | | Loss of fat by cow. | Weight of cow. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Milk. | Urine. | Feces. | Total. | of nitrogen by animal. | | | Milk. | Feces. | Total. | | |
| | Grams. | Grams | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Lbs. |
| *Ration 4.—Maximum Carbohydrates, Minimum Protein.* | | | | | | | | | | | | | |
| May 23-24 | 144.8 | 38.8 | 39.2 | 87.4 | 165.4 | ........ | 20.6 | 60.7 | 309 | 28 | 337 | 276.3 | 887 |
| May 24-25 | 144.8 | 38.4 | 36.9 | 66.5 | 141.8 | 3 | ........ | 60.7 | 306.1 | 24.4 | 330.5 | 269.8 | 889 |
| May 25-26 | 144.8 | 36.5 | 38.9 | 81.9 | 157.3 | ........ | 12.5 | 60.7 | 298 | 29.1 | 327.1 | 266.4 | 889 |
| May 26-27 | 144.8 | 34.1 | 36.8 | 87.2 | 158.1 | ........ | 13.3 | 60.7 | 255.2 | 24.4 | 284.6 | 223.9 | 890 |
| May 27-28 | 144.8 | 35.1 | 31 | 72.6 | 138.7 | 6.1 | ........ | 60.7 | 339.9 | 24.4 | 364.3 | 303.6 | 865 |
| May 28-29 | 144.8 | 34.9 | 28.9 | 86.9 | 150.7 | ........ | 5.9 | 60.7 | 301.6 | 29.2 | 330.8 | 270.1 | 892 |
| May 29-30 | 144.8 | 33.8 | 28.4 | 77.8 | 140.0 | 4.8 | ........ | 60.7 | 280.1 | 29 | 309.1 | 248.4 | 898 |
| May 30-31 | 144.8 | 33 | 27.4 | 74.3 | 134.7 | 10.1 | ........ | 60.7 | 276.2 | 31.8 | 308 | 247.3 | 884½ |
| Total | 1,158.4 | 284.6 | 267.5 | 634.6 | 1,186.7 | 24 | 52.3 | 485.6 | 2,366.1 | 225.3 | 2,591.4 | 2,105.8 | ........ |
| Average | 144.8 | 35.6 | 33.4 | 79.3 | 148.3 | ........ | 3.5 | 60.7 | 295.8 | 28.2 | 324 | 263.2 | ........ |
| *Ration 5—Two-thirds Ration 4.* | | | | | | | | | | | | | |
| May 31-June 1 | 48.3 | 32 | 25.9 | 65.2 | 123.1 | ........ | 74.8 | 20.2 | 267.3 | 18.1 | 285.4 | 265.2 | 869 |
| June 1-2 | 96.5 | 32.7 | 33.7 | 64.9 | 131.3 | ........ | 34.8 | 40.5 | 274.3 | 24.1 | 298.4 | 257.9 | 872 |
| June 2-3 | 96.5 | 33.5 | 30.4 | 47.9 | 111.8 | ........ | 15.3 | 40.5 | 277.4 | 15.3 | 292.7 | 252.2 | 873 |
| June 3-4 | 96.5 | 35.8 | 28.3 | 65.1 | 129.2 | ........ | 32.7 | 40.5 | 270.2 | 18.6 | 288.8 | 218.3 | 878 |
| June 4-5 | 96.5 | 35.2 | 31.5 | 79.7 | 146.4 | ........ | 49.9 | 40.5 | 283 | 23.7 | 306.7 | 266.2 | 889 |
| June 5-6 | 96.5 | 36.7 | 31 | 80.7 | 148.4 | ........ | 51.9 | 40.5 | 291 | 24.7 | 315.7 | 275.2 | 894 |
| June 6-7 | 96.5 | 34.9 | 31.6 | 82.2 | 148.7 | ........ | 52.2 | 40.5 | 296.3 | 25.6 | 321.9 | 281.4 | 892 |
| June 7-8 | 97.4 | 35.1 | 29.4 | 85.7 | 150.2 | ........ | 52.8 | 40.8 | 268.8 | 28.5 | 297.3 | 256.5 | 900 |
| June 8-9 | 98.3 | 33.9 | 30.7 | 77.2 | 141.8 | ........ | 43.5 | 41.1 | 277.3 | 24.5 | 301.8 | 260.7 | 873 |
| June 9-10 | 98.3 | 32.1 | 29.8 | 71.9 | 133.8 | ........ | 35.5 | 41.1 | 262 | 22.9 | 284.9 | 243.8 | 869 |
| June 10-11 | 98.3 | 31.5 | 28.6 | 65.4 | 125.5 | ........ | 27.2 | 41.1 | 241.2 | 22.2 | 263.4 | 222.3 | 873 |
| June 11-12 | 98.3 | 32.1 | 31.1 | 57 | 120.2 | ........ | 21.9 | 41.1 | 256.6 | 17.6 | 274.2 | 233.1 | 871 |
| June 12-13 | 98.3 | 30.4 | 29.6 | 60.7 | 120.7 | ........ | 22.4 | 41.1 | 270.7 | 20.4 | 291.1 | 250 | 869 |
| June 13-14 | 98.3 | 31.1 | 24 | 59.9 | 115 | ........ | 16.7 | 41.1 | 230.3 | 20.3 | 250.6 | 209.5 | 859 |
| June 14-15 | 98.3 | 30.3 | 30 | 59.7 | 120 | ........ | 21.7 | 41.1 | 247.1 | 19.6 | 266.7 | 225.6 | 863 |
| June 15-16 | 98.3 | 30.9 | 25.2 | 58 | 114.1 | ........ | 15.8 | 41.1 | 219.1 | 22.4 | 241.5 | 200.4 | 853 |
| June 16-17 | 98.7 | 30.3 | 30.1 | 62.2 | 122.6 | ........ | 23.9 | 42.5 | 249.2 | 19.5 | 268.7 | 226.2 | 860 |
| June 17-18 | 98.7 | 20.9 | 30.7 | 61.8 | 113.4 | ........ | 14.7 | 42.5 | 151.1 | 19.7 | 170.8 | 128.3 | 863 |
| June 18-19 | 98.7 | 34.6 | 22.6 | 54.7 | 111.9 | ........ | 13.2 | 42.5 | 370 | 18.4 | 388.4 | 345.9 | 830 |
| June 19-20 | 98.7 | 30.3 | 28.9 | 55.7 | 114.9 | ........ | 16.2 | 42.5 | 277.6 | 22.4 | 300 | 257.5 | 854 |
| Total | 1,905.9 | 644.3 | 583.1 | 1,315.6 | 2,543 | ........ | 637.1 | 802.8 | 5,280.5 | 428.5 | 5,709 | 4,906.2 | ........ |
| Average | 95.3 | 32.2 | 29.1 | 65.8 | 127.1 | ........ | 31.8 | 40.1 | 264 | 21.4 | 285.4 | 245.3 | ........ |

BALANCE SHEET OF NITROGEN AND FAT—(*Continued*).

| Date. 1897. | Nitrogen income. | Nitrogen Outgo. Milk. | Nitrogen Outgo. Urin. | Nitrogen Outgo. Feces. | Nitrogen Outgo. Total. | Gain of nitrogen by animal. | Loss of nitrogen by animal. | Fat incom | Fat Outgo. Milk. | Fat Outgo. Feces. | Fat Outgo. Tota | Loss of fat by cow. | Weight of cow. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grams. | Grams. | Grams. | Grams. | Grams. | Grams, | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Lbs. |
| *Transition Period.—Nitrogen Increased.* | | | | | | | | | | | | | |
| June 20-21 | 111.5 | 30.8 | 25.7 | 58 | 114.5 | .......... | 3 | 42 | 243.8 | 20.9 | 264.7 | 222.7 | 852 |
| June 21-22 | 124.4 | 31.2 | 29.8 | 55.1 | 116.1 | 8.3 | ...... | 41.5 | 235.5 | 19.2 | 254.7 | 213.2 | 852 |
| June 22-23 | 137.3 | 31.4 | 33.4 | 54.1 | 118.9 | 18.4 | ........ | 41.1 | 230.2 | 17.9 | 248.1 | 207 | 853 |
| Total | 373.2 | 93.4 | 88.9 | 167.2 | 349.5 | 26.7 | 3 | 124.6 | 709.5 | 58 | 767.5 | 642.9 | .......... |
| Average | 124.4 | 31.1 | 29.6 | 55.7 | 116.5 | 7.9 | | 41.5 | 236.5 | 19.3 | 255.8 | 214.3 | .......... |
| *Ration 2.—Extracted Foods.* | | | | | | | | | | | | | |
| June 23-24 | 201.2 | 32.5 | 36.6 | 57 | 126.1 | 75.1 | .......... | 60.9 | 272.9 | 21.2 | 294.1 | 233.2 | 864 |
| June 24-25 | 201.2 | 33.8 | 38.8 | 74 | 146.6 | 54.6 | .......... | 60.9 | 264 | 22.7 | 286.7 | 225.8 | 858 |
| June 25-26 | 192.6 | 36.7 | 39.8 | 79.8 | 156.3 | 36.3 | .......... | 59.1 | 325 | 32 | 357 | 297.9 | 886 |
| June 26-27 | 192.6 | 37.5 | 44.2 | 91 | 172.7 | 19.9 | .......... | 59.1 | 339.9 | 28.8 | 368.7 | 309.6 | 893 |
| June 27-28 | 193.1 | 39.6 | 45.2 | 89.5 | 174.3 | 18.8 | .......... | 58.6 | 333.5 | 30.8 | 364.3 | 305.7 | 895 |
| June 28-29 | 194.2 | 38.4 | 47.4 | 82.4 | 168.2 | 26 | .......... | 57.9 | 278 | 31 | 309 | 251.1 | 897 |
| June 29-30 | 194.2 | 40.3 | 51.8 | 88.3 | 180.4 | 13.8 | .......... | 57.9 | 306.7 | 26.8 | 333.5 | 275.6 | 905 |
| June 30-July 1 | 194.2 | 39.1 | 53 | 84.3 | 176.4 | 17.8 | .......... | 57.9 | 314.8 | 30.2 | 345 | 287.1 | 898 |
| Total | 1,563.3 | 297.9 | 356.8 | 646.3 | 1,301 | 262.3 | .......... | 472.3 | 2,434.8 | 223.5 | 2,658.3 | 218.6 | .......... |
| Average | 195.4 | 37.2 | 44.6 | 80.8 | 162.6 | 32.8 | .......... | 59 | 304.4 | 37.9 | 332.3 | 273.3 | .......... |

From July 1 to July 30, Ration 2 was continued, the total income of fat being 1,829.9 grams, or 63.1 grams daily, and the milk fat being 8,392.8 grams, or 289 grams daily. During this period of 29 days the urine and feces were not collected.

## Nitrogen Balance.

*Totals by Periods.*

| Rations. | Days in period | Nitrogen Income. | | Nitrogen Digested. | | Nitrogen Outgo. | | | | | | | | Nitrogen Daily. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Milk. | | Urine. | | Feces. | | Totals. | | | |
| | | Total. | Daily. | Total. | Daily. | Total. | Daily. | Total. | Daily. | Total. | Daily. | Total | Daily. | Gain. | Loss. |
| | | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. |
| 1. Normal foods | 7 | 1,307.6 | 186.8 | 862.5 | 123.2 | 325.4 | 46.5 | 523.3 | 74.8 | 445.1 | 63.6 | 1,293.8 | 184.9 | 2 | ...... |
| 2. Extracted foods | 8 | 1,546.4 | 193.3 | 823.5 | 102.9 | 360.9 | 45.1 | 430.1 | 53.7 | 722.9 | 90.4 | 1,573.9 | 189.2 | 4.1 | ...... |
| 3. Extracted foods, more N | 7 | 1,552.4 | 221.8 | 942.2 | 134.6 | 302.1 | 43.1 | 436 | 62.3 | 610.2 | 87.2 | 1,348.3 | 192.6 | 29.2 | ...... |
| Transition period to less N | 5 | 920.2 | 184 | 501.3 | 100.2 | 208.6 | 41.7 | 255.1 | 51.1 | 418.9 | 83.8 | 88 .6 | 176.6 | 7.8 | ...... |
| 4. Extracted foods, less N | 8 | 1,158.4 | 144.8 | 523.8 | 65.5 | 284.6 | 35.6 | 267.5 | 33.4 | 631.6 | 79.3 | 1,186.7 | 148.3 | ...... | 3.5 |
| 5. Extracted foods, min ration | 20 | 1,905.9 | 95.3 | 590.3 | 29.5 | 644.3 | 32.2 | 583.1 | 29.1 | 1,315.6 | 65.8 | 2,543 | 127.1 | ...... | 31.8 |
| Transition period, to more N | 3 | 373.2 | 124.4 | 206 | 68.7 | 93.4 | 31.1 | 88.9 | 29.6 | 167.2 | 55.7 | 349.5 | 116.4 | 7.9 | ...... |
| 2. Extracted foods | 8 | 1,563.3 | 195.4 | 917 | 114.6 | 297.9 | 37.2 | 356.8 | 44.6 | 646.3 | 80.8 | 1,301 | 162.6 | 32.8 | ...... |
| Totals while feeding extracted foods | 59 | 9,019.8 | ...... | 4,504.1 | ...... | 2,191.8 | ...... | 2,417.5 | ...... | 4,515.7 | ...... | 9:125 | ...... | ...... | ...... |
| | | Lbs. | | Lbs. | | Lbs. | | Lbs. | | Lbs. | | Lbs. | | | |
| Totals in protein equivalents | .. | 124.3 | ...... | 62.1 | ...... | 30.2 | ...... | 33.3 | ...... | 62.2 | ...... | 125.7 | ...... | ...... | ...... |

PROTEIN BALANCE.

*Daily for Periods.*

| RATIONS. | Days in period. | Protein daily income. | Protein digested daily. | PROTEIN DAILY OUTGO. | | | | PROTEIN DAILY. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Milk. | Urine. | Feces. | Totals. | Gain. | Loss. |
| | | Lbs | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. |
| Ration 1. Normal foods | 7 | 2.57 | 1.70 | 0.64 | 1.03 | 0.88 | 2.55 | 0.02 | ....... |
| Ration 2. Extracted foods | 8 | 2.66 | 1.42 | .62 | .74 | 1.25 | 2.61 | .05 | ....... |
| Ration 3. Extracted foods, more N | 7 | 3.06 | 1.85 | .59 | .86 | 1.20 | 2.65 | .41 | ....... |
| Transition period to less N | 5 | 2.54 | 1.38 | .57 | .70 | 1.16 | 2.43 | .11 | ....... |
| Ration 4. Extracted foods, less N | 8 | 2. | .90 | .49 | .46 | 1.09 | 2.04 | ...... | 0.04 |
| Ration 5. Extracted, foods minimum ration | 20 | 1.31 | .41 | .44 | .40 | .91 | 1.75 | ...... | .44 |
| Transition period to more N | 3 | 1.71 | .95 | .43 | .40 | .77 | 1.60 | .11 | ....... |
| Ration 2. Extracted foods | 8 | 2.69 | 1.58 | .51 | .61 | 1·11 | 2.23 | .46 | ....... |

## FAT BALANCE.

*Totals for Periods.*

| RATIONS. | Days in period. | Fat Income. | | Fat Digested. | | Fat Outgo. | | | | | | Fat Loss. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Milk. | | Feces. | | Totals. | | | |
| | | Total. | Daily. | Total. | Daily. | Total. | Daily. | Total. | Daily. | Total. | Daily. | Total. | Daily. |
| | | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams | Grams. | Grams | Grams. |
| 1. Normal foods | 7 | 2,013.9 | 287.7 | 1,422.4 | 203.2 | 3,046.3 | 435.2 | 590.5 | 84.3 | 3,636.8 | 519.5 | 1.622.9 | 231.8 |
| 2. Extracted foods | 8 | 459.2 | 57.4 | 209.5 | 26.2 | 2,676.7 | 334.3 | 249.7 | 31.2 | 2,926.4 | 365 8 | 2.467.2 | 308.4 |
| 3. Extracted foods, more N | 7 | 397.4 | 56.8 | 179.8 | 25.7 | 2,420.9 | 345.7 | 217.6 | 31.1 | 2,638.5 | 376.9 | 2,241.1 | 320.1 |
| Transition period to less N | 5 | 298 | 59.6 | 151 | 30.2 | 1,696.2 | 339.2 | 147 | 29.4 | 1,843.2 | 368.6 | 1,545.2 | 309 |
| 4. Extracted foods, less N | 8 | 485.6 | 60.7 | 260.3 | 32.5 | 2,366 1 | 295.8 | 225.3 | 28.2 | 2.591.4 | 324 | 2,105.8 | 263.2 |
| 5. Extracted foods, minimum ration | 20 | 802.8 | 40.1 | 374.3 | 18.7 | 5.280.5 | 264 | 428.5 | 21.4 | 5,709 | 285.4 | 4.906.2 | 245.3 |
| Transition period to more N | 3 | 124.6 | 41.5 | 66 6 | 22.2 | 709.5 | 236.5 | 58 | 19.3 | 767.5 | 255.8 | 642.9 | 214.3 |
| 2. Extracted foods | 8 | 472.3 | 59 | 248.8 | 31.1 | 2,434.8 | 304.4 | 223.5 | 27.9 | 2,658.3 | 332.3 | 2,186 | 273.3 |
| Totals in 59 days, grams | 59 | 3,039.9 | ........ | 1,490.3 | ........ | 17,584.7 | ........ | 1,549.6 | ........ | 19,134.3 | ........ | 16,094.4 | ........ |
| Totals in 59 days, lbs | .... | 6.7 | ........ | 3.3 | ........ | 38.8 | ........ | 3.4 | ........ | 42.2 | ........ | 35.5 | ........ |
| In preliminary period, April 26–May 3 | 7 | 391.1 | ........ | 191.6 | ........ | 2,555.2 | ........ | 199.5 | ........ | 2,754.7 | ........ | 2,363.6 | ........ |
| During July | 29 | 1,829.9 | ........ | 896.6 | ........ | 8,392.8 | ........ | 933.3 | ........ | 9.326.1 | ........ | 7,496.2 | ........ |
| Totals in 95 days, grams | 95 | 5,260.9 | ........ | 2,578.5 | ........ | 28,532.7 | ........ | 2,682.4 | ........ | 31,215.1 | ........ | 25,954.2 | ........ |
| Totals in 95 days, lbs | | 11.6 | ........ | 5.7 | ........ | 62.9 | ........ | 5.9 | ........ | 68.8 | ........ | 57.2 | ........ |

FAT BALANCE.

*Daily for Periods.*

| RATIONS. | Days in period. | Fat income, daily. | FAT OUTGO. | | | Fat loss, daily. |
|---|---|---|---|---|---|---|
| | | | Milk, daily. | Feces, daily. | Total, daily. | |
| | | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. |
| Ration 1. Normal foods | 7 | 0.63 | 0.96 | 0.18 | 1.14 | 0.51 |
| Preliminary period; Ration 2 | 7 | .12 | .80 | .06 | .86 | .74 |
| Ration 2. Extracted foods | 8 | .13 | .74 | .07 | .81 | .68 |
| Ration 3. Extracted foods | 7 | .13 | .76 | .07 | .83 | .70 |
| Transition period | 5 | .13 | .74 | .07 | .81 | .68 |
| Ration 4. Extracted foods | 8 | .13 | .65 | .06 | .71 | .58 |
| Ration 5. Extracted foods | 20 | .09 | .58 | .05 | .63 | .54 |
| Transition period | 3 | .09 | .52 | .04 | .56 | .47 |
| Ration 2. Extracted foods | 8 | .13 | .67 | .06 | .73 | .60 |
| Ration 2. Extracted foods | 29 | .14 | .64 | .07 | .71 | .57 |

## DISCUSSION OF RESULTS.

### GENERAL REMARKS.

It is proper to preface a discussion of the results of the experiment by the statement that these foods of a quite unusual character seemed to have no ill effect upon the health of the cow. Her general appearance was all that could be desired. As may be seen by the foregoing figures, the weights of water drank and of urine excreted were somewhat abnormally large, but it was not discovered that any febrile or other diseased condition existed.

The general appearance of the animal indicated a steady increase in adipose tissue throughout the experiment, except that during the feeding of Ration 5 there appeared to be no especial change. All the points by which a butcher judges the fatness of an animal indicated that at the end of the experiment the cow was in much better condition for the shambles than at the beginning. This is also shown by her generous increase in weight. Her uniformity in weight, save in a few cases where large variations were due to a failure to drink, gave to the live weights their maximum value as a guide to conclusions.

## The Food Fats and Body Fats as Sources of the Milk Fats.

The results of this experiment appear to demonstrate conclusively that food fats bear no necessary relation to the formation of milk fats.

In the ninety-five days that this cow ate rations from which the fats were largely extracted, she produced 62.9 lbs. of milk fat. The quantity of fats in the food during the same time was 11.6 lbs., only 5.7 lbs. of which was digested, leaving 57.2 lbs. of milk fats in excess of the food fat supply. It is very clear that the milk fats were not taken as such from each day's rations. Could they not have come from the body fat already deposited in the animal when the experiment began? This is so highly improbable as to justify a positive negative answer. At the beginning of the ninety-five days the cow weighed 867 lbs. She was quite lean and certainly could have been no fatter than the well-fed ox which Lawes and Gilbert found to contain 7.1 per cent of fat. The total fat in her body could, therefore, scarcely have exceeded 61 lbs., and was probably less. Practically all of this possible maximum would have been required to produce the 57.2 lbs. of milk fat and it is not reasonable to suppose that the cow lost all her body fat when we see that during the period under consideration she gained 47 lbs. in live weight. There could not have been a large increase of flesh, for during 59 days of this period the nitrogen income and outgo were about evenly balanced.

It may be suggested that a change in the water of the body and in the contents of the intestines might cause large variations in body weight, which would obscure a loss of body fat. In this case, however, such a criticism would not be rational. Not only must 57.3 lbs. of fat be replaced by water or an intestinal food residue but an addition to the body weight of 47 lbs. must be accounted for in the same way, a total of 104 lbs. Such a result would have necessitated a very marked condition of emaciation and a noticeably full condition of the intestinal tract, the reverse of which was true. As before stated the cow apparently grew fat steadily during a large part of the experiment. We are therefore impelled to the conclusion that the milk fat which this cow produced while under experimental observation had some other source than either the food fat or the previously stored body fat.

### Did this Milk Fat Come from the Protein or from the Carbohydrates?

In discussing this question we must confine ourselves to the data obtained for the fifty-nine consecutive days during which a record was kept of the income and outgo of both the nitrogen and fat. These data show that in this time 38.8 pounds of fat was found in the milk. If this fat was formed through the metabolism of protein, the most generally accepted theory is that urea would be a product of the chemical changes necessary to produce this result. This view being correct, the production of 38.8 pounds of fat would, according to several theorizers such as Wolff, Henneberg, Voit and Foster, require a minimum of from 75.5 to 95 pounds of protein. As a matter of fact, the nitrogen of the urine during the period under consideration was only 2,417.5 grams, equivalent to 33.3 lbs. of protein, assuming protein to be $N \times 6.25$. Osborne's and Ritthausen's results show that $N \times 6$ is probably more nearly correct, which would give 32 pounds of protein. If we adopt Henneberg's (also Wolff's) fat factor for protein, viz.: 51.4 per cent, which is the highest suggested, 33.3 lbs. of protein would furnish 17.1 lbs. of fat, leaving 21.7 lbs. to be accounted for in some other way. In this fifty-nine days the digested food fat was only 3.3 lbs. and the weight of the cow increased 33 lbs. with the nitrogen balance slightly against her body.

It is noteworthy, moreover, that during twenty consecutive days of the fifty-nine, the daily nitrogen in the cow's urine was equivalent to only 0.4 lb. of protein, while the average daily production of milk fat was 0.58 lb. Granting that none of this protein was metabolized for maintenance purposes, which is unlikely, it is of itself greatly insufficient to account for the milk fat, as it would theoretically be equivalent daily to not over 0.2 lb. of fat.

There is no way of explaining how milk fat could in any way proceed wholly from metabolized protein in this particular case, but by the improbable theory that the protein joins with other compounds in synthetical changes of which we so far have no hint.

Certainly, in this experiment, protein metabolism, as ordinarily understood, can account only for a minor part of the fat secreted in the milk, because without the aid of other compounds protein must form considerably less than its weight of fat. Some nitrogen compound must be split off which would take part of the carbon and hydrogen with it.

The only rational conclusion which these data seem to offer is that the milk fat, as previous experiments have demonstrated to be the case with body fat, was produced, in part at least, from carbohydrates. Such data do not constitute evidence that protein or food fats may not under other conditions be the source of milk fat, but only that in this experiment they were an utterly insufficient source, either directly or indirectly.

### THE STIMULUS OF PROTEIN UPON MILK PRODUCTION.

If further investigations, which are now planned for the immediate future, should ratify the apparent outcome of this one, the explanation of the well-known stimulus of an abundant supply of protein upon milk secretion must rest upon some other basis than that so much protein is necessary as a source of milk building material. It is generally held, from the standpoint of both science and practice, that considerably over two pounds of digestible protein, two and one-half pounds being the amount agreed upon, should be fed in connection with a sufficient supply of carbohydrates (12½ lbs.) to a cow in the full flow of milk, if a maximum food efficiency is to be attained.

Experiments have shown that the food efficiency of a unit of digestible matter is actually augmented by increasing the proportion of protein up to approximately the quantity named, as for instance when oil meal or gluten meal is substituted for a portion of the cereal grains in a ration otherwise made up wholly of home grown foods. Surely if protein takes no necessary part, as our results indicate, in providing raw material for the secretion of milk fat or milk sugar, a large part of this generous protein supply is not needed for constructive purposes.

When fed what is sometimes called the German balanced ration, a cow may sometimes yield thirty pounds of average milk, generally less rather than more. This milk would contain not over one pound of protein, leaving one and a half pounds or three-fifths of that in the ration unused, so far as known, for any necessary constructive purpose. We desire to propose as a rational explanation of the notable influence upon milk secretion of an abundant supply of digestible protein in the ration, that it is due to the influence of protein upon metabolic activity rather than because so much was needed from which to form milk solids. This view would not minimize our estimate of the importance of the nitrogenous constituents of cattle foods, but simply emphasizes more fully one reason, and perhaps the main one, why they should be supplied in such generous proportions.

Certain data from this experiment should be considered in this connection.

It appears that the daily digestible protein in the ration varied in the different periods between 1.85 lbs. as a maximum to 0.41 as a minimum. There was a corresponding, though not so wide, variation in the urea nitrogen, and it is interesting to note the relation between the protein supply, protein metabolism and the secretion of milk solids, as shown both by the figures and by the diagram.

Relation Between Protein Supply, Protein Metabolism and Secretion of Milk Solids.

| Digestible protein eaten daily. | Protein equivalent of urine nitrogen excreted daily. | Gain or loss of body protein daily. | Milk solids secreted daily. | Relation of protein destruction to milk solids secreted. |
|---|---|---|---|---|
| Lbs. | Lbs. | Lbs. | Lbs. | |
| 1.70 | 1.03 | +.03 | 2.72 | 100 : 2.64 |
| 1.42 | .74 | +.06 | 2.28 | 100 : 3.02 |
| 1.85 | .86 | +.41 | 2.22 | 100 : 2.59 |
| .90 | .46 | —.05 | 1.87 | 100 : 4.06 |
| .41 | .40 | —.44 | 1.67 | 100 : 4.19 |
| 1 58 | .61 | +.45 | 1.96 | 100 : 3.21 |

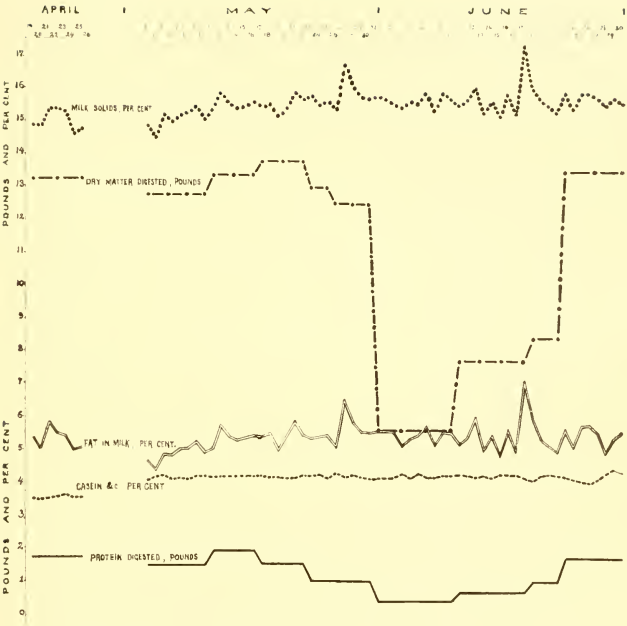


FIG. 19.—RELATION OF FOOD SUPPLY TO QUALITY OF MILK.

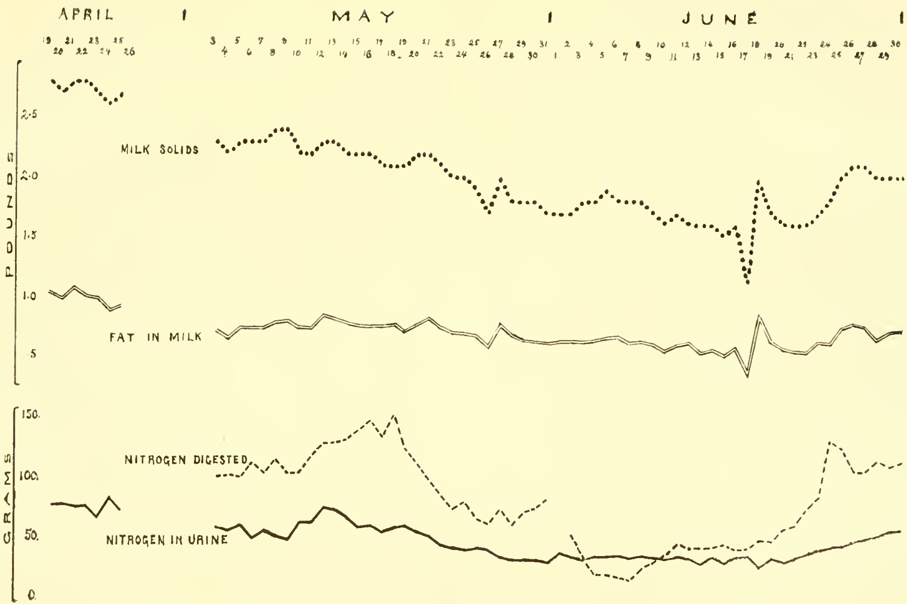


FIG. 20.—RELATION OF PROTEIN SUPPLY AND PROTEIN METABOLISM TO THE PRODUCTION OF MILK SOLIDS.

The extent of protein metabolism seems to be influenced mainly by the protein supply rather than by the quantity of milk solids secreted. When in the first periods the digestible food protein varied between 1.42 and 1.85 lbs. daily and there was an increase of body protein, the milk solids were from two and six-tenths to three times the protein equivalent of the urine nitrogen, but when the available protein in the food fell to 0.41 lbs. daily, so that the animal's needs forced a body loss of 0.44 lbs. of protein daily, the milk solids were four and two-tenths greater than the protein broken down. In view of these figures, it is not easy to avoid the conclusion that in some way the abundant metabolism induced by a generous supply of protein in the ration had a stimulative rather than a constructive (building) function in its relation to milk secretion.

## The Relation Between the Food and Quality of the Milk.

The evidence on this point is incidental to the main purpose of the experiment, but is none the less emphatic.

Changes were made in the rations in three ways: (1) By decreasing the fat in the food from about the usual quantity to practically none; (2) by producing wide variations in the protein supply and nutritive ratio; and (3) by producing wide variations in the supply of total digestible material.

Were there changes in the constitution of the milk corresponding to any or all of the variations in the kind and quantity of the food supply? A careful examination of the accompanying graphic display (Fig. 19) of the amounts and kind of food eaten and of the composition of the milk, during sixty-six days, does not reveal any such relation. To be sure, when the ration was changed from the normal to the extracted foods there was quite a marked drop in the percentage of milk solids, but in a few days the milk recovered its former richness. Neither a deficiency in the protein of the ration nor a depression of the digestible nutrients to about 5.5 lbs. per day caused the cow to produce poorer milk. The only apparent effect was in changing the quantity of product. The percentages of milk solids and fat varied greatly from day to day, usually without definite relation to any known causes. This bit of experience does not establish a law, but is in itself an event worth noting.

### Total Milk Solids and Milk Fat.

In this experiment the variations in milk solids were due almost wholly to changes in the percentages of milk fat. The corresponding rise and fall of the total solids and the fat, and the uniform percentages of nitrogenous compounds are certainly remarkable and are strikingly shown in the diagramatic chart (Fig. 20). This is not a new observation, for it has been noticed repeatedly that the fat of milk is its most variable compound in percentage relations.

# I. DIGESTION AND FEEDING EXPERIMENTS.*

W. H. JORDAN AND C. G. JENTER.

## SUMMARY.

### I. The New Corn Product.

The claim that the removal of the pith from corn stover modifies the composition and increases the digestibility of the remaining portions of the stalk and leaves is not substantiated by investigations at this Station. (*a*) The pith was found to be much like the whole stover in composition. (*b*) In a trial with three sheep, corn stover with the pith was only one-half of one per cent less digestible than similar stover without the pith.

### II. Actual and Calculated Digestibility.

In digestion trials with two fairly elaborate rations quite unlike in origin, the actual digestible matter closely approximated in both cases to the quantities that were calculated by the use of figures from feeding tables representing the average composition and digestion coefficients of similar materials.

### III. Comparative Value of Rations from Unlike Sources.

In an extended feeding trial with two rations in which the compounds that were the source of the digestible carbohydrates were quite dissimilar, the ration containing the less fiber and a nitrogen-free extract richer in starch and sugar showed no superiority over the other. Also by-products such as malt sprouts, brewer's grains and gluten feed were successfully substituted for oats and peas.

## I. THE "NEW CORN PRODUCT."

The cattle feeder is beset on every hand with new feeding stuffs—new in name if not in kind. One of the latest of these is "Marsden's Stock Food," otherwise called "A New Corn Product."



*Reprint of Bulletin No. 141.

This is a finely ground product, a refuse from the utilization of the pith of the stalk. The leaves are stripped from the stalk, the pith is removed, and the remaining portion, or the outside of the stalk, is ground into meal.

The attention of the writer was called to this food so long ago as December, 1896, through an inquiry from a correspondent of the *New York Tribune*, and in response to a request from the Agricultural Editor of that paper, the following statement was made:

"Meal which is made by grinding dry corn stalks has entirely the same food properties as the corn stalks themselves, the only possible advantage being that the animals are saved from chewing them; and also because of its fineness the meal may possibly be a little more digestible than the stover. There is no real merit in this meal which gives it any superiority over hay, corn stover or silage in so far as these latter materials are eaten and thoroughly masticated."

Since the above statement was made, this new product has received considerable attention, notably by two bulletins from the Maryland Agricultural Experiment Station* and by an article in the *Country Gentleman*† from Hon. Edward Atkinson.

The important general conclusions which Patterson draws from the Maryland Experiment Station work are that (1) the "New Corn Product" is more digestible than corn stover even if finely ground, and that (2) this product may be successfully substituted for other rough fodders and hay in a fattening ration and in feeding horses. Patterson's discussion of his data leans to the view that the presence of the pith actually depresses the digestibility of the other parts of the stover, and he offers as a reason for this the wholly hypothetical explanation that the pith so freely absorbs the digestive juices as to leave a quantity insufficient to act efficiently upon the other portions of the plant.

Atkinson discusses this new food from the economic side, but bases much of his reasoning upon what he seems to regard as two established facts, viz.: that the pith of the corn stalk is practi-

*Nos. 43 and 51.

†Issue December 16, 1897.

cally pure cellulose and that its presence depresses the digestibility of the other portions of the plant by absorbing "the saliva and the gastric juices, thus clogging the intestines ———."

All that has been said in regard to the great saving that would result from a complete utilization of the entire corn product, grain and stover, can be entirely accepted by every person well informed in cattle food matters.

The supreme importance of maize in animal husbandry and the availability and high food quality of every portion of the plant when properly harvested do not need to be established by further investigation. These are now facts of common knowledge among well-informed farmers.

Any process, therefore, which tends to a completer utilization of maize stover should be heartily welcomed. It is the opinion of the writer, however, that whatever benefit may accrue to agriculture from the Marsden process, in so far as it touches cattle feeding, will come wholly from the saving in a useful form of a valuable food material which is now largely wasted. No conclusive evidence seems to be yet secured that this "New Corn Product" possesses unusual food properties, or those which differ in any way from well cured, well prepared corn stover.

There are serious doubts whether the corn pith is so greatly unlike the remainder of the plant that its removal materially modifies the composition or digestibility of the portion that is left, and the hypothesis that this pith retards or prevents digestion by absorbing and holding the gastric juice (to say nothing of the intestinal juices) is so far too nearly guesswork to have much weight, and may be as far from the truth as the assumption that the pith is "pure" cellulose. The chances are that the "New Corn Product" is nothing more or less than *ground corn stalks* in all the essentials that pertain to digestibility and to food function or value.

This question is of sufficient importance, however, to make it desirable to secure evidence concerning the points under discussion, and for this reason this Experiment Station has been investigating the matter somewhat.

## THE EXPERIMENTS AT THIS STATION.

In order to show that the removal of the pith from maize stover is beneficial from a food standpoint it must be demonstrated that the pith either contains compounds directly injurious to the animal or that in its absence the remaining portions of the plant are more fully utilized than would otherwise be the case.

Certainly the compounds in the outside stalk and leaves are not in any way changed by the presence or absence of the pith. This investigation was directed to two points, therefore, viz.: (1) the composition of maize pith as compared with the rest of the plant, and (2) the effect of removing the pith upon the digestibility of the leaves and remainder of the stalk.

## THE RELATION IN WEIGHT OF DIFFERENT PARTS OF MAIZE STOVER.

About 200 lbs. of well-cured, bright corn stover, all of which came from the same lot of corn, was selected for the experiment. The leaves and husks were first stripped from one-half of each bundle and then by the use of instruments specially made for the purpose the pith was removed from the stalks.

The following are the weights of the several parts in the air dry condition:

WEIGHTS AND PROPORTION OF PARTS OF CORN STOVER.

| | Weight. | | Proportion. |
|---|---|---|---|
| | Grams. | Pounds. | Per cent. |
| Leaves and husks | 25,021 | 55.0 | 65.2 |
| Stalks minus pith | 9,046 | 20.7 | 24.5 |
| Pith | 3,948 | 8.7 | 10.3 |

It appears that the pith constituted about one-tenth of this lot of maize stover.

## THE COMPOSITION OF THE STOVER AND ITS VARIOUS PARTS.

The whole stover from one-half the bundles, and the separate parts of the dissected stover were finely ground in an iron mill and from the thoroughly mixed materials samples were selected for analysis.

The composition of the whole stover, the stover without the pith and the pith are given below.

COMPOSITION OF CORN STOVER.

| | Water. | Ash. | Protein. | Fiber. | Nitrogen-free extract. | Fat. |
|---|---|---|---|---|---|---|
| | AIR-DRY MATERIALS. | | | | | |
| | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| Whole stover | 19.81 | 4.55 | 4.19 | 26.02 | 42.87 | 2.56 |
| Stover without pith | 12.21 | 4.58 | 4.60 | 28.55 | 47.35 | 2.71 |
| Pith | 13.27 | 3.92 | 3.02 | 29.15 | 45.77 | 4.87 |
| | WATER FREE MATERIALS. | | | | | |
| Whole stover | ...... | 5.68 | 5.22 | 32.45 | 53.46 | 3.19 |
| Stover without pith | ...... | 5.22 | 5.24 | 32.52 | 53.93 | 3.09 |
| Pith | ...... | 4.52 | 3.48 | 33.61 | 52.77 | 5.62 |

It is clearly shown by these analyses that the pith of this particular lot of stover, at least, did not differ in composition to a remarkable degree from the remaining portion of the plant. It contained about two-thirds as much nitrogenous material and nearly twice as much ether extract, the proportions of fiber (crude cellulose) and nitrogen-free extract, which together make up the greater part of the stover, being very nearly the same as in the other nine-tenths of the plant. This pith, instead of being nearly pure cellulose, is at least two-thirds something else, and there is no reason for supposing that the pith of other lots of maize would be essentially unlike this sample.

It is interesting to know something of the character of the nitrogen-free extract in maize pith, as compared with the other tissue of the stover. Do the leaves and outside portion of the stalk contain a larger proportion of sugars and starch and less of those compounds concerning whose nutritive value we are less definitely informed? Actual determinations answer this question in the negative, so far as one lot of stover is concerned.

NITROGEN FREE EXTRACT IN CORN STOVER.

| Laboratory number. | | Calculated as Dextrose. Soluble in water. | Soluble in malt extract. | Total. |
|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent. |
| 58 | Maize stover, whole | .82 | .21 | 1.03 |
| 59 | Maize stover, without pith | .61 | .29 | .90 |
| 60 | Pith of maize stover | 1.37 | .11 | 1.48 |

This analysis of maize pith does not furnish any reason why its removal from the stover should be favorable to increased digestibility, or why the pith itself should not be nearly as digestible as the remainder of the stalk, leaves and husks.

### THE COMPARATIVE DIGESTIBILITY OF MAIZE STOVER WITH AND WITHOUT THE PITH.

It was deemed essential that in order to get reliable evidence on this point the materials compared should be entirely alike in origin and treatment. The well known variations in digestibility caused with coarse fodders by the conditions of growth, the period of harvesting and the manner of curing, demand that this problem shall be studied with the use of stover from a single lot of corn, harvested at the same time and cured in the same manner. The lot of stover used satisfied all these requirements.

As before stated, the pith was removed from one-half of each bundle of stover, the other half remaining in its ordinary condition. These materials were ground in an iron feed mill, not to so fine a condition as is the case with the New Corn Product but sufficiently so to allow very thorough mixing and sampling.

Four young healthy wethers were selected for the digestion experiment. They were fed 600 grams of material daily. The preliminary period of feeding occupied eight days and the feces were collected during five days.

The composition of the stover has already been given and the other essential data are shown in the tables which follow.

COMPOSITION OF THE FECES FROM THE STOVER.

| Lab. number. | SAMPLE. | AIR DRY. | | | | | |
|---|---|---|---|---|---|---|---|
| | | Water. | Ash. | Protein. | Fiber. | Nitrogen-free extract. | Ether extract. |
| | *First Period.* | Per cent. | Per ct. | Per cent. | Per cent. | Per cent. | Per cent. |
| 51 | Feces from sheep No. 1. | 4.96 | 10.80 | 9.62 | 24.62 | 47.96 | 2.04 |
| 52 | Feces from sheep No. 2. | 5.08 | 12.15 | 9.06 | 24.77 | 47.43 | 1.51 |
| 53 | Feces from sheep No. 3. | 4.98 | 12.14 | 8.75 | 23.60 | 48.87 | 1.66 |
| 54 | Feces from sheep No. 4. | 5.20 | 11.88 | 9.00 | 23.67 | 48.58 | 1.67 |
| | *Second Period.* | | | | | | |
| 55 | Feces from sheep No. 1. | 5.09 | 8.35 | 8.94 | 26.85 | 48.86 | 1.91 |
| 56 | Feces from sheep No. 3. | 5.22 | 9.28 | 7.94 | 25.31 | 50.64 | 1.61 |
| 57 | Feces from sheep No. 4. | 5.49 | 9.71 | 9.50 | 24.52 | 48.82 | 1.96 |

## Digestibility of Corn Stover.

| | Dry matter. | Ash. | Organic substance. | Protein. | Fiber. | Nitrogen-free extract. | Fat. |
|---|---|---|---|---|---|---|---|
| *Sheep No. 1.* | Grams. | Grams | Grams. | Grams. | Grams | Grams. | Grams. |
| Amount fed in 5 days, 3,000 grams* | 2,405.7 | 136.5 | 2,269.2 | 125.7 | 780.5 | 1,286.2 | 76.8 |
| Amount excreted in 5 days | 1,109.1 | 126.0 | 983.1 | 112.3 | 287.3 | 559.7 | 23.8 |
| Amount digested | 1,296.6 | 10.5 | 1,286.1 | 13.4 | 493.2 | 726.5 | 53.0 |
| Per cent digested | 53.9 | 7.7 | 56.7 | 10.7 | 63.2 | 56.5 | 69.0 |
| *Sheep No. 2.* | | | | | | | |
| Amount fed in 5 days, 3,000 grams | 2,405.7 | 136.5 | 2,269.2 | 125.7 | 780.5 | 1,286.2 | 76.8 |
| Amount excreted in 5 days | 1,091.6 | 139.7 | 951.9 | 104.2 | 284.9 | 545.4 | 17.4 |
| Amount digested | 1,314.1 | ........ | 1,317.3 | 21.5 | 495.6 | 740.8 | 59.4 |
| Per cent digested | 54.6 | ........ | 58.1 | 17.1 | 63.5 | 57.6 | 77.4 |
| *Sheep No. 3.* | | | | | | | |
| Amount fed in 5 days, 3,000 grams | 2,405.7 | 136.5 | 2,269.2 | 125.7 | 780.5 | 1,286.2 | 76.8 |
| Amount excreted in 5 days | 1,137.4 | 145.3 | 992.1 | 104.7 | 282.5 | 585.1 | 19.8 |
| Amount digested | 1,268.3 | ........ | 1,277.1 | 21.0 | 498.0 | 701.1 | 57.0 |
| Per cent digested | 52.7 | ........ | 56.3 | 16.7 | 63.8 | 54.5 | 74.2 |
| *Sheep No. 4.* | | | | | | | |
| Amount fed in 5 days, 3,000 grams | 2,405.7 | 136.5 | 2,269.2 | 125.7 | 780.5 | 1,286.2 | 76.8 |
| Amount excreted in 5 days | 1,133.3 | 129.5 | 1,003.8 | 98.1 | 258.0 | 529.5 | 18.2 |
| Amount digested | 1,272.4 | 7.0 | 1,265.4 | 27.6 | 522.5 | 756.7 | 58.6 |
| Per cent digested | 52.9 | 5.1 | 55.8 | 22.0 | 66.9 | 58.8 | 76.3 |
| Per cent digested, averaging 4 sheep | 53.5 | ........ | 56.7 | 16.6 | 64.3 | 56.8 | 76.2 |

* Composition given in table on page 527.

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DIGESTIBILITY OF CORN STOVER WITHOUT PITH.

| | Dry matter. | Ash. | Organic matter. | Protein. | Fiber. | Nitrogen-free extract. | Fat. |
|---|---|---|---|---|---|---|---|
| *Sheep No. 1.* | Grams. | Grams. | Grams. | Grams. | Grams. | Grams | Grams. |
| Amount fed in 5 days, 3,000 grams | 2633.7 | 137.4 | 2496.4 | 138 | 856.5 | 1420.5 | 81 3 |
| Amount excreted in 5 days | 1222.4 | 107.5 | 114.9 | 115.2 | 345.8 | 629.3 | 24.6 |
| Amount digested | 1411.3 | 29.9 | 1381.4 | 22.8 | 510.7 | 791.2 | 56.7 |
| Per cent digested | 53.6 | 21.8 | 55.3 | 16.5 | 59.6 | 55.7 | 69.8 |
| *Sheep No. 3.* | | | | | | | |
| Amount fed in 5 days, 3,000 grams | 2633.7 | 137.4 | 2496.3 | 138 | 856.5 | 1420.5 | 81.3 |
| Amount excreted in 5 days | 1183.8 | 115 9 | 1067.9 | 99.2 | 316.1 | 632.5 | 20.1 |
| Amount digested | 1449.9 | 21.5 | 1428.4 | 38.8 | 540.4 | 788 | 61.2 |
| Per cent digested | 55.1 | 15.6 | 57.2 | 28.1 | 63.1 | 55.5 | 75.3 |
| *Sheep No. 4.* | | | | | | | |
| Amount fed in 5 days, 3,000 grams | 2633.7 | 137.4 | 2496.3 | 138 | 856.5 | 1420.5 | 81.3 |
| Amount excreted in 5 days | 1140.7 | 117.2 | 1023.5 | 114.7 | 295.9 | 589.2 | 23.7 |
| Amount digested | 1,493 | 20.2 | 1472.8 | 23.3 | 560.6 | 831.3 | 57.6 |
| Per cent digested | 56.7 | 14.7 | 59 | 16.9 | 65.5 | 58.5 | 70.9 |
| Per cent digested, average 3 sheep | 55.1 | ........ | 57.2 | 20.5 | 62.7 | 56.6 | 72 |

The comparative digestibility of the stover with and without the pith is more readily seen by bringing together the coefficients showing the average results.

DIGESTIBILITY OF CORN STOVER.

| | Dry matter. | Organic matter. | Protein. | Fiber. | Nitrogen-free extract. | Fat. |
|---|---|---|---|---|---|---|
| | Per cent | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| Stover with pith ........ | 53.5 | 56.7 | 16.6 | 64.3 | 56.8 | 76.2 |
| Stover without pith ..... | 55.1 | 57.2 | 20.5 | 62.7 | 56.6 | 72 |

We do not have here any evidence that the removal of the pith of the maize plant materially increases the food value of the remaining portion. One sheep digested more from the stover containing the pith and two digested less, the average being not greatly different in the two cases.

The real test of the digestibility of a feeding stuff is the digestibility of the organic matter, because in the case of such materials as corn stover the *accidental* mineral matter is a modifying factor. One-half of one per cent more of organic matter was digested from the stover without pith than from that with pith, a difference so small as to be well within the limits of error of such work.

It is fair to observe that in Patterson's trials the stover and ground products had a similar origin only in one instance, and that in ascertaining the digestibility of the whole stover like that from which the New Corn Product was made, the coefficients obtained for dry matter differed 8.5 per cent with the two animals used, a fact which detracts somewhat from the value of the data.

## II. THE CALCULATION OF THE VALUE OF RATIONS.

During the past fifteen or twenty years farmers have had their attention directed to the so-called feeding standards, which they have been urged to follow more or less closely in making up rations for various purposes. In order to ascertain whether any given ration approximates to a desired standard it is necessary to determine the amounts and proportions of digestible nutrients which the proposed mixture of foods contains. A knowledge of the exact composition and digestibility of the feeding stuffs to be used is not possible, usually, certainly not in ordinary practice, and the computation of the amounts of digestible compounds must be based upon the average composition and digestibility of similar materials. It is assumed that figures reached in this way are sufficiently accurate for all practical purposes.

The compounding of rations from a variety of foods to correspond to certain standards, as usually done, involves another assumption, viz.: That a pound of digestible material, carbohydrates for instance, has a uniform value no matter what its source.

Probably well-informed agricultural chemists do not assent to this statement, and doubtless they are agreed that this assumption is possibly an element of weakness in the effort to compound equivalent rations from greatly different mixtures of feeding stuffs.

Much of the doubt on this point pertains to the nitrogen-free extract. Great uncertainty exists as to the relative nutritive value of the sugars, starches, pentosans, cellulose and other compounds, some of which belong to the hexose group, others to the pentose, etc. We do know, however, that there is a marked variation in the proportions in which these carbohydrates and other compounds are found in the nitrogen-free extract of feeding stuffs, especially when the coarse fodders are compared with the cereal grains.

Moreover, the protein of cattle foods is a collective name for a mixture of nitrogenous compounds and there is good reason for believing that $N \times 6.25$ does not always represent the same nutritive value, as for instance in roots, in green crops and in the oil meals.

It is proper to inquire, therefore, to what extent these possible variations of composition and food values of different compounds of the same class may cause actual differences in the relative efficiency of two rations combined from unlike foods, but similar in amount of digestible material and nutritive ratio when calculated on the basis of average composition and digestibility.

The writer is not aware that any comparison has so far been made of the *calculated* and the *actual* digestibility of rations, nor between the nutritive effect of the two rations with especial reference to the points which are discussed in this connection.

## THE CALCULATED AND THE ACTUAL DIGESTIBILITY OF TWO RATIONS.

Two rations quite unlike in origin were selected for an experiment by this Station. In one the proportion of timothy hay was large and the grains were entirely by-products. In the other corn silage was freely used and the grains were entirely ground oats and ground peas. The hay, silage and oats were home grown and the other materials were of the usual commercial grade. Without knowing the composition of these feeding stuffs, the digestible nutrients they would supply were calculated from the averages of feeding tables.

AVERAGE COMPOSITION AND DIGESTIBILITY OF CERTAIN FEEDING STUFFS.

| | Water. | Ash. | Protein. | Fiber. | Nitrogen-free extract. | Fat. | Digestion Coefficients.† | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Protein. | Fiber | Nitrogen-free extract. | Fat. |
| | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | | | | |
| Timothy hay* | 13.2 | 4.4 | 5.9 | 29 | 45 | 2.5 | 49 | 53 | 63 | 57 |
| Corn silage‡ | 73.6 | 2.1 | 2 7 | 7.8 | 12.9 | .9 | 55 | 66 | 69 | 72 |
| Oats* | 11 | 3 | 11.8 | 9.5 | 59.7 | 5 | 78 | 26 | 77 | 83 |
| Peas* | 10.5 | 2.6 | 20.2 | 14.4 | 51.1 | 1.2 | 83 | 26 | 94 | 54 |
| Malt sprouts* | 10.2 | 5.7 | 23.2 | 10.7 | 48.5 | 1.7 | 80 | 33 | 68 | 100 |
| Brewer's grains* | 8.2 | 3.6 | 19.9 | 11 | 51.7 | 5.6 | 79 | 53 | 59 | 91 |
| Buffalo gluten meal§ | 8.2 | .9 | 23.2 | 6.8 | 49.4 | 11.5 | 85 | 43 | 81 | 81 |

* Jenkins & Winton. † American excepting those for oats. ‡ Wisconsin analyses.
§ Rep. Mass. Station, Jan., 1897.

The calculated digestible nutrients in two rations, based upon the foregoing figures would be as follows:

DIGESTIBLE NUTRIENTS IN CONTRASTED RATIONS.

| | Protein. | Carbohydrates. | Fats. |
|---|---|---|---|
| *Ration 1.* | | | |
| | Lbs. | Lbs. | Lbs. |
| Five pounds timothy hay | 0.14 | 2.18 | 0.07 |
| Forty pounds corn silage | .60 | 5.60 | .26 |
| Five pounds ground oats | .46 | 2.43 | .20 |
| Six pounds ground peas | 1.01 | 3.10 | .04 |
| Total 16.1 pounds | 2.21 | 13.31 | .57 |
| *Ration 2.* | | | |
| Fifteen pounds timothy hay | 0.43 | 6.55 | 0.21 |
| Twenty-five pounds corn silage | .38 | 3.50 | .16 |
| Two pounds malt sprouts | .37 | .73 | .03 |
| Three pounds brewer's grains | .47 | 1.03 | .15 |
| Three pounds Buffalo gluten feed | .59 | 1.29 | .28 |
| Total 16.2 pounds | 2.24 | 13.10 | .83 |

In the succeeding table is stated the actual composition of the feeding stuffs used in this comparison.

COMPOSITION OF FEEDING STUFFS.

| Station number. | | Water. | Ash. | Protein. | Fiber. | Nitrogen-free extract. | Fats. |
|---|---|---|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent | Per cent. | Per cent. | Per cent. |
| 17 | Timothy hay | 12.63 | 4.09 | 5.49 | 29.18 | 45.33 | 3.28 |
| 45 | Corn silage | 75.27 | 1.25 | 2.27 | 5.34 | 14.04 | 1.83 |
| 46 | Corn silage | 75.85 | 1.23 | 1.99 | 5.80 | 13.31 | 1.82 |
| 47 | Corn silage | 77.20 | 1.13 | 1.81 | 5.73 | 12.21 | 1.92 |
| 48 | Corn silage | 77.32 | 1.02 | 1.82 | 5.39 | 12.62 | 1.83 |
| 49 | Corn silage | 76.97 | 1.04 | 1.81 | 5.54 | 12.73 | 1.91 |
| 20 | Oats | 10.57 | 2.95 | 12.48 | 10.54 | 58.37 | 5.09 |
| 50 | Oats | 10.48 | 2.57 | 13.06 | 9.79 | 59.10 | 5.00 |
| 21 | Peas | 11.35 | 2.59 | 23.39 | 5.20 | 56.26 | 1.21 |
| 16 | Malt sprouts | 9.58 | 5.34 | 26.18 | 11.05 | 44.52 | 3.33 |
| 18 | Brewer's grains | 7.68 | 2.82 | 27.59 | 13.01 | 40.46 | 8.44 |
| 19 | Buffalo gluten feed | 10.29 | 3.29 | 24.95 | 5.28 | 52.97 | 3.22 |

A digestion experiment with two mixtures of foods similar in kind and proportions to the rations previously given was carried on with four sheep.

CONSTITUENTS AND AMOUNTS OF RATIONS COMPARED.

| | Period 1. | | Period 2. | |
|---|---|---|---|---|
| | Full ration No. 1. Sheep 1 and 2. | Half ration No. 2. Sheep 3 and 4. | Full ration No. 2. Sheep 1 and 2. | Half ration No. 1. Sheep 3 and 4 |
| | Grams. | Grams. | Grams. | Grams. |
| Timothy hay | 100 | 150 | 300 | 50 |
| Corn silage | 800 | 250 | 500 | 400 |
| Oats, ground | 100 | .......... | .......... | 50 |
| Peas, ground | 120 | .......... | .......... | 60 |
| Malt sprouts | .......... | 20 | 40 | .......... |
| Brewer's grains | .......... | 30 | 60 | .......... |
| Buffalo gluten feed | .......... | 30 | 60 | .......... |

COMPOSITION OF FECES.

| Laboratory number. | SAMPLES. | Air Dry. | | | | | |
|---|---|---|---|---|---|---|---|
| | | Water. | Ash. | Protein. | Fiber. | Ether extract. | Nitrogen free extract. |
| | *First Period.* | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. |
| 37 | Feces from sheep No. 1 | 4.26 | 10.48 | 10 | 25.62 | 3.40 | 46.24 |
| 38 | Feces from sheep No. 2 | 4.24 | 10.83 | 12.56 | 23.66 | 3.33 | 45.38 |
| 39 | Feces from sheep No. 3 | 4.19 | 9.74 | 12.31 | 22.90 | 3.70 | 47.16 |
| 40 | Feces from sheep No. 4 | 4.15 | 11.75 | 11.50 | 24.96 | 3.32 | 44.32 |
| | *Second Period.* | | | | | | |
| 41 | Feces from sheep No. 1 | 4.55 | 10.92 | 11.94 | 24.91 | 3.44 | 44.24 |
| 42 | Feces from sheep No. 2 | 4.60 | 10.77 | 11.75 | 24.90 | 3.03 | 44.95 |
| 43 | Feces from sheep No. 3 | 4.21 | 9.31 | 11.32 | 25.41 | 3.58 | 46.17 |
| 44 | Feces from sheep No. 4 | 4.08 | 10.32 | 10.06 | 27.48 | 3.52 | 44.54 |

DIGESTIBILITY OF RATIONS — PERIOD I.

| Laboratory number. | RATION No. 1. | Amount fed. | Dry matter. | Ash. | Organic substance. | Protein. | Fiber. | Nitrogen-free extract. | Fat. |
|---|---|---|---|---|---|---|---|---|---|
| | *Sheep No. 1.* | Grams. | Grams. | Grams | Grams. | Grams. | Grams. | Grams. | Grams. |
| 17 | Timothy hay fed in 5 days | 500 | 436.8 | 20.4 | 416.4 | 27.5 | 145.9 | 226 6 | 16.4 |
| 47–48 | Silage fed in 5 days | 4,000 | 909.6 | 42.8 | 866.8 | 72.8 | 222.4 | 496.8 | 74.8 |
| 20 | Oat meal fed in 5 days | 500 | 447.1 | 14.7 | 432.4 | 62.4 | 52.7 | 291.9 | 25.4 |
| 21 | Pea meal fed in 5 days | 600 | 531.9 | 15.5 | 516.4 | 140.3 | 31.2 | 337.6 | 7.3 |
| | Total fed in 5 days | ........ | 2,325.4 | 93.4 | 2,232 | 303 | 452.2 | 1,352.9 | 123.9 |
| 41 | Amount excreted in 5 days* | 744 | 710.1 | 81.2 | 628.9 | 88.8 | 185.3 | 329.2 | 25.6 |
| | Amount digested | ........ | 1,615.3 | 12.2 | 1,603.1 | 214.2 | 266.9 | 1,023.7 | 98.3 |
| | Per cent digested | ........ | 69.5 | 13.1 | 71.8 | 70.7 | 59 | 75.7 | 79.3 |
| | *Sheep No. 2.* | | | | | | | | |
| | Total fed in 5 days | ........ | 2,325.4 | 93.4 | 2,232 | 303 | 452.2 | 1,352.9 | 123.9 |
| 42 | Amount excreted in 5 days* | 747.5 | 713.1 | 80.5 | 632.6 | 87.8 | 186.1 | 336.1 | 22.6 |
| | Amount digested | ........ | 1,612.3 | 12.9 | 1,599.4 | 215.2 | 266.1 | 1,016.8 | 101.3 |
| | Per cent digested | ........ | 69.3 | 13.8 | 71.7 | 71 | 58.9 | 75.2 | 81.8 |

* Air dry.

Digestibility of Rations.—Period I.—(*Concluded*).

| Laboratory number. | RATION No. 2. | Amount fed. | Dry matter. | Ash. | Organic substance. | Protein. | Fiber. | Nitrogen-free extract. | Fat. |
|---|---|---|---|---|---|---|---|---|---|
| | *Sheep No. 3.* | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. |
| 17 | Timothy hay fed in 5 days | 750 | 655.3 | 30.7 | 624.6 | 41.2 | 218.8 | 340 | 24 6 |
| 48–49 | Silage fed in 5 days | 1,250 | 285.7 | 12.9 | 272.8 | 22.7 | 68.2 | 158.5 | 23.4 |
| 16 | Malt sprouts fed in 5 days | 100 | 90.4 | 5.3 | 85.1 | 26.2 | 11.1 | 44.5 | 3.3 |
| 18 | Brewer's grains fed in 5 days | 150 | 138.5 | 4.2 | 134.3 | 41.4 | 19.5 | 60.7 | 12.7 |
| 19 | Gluten feed fed in 5 days | 150 | 134.5 | 4.9 | 129.6 | 37.4 | 7.9 | 79.5 | 4.8 |
| | Total fed in 5 days | | 1,304.4 | 58 | 1,246.4 | 168.9 | 325.5 | 683.2 | 68.8 |
| 43 | Amount excreted in 5 days* | 451.5 | 432.5 | 42 | 390.5 | 51.1 | 114.7 | 208.5 | 16.2 |
| | Amount digested | | 871.9 | 16 | 855.9 | 117 8 | 210.8 | 474.7 | 52.6 |
| | Per cent digested | | 66.9 | 27.6 | 68.7 | 69.8 | 64.8 | 69.5 | 76.5 |
| | *Sheep No. 4.* | | | | | | | | |
| | Total fed in 5 days | | 1,304.4 | 58 | 1,246.4 | 168.9 | 325.5 | 683.2 | 68.8 |
| 44 | Amount excreted in 5 days* | 475 | 455.6 | 49 | 406.6 | 47.8 | 130.5 | 211.6 | 16.7 |
| | Amount digested | | 848.8 | 9 | 839.8 | 121.1 | 195 | 471.6 | 52.1 |
| | Per cent digested | | 65.1 | 15.5 | 67.4 | 71.7 | 59.9 | 69 | 75.7 |

* Air dry.

DIGESTIBILITY OF RATIONS.—PERIOD I.

| Labratory number. | RATION No. 2. | Amount fed. | Dry matter | Ash. | Organic substance. | Protein. | Fiber. | Nitrogen-free extract. | Fat. |
|---|---|---|---|---|---|---|---|---|---|
| | *Sheep No. 1.* | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. |
| 17 | Timothy hay fed in 5 days | 1,500 | 1,310.5 | 61.4 | 1,249.1 | 82.3 | 437.7 | 679.9 | 49.2 |
| 45–46 | Silage fed in 5 days | 2,500 | 611 | 31 | 580 | 53.2 | 139.2 | 342.1 | 45.5 |
| 16 | Malt sprouts fed in 5 days | 200 | 180.8 | 10.7 | 170.1 | 52.3 | 22.1 | 89 | 6.7 |
| 18 | Brewer's grains fed in 5 days | 300 | 277 | 8.5 | 268.5 | 82.8 | 39 | 121.4 | 25.3 |
| 19 | Gluten feed fed in 5 days | 300 | 269.1 | 9.9 | 259.2 | 74.8 | 15.8 | 158.9 | 9.7 |
| | Total fed in 5 days | ........ | 2,648.4 | 121.5 | 2,526.9 | 345.4 | 653.8 | 1,391.3 | 136.4 |
| 37 | Amount excreted* | 1,047 | 1,002.4 | 109.7 | 892.7 | 104.7 | 268.2 | 484.2 | 35.6 |
| | Amount digested | ........ | 1,646 | 11.8 | 1,634.2 | 240.7 | 385.6 | 907.1 | 100.8 |
| | Per cent digested | ........ | 62.2 | 9.7 | 64.7 | 69.7 | 59 | 65.2 | 73.9 |
| | *Sheep No. 2.* | | | | | | | | |
| | Total fed in 5 days | ........ | 2,648.4 | 121.5 | 2,526.9 | 345.4 | 653.8 | 1,391.3 | 136.4 |
| 38 | Amount excreted in 5 days* | 1,076 | 1,030.3 | 116.5 | 913.8 | 135.1 | 254.6 | 488.3 | 35.8 |
| | Amount digested | ........ | 1,618.1 | 5 | 1,613.1 | 210.3 | 399.2 | 903 | 100.6 |
| | Per cent digested | ........ | 61.1 | 4.1 | 63.8 | 60.9 | 61.1 | 64.9 | 73.8 |

* Air dry.

DIGESTIBILITY OF RATIONS. — PERIOD I. — (*Concluded*).

| Laboratory number. | RATION No. 1. | Amount fed. | Dry matter. | Ash. | Organic substance. | Protein. | Fiber. | Nitrogen-free extract | Fat. |
|---|---|---|---|---|---|---|---|---|---|
| | *Sheep No.* 3. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. | Grams. |
| 17 | Timothy hay fed in 5 days | 250 | 218.4 | 10.2 | 208.2 | 13.7 | 72.9 | 113.4 | 8.2 |
| 46–47 | Silage fed in 5 days | 2,000 | 469.6 | 23.6 | 446 | 38 | 115.4 | 255.2 | 37 4 |
| 20 | Oat meal fed in 5 days | 250 | 223.6 | 7.4 | 216.2 | 31.2 | 26.4 | 145.9 | 12.7 |
| 21 | Pea meal fed in 5 days | 300 | 265.9 | 7.8 | 258.1 | 70.2 | 15.6 | 168.7 | 3.6 |
| | Total fed in 5 days | ........ | 1,177.5 | 49 | 1,128.5 | 153 1 | 230.3 | 683.2 | 61.9 |
| 39 | Amount excreted* | 299 | 286.5 | 29.1 | 257.4 | 36.8 | 68.5 | 141 | 11.1 |
| | Amount digested | ........ | 891 | 19.9 | 871.1 | 116.3 | 161.8 | 542.2 | 50.8 |
| | Per cent digested | ........ | 75.7 | 40.6 | 77.2 | 76 | 70.3 | 79.4 | 82.1 |
| | *Sheep No.* 4. | | | | | | | | |
| | Total fed in 5 days | ........ | 1,177.5 | 49 | 1,128.5 | 153.1 | 230.3 | 683.2 | 61.9 |
| 40 | Amount excreted in 5 days* | 330.5 | 316.8 | 38.8 | 278 | 38 | 82.5 | 146.5 | 11 |
| | Amount digested | ........ | 860.7 | 10.2 | 850.5 | 115.1 | 147.8 | 536.7 | 50.9 |
| | Per cent digested | ........ | 73.1 | 20.8 | 75.4 | 75.2 | 64.2 | 78.6 | 82.2 |

* Air dry.

These coefficients can be more easily seen by bringing them together as averages.

AVERAGE DIGESTIBILITY OF RATIONS.

| | Dry matter. | Ash. | Organic matter. | Protein. | Fiber. | Nitrogen-free extract | Fat. |
|---|---|---|---|---|---|---|---|
| | Per ct. | Per ct. | Per ct | Per ct. | Per ct. | Per ct. | Per ct. |
| Ration 1. Full amount | 69.4 | 13.4 | 71.7 | 70.8 | 59 | 75.4 | 80.5 |
| Ration 1. Half amount | 74.4 | 30.7 | 76.4 | 75.6 | 67.2 | 79 | 82.1 |
| Ration 2. Full amount | 61.6 | 7.9 | 64.2 | 65.3 | 60 | 65 | 73.8 |
| Ration 2. Half amount | 66 | 21.5 | 68 | 70.7 | 62.3 | 69.2 | 76.1 |

THE DIGESTIBLE NUTRIENTS IN THE TWO RATIONS BASED UPON ACTUAL FEEDING TRIALS.

| | TOTALS IN THE FEEDING STUFFS. | | | | |
|---|---|---|---|---|---|
| | Organic matter. | Protein. | Fiber. | Nitrogen-free extract. | Fat. |
| *Ration* 1. | Pounds. | Pounds. | Pounds. | Pounds. | Pounds. |
| 5 pounds timothy hay | 4.16 | 0.27 | 1.46 | 2.27 | 0.16 |
| 40 pounds corn silage | 8.67 | .73 | 2.22 | 4.97 | .75 |
| 5 pounds oats, ground | 4.32 | .62 | .53 | 2 92 | .25 |
| 6 pounds peas, ground | 5.16 | 1.40 | .31 | 3.88 | .07 |
| Totals | 22.31 | 3.02 | 4.52 | 13.54 | 1.23 |
| Coefficients of degestibility * | 71.7 | 70 8 | 59 | 75.4 | 80.5 |
| Actually digested | 16 | 2.14 | 2.67 | 10.20 | .99 |
| *Ration* 2. | | | | | |
| 15 pounds timothy hay | 12.49 | 0.82 | 4.38 | 6.80 | 0.49 |
| 25 pounds corn silage | 5.80 | .53 | 1.39 | 3.42 | .46 |
| 2 pounds malt sprouts | 1.70 | .52 | .32 | .89 | .07 |
| 3 pounds brewer's grains | 2.68 | .83 | .39 | 1.21 | .25 |
| 3 pounds Buffalo gluten feed | 2.59 | .75 | .15 | 1.59 | .10 |
| Totals | 25.26 | 3.45 | 6.53 | 13.91 | 1.37 |
| Coefficients of digestibility * | 64.2 | 65.3 | 60 | 65 | 73.8 |
| Actually digested | 16.22 | 2.25 | 3.92 | 9.04 | 1.01 |

* Those from the "full amount."

It is now possible to compare the calculated and actual digestibility of the two rations. The first step necessary is to apply the coefficients which are found by experiments with these mixtures of foods, to the quantities of dry matter and of the several classes of ingredients actually contained in the proposed rations.

DIGESTIBLE NUTRIENTS IN TWO RATIONS AS CALCULATED AND AS ACTUALLY DETERMINED.

| | | Organic matter. | Protein. | Carbohydrates. | Fats. |
|---|---|---|---|---|---|
| | | Lbs. | Lbs. | Lbs. | Lbs. |
| Ration 1. | Calculated | 16.1 | 2.21 | 13.31 | 0.57 |
| | Actual | 16 | 2.14 | 12.89 | .99 |
| Ration 2. | Calculated | 16.2 | 2 24 | 13.1 | .83 |
| | Actual | 16.22 | 2.25 | 12.96 | 1.01 |

The closeness of agreement between what was actually digested from these rations and the calculated amounts is encouraging. Variations greater than those observed in these trials doubtless occur, but if the calculated and the actual digestible organic matter will agree within one-fourth or even one-half a pound, such a calculation insures much greater accuracy and certainty than could be secured by any other method.

Two events do not establish a rule but these here noted are regarded as important and significant.

*The influence of the quantity of food eaten upon its digestibility.*— The results of the comparison of the "full" and "half" ration show the latter to be uniformly more fully digested. This outcome conflicts with the teachings of certain former experiments. Wolff's experiments* with clover hay alone and with clover hay and roots fed to oxen and sheep appear to demonstrate that the digestibility of a ration is not influenced by its size.

Later investigation† gave the same results when lucerne hay was fed to both sheep and the horse. On the contrary Weiske‡ found that when oats were fed to dogs the digestibility was inversely proportional to the amount eaten.

In our experiment the difference between the large and small rations is too large and too uniform to be explained by errors.

* Die Ernährung.

† Landw. Versuchs Stationen, XXI, p. 20.

‡ Landw. Versuchs Stationen, LXI, p. 145.

## THE RELATIVE NUTRITIVE EFFECT OF RATIONS FROM UNLIKE SOURCES.

The main reason why a unit of digestible material from unlike sources may not have a fixed food value has already been discussed, viz.: the great variations in the character of the protein and nitrogen-free extract. For instance, in the grains, the nitrogen is almost wholly albuminoid, and the nitrogen-free extract is largely starch, while in coarse fodders and roots, much of the nitrogen may come from amid compounds and the nitrogen-free extract contains a generous proportion of pentosans and other bodies not so well understood. Even among the grain foods there are important differences of this kind. Certain of the commercial feeds are residues of the manufacture of beer, glucose and starch from the cereal grains, the starch of the barley and corn having been largely extracted. This results in a concentration of the nitrogen compounds as a whole, and of the nitrogen free compounds that are not starch or sugars. May these undoubted differences have an appreciable influence upon the nutritive effect of two rations?

The two rations under discussion in this connection were selected for a feeding experiment because they illustrate the facts we are now considering. We have shown that they contain practically the same amounts of digestible material with very nearly the same nutritive ratio. The actual compounds in the two rations are in part quite unlike, however. It is well to call attention, in this connection, to the fact that the hexose sugars and the starches as found in cattle foods possess certain characteristics that distinguish them from any other of the compounds which make up the nitrogen-free extract. The sugars either require no changes through digestion in order to be directly absorbed into the circulation, or only a change from one sugar to another, while starch, through the action of diastatic ferments easily suffers complete hydrolysis to one form of sugar. In other words, these carbohydrates are readily and wholly transformed, without waste, into a sugar which is completely absorbed into the blood. It is true at least that repeated trials have failed to reveal the presence of either sugar or starch in the fecal residue, which indicates complete solution and absorbtion. Other compounds which contribute to the so-called digestible carbohydrates, such as cellulose and pentosans are digested in part only, and we are not able to declare whether that which is digested serves the purposes of nutrition as efficiently as the hexose sugars and the starches. The writer has been inclined to regard the high comparative value of grain foods as partly explained by the kind and not wholly by the proportion, of compounds digested.

The percentage of total sugars and starches was determined in the several materials that were used in compounding the two rations previously given. All the carbohydrates soluble in an extract of malted barley grains were assumed to belong to these compounds in Rations 1 and 2.

THE STARCH AND SUGAR IN CERTAIN FEEDING STUFFS.

| Laboratory number. | | In Water-Free Materials. | | | Per cent nitrogen free extract not starch and sugar. |
|---|---|---|---|---|---|
| | | Total nitrogen-free extract. | Soluble in malt extract. | Insoluble in malt extract. | |
| | | Per cent. | Per cent. | Per cent. | Per cent. |
| 17 | Timothy hay | 51.9 | 15.7 | 36.2 | 70 |
| 45–49 | Corn silage | 55.3 | 26.4 | 28.9 | 52.3 |
| 20 | Oats | 65.3 | 50.3 | 15 | 23 |
| 21 | Peas | 63.5 | 53.9 | 9.6 | 15.1 |
| 16 | Malt sprouts | 49.2 | 22.9 | 26.3 | 55.5 |
| 18 | Brewer's grains | 43.8 | 12.9 | 30.9 | 70.5 |
| 19 | Buffalo gluten feed | 59 | 37.1 | 21.9 | 37.1 |

After having carried our analyses to this point it is possible to calculate the amounts of these two classes of nitrogen-free compounds in Rations 1 and 2.

Starch and Sugar in Rations Compared.

| | Amount fed. | Dry matter fed. | Percentage of starch and sugar. | Amount starch and sugar fed. |
|---|---|---|---|---|
| *Ration No. 1.* | | | | |
| | Pounds. | Pounds. | Pounds. | Pounds. |
| Timothy hay | 5 | 4.4 | 15.7 | 0.69 |
| Corn silage | 40 | 9.1 | 26.4 | 2.40 |
| Oats, ground | 5 | 4.5 | 50.3 | 2.26 |
| Peas, ground | 6 | 5.3 | 53.9 | 2.86 |
| Total | .......... | 23.3 | .......... | 8.21 |
| *Ration No. 2.* | | | | |
| Timothy hay | 15 | 13.1 | 15.7 | 2.05 |
| Corn silage | 25 | 6.1 | 26.4 | 1.61 |
| Malt sprouts | 2 | 1.8 | 22.9 | .41 |
| Brewer's grains | 3 | 2.8 | 12.9 | .36 |
| Buffalo gluten feed | 3 | 2.7 | 37.1 | 1 |
| Total | .......... | 26.5 | .......... | 5.43 |

The data here recorded show that the nitrogen-free dry matter in these rations, exclusive of ash and fat, was made up as follows:

Nitrogen-Free Matter in Rations.

| | Ration 1. Lbs. | Ration 2. Lbs. |
|---|---|---|
| Starch and sugar | 8.21 | 5.43 |
| Other nitrogen-free extracts | 5.33 | 8.48 |
| Fiber | 4.52 | 6.53 |
| Total fed | 18.06 | 20.44 |

The digestible "carbohydrates" had three sources.*

Digestible Carbohydrates in Rations.

| | Ration 1. Lbs. | Ration 2. Lbs. |
|---|---|---|
| From starch and sugar | 8.21 | 5.43 |
| From other nitrogen-free extract | 1.99 | 3.61 |
| From fiber | 2.67 | 3.92 |
| Total digested | 12.87 | 12.96 |

* See also results of digestion experiments, p. 540.

It appears that in Ration No. 1, 64 per cent, and in Ration No. 2, 42 per cent of the digested "carbohydrates" consisted of starch and sugar.

Of the nitrogen-free extract not starch and sugar. 37 per cent and 42 per cent were digested in the two cases, the amount being nearly twice as much in Ration No. 2 as in No. 1. In Ration No. 1, 20.7 per cent and in Ration No. 2, 30.2 per cent of the digestible carbohydrates came from the fiber. From a theoretical point of view, when we consider that the pentose sugars formed may be less assimilable than the hexose, and that cellulose digestion may in part be due to destructive fermentations, it is reasonable to admit the possibility of unlike nutritive values for a unit of digestible material from these two sources; but the demonstration of this fact, if it be a fact, is a difficult matter, and must be secured through some kind of experiments with animals. A large difference in the value of two rations may be shown, perhaps, by ordinary feeding trials, but small differences may be obscured by the errors to which such experiments are subjected. The experiment subsequently described should not be regarded, therefore, as furnishing evidence of the highest character. This experiment was planned because of a desire to learn whether the milk-producing capacity of a ration is modified by the sources of the digestible compounds, other conditions being uniform.

### The Experiment.

Rations similar to Nos. 1 and 2 in the kinds and proportions of fodders and grains were used in an experiment with ten cows selected from the Station herd. Some of the animals were in the early stages of lactation, and none of them were so far advanced as to endanger the reliability of the data.

They were not all fed the same quantity of food, but the weight of the ration varied with the appetite, size and production of the several cows.

The preliminary feeding began February 25 and the experiment was concluded on May 10. This time was divided intc two periods, and the ten cows into two lots. During the first period Lot 1 was fed Ration No. 1 and Lot 2 Ration No. 2. In the second period this order was reversed. All the necessary data were recorded, such as the weights of foods, the weights of the animals and the weight and composition of the milk. The composition of the foods and the digestibility of the rations have been stated on previous pages.

The maximum rations fed were those previously given:

CONSTITUENTS AND AMOUNTS OF RATIONS COMPARED.

| | Ration No. 1. | Ration No. 2. |
|---|---|---|
| Timothy hay | 5 pounds. | 15 pounds. |
| Corn silage | 40 pounds. | 25 pounds. |
| Oats, ground | 5 pounds. | |
| Peas, ground | 6 pounds. | |
| Malt sprouts, dried | | 2 pounds. |
| Brewer's grains, dried | | 3 pounds. |
| Buffalo gluten feed | | 3 pounds. |

These rations, as before stated, were modified in quantity to suit the needs of the different animals, the proportions of the several materials being maintained unchanged.

Without stating the data in full detail, we give herewith the important part in a condensed form, showing the amount of each food and of the digestible matter which each cow ate and the yields of milk and milk solids.

QUANTITIES OF FOOD EATEN.

| | Weights of cows. | FOOD EATEN. | | |
|---|---|---|---|---|
| | | Silage. | Hay. | Grain. |
| *First period—30 days, March 2 to April 1.* | | | | |
| *Ration 1—Lot 1.* | Lbs. | Lbs. | Lbs | Lbs. |
| Neth. Constance | 1,072 | 1.087.4 | 146.8 | 330 |
| Rachel | 1,068 | 1,080 | 134 | 300 |
| Myra | 965 | 1,074.7 | 133.5 | 330 |
| Manton Belle | 1,057 | 1,200 | 150 | 300 |
| Barbara Allen | 1,032 | 1,045.7 | 129.9 | 291 |
| *Ration 2—Lot 2.* | | | | |
| Beauty Pledge | 1,101 | 750 | 447.9 | 240 |
| Betsey 10th | 1,320 | 647.7 | 392.5 | 210 |
| Dinah | 924 | 674.9 | 360.7 | 202.3 |
| Junietta Peerless | 964 | 748.5 | 442.3 | 221.2 |
| Countess Flavia | 814 | 517.3 | 317.7 | 176.7 |
| *Second period—33 days, April 8 to May 10.* | | | | |
| *Ration 2—Lot 1.* | | | | |
| Neth. Constance | 1,090 | 772.6 | 426 | 214.1 |
| Rachel | 1,117 | 742.5 | 425.2 | 231 |
| Myra | 977 | 741.8 | 297.9 | 226.1 |
| Manton Belle | 1,098 | 825 | 493 3 | 263.9 |
| Barbara Allen | 1,081 | 735.7 | 392.8 | 203.2 |
| *Ration 1—Lot 2.* | | | | |
| Beauty Pledge | 1,095 | 1.320 | 165 | 361.5 |
| Betsey 10th | 1,324 | 1,181.5 | 147.3 | 330 |
| Dinah | 919 | 1,183.6 | 140.1 | 260.7 |
| Junietta Peerless | 975 | 1,318.3 | 163.7 | 352.1 |
| Countess Flavia | 825 | 988.5 | 125.3 | 277.2 |

DIGESTIBLE MATTER EATEN.

| | Digestable Food Eaten. | | | | Milk Yield. | |
|---|---|---|---|---|---|---|
| | Protein. | Carbo-hydrates. | Fat. | Total. | Milk. | Milk solids. |
| *First period—30 days, March 2 to April 1.* | | | | | | |
| *Ration 1—Lot 1.* | Pounds. | Pounds. | Pounds. | Pounds. | Pounds. | Pounds. |
| Neth. Constance | 67.8 | 375 | 31.4 | 474.2 | 1009.6 | 109.6 |
| Rachel | 63.2 | 353.3 | 30.2 | 446.7 | 425.1 | 57 |
| Myra | 63 | 352.5 | 30.1 | 445.6 | 446.5 | 63.5 |
| Manton Belle | 69.8 | 391.9 | 33.5 | 495.2 | 939.8 | 113.8 |
| Barbara Allen | 61.2 | 342.6 | 29.2 | 433 | 418.3 | 60 |
| *Ration 2—Lot 2.* | | | | | | |
| Beauty Pledge | 72.5 | 377 | 32.3 | 481.8 | 1071.8 | 118.3 |
| Betsey 10th | 63.8 | 332.4 | 28.6 | 424.8 | 393 | 55.1 |
| Dinah | 61.1 | 315.3 | 27.5 | 403.9 | 477 5 | 70.7 |
| Junietta Peerless | 69.1 | 367.6 | 31.4 | 468.1 | 816.1 | 102.2 |
| Countess Flavia | 52.8 | 271.6 | 23.4 | 347.8 | 605 8 | 86.3 |
| *Second period—33 days, April 8 to May 10.* | | | | | | |
| *Ration 2—Lot 1.* | | | | | | |
| Neth. Constance | 60.7 | 363.1 | 41.6 | 465.4 | 1054.7 | 117.5 |
| Rachel | 63.1 | 364.7 | 41.7 | 469.5 | 424 | 54.9 |
| Myra | 58.3 | 308.3 | 35.2 | 401.8 | 481 | 68.2 |
| Manton Belle | 72.1 | 416.7 | 47.7 | 536.5 | 999.9 | 124.3 |
| Barbara Allen | 57.3 | 339.9 | 39 | 436.2 | 446.9 | 64 |
| *Ration 1—Lot 2.* | | | | | | |
| Beauty Pledge | 72.3 | 450.2 | 40.2 | 562.7 | 1125.5 | 126.5 |
| Betsey 10th | 65.7 | 406.2 | 36.1 | 508 | 389.3 | 55.2 |
| Dinah | 56.4 | 369.7 | 34.1 | 460.2 | 512.2 | 76.4 |
| Junietta Peerless | 71.2 | 444.9 | 39.8 | 555.9 | 849 | 115.9 |
| Countess Flavia | 55.2 | 340.9 | 30.3 | 426.4 | 581.9 | 87.1 |
| Daily average, Ration 1 | 2.05 | 12.15 | 1.06 | ...... | ........ | ...... |
| Daily average, Ration 2 | 2 | 10.97 | 1.11 | ...... | ........ | ...... |

Digestible Matter Eaten and Milk Solids Produced.

| | Ration 1. | | Ration 2. | |
|---|---|---|---|---|
| | Digestible matter eaten. | Milk solids produced. | Digestible matter eaten. | Milk solids produced. |
| | Pounds. | Pounds. | Pounds. | Pounds. |
| | 30 days | | 33 days | |
| Neth. Constance | 474.2 | 109.6 | 465.4 | 117.5 |
| Rachel | 446.7 | 57 | 469.5 | 54.9 |
| Myra | 445.6 | 63.5 | 401.8 | 68.2 |
| Manton Belle | 495.2 | 113.8 | 536.5 | 124.3 |
| Barbara Allen | 433 | 60 | 436.2 | 64 |
| | 33 days | | 30 days | |
| Beauty Pledge | 562.7 | 126.5 | 481.8 | 118.3 |
| Betsey 10th | 508 | 55.2 | 424.8 | 55.1 |
| Dinah | 460.2 | 76.4 | 403.9 | 70.7 |
| Junietta Peerless | 555.9 | 115.9 | 468.1 | 102.2 |
| Countess Flavia | 426.4 | 87.1 | 347.8 | 86.3 |
| Totals, 5 cows in 63 days | 4,807.9 | 865 | 4,435.8 | 861.5 |
| Daily average, 1 cow | 15.26 | 2.74 | 14.08 | 2.73 |
| Digestible nutrients for 1 lb. milk solids. | 5.56 | | 5.15 | |

The results of this experiment furnish no testimony in favor of the superior quality of Ration No. 1, i. e., in favor of the ration containing the larger proportion of easily digestible carbohydrates that belong to the hexose group.

The evidence, if literally applied, shows Ration No. 2 to be even the better one. The daily production of milk solids was essentially the same with the two rations, viz.: 2.74 lbs., but the daily consumption of digestible nutrients was greater with Ration No. 1, the respective quantities being 15.3 lbs. and 14.1 lbs. and the amounts of digestible material eaten for each pound of milk solids produced were 5.56 lbs. and 5.15 lbs. If, therefore, a certain class of carbohydrate compounds possesses a superior nutritive value the fact must be brought to light through some method of investigation more searching than feeding experiments of this character.

This experiment does bear testimony concerning one matter of considerable importance. It is certainly clearly shown that in one case at least, the commercial feeding stuffs of the by-product class were successfully substituted for such grains of high quality as oats and peas.

Moreover, a much larger percentage of the digestible dry matter of the ration was supplied in timothy hay and silage in Ration 2 than in Ration 1, the proportion being about 70:55 in the two cases, but as has been stated, no evidence appeared that Ration 2 was inferior to the other. Such an outcome is encouraging to those farmers who wish to avoid the purchase of cattle foods by feeding largely of home-grown fodders and purchasing sparingly of such grains as are best calculated to supplement hay and silage.

PLATE XXIX.—STATION ALFALFA FIELD, AUGUST 16, 1896; SHOWING THE THIRD CROP OF THE SEASON. THE THREE CROPS AGGREGATED OVER 15.5 TONS OF GREEN FODDER PER ACRE. SEEDED, 1893.

# REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY.

## PART II.

## I. ALFALFA.*

W. P. WHEELER.

### SUMMARY.

Alfalfa is not suited to all kinds of soils, and is probably not hardy much north of the central portion of this State. It is, however, a plant of such decided value that it is well worth a trial in any locality where there is a fair prospect of its growing.

### ALFALFA.

Since the publication of a bulletin in November, 1894, in which were stated results accompanying the feeding of alfalfa at this Station, this fodder has constituted during two more summers a larger or smaller part of the rations for milch cows. The favorable opinion then expressed concerning alfalfa has been strengthened by the further experience. Many rations containing this fodder have been as efficient and economical as those used in the fourteen feeding trials reported in the bulletin, and the good crops obtained each year warrant a recommendation of its more general trial.

The chief value of alfalfa for this State lies in its excellence as a soiling crop. In palatability it ranks high, and is not inferior in this respect to corn. It is readily eaten by all farm

*Reprint of Bulletin No. 118.

stock. Three or more cuttings can be had in a season. It furnishes a fodder rich in nitrogenous matter, and is well constituted to supplement our great fodder crop, Indian corn, which is, both in the grain and entire plant, somewhat lacking in this essential class of constitutents.

Alfalfa has proved a reliable crop at this Station for several years, although on soil apparently not best suited to it, and, while not hardy enough to endure the winters of some portions of the State, it has never been winter-killed here except on small areas where water remained on the surface over little depressions of the field.

## History.

This plant, under the name of lucerne, is said to have been introduced into New York State nearly eighty years ago, but its value was apparently recognized by very few untii alfalfa, which was brought into California from South America thirty years later, proved such a marked success in the West. Possibly this was because the alfalfa, early taken to Mexico, from there carried to western South America, finally to California, and from there elsewhere, became more thoroughly acclimated; for the alfalfa from the West is said to be hardier and to grow larger than the lucerne from Europe.

Alfalfa, or lucerne (*Medicago sativa*), is probably a native of the valleys of western central Asia, and has been in cultivation for a long time. It was introduced into Greece by the Persians in 490 B. C. It was highly esteemed and largely grown by the Romans, and later cultivated by the natives of southern Europe. It was, in the time of the conquest, carried by the Spaniards into Mexico under the Arabic name of alfalfa, the one then commonly used in Spain.

## Characteristics.

Alfalfa is a perennial—the root living many years. The annual upright and branching stems when cut do not sprout, but die back to the crown, where new shoots start and grow rapidly. The roots extend much deeper than those of most plants, and alfalfa is, therefore, not obliged to feed altogether near the surface. In fact, although nodules or excrescences caused by the micro-organisms are common on the roots near the surface, there are few of the small fibrous roots except at the greater depths reached, where they are abundant. This indicates a power of deep feeding. At the same time alfalfa responds readily to a top dressing of fertilizers, and abundant rainfall or surface irrigation is necessary to assure the largest crops. Old plants, will, however, make a fair growth in times of drought seriously affecting many crops. The normal root seems to be a single long tap root running to the depth of three or more feet before dividing into branches which run to greater depths of even twelve feet or more, although they will not extend below the permanent water table, nor more than a few inches into the permanently saturated soil.

Alfalfa is often able to adapt itself to soils where the roots cannot extend deeply, and plants transplanted when young, off which the tap roots have been cut at the depth of less than a foot, have endured well.

Under favorable conditions the yield of alfalfa increases up to three or four years, and good crops follow for ten years or more. Often, however, such grasses as quack and June grass, and plantains, dandelion and similar weeds spread over the field to the increasing injury of the crop, although many weeds are subdued by the frequent cuttings. Ordinarily it will pay to plow up the field after about six or eight years. Sometimes the alfalfa appears able to hold its own indefinitely. A small plat seeded to alfalfa about twelve years ago still gives two or three good cuttings each season, although it has been densly overgrown with grass for several years, and probably for the whole time. There was never more than a very scattering stand, but there appears no decrease in the number of plants.

## AVERAGE YIELD.

The average of five crops of four cuttings each obtained at this Station during the three past years was over seventeen tons of green fodder per acre. This was from fields one to three years old.

### Crops in Different Years.

There was cut in 1894, from a field of 2.3 acres seeded in 1890, a total per acre of 28,085 pounds green fodder. The total dry matter was 7,406 pounds, containing 1,119 pounds of protein, of which the albuminoids constituted 899 pounds. The first cutting was in June, beginning on the 1st, the second was begun July 28th, the third September 8th, and the fourth October 15th. The first crop was a very heavy one, the second much lighter, and the last two were very light. The season was very dry.

There was cut in 1894, from a field of 1.3 acres, seeded in 1893, a total of 33,803 pounds. The dry matter was 8,116 pounds, containing 1,660 pounds of protein, of which the albuminoids constituted 1,278 pounds. The first cutting was in May, commencing on the 11th. The second cutting begun July 9th, after very dry weather; the third begun September 1st, after severe drought, and the fourth on October 18th.

There was cut in 1895 from the field of 1.3 acres seeded in 1893, a total of 37,129 pounds. The dry matter was 8,666 pounds, containing 1,452 pounds of protein, of which the albuminoids constituted 1,120 pounds. The first cutting began May 15th, the second June 15th, the third July 30th, and the fourth on September 9th. The last crop was light, and others all good.

There was cut in 1896, from the field of 1.3 acres, seeded in 1893, a total of 34,991 pounds. The dry matter in the crop was 8,527 pounds, containing 1,522 pounds of protein, of which the albuminoids constituted 1,167 pounds. The first cutting began May 27th, the second June 29th, the third August 13th, and the fourth on October 1st. The last crop was light, the others all good, the first and third being the heaviest.

There was cut in 1896, from a field of about one and one-quarter acres, seeded in 1895, a total of 36,514 pounds. The dry matter in the crop was 7,461 pounds, containing 1,302 pounds of protein, of which the albuminoids constituted 1,054 pounds. The first cutting began May 12th, the second June 13th, the third July 22d, and the fourth September 8th. The second crop was the lightest, although containing more dry matter than the last. All were good.

Occasionally, when conditions are favorable, quite a crop can be cut the same season the seed is sown. In 1895 there was cut from a field of about one and one-quarter acres, seeded in the spring, a total of 13,558 pounds. The dry matter was 3,330 pounds, containing 548 pounds of protein, of which the albuminoids constituted 416 pounds. The field was cut twice. The first cutting began July 9th, and the second August 26th.

### FOOD VALUE OF SEVERAL FODDER CROPS.

In order to show the high feeding value of the alfalfa from an acre, the average product obtained at this Station during the three years past is stated in the following table in comparison with the food supplied by several of our best common fooder crops. The average of the five alfalfa crops was 34,104 pounds of green fodder, or 8,035 pounds of dry matter, containing 1,411 pounds of protein, 1,103 pounds of this being albuminoids.

FOOD VALUE OF FODDER CROPS.

| | Yield per acre of total crop. | Dry matter per acre. | Total digestible matter per acre. | Digestible protein. |
|---|---|---|---|---|
| | Pounds. | Pounds. | Pounds. | Pounds. |
| Alfalfa | 34,100 | 8,000 | 5,280 | 875 |
| Corn, entire plant | 28,000 | 5,800 | 3,800 | 300 |
| Red clover | 18,000 | 5,220 | 3,200 | 491 |
| Oats and peas | 13,000 | 3,120 | 2,521 | 350 |
| Timothy | 10,000 | 3,500 | 2,000 | 228 |
| Rutabagas | 31,700 | 3,400 | 3,000 | 279 |
| Mangels | 25,000 | 3,500 | 2,750 | 232 |
| Sugar beets | 17,800 | 2,500 | 1,800 | 213 |

The acreage yields of the several crops given above are such as have been secured at different places in this part of the country from Pennsylvania to Canada. Sometimes considerably larger crops have been obtained, but the average crop would be less than any mentioned in the table.

### COMPOSITION OF THE FRESH FODDER.

The average composition of twenty lots of fresh alfalfa fodder fed at this station during the last four seasons is stated below. Corn is probably our best all around forage crop, and for comparison the average composition of the mature fresh corn fodder fed during the last three seasons is also stated.

| | Alfalfa. | Corn. |
|---|---|---|
| Moisture, per cent | 75.6 | 73 |
| Ash, per cent | 2.1 | 1.2 |
| Crude protein, per cent | 4.4 | 2.3 |
| Albuminoids, per cent | 3.4 | 2 |
| Crude fibre, per cent | 6.5 | 5.3 |
| Nitrogen-free extract, per cent | 10.1 | 17.1 |
| Crude fats (ether extract), per cent | 1.3 | 1.1 |

### Soil.

Alfalfa grows well on varying kinds of soils, provided the subsoil is open and porous. The most favorable soil is a rich, somewhat sandy loam, warm and friable, with a deep and loose or gravelly subsoil, well supplied with lime. A dense clay or hardpan subsoil is most unfavorable. Although a rich soil is of course the best and gives the largest crops alfalfa sometimes does unexpectedly well on poor, gravelly land.

The plant consumes much water, but will not survive long in a saturated or flooded soil, and much water in or on the ground during winter is fatal. If water stands for any considerable time within a few feet of the surface the crop will be injured.

### Food for the Plant.

An abundance of lime in the soil is especially desirable, and much iron is injurious. The plant is a heavy feeder and will not be productive on soils deficient in plant food. It is a leguminous plant and can obtain nitrogen not available to many plants, although it responds quickly to applications of nitrogenous manures. The extent of its power to obtain atmospheric nitrogen is not certain, but it is important to utilize it so far as possible and feed the crop mainly potash and phosphoric acid.

### Improvement of Soil.

Although so rank a feeder and large producer alfalfa is less exhaustive to the soil than many plants of lighter producing power. Where the crop is fed on the farm, as it should be, and the manure returned to the land, there is a very noticeable increase of fertility, which may be made more permanent by moderate applications of potash salts and phosphatic fertilizers, which are well paid for by the increased yield.

In the west the great improvement in fields where alfalfa has been grown is a commonly recognized fact, although the crop is not always fed on the field. Improvement, however, cannot be lasting when plant food is continually removed. Much of the plant food left in the soil has been brought from an unusual depth. The stubble and roots of manure growth contain, on an acre, of the essential fertilizing constituents, an amount that would require about thirty-five dollars to purchase. The mechanical condition of the soil is also left improved when an alfalfa field is broken up. A crop of alfalfa virtually deepens the soil and extends the feeding ground of subsequent crops.

## Seeding.

The seed should not be sown unless the soil has received careful thorough preparation, for it is very important to secure a full and uniform stand, especially if hay is to be made. The seed should be sown in the spring, after danger of severe frost is passed, and when the ground would be considered in the best possible condition for planting garden seeds. The treatment of the field for the preceding season should have been such as to have most effectually subdued all weeds, and caused the sprouting and destruction of any seed in the ground. The seed should not be sown with grain, but alone, although a good catch is sometimes secured when sown with oats, only about half the usual quantity of grain being used. If sown with grain the young plants are likely to be killed by the sun after the grain is cut.

It is best to sow about thirty pounds of seed per acre to insure a full stand. Some consider twenty pounds of seed ample. If the seeds were evenly distributed, and all would germinate and grow there would be several times the number of seeds necessary in this smaller quantity to produce a thick stand. But all conditions of soil, moisture and seed cannot always be favorable, and it is well to sow liberally. An uneven stand is very unsatisfactory. An even stand, where the plants are several inches apart, will give as large a crop as a much thicker stand, but generally where hay is made, a thick stand is desired.

The seed should be covered, but the covering of soil should be as thin as possible, except on very light soils in a dry time. Although several methods of sowing the seed have given good results at this Station, the method usually followed has been to sow the seed broadcast and follow with a very light or brush harrow. Sometimes a very successful method is to drill in the seed and harrow very lightly across the drill marks. Sometimes simply rolling after broadcast sowing is desirable.

It will not pay to sow late in the summer. June sowing is perhaps as late as should be risked. The young plants are hardly able to endure the winter until they have had several months growth, although mature plants appear able to withstand very cold weather if the soil is not wet. The first winter is the hardest.

### SEED.

Pure seed is essential. Only bright, plump, clean seeds should be sown, for shrunken seeds may produce weak and worthless plants. The seed resembles that of red clover, but is larger. Fresh seed has a greenish-yellow color, but after it has been kept in the light for a time it becomes reddish brown. Good seed retains its vitality several years if kept under favorable conditions.

The presence of the seed of narrow leaf plantain it is of vital importance to avoid. This is a long brownish seed, like a diminutive date seed, and is easily detected without the aid of a glass by any one familiar with it.

### EARLY TREATMENT.

In order to check the growth of weeds a mowing machine can be run over the field of young alfalfa with the cutting-bar raised to avoid cutting near the crowns of the young plants. If the clipping is not too heavy it can be left on the field, and will serve as a mulch during the dry weather. On rich soil sometimes two crops can be secured the first summer, but on poor soil, or in a dry season, no crop can be expected until the second year.

### ESTABLISHED FIELDS.

Alfalfa should be cut every time it begins to blossom, whether the growth is short or tall, unless a seed crop is desired. The second crop of the season is better for seed than the first, probably on account of the greater number of insects that assist in fertilizing the blossoms.

The chief value of alfalfa, before stated, is as a soiling crop to be cut and fed fresh. From a field in area suited to the number of animals to be fed, there can be obtained a fairly regular succession of cuttings of green fodder. By cutting each day across the field there will be, by the time the field is cut over, a new growth where the first cutting was made. The field that will produce ample fodder during the dry weather of late summer will yield an excess during the more favorable weather of spring. This surplus can be made into hay—for the crop should always be cut when the purple blossoms show. The first crop of the season will, as a rule, prove much the heaviest if allowed to reach full development, the later cuttings being light. For this reason it may often be found preferable to begin the first cuttings when the fodder is rather imature, in this locality early in May.

### PASTURAGE.

Alfalfa is not a safe pasturage for cattle and sheep, for it is liable to cause bloat. Where cattle and sheep are allowed to eat all they will, the fodder should be allowed to wilt before it is fed. Horses and pigs can be pastured on alfalfa, but by pasturing heavy animals, many of the crowns are broken by the hoofs and the plants are injured. Sheep cut off the crowns too close to the ground. When used to supplement dry pastures it is best to cut the fodder and carry it, when wilted, to the nearest place where it can be fed.

## SILAGE.

Alfalfa silage compares well in chemical composition with clover and similar forms of silage. It is said to usually have a disagreeable odor and taste, although it is freely eaten by cattle. No experiments in the use of alfalfa silage have been made at this Station. The green fodder has been in such continual demand for feeding that not enough has been available at any time to fill a silo. Alfalfa, like clover, would require more careful packing and a greater depth of silo for best results than is necessary for corn.

## HAY.

Alfalfa hay is an excellent fodder. It is palatable and very nutritious. Experience and good judgment are required, and much time and care are necessary, to make good hay. If handled too much when dry all the leaves and small stems are liable to fall off, and if not thoroughly cured it is liable to mold and mildew. The hay will not shed water well, and stacks, when left long, should be well covered. Hay caps are often of great service. The hay suffers much deterioration in feeding value by exposure to rain.

The leaves constitute in weight about half the plant—from forty to sixty per cent. Sometimes the loss of leaves and small stems amounts, with careless handling, to much more than half the weight of the crop. The ordinary loss with careful handling in about one-fifth or one-sixth. The leaves contain from three to four times as much protein and fat as the stems, and more starchy substance, while the stems contain three or four times as much woody substance as the leaves. It can be understood from this that the best part of the crop may be lost unless great care is taken. As the ash content of the leaves is also very high, the surface soil is enriched by their decay, but their great feeding value is lost.


PLATE XXX.—CAPONS DRESSED FOR MARKET.


FIG. 21.—THE FIRST DAY OUTDOORS.

# II. FEEDING EXPERIMENTS WITH CHICKS AND CAPONS.*

## THE RELATIVE EFFICIENCY OF WHOLE AND GROUND GRAINS AS COMMONLY FED.

W. P. WHEELER.

### SUMMARY.

A ration consisting mostly of the ordinary ground grain foods and containing no whole grain was more profitably fed to chicks than another ration consisting mostly of whole grain and containing no ground grain.

Capons from the one lot afterward made a somewhat cheaper gain in weight on the whole grain ration, but the grain was too slow to compensate for the more rapid growth which had been made, as chicks, by the lot having the ground grain ration.

Of two other lots of capons, those having the ground grain ration made the more profitable gain during several months.

In every trial more food was eaten when the ground grain was fed than when the whole grain was fed.

Neither the chicks and capons having only the whole grain nor those having only the ground grain showed any lack of health and vigor.

### INTRODUCTION.

A number of experiments have been made at this Station to obtain information concerning the economy of feeding ground grain to poultry. The results from several of these tests with laying hens were published in Bulletin No. 106. The results of some other feeding experiments made at that time with young chicks and with capons seem of interest enough to warrant separate publication in this bulletin, for many inquiries are made concerning the relative advantage of feeding ground and whole grain to young stock.

*Reprint of Bulletin No. 126.

## GENERAL CONSIDERATIONS.

While opinions have differed somewhat among poultrymen in regard to the manner of feeding and form of grain to be used, the different grain foods have almost necessarily, as a rule, constituted much the greater portion of all rations. In common practice there is a considerable saving of time and labor by feeding whole grain; and when it is necessary to insure exercise, as with laying hens and breeding stock, whole grain can be fed to good advantage. But by-products, much cheaper than whole grain, and, if desired, much more nitrogenous, are usually available for part of the ground grain rations. If the food consists largely of the whole grains which can ordinarily be obtained, it is not possible to secure a ration as nitrogenous as is by many considered essential.

As generally found, then, rations in which whole grains largely predominate will, unless special effort is made to prevent, have wider nutritive ratios than rations containing much ground grain. The difference is more pronounced whenever certain by-products are used and animal meal mixed with the ground grain.

So in general practice a change from "whole grain" to "ground grain" or vice versa, involves also considerable change in chemical composition of the food.

## RATIONS FED.

In the feeding experiments here recorded only ordinary foods were used and such foods omitted as would make a pronounced difference in the chemical composition of the rations. There were, however, some of the usual differences in composition, although in much less degree than ordinarily occurs. An attempt to avoid any difference would have prevented the use of many common foods and this was not desired.

## STOCK USED.

Two lots of chicks were fed for three months during the summer and four lots of capons for about seven months during the fall and winter. The two lots of chicks were hatched in incubators and reared in out-door lamp-brooders. They were taken from two hatches, from which many of the chicks were used for other purposes, and, although the two lots were entirely comparable, the chicks in each lot varied a week or more in age. They were of several breeds, the Light Brahma, Dark Brahma, Buff Cochin, Partridge Cochin and some of Cochin-Game cross. The records of feeding and of growth were kept from the time the chicks were hatched until they were three months of age. The cockerels were then caponized and were fed during the winter. The pullets were also fed the contrasted rations for a while, but were too few in number to make the results satisfactory, and were not carried through.

## FOODS.

The grain food for one lot of chicks, No. I, consisted from the start entirely of ground grain, and that for lot No. II, entirely of whole or cracked grain. Both lots were fed skim milk freely. Lot No. I had dried blood. Lot No. II had cut, fresh bone, all the chicks would eat, twice a week, and what dried blood they could be induced to eat with the whole grain. Of these animal foods not enough was eaten, however, to bring the amount of nitrogen in the whole grain ration entirely up to that in the other. Each lot was kept on a small enclosed grass run, surrounding the brooder, from which their green food was obtained. In some preceding experiments it had been found that the dry matter of the green food eaten by the chicks was so small that its consideration would not affect the averages for short periods. The cost also of the green food was so small as not to appear in the average estimates, but only in the aggregates for long periods. For this reason, although green food is of great importance in feeding, account of it does not appear in the data which follow.

The grain mixture, No. I, fed to the chicks, consisted of two parts by weight of corn meal, two parts of wheat bran and one part each of wheat middlings, old process linseed meal and ground oats. The mixture, No. II, fed to the capons, consisted of ten parts by weight of corn meal, two parts wheat bran, and one part each of wheat middlings, ground oats and ground barley.

## CHEMICAL COMPOSITION.

The grain mixtures and other foods averaged in composition as follows:

COMPOSITION OF FOODS.

| FOOD. | Water. | Ash. | Crude protein. | Crude fibre. | Nitrogen-free extract. | Crude fats. |
|---|---|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| Grain mixture No. 1 | 12 | 3.2 | 14.7 | 4.7 | 61.6 | 3.8 |
| Grain mixture No. 2 | 15.8 | 1.8 | 9.8 | 2.9 | 66.2 | 3.5 |
| Oat meal (granulated) | 10.1 | 3.5 | 13 | 2 | 66.7 | 4.7 |
| Ground oats | 12.1 | 3.1 | 12 | 8.1 | 60.5 | 4.2 |
| Corn meal | 12.7 | 2.1 | 10.4 | 2.2 | 68.5 | 4.1 |
| Wheat | 12.1 | 1.7 | 12.2 | 2.4 | 69.8 | 1.8 |
| Corn | 12.8 | 1.1 | 8.8 | 1.3 | 72.3 | 3.7 |
| Barley | 13.7 | 2.9 | 12.6 | 4 | 64.6 | 2.2 |
| Oats | 12.8 | 3.4 | 11.7 | .4 | 57.8 | 3.9 |
| Dried blood | 9.7 | 1.9 | 82.4 | 1.05 | 5 3 | .2 |
| Skim milk | 90.5 | .7 | 3.2 | ...... | 5.1 | .5 |
| Fresh bone | 34.2 | 22.8 | 20.6 | ...... | 1.9 | 20.5 |

## VALUATION.

In estimating the cost of food, corn meal was rated at $16 per ton, wheat bran and wheat middlings at $14, ground oats at $18 and linseed meal at $20. Wheat was rated at 69 cents per bushel, corn at 40 cents, oats at 24 cents and barley at 41 cents, granulated oat meal at 3 cents per pound and dried blood at 2 cents, skim milk at 24 cents per 100 pounds and fresh bone at 80 cents.

## NUTRITIVE RATIO.

During the first few weeks the food taken by the lot having the whole grain ration had somewhat the wider nutritive ratio. During the last few weeks there was little or no difference in this respect. All the food eaten during the three months by Lot No. I showed the average nutritive ratio of 1:3.3. That eaten by Lot No. II showed a ratio approximately 1:4.6.

## EXPERIMENT WITH CHICKS.

The records of feeding and the average results from the feeding trial with the growing chicks arranged in periods of one week, are given in the following tables:

## Food Eaten by Chicks (Lot No. I) Fed Ground Grain.

| Number of days in period. | Average age of chicks at beginning of period. | Number of chicks. | Average per Chick During Period. Mixed grain. | Ground oats. | Corn meal. | Dried blood. | Skim milk. | Total food. | Approximate water-free food per day. | Total cost of food per day. | Approximate nutritive ratio. | Average gain in weight per chick during period. | Water-free food consumed for one pound gain in weight | Water-free food per day for each 100 pounds live weight fed. | Cost of food for each pound gain in weight. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Weeks. | | Ozs | Ozs. | Ozs. | Ozs. | Ozs. | Ozs | Ozs | Cts. | | Ozs. | Lbs. | Lbs. | Cts. |
| 7..... | 0.1 | 12 | 0.8 | 0.3 | 1.1 | 0.4 | .... | 2.6 | 0.3 | 0.02 | 1:2.7 | 0.7 | 3.5 | 17.4 | 4 |
| 8..... | .7 | 20 | 1.8 | .3 | .5 | 1 | 5.2 | 8.8 | .4 | .04 | 1:1.6 | 1.6 | 2.2 | 15.7 | 3.2 |
| 7..... | 1.7 | 20 | 1.6 | .6 | 1.4 | .8 | 7.4 | 11.8 | .6 | .05 | 1:2.3 | 2 | 2.2 | 13.7 | 3.1 |
| 7..... | 2.2 | 25 | 2.9 | .3 | 1.1 | .6 | 7.1 | 12 | .7 | .06 | 1:2.8 | 2.8 | 1.8 | 11.6 | 2.3 |
| 7..... | 3.3 | 23 | 3 4 | .8 | 1 | 1.1 | 8.4 | 14.7 | 1 | .08 | 1:2.6 | 2.4 | 3 | 11.3 | 3.9 |
| 7..... | 4.3 | 23 | 4.3 | .7 | 2.4 | 1.1 | 10.5 | 19 | 1.2 | .12 | 1:2.3 | 3.3 | 2.5 | 10.2 | 3 2 |
| 7..... | 5.4 | 22 | 5.3 | 1.5 | 3.8 | 1.4 | 10.7 | 22.7 | 1.6 | .12 | 1:3 | 3.4 | 3.3 | 10.4 | 4 |
| 7..... | 6.4 | 22 | 6.2 | 1.6 | 3.7 | 2.1 | 10.6 | 24.2 | 1.9 | .14 | 1:2.6 | 4.7 | 2.8 | 9.5 | 3.4 |
| 7..... | 7.4 | 22 | 6.4 | 1.7 | 5.6 | 2 | 9.8 | 25.5 | 2.1 | .15 | 1:2.9 | 4.1 | 3.6 | 8.7 | 4.3 |
| 7..... | 8.4 | 22 | 6.3 | 2.3 | 5.4 | 1.8 | 8.2 | 24 | 2.1 | .15 | 1:5.1 | 3.1 | 4.8 | 7.6 | 5.6 |
| 7..... | 9.4 | 22 | 8.1 | 2.8 | 5.1 | 1.7 | 13.4 | 31.1 | 2.4 | .17 | 1:3.2 | 5.5 | 3.1 | 7.5 | 3.6 |
| 7..... | 10.4 | 22 | 8.8 | 2 | 6.7 | ... | 10.1 | 27.6 | 2.3 | .15 | 1:5.3 | 6.6 | 2.5 | 6.1 | 2.5 |
| 7..... | 11.4 | 22 | 10 | 2.7 | 7.8 | ... | 12 | 32.5 | 2.7 | .17 | 1:5.3 | 7.9 | 2.4 | 6 | 2.5 |

FOOD EATEN BY CHICKS (LOT NO. II) FED WHOLE GRAIN.

| Number of days in period. | Average age of chicks at beginning of period. | Number of chicks. | Average per Chick During Period. | | | | | | | | | | Approximate nutritive ratio. | Average gain in weight per chick during period. | Water-free food consumed for one pound gain in weight | Water-free food per day for each 100 lbs. live weight fed. | Cost of food for each pound gain in weight. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Granulated oat meal. | Cracked wheat and wheat. | Cracked corn. | Barley. | Dried blood. | Fresh bone. | Skim milk. | Total food. | Approximate water-free food per day. | Total cost of food per day. | | | | | |
| | Weeks | | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Cts. | | Ozs. | Lbs. | Lbs. | Cts. |
| 7............ | 0.1 | 12 | 0.8 | 0.9 | 0.4 | ...... | ...... | 0.4 | ....... | 2.5 | 0.3 | 0.03 | 1:6.2 | 0.1 | 2.4 | 15 | 4.9 |
| 8............ | .7 | 19 | 1 | 1 | .7 | ...... | ...... | .1 | 2.2 | 5.0 | .3 | .04 | 1:5.6 | .6 | 3.6 | 13.6 | 6.3 |
| 7............ | 1.7 | 19 | 1.6 | 1.6 | .7 | ...... | ...... | .1 | 3.9 | 7.9 | .6 | .07 | 1:5.3 | 1.4 | 2.7 | 15.5 | 5.6 |
| 7............ | 2.2 | 24 | .9 | 2 | .8 | ...... | ...... | .1 | 4.8 | 8.6 | .5 | .06 | 1:5.3 | 1.5 | 4.8 | 12.1 | 7.9 |
| 7............ | 3.3 | 23 | 1.2 | 2.4 | 1.5 | ...... | 0.4 | .2 | 4.4 | 10.1 | .8 | .08 | 1:3.8 | 2.3 | 2.7 | 12 | 4.6 |
| 7............ | 4.3 | 23 | .7 | 1 | 1.9 | ...... | .4 | .4 | 8.7 | 13.1 | .7 | .07 | 1:3.4 | 3 | 1.6 | 7.6 | 2.7 |
| 7............ | 5.4 | 22 | 1.1 | 2.1 | 2.3 | ...... | .4 | .2 | 7.1 | 13.2 | .8 | .09 | 1:4.1 | 3.9 | 2.3 | 7.1 | 3.7 |
| 7............ | 6.4 | 22 | ...... | 9 | 3.3 | ...... | ...... | .3 | 8.7 | 21.3 | 1.7 | .13 | 1:5.8 | 4.7 | 2.7 | 10.9 | 3.4 |
| 7............ | 7.4 | 22 | ...... | 5.9 | 4.6 | ...... | .6 | .7 | 9.1 | 20.9 | 1.6 | .13 | 1:4.3 | 5.4 | 2.9 | 8.1 | 3.7 |
| 7............ | 8.4 | 22 | Oats. | 8.6 | 4.7 | ...... | .3 | .7 | 7.2 | 21.5 | 1.9 | .14 | 1:5.3 | 6.1 | 4.7 | 8.2 | 5.5 |
| 7............ | 9.4 | 22 | 0.4 | 6.5 | 5.2 | 2 | .6 | 2.2 | 14.7 | 31.6 | 2.2 | .18 | 1:4.2 | 6.8 | 2.2 | 8.1 | 2.8 |
| 7............ | 10.4 | 22 | 1.2 | 6.6 | 5.9 | 1.2 | 1.2 | 2.6 | 12.4 | 31.1 | 1.8 | .19 | 1:3.8 | 7.6 | 2.5 | 7 | 3.2 |
| 7............ | 11.4 | 22 | .4 | 7.5 | 7.4 | 3 | .2 | 1.1 | 14.6 | 34.2 | 2.6 | .19 | 1:5.3 | 8.3 | 3.1 | 6.4 | 3.7 |

COST OF FOOD TO GIVEN AGE AND WEIGHT OF CHICKS FED GROUND GRAIN AND WHOLE GRAIN.

LOT NO. I.—GROUND GRAIN.

| Average age chicks. | Average weight per chick. | Average cost per chick to age given for food, etc. | Average weight per chick. | Cost of food per chick to weight given. | Average total cost per chick for food, etc. |
|---|---|---|---|---|---|
| Weeks. | Lbs. | Cts. | Lbs. | Cts. | Cts. |
| 0.1 | 0.1 | 4 | 0.10 | ........ | 4 |
| 1 | .2 | 4.5 | .25 | 0.7 | 5.1 |
| 2 | .3 | 5.3 | .50 | 1.3 | 6.2 |
| 3 | .4 | 5.9 | .75 | 2.2 | 7.3 |
| 4 | .6 | 6.6 | 1 | 3 | 8.3 |
| 5 | .8 | 7.4 | 1.25 | 3.9 | 9.3 |
| 6 | 1 | 8.3 | 1.50 | 4.9 | 10.5 |
| 7 | 1.3 | 9.4 | 1.75 | 6.1 | 11.8 |
| 8 | 1.5 | 10.5 | 2 | 0.2 | 13 |
| 9 | 1.8 | 11.8 | 2.25 | 7 | 13.7 |
| 10 | 2 | 13 | 2.50 | 8.6 | 14.3 |
| 11 | 2.4 | 14.1 | 2.75 | 9.2 | 14.9 |
| 12 | 2.9 | 15.3 | 3 | 9.9 | 15.6 |
| 13 | 3.3 | ........ | ........ | ........ | ........ |

LOT NO. II.—WHOLE GRAIN.

| Average age chicks. | Average weight per chick. | Average cost per chick to age given for food, etc. | Average weight per chick. | Cost of food per chick to weight given. | Average total cost per chick for food, etc. |
|---|---|---|---|---|---|
| Weeks. | Lbs. | Cts. | Lbs. | Cts. | Cts. |
| 0.1 | 0.1 | 4 | 0.10 | 0.1 | 4.2 |
| 1 | .1 | 4.6 | .25 | 1.1 | 5.8 |
| 2 | .2 | 5.4 | .50 | 2.1 | 7.2 |
| 3 | .3 | 6.1 | .75 | 2.8 | 8.1 |
| 4 | .4 | 6.8 | 1 | 3.7 | 9.2 |
| 5 | .6 | 7.5 | 1.25 | 4.6 | 10.2 |
| 6 | .8 | 8.2 | 1.50 | 5.8 | 11.5 |
| 7 | 1 | 9.2 | 1.75 | 6.6 | 12.3 |
| 8 | 1.2 | 10.1 | 2 | 7.3 | 13 |
| 9 | 1.5 | 11.3 | 2.25 | 8.2 | 13.9 |
| 10 | 1.8 | 12.4 | 2.50 | 9 | 14.8 |
| 11 | 2.2 | 13.7 | 2.75 | 9.9 | 15.8 |
| 12 | 2.6 | 15 | ........ | ........ | ........ |
| 13 | 3 | ........ | ........ | ........ | ........ |

### COST OF OIL AND FOOD.

The oil required by each brooder during the ten weeks that they were heated amounted to 4½ gallons. Considering only the cost of oil and food, the cost of the gain in weight made by Lot No. I during the three months would be 3.98 cents per pound. The cost of the gain made by Lot No. II would be 4.5 cents per pound.

### RELATION OF FOOD TO GROWTH.

The food eaten during the three months by Lot No. I, having the ground grain ration, contained 31.2 pounds more dry matter than that eaten by Lot No. II and the gain in weight was 8.9 pounds greater. For every pound gain in weight made by Lot No. I there were 4.56 pounds of dry matter in the food consumed. For every pound gain in weight made by Lot No. II there were 4.4 pounds of dry matter in the food.

### COST OF FOOD FOR GROWTH.

By Lot No. I one pound gain in weight was made for every 3.33 cents worth of food consumed. By Lot No. II one pound gain was made for every 3.76 cents worth of food.

At the average weight of one pound the food had cost per chick for Lot No. I, 3 cents and for Lot No. II, 3.7 cents. At the average weight of 1.5 pounds the food had cost per chick 4.9 cents for Lot No. I and 5.8 cents for Lot No. II. At the average weight of 2 pounds the cost per chick for Lot No. I was 7.2 cents and for Lot No. II 7. 3 cents. At the average weight of 2.5 pounds the cost per chick for Lot No. I was 8.6 cents and for Lot No. II, 9 cents.

### RAPIDITY OF GROWTH.

The chicks in Lot No. I averaged one pound in weight at six weeks of age and in Lot No. II at seven weeks of age. In Lot No. I at ten weeks of age the average weight was 2 pounds and in Lot No. II, 1.8 pounds.

### COST OF PRODUCTION.

Rating the cost of hatching (including the cost of eggs, etc.) at the average cost found in former experiments, and considering the cost of food and of oil for brooders, gives as the total cost per


FIG. 22.—CAPONS FROM EXPERIMENT PENS, 1896.

chick at twelve weeks of age 15.3 cents for Lot No. I and 15 cents for Lot No. II. The average weight per chick at this age for Lot No. I was 2.9 pounds and for Lot No. II, 2.6 pounds. In the accompanying tables will be found stated the "total cost" at different ages and weights. This total cost represents only the cost of eggs, of hatching, of heating brooders and of food. It does not account for labor or the rent of buildings or losses. There was however in no lot during this experiment any loss from disease. The chicks, and later the capons, remained in good health throughout under either ration.

## FIRST EXPERIMENT WITH CAPONS.

The cockerels from these two lots of chicks were caponized and fed these same contrasted rations during the winter. The records of feeding are given in the following tables calculated to the average per fowl for periods of two weeks.

### LOSS DUE TO THE OPERATION.

During the first period recorded all the birds in each lot were caponized; but notwithstanding this temporary disadvantage the average gain made for the period was a good one and at little cost for food. The average loss in weight per fowl caused by the necessary fasting and the operation was a little less than 11 per cent, not quite one-half pound each. The twelve capons in each lot were kept in one pen until January 1, and eight were fed in each lot for the rest of the winter.

### RELATIVE FOOD CONSUMPTION.

During the first few weeks the ground grain ration had somewhat the narrower nutritive ratio and for the remainder of the feeding trial somewhat the wider ratio. The food eaten during the six months by Lot No. I having the ground grain ration contained 52 pounds more dry matter than that eaten by Lot No. II, but almost exactly the same total gain in weight was made; the gains being 81 pounds and 80.6 pounds respectively. After January 1 the gain in weight was slow and there was very little difference in the amount of food consumed. For the first 16 weeks from September 10 to December 31 most of the difference in food consumption for the trial occurred. For this time the dry matter in the food was about 50.5 pounds more for Lot No. I and the gain made by this lot exceeded that made by the other by about 2.5 pounds.

### GAIN IN WEIGHT AND FOOD REQUIRED.

From September 10 to December 31 Lot No. I having the ground grain ration gained one pound in weight for every 6.5 pounds of water-free food consumed, and Lot No. II having the whole grain ration, gained one pound for every 6.0 pounds of water-free food. During the six months Lot No. I made a pound gain for every 8.06 pounds of water-free food consumed and Lot No. II one pound gain for every 7.45 pounds of water-free food.

### COST OF FOOD FOR GAINS MADE.

For the first four months the cost of food for each pound gain in weight made by Lot No. I was about 7.2 cents and for each pound gain made by Lot No. II 6.9 cents. For the six months the food cost per pound gain made by Lot No. I was 8.6 cents and for that made by Lot No. II was 8.3 cents.

FOOD EATEN BY CAPONS (LOT NO. I) FED GROUND GRAIN.

| PERIOD. | Average per Day per Fowl. | | | | | | | | | Approximate nutritive ratio. | Average gain in weight per fowl during period | Water-free food consumed for one pound gain in weight. | Water-free food per day for each 100 pounds live weight fed. | Cost of food for each pound gain in weight. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mixed grain.* | Ground oats. | Corn meal. | Skim milk. | Fresh bone. | Dried blood. | Total food. | Water-free food. | Total cost of food per day | | | | | |
| | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Cts. | | Ozs. | Lbs | Lbs | Cts. |
| Sept. 10 to Sept. 24 | 1.8 | 0.3 | 1 | 4.1 | 0.4 | 0.3 | 7.9 | 3.7 | 0.28 | 1:3.1 | 13.3 | 3.9 | 5.3 | 4.8 |
| Sept. 24 to Oct. 8 | 2.2 | .8 | 1.8 | 3.5 | .4 | .2 | 8.9 | 5 | .34 | 1:4.1 | 18.8 | 3.7 | 5.8 | 4.1 |
| Oct. 8 to Oct. 22 | 2.7 | .8 | 1.7 | 4.4 | .4 | .5 | 10.5 | 5.8 | .42 | 1:3.3 | 17.6 | 4.6 | 5.5 | 5.2 |
| Oct. 22 to Nov. 5 | 2.8 | 1.3 | 3 | 3.8 | .5 | .3 | 11.7 | 7 | .41 | 1:4.5 | 16.4 | 6 | 5.9 | 6. |
| Nov. 5 to Nov. 19 | 2.6 | .5 | 2.2 | 5.1 | .6 | .2 | 11.2 | 5.6 | .40 | 1:4.3 | 13.5 | 5.9 | 4.2 | 6. |
| Nov. 19 to Dec. 3 | 4.9 | .7 | 1 | 3.6 | .2 | .1 | 10.5 | 6.2 | .41 | 1:6 | 5.7 | 15.4 | 4.3 | 21. |
| Dec. 3 to Dec. 17 | 3.2 | .7 | 2.3 | 4 | .2 | .2 | 10.6 | 6 | .40 | 1:5.3 | 8.8 | 9.5 | 4 | 10. |
| Dec. 17 to Dec. 31 | 3.4 | .8 | 2.9 | 2.9 | .4 | ..... | 10.2 | 6.4 | .41 | 1:6.9 | 5.4 | 16.6 | 4.1 | 16. |
| Dec. 31 to Jan. 14 | 4.9 | .6 | 1.1 | 2.2 | .1 | ..... | 8.9 | 6.6 | .37 | 1:6.9 | 6 | 13.8 | 4 | 13. |
| Jan. 14 to Jan. 28 | 3.2 | .6 | 2.2 | 1.6 | .4 | ..... | 8 | 5.6 | .35 | 1:6.7 | 6 | 13 | 3.2 | 12.7 |
| Jan. 28 to Feb. 11 | 1.9 | .5 | 3 | 1.7 | .1 | ..... | 7.2 | 4.9 | .30 | 1:7.4 | 2.3 | ...... | 2.7 | ...... |
| Feb. 11 to Feb. 25 | 2.7 | .7 | 2.6 | .9 | .3 | ..... | 7.2 | 5.4 | .34 | 1:7 | 2.3 | ...... | 2.9 | ...... |
| Feb. 25 to Mar. 10 | 2.6 | .7 | 2.4 | 1 | .3 | ..... | 7 | 5.3 | .32 | 1:7 | 3.6 | ...... | 2.9 | ...... |

* Mixture No. 1 fed until November 10, No. 2 for remaining time.

FOOD EATEN BY CAPONS (LOT NO. II) FED WHOLE GRAIN.

| PERIOD. | AVERAGE PER DAY PER FOWL. | | | | | | | | | | Approximate nutritive ratio. | Average gain in weight per fowl during period. | Water-free food consumed for one pound gain in weight. | Water-free food per day for each 100 pounds live weight fed. | Cost of food for each pound gain in weight. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wheat. | Cracked corn. | Oats. | Barley. | Skim milk. | Fresh bone. | Dried blood. | Total food. | Water-free food. | Total cost of food per day. | | | | | |
| | Ozs. | Ozs. | Ozs. | Ozs. | Ozs | Ozs. | Ozs. | Ozs. | Ozs. | Cts. | | Ozs | Lbs. | Lbs. | Cts |
| Sept. 10 to Sept. 24 ........ | 1.2 | 0.9 | 0.5 | 0.3 | 3.4 | 0.4 | 0.1 | 6.8 | 3.2 | 0.25 | 1:5.6 | 9.6 | 4.7 | 4.9 | 5.9 |
| Sept. 24 to Oct. 8 ........ | 1.9 | 1.6 | .8 | .2 | 2.5 | .4 | .1 | 7.5 | 4.4 | .32 | 1:5.4 | 18.5 | 3.4 | 5.7 | 3.9 |
| Oct. 8 to Oct. 22 ........ | 1.7 | 1.8 | 1 | .6 | 3.7 | .4 | .3 | 9.5 | 5.3 | .40 | 1:4.2 | 19.1 | 3.9 | 5.5 | 4.7 |
| Oct. 22 to Nov. 5 ........ | 1.7 | 2.6 | .8 | .9 | 3.4 | .5 | .1 | 10 | 6 | .42 | 1:5.3 | 13.9 | 6.1 | 5.3 | 6.8 |
| Nov. 5 to Nov. 19 ........ | 1.7 | 1.9 | .4 | .3 | 5 | .9 | .1 | 10.3 | 4.9 | .38 | 1:5.1 | 9.3 | 7.4 | 4 | 9.2 |
| Nov. 19 to Dec. 3 ........ | 1.3 | 3.4 | .1 | .2 | 3.5 | .5 | .1 | 9.1 | 5.1 | .35 | 1:5.6 | 7.5 | 9.5 | 3.9 | 10.5 |
| Dec. 3 to Dec. 17 ........ | 1.7 | 3.3 | .5 | .2 | 3.5 | .6 | .1 | 9.9 | 5.8 | .40 | 1:5.7 | 9.3 | 8.8 | 4.1 | 9.7 |
| Dec. 17 to Dec. 31 ........ | 1.4 | 3.6 | .4 | .6 | 2.8 | .9 | ...... | 9.7 | 5.9 | .39 | 1:5.9 | 8.8 | 9.3 | 4 | 9.9 |
| Dec. 31 to Jan. 14 ........ | 1.4 | 3.8 | .3 | .3 | 3.6 | .4 | ...... | 9.8 | 5.6 | .37 | 1:6.3 | 5.8 | 13.6 | 3.5 | 14.6 |
| Jan. 14 to Jan. 28 ........ | 1.3 | 3.5 | .4 | .4 | 3.8 | 1.2 | ...... | 10.6 | 5.5 | .38 | 1:5.5 | 5.4 | 14.3 | 3.3 | 15.9 |
| Jan. 28 to Feb. 11 ........ | .8 | 5.6 | .5 | .4 | 3.9 | .1 | ...... | 11.3 | 6.8 | .43 | 1:6.9 | .9 | ....... | 4 | ...... |
| Feb. 11 to Feb. 25 ........ | .8 | 2.1 | .3 | .4 | 2.2 | .6 | ...... | 6.4 | 3.7 | .25 | 1:5.6 | 10.3 | 5.1 | 2.1 | 5.5 |
| Feb. 25 to Mch. 10 ........ | .4 | 4 | .3 | .6 | 1.9 | .6 | ...... | 7.8 | 5.2 | .31 | 1:6.5 | 3.6 | ....... | 2.9 | ...... |

### AGE AND SIZE RELATED TO GAINS.

Although the birds in one lot were of the same age as those in the other, the average size at the start was greater with Lot No. I, for the chicks in Lot No. I had grown the faster. The average weight of the cockerels at the start was about 3.9 pounds in Lot No. I and 3.7 pounds in Lot No. II. A difference in weight was generally maintained until the capons were fully grown, the average weight of 10 pounds being attained much sooner by Lot No. I, and also the average weight of 11 pounds several weeks sooner than by Lot No. II.

While the gain was made much of this time at less cost by the capons having the whole grain ration it was made by birds of smaller size; and although by capons of the same age a gain was made at less cost per pound under the whole grain ration it was not the case with birds of equal size.

In this feeding experiment, as in others, the cost of any increase in weight was greater as the birds approached maturity, the most profitable gains being made by the young birds under four pounds in weight.

### COST AT DIFFERENT AGES.

At five months of age the food from hatching for each bird in Lot No. I having the ground grain had cost 35.5 cents and for each bird in Lot No. II 34 cents; but the average weight was 8.1 pounds in Lot No. I and 7.5 pounds in Lot No. II. Up to 6½ months of age the average cost for food was, for Lot No. I, 54 cents and for Lot No. II 52.2 cents; but the average weight at this age was 10 pounds in Lot No. I and 9.5 pounds in Lot No. II.

In the accompanying tables will be found stated the cost of food up to different ages and weights.

COST OF FOOD TO GIVEN AGE AND WEIGHT OF CAPONS FED GROUND GRAIN AND WHOLE GRAIN.

| Lot No. I.—Ground Grain. | | | | | | Lot. No. II.—Whole Grain. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Age. | Average weight per fowl. | Average total cost of food per fowl up to weight given. | Average weight per fowl. | Average age. | Average total cost of food per fowl at weight given. | Age. | Average weight per fowl. | Average total cost of food per fowl up to weight given. | Average weight per fowl. | Average age. | Average total cost of food per fowl at weight given. |
| Mos. | Lbs. | Cts. | Lbs. | Mos. | Cts | Mos. | Lbs. | Cts. | Lbs | Mos. | Cts. |
| 3 | 3.6 | 12 | 5 | 3.7 | 17.7 | 3 | .... | 13.3 | 5 | .... | 19 |
| 3.5 | 4.6 | 16.3 | 5.5 | 3.8 | 19.9 | 3.5 | 5.2 | 19.5 | 5.5 | 4 | 22 |
| 4 | 6 | 21.9 | 6 | 4 | 21.9 | 4 | 5.5 | 22 | 6 | 4.2 | 24.3 |
| 4.5 | 7 | 27.5 | 6.5 | 4.3 | 24.7 | 4.5 | 6.7 | 27.5 | 6.5 | 4.4 | 26.6 |
| 5 | 8.1 | 35.5 | 7 | 4.5 | 27.5 | 5 | 7.5 | 34 | 7 | 4.7 | 30 |
| 5.5 | 8.9 | 41.4 | 7.5 | 4.7 | 30.9 | 5.5 | 8.1 | 40 | 7.5 | 5 | 34 |
| 6 | 9.4 | 47.8 | 8 | 4.9 | 34.7 | 6 | 8.7 | 46 | 8 | 5.4 | 38.7 |
| 6.5 | 10 | 54 | 8.5 | 5.2 | 37.8 | 6.5 | 9.5 | 52.2 | 8.5 | 5.8 | 43.7 |
| 7 | 10.5 | 60 | 9 | 5.6 | 42.8 | 7 | 10.1 | 58 | 9 | 6.3 | 48.5 |
| 7.5 | 10.9 | 65 | 9.5 | 6.1 | 49 | 7.5 | 10.4 | 63.5 | 9.5 | 6.5 | 52.2 |
| 8 | 11.1 | 70.2 | 10 | 6.5 | 54 | 8 | 10.7 | 69.8 | 10 | 6.9 | 57.2 |
| 8.5 | 11.3 | 75 | 10.5 | 7 | 60.1 | 8.5 | 11 | 73.5 | 10.5 | 7.7 | 65 |
| 9 | 11.5 | 79.5 | 11 | 7.7 | 66.8 | 9 | 11.3 | 79.2 | 11 | 8.5 | 73.5 |
| 9.5 | .... | 84.4 | 11.5 | 9 | 79.5 | 9.5 | 11.4 | 83.2 | 11.5 | 10 | 87.2 |
| .... | .... | .... | .... | .... | .... | 10 | 11.5 | 87.2 | .... | .... | .... |

## SECOND EXPERIMENT WITH CAPONS.

Two other similar lots of capons were also fed these contrasted rations for about five months. These were from a lot of young birds that had been hatched under hens and grown by the ordinary methods. The food and care had been alike for all until after the cockerels were caponized and separated for this feeding trial. The capons were of the same breeds used in the trials just reported. Record of feeding was not begun until some days after the cockerels were caponized. There were 12 capons in each lot until January 30, and then 8 for the rest of the trial. At the beginning of this trial the capons in the two lots averaged exactly alike in weight, a trifle less than 5½ pounds each.

### RATIONS.

Lot No. III was fed the ground grain ration like that fed to Lot No. I, and Lot No. IV was fed the whole grain ration like that fed to Lot No. II. With both rations the nutritive ratio was narrower at the commencement of the feeding trial and wider toward its close. The average nutritive ratio was the same for each lot.

### RELATIVE FOOD CONSUMPTION AND GAIN.

During the whole time of feeding, Lot No. III having the ground grain ration consumed 13.4 pounds more water-free food than Lot No. IV having the whole grain ration and gained 12 pounds more in weight. Lot No. III made one pound gain for every 8.3 pounds of water-free food consumed and Lot No. IV made one pound gain for every 10.1 pounds of water-free food.

During the last 8 weeks there was very slow increase in weight with both lots. During the first eleven weeks Lot No. III consumed 15 pounds more water-free food and made 3 pounds more gain in weight than Lot No. IV. One pound gain was made for every 6.8 pounds of water-free food by Lot No. III and one pound gain for every 6.9 pounds by Lot No. IV. The cost of food for each pound gain made by Lot No. III was 7.2 cents and for Lot No. IV, 7.8 cents.

FOOD EATEN BY CAPONS (LOT NO. III) FED GROUND GRAIN.

| PERIOD. | AVERAGE PER DAY PER FOWL. | | | | | | | | | Approximate nutritive ratio. | Average gain in weight per fowl during period. | Water-free food consumed for one pound gain in weight. | Water-free food per day for each 100 pounds live weight fed. | Cost of food for each pound gain in weight. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mixed grain* | Ground oats. | Corn meal. | Skim milk. | Fresh bone. | Dried blood. | Total food. | Water-free food. | Total cost of food per day. | | | | | |
| | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Cts. | | Ozs. | Lbs. | Lbs. | Cts. |
| Oct. 31 to Nov. 7 | 2.5 | 1.1 | 1.9 | 2.4 | 0.4 | 0.3 | 8.6 | 5.6 | 0.37 | 1:4 | 15.8 | 2.5 | 5.8 | 2.7 |
| Nov. 7 to Nov. 21 | 2.7 | .6 | 2.2 | 6 | .5 | .2 | 12.2 | 5.9 | .49 | 1:4.1 | 13 | 6.4 | 5.4 | 7.3 |
| Nov. 21 to Dec. 5 | 3 | .6 | 1.9 | 4.4 | .3 | .2 | 10 4 | 5.7 | .38 | 1:4.4 | 14.3 | 5.5 | 4.6 | 6 |
| Dec. 5 to Dec. 19 | 3.3 | .7 | 2.7 | 2.5 | .2 | .2 | 9.6 | 6.2 | .40 | 1:5.7 | 9 | 9.7 | 4.6 | 10.1 |
| Dec. 19 to Jan 2 | 4.7 | .6 | 1.9 | 2.1 | .2 | ...... | 9.5 | 6.1 | .38 | 1:6.8 | 7.2 | 12 | 4.3 | 12 |
| Jan. 2 to Jan. 16 | 4.2 | .7 | 1.1 | 2.1 | .1 | ...... | 8.2 | 5.4 | .34 | 1:6.8 | 6.7 | 11.3 | 3.6 | 11.3 |
| Jan. 16 to Jan. 30 | 2.5 | .7 | 2.4 | 1.8 | .2 | ...... | 7.6 | 5.1 | .32 | 1:6.7 | 5.5 | 13 | 3.3 | 13 |
| Jan. 30 to Feb. 13 | 2.4 | .8 | 3 | 1.5 | .1 | ...... | 7.8 | 6.4 | .34 | 1:7.1 | 4.8 | 16.3 | 4 | 16.1 |
| Feb. 13 to Feb 27 | 4.5 | .4 | 1 | 1 | .2 | ...... | 7.1 | 5.2 | .32 | 1:7.1 | 2.3 | ....... | 3.2 | ....... |
| Feb. 27 to Mar. 12 | 2.8 | .4 | 2.5 | .9 | .2 | ...... | 6.8 | 5.2 | .30 | 1:7.6 | 6.1 | 11.8 | 3 | 10.9 |

* Mixture No. 1 fed until December 5, No. 2 for remaining time.

FOOD EATEN BY CAPONS (LOT NO. IV) FED WHOLE GRAIN.

| PERIOD. | Average per Day per Fowl. | | | | | | | | | | Approximate nutritive ratio. | Average gain in weight per fowl during period. | Water-free food consumed for one pound grain in weight. | Water-free food per day for each 100 lbs. live wt. fed. | Cost of food for each pound gain in weight. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wheat. | Cracked corn. | Oats. | Barley. | Skim milk. | Fresh bone. | Dried blood. | Total food. | Water-free food. | Total cost of food per day. | | | | | |
| | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Cts. | | Ozs. | Lbs. | Lbs. | Cts. |
| Oct. 31 to Nov. 7...... | 2.3 | 2.2 | 0.4 | 0.8 | 2 | 0.5 | 0.3 | 8.5 | 5.8 | 0.42 | 1:4.5 | 9.8 | 4.1 | 6.3 | 4.8 |
| Nov. 7 to Nov. 21...... | 1.9 | 2.2 | .4 | .5 | 5.8 | .7 | .4 | 11.9 | 5.7 | .45 | 1:3.8 | 14.1 | 5.6 | 5.4 | 7.1 |
| Nov. 21 to Dec. 5...... | 1.9 | 3 | .3 | .3 | 3.9 | .7 | .1 | 10.2 | 5.7 | .41 | 1:5.1 | 12.7 | 6.3 | 4.9 | 7.3 |
| Dec. 5 to Dec. 19...... | 1.2 | 3.3 | .4 | .9 | 3.1 | .6 | ...... | 9.5 | 5.6 | .37 | 1:6.7 | 10.8 | 7.3 | 4.3 | 7.8 |
| Dec. 19 to Jan. 2...... | 1.5 | 3.2 | .4 | .1 | 2.7 | .7 | ...... | 8.6 | 5.2 | .35 | 1:6.1 | 5.7 | 12.8 | 3.8 | 13.8 |
| Jan. 2 to Jan. 16...... | 1.3 | 3.5 | .4 | .6 | 2.6 | .4 | ...... | 8.8 | 5.5 | .36 | 1:6.4 | 8.9 | 8.7 | 3.8 | 9.1 |
| Jan. 16 to Jan. 30...... | 1 | 2.4 | .4 | .6 | 3 | .7 | ...... | 8.1 | 4.5 | .31 | 1:5.5 | .8 | ....... | 3.8 | ....... |
| Jan. 30 to Feb. 13...... | 1.6 | 3.4 | .6 | .6 | 4.1 | .3 | ...... | 10.6 | 5.9 | .40 | 1:6.2 | 11.9 | ....... | 3 | ....... |
| Feb. 13 to Feb. 27...... | .6 | 3.9 | .7 | .7 | 2.6 | .6 | ...... | 9.1 | 5.7 | .36 | 1:6.2 | 4.6 | ....... | 3.5 | ....... |
| Feb. 27 to March 12...... | .9 | 4 | .3 | .4 | 2.3 | .6 | ...... | 8.5 | 5.4 | .34 | 1:6.4 | 5.4 | ....... | 3.3 | ....... |

## GENERAL REMARKS.

In these feeding trials all the fowls remained in good condition throughout, the capons as well as the young chicks, and no differences were noticeable in the general vigor. The birds in the two lots were fed from hatching up to weights of from 10 to 14 pounds each at ten months of age, the one lot having had no whole grain and the other lot no ground grain, without any difference being apparent except in the amount of food eaten and rapidity of growth.

At the prices of foods assumed for the season 1896 (mentioned on page 564) the ground grain ration gave the greater profit in general. There was a somewhat more profitable gain made for several months by the one lot of capons with the whole grain ration, but the birds were enough longer in reaching marketable maturity to make the profit greater with the contrasted lot.

The rations which contained only the ordinary foods, showed some of the usual differences in composition, but these differences were much less than usually exist between rations of whole and ground grain.

The capons marketed after the close of the feeding experiment sold readily at retail in the local market for 20 cents per pound. The loss of weight in dressing was small, being almost entirely due to the fasting necessary to empty the crop. At this price there was a good margin over the cost of food under either ration. The accompanying illustration is from a photograph of a number of these capons ready for market.

# REPORT

OF THE

# Department of Field Crops.

W. H. JORDAN, Sc. D., Director.
G. W. CHURCHILL, Agriculturist.

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# REPORT OF THE DEPARTMENT OF FIELD CROPS.

## I. THE OUTLOOK FOR THE SUGAR BEET INDUSTRY.*†

W. H. JORDAN.

### SUMMARY.

The following facts may be regarded as favorable to the successful production of beet sugar:

(1) The experience of 1897, so far as a single season can show, appears to demonstrate that our climatic and soil conditions are adapted to the growth of beets which are satisfactory in quantity and quality of yield.

(2) The cultivated lands of central and western New York may be so managed as to compete with any in the United States in those lines for which they are adapted.

(3) The ability of the American farmer to take up a new enterprise successfully is a helpful factor. American inventive genius may also be relied upon to provide implements necessary to cheap culture.

(4) At present there is an unlimited home market at good prices for all the sugar that can be produced; but it cannot be definitely known how long this condition may last.

(5) An added cash crop yielding fair returns is most desirable for our farmers.

The following facts must also be considered in connection with those preceding:

(1) To cultivate a plant so sensitive in regard to its content of sugar as the sugar beet requires such careful attention to details as is demanded by no other crop commonly grown on our farms.

*A reprint, largely, from an article in the *Country Gentleman*, Dec. 30, 1897.
†Partial reprint of Bulletin No. 135.

(2) There is danger of regarding exceptional yields as representing the average. An average of 12 tons of beets an acre for the first few years may be regarded as a fair average, if we are to judge by results secured in other places.

(3) There is danger that capital may be inefficiently directed in the erection of factories, as this is a line in which our eastern business men have had no experience. Beet-sugar manufacture should be entered upon with great caution and only after exhaustive study of the problems involved. Farmers should be cautious about taking stock in factories, unless the men who control the enterprises are personally known to and trusted by them.

(4) The question of home and foreign competition must not be ignored. Strong competition will come from the Pacific States until their soils become exhausted. We shall be brought into competition with the lower wages paid in Europe, if at any time the strong sentiment existing in favor of free sugar comes to find expression in tariff regulations.

Taking all facts into consideration, farmers may not expect to realize unusual profits for any long period of time from the growing of sugar beets. The crop promises to become one which will give satisfactory returns to those who learn to grow it successfully.

## FAVORABLE CONSIDERATIONS.

The forecasting of the future of any new industrial enterprise is a difficult matter. This is so because the conditions affecting production, manufacture, competition and market prices, which are sure to prevail for any length of time, cannot be definitely known; and the discussion now going on throughout the entire State of New York relative to the establishment of beet sugar factories in our midst deals with the usual number of indefinite factors.

The situation is such, however, that all who attempt to influence the public opinion should take a conservative position in this matter, one that will be justified by future events.

There are some facts which are regarded as favorable to a successful production of beet sugar. The experience which has been gained in the season of 1897 certainly indicates that our soils and climate are favorable to the growth of beets which are satisfactory in quantity and quality. Of course figures in great variety have been reported from a large number of experimental plats, varying from very low yields to those which are suspiciously high. The experience on the Station farm this year in the culture of two acres of beets indicates that by proper methods the best farmers may possibly produce in favorable seasons from 15 to 18 tons of high grade beets. The average crop will doubtless be considerably below this. It must be confessed, however, that one season's experience is not enough upon which to base final conclusions.

It is unquestionably true that the cultivated lands of central and western New York are capable of a high rate of production of almost anything which is adapted to the conditions there prevailing. These lands, managed by intelligent farmers, may compete with any in the United States, and this is entirely favorable to success in growing sugar beets, after it is established that the conditions are suitable to this crop.

The capacity of the American farmer is cited as an evidence of his probable success in whatever he undertakes. This is, certainly, a strong argument. In intelligence, industry and capacity to master the details of new methods, even expert methods, he is not excelled by the farmers of any civilized country. We may expect, moreover, that the inventive genius of American manufacturers will meet the farmer half way in providing the implements necessary to cheap culture.

The enthusiastic advocate of this new enterprise claims the certainty of an unlimited market for the sugar. It is true that we now buy from eighty to a hundred million dollars' worth of beet sugar from France, Germany and other countries, and so long as a protective tariff places the foreign producer at a disadvantage, we may reasonably expect to be able to sell at fair prices all the sugar we can produce for some time to come. Regarded with reference to the immediate future, this argument appears to have weight. The doubt here lies with the continuation of existing conditions.

It will be an undoubted gain, too, if we can add another cash crop to those which we already regard as yielding fair returns for the labor expended and a moderate rental for the land. Crops which find a steady sale at living prices are needed by the American farmer. Every new, successful crop also tends to prevent overproduction along other lines.

## THE OTHER SIDE.

There are many facts to be considered on the other side of this question, which, while not necessarily arguments against an attempt to produce and manufacture beet sugar in this State, nevertheless are worthy of the most careful attention.

In the first place, the sugar beet is a highly bred plant, sensitive, so far as content of sugar is concerned, to the conditions under which it is grown. The farmers who cultivate it successfully must be those who are willing to adhere faithfully to definite, careful methods. This does not mean that a minority of our farmers will not succeed, but that the average results are almost sure for a time to be disappointing, and it is average results which will determine the success of the business when broadly considered. Beet-sugar factories cannot be maintained unless the average experience of farmers in the growth of this crop is satisfactory.

We are greatly elated over the high percentages of sugar which have been found in New York beets this season, but we must bear in mind that high quality and a large production, as some regard production, are not consistent.

Some samples which have been sent to this Station for analysis have been accompanied by a statement that the crop of beets produced was at the rate of thirty tons per acre. It is probable, either that the method of estimating these crops was not a safe one, or that the beets were not properly grown. Erroneous and greatly excessive figures are very likely to result from computations based upon the theoretical possibility of growing a certain number of a certain size of beets per acre, or from the weight of a short section of a row of beets. Nothing short of the weighing of the entire actual product from a fairly extensive area will give safe figures.

The yield this year on the Station farm from a two-acre field was at the rate of sixteen and a quarter tons per acre, which quantity, after cutting off the top of the beet in the manner required at the factory, and making due allowance for dirt, was considerably reduced. This field of beets was on some of the best land the Experiment Station farm contains, and was given thorough cultivation and the best of care. The sugar content in this crop was very satisfactory.

It is significant that during the past five years the average production in Belgium, and also in Germany, has varied from about eleven to approximately thirteen and a half tons per acre. To be sure these are averages, and while averages are not a measure of what the best farmers may do, they are the standards by which, as before stated, the success of a business must be gauged. We should not expect the American farmer to do much better than the European farmer, where this industry has for a long time existed, especially at first. New York farmers, if they enter upon the production of sugar beets, will have occasion to congratulate themselves, if, for the first two or three years they reach an average of twelve tons of high grade product per acre. This is not necessarily a condemnation of the business.

We must remember still further that it is necessary for the farmer and the manufacturer to be mutually prosperous, and there certainly are some facts which seem to warrant careful consideration, by the farmer, of the manufacturer's side of the business.

There is great danger that much of the capital which is likely to be invested in this new enterprise will be inefficiently directed. The manufacture of beet sugar is something with which eastern business men have had no experience, and no careful study of means and methods will take the place of the knowledge which comes from experience. Disasters to capital which may cause losses to farmers are to be feared. It behooves business men, therefore, to proceed with the erection of beet-sugar factories with great caution and only after the most exhaustive study of the problems involved.

Doubtless farmers will be invited to invest in beet-sugar factory stock. They will be told not only that the stock will be profitable, but also that it is their duty to share in the risks. They should be very careful in this matter. If the professional boomer appears among them, they should give him a wide berth. He may be resourceful in plausible argument, and it may be hard to resist the fascination of his apparently sound reasoning; but unless the farmers resist his appeals, history will repeat itself, and shares of worthless stock will be very widely distributed among those who cannot afford to suffer the loss. This does not mean that under certain other conditions farmers may not wisely own a share of the factory. If local business men of unquestioned integrity and sound business judgment take the lead in the new enterprise—men who as the directors of banks and other financial organizations have won the confidence of the community by their successful and honorable methods—then perhaps the farmer may as safely entrust his money to them in this enterprise as in some others.

In discussing this matter we should ignore neither home nor foreign competition. The immense factory which Spreckels is erecting in the West to be sustained from cheap western fertility, is a significant beginning. Certainly if beet-sugar production and manufacture are at first unusually profitable we may expect to see this industry rapidly develop to a condition of the usual competition.

Prof. Brooks, of Massachusetts, has recently pointed out the fact that we can hardly compete with the lower wages paid in foreign countries, but he failed to note that the necessary fuel and limestone are much cheaper in the United States than in France and Germany. Probably European producers will have no advantage over us so long as we have a protective tariff, but we know how strong a sentiment there is in this country in favor of free sugar, and political revolutions are likely to make changes in the tariff conditions affecting this commodity. It seems probable, though, that the existence of a new industry in the early stages of successful development might modify or prevent legislation that would otherwise take place.

There is, however, a law of compensation operating in the world's industries to which we must give proper weight. We cannot safely leave out of account the rest of the world in estimating what may be done through a period of years along any line of production. It is a narrow view which only discovers that we are not producing our own sugar.

## CONCLUSIONS.

What conclusions, then, shall we draw from all these facts and conditions? It seems very probable that farmers will not realize unusual profits for any extended period of time from sugar-beet growing. The facts appear to justify the belief, however, that this crop may come to rank among those which for some time will be regarded as giving satisfactory returns. It will be a business of moderate profits and one that will not spring into uninterrupted success. If it is a success at all, it will become so by growth through education and experience. Above all, the manufacturer must guard the interests of the farmer, and the farmer must be able to have confidence in the manufacturer, and both must have a patient faith in the final triumph of intelligent means and reliable, conservative methods of management.

# II. THE STATION EXPERIMENTS WITH SUGAR BEETS.*

G. W. CHURCHILL.

## SUMMARY.

(1) Soil used. The soil was a heavy clay loam, in good condition of fertility and cultivation.

(2) Planting, cultivation and harvesting. The land was ploughed and subsoiled 14 inches deep on May 7 and 8. Commercial fertilizer was applied at the rate of 950 pounds an acre. The surface was given careful preparation and the seed sown on May 17 at the rate of 15 pounds an acre. About June 1 the rows of plants were distinguishable and a hand cultivator was run through them, which was soon followed by hoeing and partial thinning. On June 15 a horse cultivator was used and the final thinning commenced. This was followed by two more cultivations. Harvesting began September 22.

(3) Cost of crop. On a basis of wages commonly paid for labor, the cost amounted to $75.80 an acre; on a basis of cheaper labor, the cost was $54.30.

(4) Yield. The yield was 32,548 pounds an acre or about 16¼ tons. For 1,000 pounds of beets, the loss of weight caused by cutting off the crowns was 73 pounds; and the loss of weight caused by washing off the dirt was 49 pounds. This would make a yield of marketable beets equal to 15.1 tons an acre.

(5) Size and composition. The average weight was 12 ounces. The beets contained 15.2 per cent sugar, equivalent to 16 per cent sugar in juice, having a coefficient of purity equal to 81.

(6) Influence of fertilizer. The yield was increased about 6 tons an acre by the use of fertilizer.

*Partial reprint of Bulletin No. 135.

## SOIL, PLANTING AND CULTIVATION.

The field selected for the experiment with sugar beets is a clay loam bordering on what is usually termed heavy, having a tendency to "puddle" when overcharged with moisture, and to cake or crust over when quickly dried by a hot sun and wind. If not disturbed in times of drought it will soon seam or crack open.

These features are characteristic of a large portion of the farm lands of this section, and render the growing of small seed crops more difficult and expensive than on sandy or porous loams.

From a farmer's point of view, this soil would be considered to be in a good state of cultivation and fertility. The crops in the rotation that have been grown on it during the past ten years have yielded fully up to, if not above, the average of the farm lands in this section of the State.

The two-acre plat which was selected had been used for fertilizer experiments with potatoes in 1896.

On May 7 and 8 the land was ploughed and subsoiled to the depth of fourteen inches, and the surface was worked down with springtooth harrow, followed by a Thomas smoothing harrow, and finished by rolling.

On May 11, after working down with the springtooth harrow, and before smoothing, 950 pounds per acre of the following mixture of commercial fertilizers was sown broadcast:

| | |
|---|---|
| Sulphate of potash | 250 pounds, 50 per cent $K_2O$ |
| Acid rock | 300 pounds, 14 per cent $P_2O_5$ |
| Dried blood | 200 pounds, 10 per cent N. |
| Nitrate of soda | 200 pounds, 15 per cent N. |
| Total | 950 pounds. |

After the fertilizer had been sown and thoroughly worked in, the ground was smoothed and rolled. A marker to be drawn by one horse was then constructed from an old corn marker so that five rows could be lined out at one time, at a distance of twenty inches apart.

The teeth were fitted at the bottom with shoes about eighteen inches in length and three inches deep, made from one and one-half inch plank. These were fastened by cutting a notch out of the bottom of the tooth one and one-half inches wide and about three inches deep. Holes were bored through the teeth at right angles to the shoes. Bolts passing through these holes and a corresponding hole in the shoe fastened the latter and the tooth together. The first plan for having the shoes work freely on the bolts as pivots was modified by nailing beveled blocks or the back of the teeth just above the shoes, making them stationary. The difficulty encountered in the loose shoe was that when any resistance was met by the forward part, it would tip down, and in digging into the soil raise the rear end out of the ground, thus throwing the whole marker out of line. After this change the marker, though crude, worked to our entire satisfaction, making a mark about one inch deep and two inches wide, which could be followed with ease by the seeder.

After seeding six rows an unexpected and very heavy shower of rain so saturated the ground that it was impossible to continue the work until May 17.

It was a mistake to completely fit the entire plat before commencing to sow the seed, for we were obliged to again harrow and roll the ground before seeding could be resumed. The only safe way is to prepare the ground as needed, thus avoiding the extra expense of re-working after every rainfall.

Another mistake was made which was a source of annoyance throughout the season. Because of haste to complete the seeding as soon as possible, the small stones scattered over the plat were not picked. While these did not affect the growth of the beets, they were a hindrance in seeding, and, later, in the cultivation of the crop. It would have been economy in the end if they had been removed. Any obstruction in the way of the seeder will give it a jerky motion which will bunch the seed. The motion should be smooth and continuous in order to allow an even distribution of seed. Later the stones interfered with hand and horse cultivation and more or less with hoeing and thinning the beets.

The seed was sown with an "Improved Model" Mathews hand drill. It was found that by attaching the ends of a rope to the seeder, and fastening a short strap to this, making a device similar to a "breast collar" used in single harness, that two men, one to draw and the other to push and guide the seeder, could accomplish more than double the work of one man alone, and with greater ease and efficiency. Doubtless seeders will be used that will sow several rows at one time.

With the exception of six rows sown at an earlier date, two men sowed the two-acre plat in eight hours. The only fault that could be found with the seeding was the bunching of the seed in places where small stones or clods were encountered by the drill, causing it to slacken motion or to stop altogether. When this happened, several seeds were dropped within a very small compass, and before the seed commenced flowing again the machine had moved along, leaving a space without any seed.

Fifteen pounds of seed were sown to the acre. The ground was moist and in good condition for promoting quick germination, and vegetation commenced in about ten days from the time of seeding. About June 1 the plants were large enough for the rows to be easily distinguished and the hand cultivator was started, the machine used being a "Buckley," having several combinations of blades.

The arrangement that was found to work to the best advantage at this time was a broad V-shaped blade set in the center of the frame in front, and two smaller ones set on the right and left sides of the frame well to the rear of the machine. These latter are flat pieces of steel sharpened on the edges, and made to form a right-angle turned so that the points extend toward the center of the row, and as they are about eight inches in length they nearly meet in the middle, forming what is commonly termed a "a scarifier." One advantage of this form of blade is that the crust can be broken very near to the young plants without throwing the dirt over them. Soon after this cultivation, hoeing and the first or partial thinning were commenced. For the work of partial thinning the blades of ordinary hoes were cut down to four inches.

By cutting across the row with such a hoe, bunches were left which could be thinned, leaving the plants from six to nine inches apart. At the same time the soil was loosened around the plants and all of the weeds removed.

On June 15 the beets were cultivated with a one-horse Syracuse harrow-tooth cultivator, and the final thinning commenced.

It was intended to have the beets left eight inches apart in the rows. It was found necessary in some cases, however, to vary these distances on account of the spaces left by the seeder, and in order to preserve the strongest plants.

After the final thinning, the beets received another cultivation to loosen the ground, as it had become more or less compacted by rain and the passing of the men while thinning. After this but one more cultivation with the horse cultivator was given, for the beet tops covered the ground to such an extent that a horse could not pass through without doing serious damage. The subsequent hand labor was small, and would not have been considered necessary by many growers, but in order to adhere to strictly clean culture, men were sent through the field once to pull the weeds that had escaped previous cultivation. This consumed less than one day's time for two men, and at the time of harvesting the crop the field was entirely clear of weeds.

## HARVESTING AND RESULTS.

The harvesting of the beets began on September 22. Two methods were tried; first, plowing three furrows for each row, the third furrow turning out the beets, and plowing two furrows for each row, after which the beets were pulled by hand. The last named method seems preferable where the beets do not have too long tap roots, because in the first method the small beets are covered by the furrow and it is more work to uncover them by hand than it is to pull them out when they are standing upright and in plain sight.

As the beets were pulled out they were thrown in heaps, and men followed aud cut off the tops. The harvesting, which includes pulling, topping and hauling, was found to be the most expensive operation connected with the growing of this crop.

It should be borne in mind that the very best of culture was given throughout the season and no expense spared in either hand or team labor, and that a liberal allowance has been made in all cases wherever estimates were necessary. Some mistakes were also made which were costly, and which can be avoided in the future. On the whole, therefore, it is probable that these figures err on the side of too great cost, and that with the experience gained in this season's work, we can cheapen the cost of growing an acre of beets quite materially.

In the table below we give the cost of growing one acre of sugar beets, based on hand labor at $1.25 per day for hoeing and thinning, and team at $3.50 per day; and on hand labor at $0.75 and team at $3.00:

Cost Per Acre of Growing Sugar Beets.

| | Expensive labor. | Cheap labor. |
|---|---|---|
| Fitting ground | $7 00 | $6 00 |
| Sowing fertilizer | 1 12 | 1 12 |
| Sowing seed | 1 25 | 1 25 |
| Hoeing, thinning and weeding | 23 43 | 13 88 |
| Harvesting | 24 25 | 14 80 |
| Horse cultivation | 2 00 | 2 00 |
| Hand cultivation | 3 75 | 2 25 |
| Seed | 3 00 | 3 00 |
| Fertilizer | 10 00 | 10 00 |
| Total | $75 80 | $54 30 |

Doubtless these figures will be criticised on the ground that they are too high, but it is probable that, if careful accounts were kept by one hundred farmers of the cost of everything connected with the growing and delivery to the factory of one acre of properly grown sugar beets, the average would not fall below $50.00, with the present methods and machinery at the command of the grower.

The yield per acre, as harvested, was 32,548 lbs., or approximately 16¼ tons.

In order to determine the actual yield of perfectly clean beets, topped as they would be when sent to the factory, a lot weighing

1,000 lbs. was thoroughly washed and dried, after which the crowns were removed.

| | |
|---|---|
| Weight of beets taken | 1000 pounds. |
| Loss by washing | 49 pounds. |
| Weight of crowns | 73 pounds. |
| Weight of washed beets without crowns | 878 pounds. |

At this rate the yield of topped, washed beets was 14 tons 577 lbs.; of topped, unwashed beets 15 tons 200 lbs. At $4 per ton the returns per acre would not be over $60.

The shape of these beets was very satisfactory. With but few exceptions, they were symmetrical and sent down a tap root to a good depth.

The average size was rather small, being not over three-fourths of a pound. This was the result of close planting, as the average distance between the beets was probably less than eight inches. The beets grew wholly in the ground, no special precautions being necessary to secure this result excepting the subsoiling. A careful chemical examination of these beets gave the following results:

| | |
|---|---|
| Sugar in beets | 15.2 per cent. |
| Sugar in juice | 16 per cent. |
| Coefficient of purity | 81 |

According to these figures about 12 lbs. of sugar could actually be made from 100 lbs. of washed topped beets. This shows that the yield of manufactured sugar from the Station farm would be 3,429 lbs. per acre.

An observation was made on the value of an application of commercial fertilizer in sugar beet growing. The plat from which the two acres of ground was measured for the experiment recorded contained an additional area of four-fifteenths of an acre. This ground was prepared with the two-acre plat and received the same treatment, except that it was not fertilized in any way. The seed was sown at the same time and the crop received the same treatment, only that it was the last to be reached in thinning. From the start a marked difference was noticed in favor of the fertilized plants. The young plants did not vegetate so quickly on the unfertilized plat, and afterwards they were not so vigorous as on the fertilized area.

The yield of beets on the unfertilized portion of the field was between 7½ and 8 tons per acre, which shows that the fertilizer caused an increase of at least 6 tons of beets. At four dollars per ton this increase would pay for at least twice the amount of fertilizer used.

# III. COMMERCIAL FERTILIZERS FOR POTATOES.*

W. H. JORDAN.

## SUMMARY.

In experiments on four farms including eight acres of land and eighty plats, the production of potatoes from the application of 500 pounds, 1,000 pounds, 1,500 pounds, and 2,000 pounds of commercial fertilizer per acre was ascertained.

(1) The use of 1,000 pounds of fertilizer per acre gave the greatest profit. The slightly larger yield caused by increasing this application to 1,500 or 2,000 pounds, cost in fertilizer expense considerably more than the market value of the potatoes.

(2) The fertilizer cost of the increased yield of potatoes where 500 or 1,000 pounds of fertilizer was used per acre was 20 cents per bushel in those experiments that proceeded without unfortunate conditions.

(3) The yield of tubers from the L. I. formula was somewhat larger than from a formula compounded with reference to the composition of the potato plant.

(4) The evidence obtained in these experiments concerning the relative effect of the muriate and the sulphate of potash upon the composition of the potato tuber is inconclusive.

(5) The proportions of the valuable plant-food compounds found in the potato tubers were not influenced appreciably by the amount or kind of fertilizer used.

## INTRODUCTION.

The economical purchase and use of commercial plant food is at present one of the very complex problems of Agriculture. This is especially the case where intensive methods of culture are followed and where the larger part of the materials needed for the production of crops must be obtained from some source outside the soil.

*Reprint of Bulletin No. 137.

There are at least three important factors which should be considered in an attempt to buy and use commercial fertilizers with profit.

(1) The quantity of fertilizer to be applied should receive careful consideration. Where a rapid rotation of crops is followed, with severe cropping, this amount should not exceed that which is necessary to secure the maximum *profitable* increase of the immediate crop. The largest possible crop is not necessarily the most profitable and a great excess of unused available plant food, especially of nitrogen, at the end of the growing season does not conduce to economy.

(2) The fertilizer should be purchased, so far as possible, with reference to both soil deficiencies and the needs of the crop. As a rule the soil is the controlling factor.

(3) The fertilizer applied should be one that will promote the highest quality in the crop to be grown.

With our present knowledge it is easier to state these principles than to point out their application to specific cases, and much of the experimental work now being conducted in the field of plant nutrition is directed towards answering the questions which relate to these fundamental considerations.

The farmers of Long Island are especially interested in all that pertains to commercial fertilizers. In no part of New York are these manures more largely purchased in proportion to the acreage of tilled land, and in but few localities do the conditions so fully justify the very large money expenditure which this involves. In the first place these farmers are in close proximity to one of the world's largest markets, requiring an enormous supply of market-garden and forcing-house products. Land so situated must be worked intensively, which requires a liberal and continuous use of manures. In the second place, much of the soil in this locality does not possess great original fertility. Its natural supply of available plant food is small, even with the best of culture. Long Island farmers are obliged, therefore, to go to the markets for a large part of the plant food which they need in such generous quantities. An outlay of $800 to $1,000 for commercial manures on a farm of forty or fifty acres is not unusual. It is probable, therefore, that in this locality there is no direction which offers so promising an opportunity for the practice of economy.

### The Quantity of Fertilizer.

It is fair to inquire, first of all, whether the quantity of fertilizers which is used on Long Island farms is not often excessive. In many instances as much as one ton of high grade superphosphate is used per acre. Potato growers often fertilize their land at this rate. Is this profitable? The results of two years' experiments reported by Dr. Van Slyke, in Bulletins Nos. 93 and 112, indicate that it is not, when only the immediate crops are considered. In these experiments three quantities of fertilizer were applied, viz., 1,000 lbs., 1,500 lbs. and 2,000 lbs. per acre and in every instance the largest profits resulted from the use of 1,000 lbs. Slightly larger crops were obtained with 2,000 lbs. than with 1,000 lbs. of fertilizer, but the greater yield from the former quantity did not equal the greater cost. Moreover, the second year's effect of the different quantities of fertilizer, although quite marked, was practically the same with 1,000 lbs. and with 2,000 lbs.

These facts are not surprising when we consider the quantities of plant food which are applied to the soil in one ton of fertilizer as compared with the amounts of nitrogen, phosphoric acid and potash actually removed by a fairly large potato crop. Assuming that the tops are returned to the soil, the average of analyses herewith reported shows that a potato crop of 200 bushels removes from the soil about 36 lbs. nitrogen, 13 lbs. phosphoric acid and 60 lbs. potash.

If the fertilizer used is made after the formula so commonly in favor on Long Island, viz., 4 per cent N, 8 per cent $P_2O_5$ and 10 per cent $K_2O$, the needs of the crop and the plant food supplied by 2,000 lbs. would compare as follows:

INGREDIENTS APPLIED IN FERTILIZER AND REMOVED BY TUBERS.

| | Nitrogen. | Phosphoric acid. | Potash. |
|---|---|---|---|
| | Pounds. | Pounds. | Pounds. |
| Contained in fertilizer | 80 | 160 | 200 |
| Removed by tubers | 36 | 13 | 60 |
| Excess in fertilizer | 44 | 147 | 140 |

Of course much larger crops of potatoes are sometimes raised, but it would seldom be the case that the increase of crop over what the soil would produce with no fertilizer would exceed 200 bushels. In fact that is probably more nearly an average total crop, and when we take into consideration what the soil itself will furnish of plant food, it becomes a serious question, even if considered wholly from the theoretical standpoint, without the aid of experimental evidence, whether the constant addition to the soil of such an excess of the valuable manurial ingredients is profitable. It is certainly of the highest importance that farmers shall learn the truth in regard to this matter.

## EXPERIMENTS ON LONG ISLAND.

### THE EXPERIMENTS NOW IN PROGRESS.

The ultimate effect of any system of fertilizing the soil cannot be ascertained without a long and continuous series of observations on the same piece of land. It is entirely possible that while the application of a ton of fertilizer per acre would not be warranted by the returns from a single crop, the larger returns throughout an entire rotation might justify it. In view of these facts, the present series of fertilizer experiments has been planned with reference to their continuance for a period of years sufficiently extended to form the basis of safe conclusions. The possible large errors in plat experimentation are clearly recognized, but it is believed that with the precautions which are taken to minimize these errors they certainly cannot obscure any important effect of a particular system of manuring the land.

## The Questions Asked of the Experiment.

The main object of this experiment is to get information in regard to the profitable quantity of fertilizer to be used, but there are certain incidental problems which may be studied in connection with the main one without diverting the work from its chief purpose.

Three questions are asked, therefore:

(1) What is the profitable amount of commercial fertilizer to apply in potato growing?

(2) Shall we apply plant food in the proportions used by the potato plant or in some other?

(3) Is the sulphate of potash preferable to the muriate for use in growing potatoes?

## The Fertilizers Used.

The purposes of this experiment require the use of four different mixtures of fertilizing materials, the ingredients and actual composition of which are given below.

*Formula No. 1.*—This formula is supposed to contain plant food in nearly the proportions used by the entire potato plant excepting that the phosphoric acid is in considerable excess; and was mixed as follows:

Potato Formula A.

| *Ingredients.* | | *Composition.* | |
|---|---|---|---|
| Nitrate of soda....... | 192 pounds. | Nitrogen .......... | 6.6 per cent. |
| High grade dried blood | 800 pounds. | Available phos. acid | 4.75 per cent. |
| Acid phosphate....... | 570 pounds. | Potash ............ | 10.31 per cent. |
| Muriate of potash..... | 400 pounds. | | |
| Land plaster.......... | 38 pounds. | | |
| | 2000 pounds. | | |

*Formula No. 2.*—This formula was intended to contain the same percentages of the three ingredients as Formula No. 1, the only difference being that the potash is supplied as the sulphate instead of the mutriate.

POTATO FORMULA B.

| Ingredients. | | Composition. | | |
|---|---|---|---|---|
| Nitrate of soda....... | 192 pounds. | Nitrogen .......... | 6.5 | per cent. |
| High grade dried blood | 800 pounds. | Available phos. acid | 4.9 | per cent. |
| Acid phosphate....... | 570 pounds. | Potash ............ | 10.1 | per cent. |
| Sulphate of potash.... | 400 pounds. | | | |
| Land plaster.......... | 38 pounds. | | | |
| | 2000 pounds. | | | |

*Formula No. 3.*—This formula is an imitation of the one so commonly followed by clubs of farmers on Long Island who purchase their fertilizers on the coöperative plan.

L. I. FORMULA A.

| Ingredients. | | Composition. | | |
|---|---|---|---|---|
| Nitrate of soda....... | 127 pounds. | Nitrogen .......... | 3.8 | per cent. |
| High grade dried blood | 440 pounds. | Available phos. acid | 8.0 | per cent. |
| Acid phosphate....... | 1000 pounds. | Potash ............ | 10.4 | per cent. |
| Muriate of potash..... | 400 pounds. | | | |
| Land plaster.......... | 33 pounds. | | | |
| | 2000 pounds. | | | |

*Formula No. 4.*—This formula is similar to No. 3, except that the potash is supplied as the sulphate instead of the muriate.

L. I. FORMULA B.

| Ingredients. | | Composition. | | |
|---|---|---|---|---|
| Nitrate of soda....... | 127 pounds. | Nitrogen .......... | 4 | per cent. |
| High grade dried blood | 440 pounds. | Soluble phos. acid.. | 8.4 | per cent. |
| Acid phosphate....... | 1000 pounds. | Potash ............ | 9.2 | per cent. |
| Sulphate of potash.... | 400 pounds. | | | |
| Land plaster.......... | 33 pounds. | | | |
| | 2000 pounds. | | | |

It was intended that approximately one-fourth of the nitrogen furnished by these mixtures should be nitric, and three-fourths organic nitrogen. The manufacturers who mixed the fertilizer were also instructed that the phosphoric acid should be as largely soluble as possible. The analyses of the four mixtures showed that these conditions were secured.

## THE AREA AND ARRANGEMENT OF PLATS.

The total area under experimental treatment is eight acres, divided into eighty plats of one-tenth acre in size.

This area is distributed equally on four farms, the arrangement of the plats and amounts and kinds of fertilizers being the same in each case.

### FERTILIZERS APPLIED ON PLATS.

| | |
|---|---|
| Plat No. 1, no fertilizer. | Plat No. 11, no fertilizer. |
| Plat No. 2, 500 lbs., formula No. 1. | Plat No. 12, 500 lbs., formula No. 3. |
| Plat No. 3, 1000 lbs., formula No. 1. | Plat No. 13, 1000 lbs., formula No. 3. |
| Plat No. 4, 1500 lbs., formula No. 1. | Plat No. 14, 1500 lbs., formula No. 3. |
| Plat No. 5, 2000 lbs., formula No. 1. | Plat No. 15, 2000 lbs., formula No. 3. |
| Plat No. 6, no fertilizer. | Plat No. 16, no fertilizer. |
| Plat No. 7, 500 lbs., formula No. 2. | Plat No. 17, 500 lbs., formula No. 4. |
| Plat No. 8, 1000 lbs., formula No. 2. | Plat No. 18, 1000 lbs., formula No. 4. |
| Plat No. 9, 1500 lbs., formula No. 2. | Plat No. 19, 1500 lbs., formula No. 4. |
| Plat No. 10, 2000 lbs., formula No. 2. | Plat No. 20, 2000 lbs., formula No. 4. |

## LOCATION AND MANAGEMENT OF THE EXPERIMENT.

Land is leased of four farmers:

W. A. Fleet, Cutchogue; W. L. Jagger, Southampton; H. L. Hallock, Jamesport; R. H. Robbins, East Williston.

Arrangements have been made with Mr. Fleet to give general supervision to the experiments on all these farms; and with each farmer, to do the necessary work.

The following directions for conducting the experiments were placed in Mr. Fleet's hands:

### DIRECTIONS FOR FIELD EXPERIMENTS WITH FERTILIZERS.

1. Select about two acres of land that is as uniform in character as possible, and which has received no manure for several years (run-out land if you have it).

2. Before the plats are laid out plow the whole piece, and pulverize thoroughly.

3. Make the size of each plat one-tenth of an acre.

4. Measure off the plats and drive permanent stakes at each corner, leaving a strip of land two feet wide between the plats. If the land is inclined, the length of the plats should be up and down the slope.

5. Number the plats from 1 to 20.

6. Put no fertilizer on plats 1, 6, 11 and 16, and no fertilizer on any plat except that contained in the bags.

7. Put the fertilizers on the plats numbered to correspond to the numbers on the bags. Put bag No. 2 on plat No. 2, etc., etc.

8. Apply the fertilizers in the method which you have practiced.

9. Make the same number of rows on each plat, with the same number of hills in each row if possible.

10. Put the same amount of the same kind of seed on each plat.

11. Plant the seed (or sow) on the same day on all the plats, if possible.

12. Cultivate the plats while the crop is growing, as nearly at the same time as possible.

13. Spray the crop as needed to prevent insect and fungous pests.

14. Weigh the crop carefully on each plat—both grain and straw if grain is sown, both corn and fodder if corn is planted (that is, find weight of grain and straw separately) or both large and small potatoes.

15. Carefully report any misfortune to the crop on any plat, and keep a record of the appearance of each plat.

## CONDITIONS AFFECTING THE EXPERIMENTS.

These experiments were subject to certain unfortunate conditions which rendered the results on at least two farms of less value than otherwise would have been the case. In the first place the seed proved to be somewhat inferior and as a result the plants were tardy in establishing vigorous growth, being somewhat sickly in appearance at first. Later the dry weather, early blight and the rot also entered as disturbing factors. These several conditions, one or all combined, greatly diminished the accuracy of the data from the experiments on Mr. Robbins' and Mr. Jagger's farms, so that conclusions derived from Mr. Fleet's and Mr. Hallock's experiments are more reliable than the average results from the four farms. The following data are important:

*Crop preceding the experimental crop.*—Experiment of W. A. Fleet, corn stubble; H. L. Hallock, timothy sod; W. L. Jagger, timothy sod; R. H. Robbins, corn stubble.

*Care of crop.*—W. A. Fleet sprayed six times, H. L. Hallock five times, R. H. Robbins twice, and W. L. Jagger once. All the fields were well cultivated and kept free from weeds.

*Growth of vines.*—Vines weak at first, some hills missing. On July 3 vines green and healthy, excepting on farm of Mr. Robbins where they seemed to have about finished growing and were inclined to ripen.

August 7, vine growth improved, excepting on Robbins' field where the vines were about dead.

The fertilizers had a marked effect on the size of the vines. On the plats receiving 500 lbs. of fertilizer per acre they were 1½ to 2 times larger than on the plats with no fertilizer. Those from 1,000 lbs., 1,500 lbs. and 2,000 lbs. of fertilizers per acre did not differ in sizes and were about three times as large as on the unfertilized plats.

In one instance the vines from the "potato formula" were darker green than from the "L. I. formula" and in two other cases the "L. I. formula" caused the vines to grow one-fourth larger.

*Prevalence of disease.*—On Mr. Fleet's and Mr. Hallock's farms the vines were healthy with very little blight or rot. Either dry weather caused premature ripening of Mr. Robbins' potatoes or else the early blight killed the vines. Mr. Jagger's crop was badly affected by rot.

## Results of the Experiments.

In order to answer the questions asked of this experiment, both the weight and composition of the product must be known. In the several tables of figures given herewith can be found a statement of the yield of potatoes from the different mixtures and amounts of fertilizers and also the content in dry matter, starch and the important plant food constituents of the potatoes grown by Messrs. Fleet and Hallock.

Table I. Yield of potatoes on tenth acre plats.

Table II. Average yield of potatoes per acre from different amounts of fertilizer.

Table III. Partial composition of potatoes.

TABLE I.—YIELD OF POTATOES ON ONE-TENTH ACRE PLATS.

| FERTILIZER. | No. of plat. | Amount of fertilizer per acre. | Potatoes on Plats on Farms of | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | William A. Fleet. | | | H. L. Hallock. | | | W. L. Jagger. | | | R. H. Robbins. | | |
| | | | Large. | Small. | Total. | Large. | Small. | Total. | Large. | Small. | Total. | Large. | Small. | Total. |
| | | Formula 1. Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. |
| Potato formula A | 1 | 0 | 559 | 77 | 636 | 311 | 277 | 588 | 93 | 55 | 148 | 504 | 62 | 566 |
| | 2 | 500 | 698 | 79 | 777 | 453 | 274 | 727 | 178 | 115 | 293 | 520 | 66 | 586 |
| | 3 | 1,000 | 884 | 70 | 954 | 650 | 214 | 864 | 207 | 84 | 291 | 401 | 70 | 471 |
| | 4 | 1,500 | 1,085 | 78 | 1,163 | 676 | 120 | 796 | 363 | 131 | 494 | 501 | 85 | 586 |
| | 5 | 2,000 | 1,082 | 78 | 1,160 | 595 | 247 | 762 | 257 | 96 | 353 | 449 | 70 | 519 |
| | | Formula 2. | | | | | | | | | | | | |
| Potato formula B | 6 | 0 | 544 | 94 | 638 | 235 | 233 | 468 | 115 | 67 | 182 | 452 | 60 | 512 |
| | 7 | 500 | 772 | 75 | 847 | 415 | 247 | 662 | 180 | 90 | 270 | 430 | 90 | 520 |
| | 8 | 1,000 | 1,067 | 82 | 1,149 | 773 | 248 | 1,021 | 171 | 91 | 262 | 411 | 128 | 539 |
| | 9 | 1,500 | 1,165 | 71 | 1,236 | 687 | 122 | 809 | 225 | 94 | 319 | 523 | 102 | 625 |
| | 10 | 2,000 | 1,188 | 80 | 1,268 | 810 | 284 | 1,094 | 207 | 56 | 263 | 386 | 72 | 458 |
| | | Formula 3. | | | | | | | | | | | | |
| L. I. formula A | 11 | 0 | 713 | 105 | 818 | 367 | 317 | 684 | 39 | 32 | 71 | 456 | 70 | 526 |
| | 12 | 500 | 980 | 119 | 1,099 | 570 | 230 | 800 | 137 | 96 | 233 | 618 | 81 | 699 |
| | 13 | 1,000 | 1,035 | 132 | 1,167 | 790 | 199 | 989 | 219 | 131 | 350 | 674 | 88 | 762 |
| | 14 | 1,500 | 1,176 | 100 | 1,276 | 701 | 233 | 934 | 258 | 125 | 383 | 713 | 90 | 803 |
| | 15 | 2,000 | 1,180 | 123 | 1,303 | 813 | 156 | 969 | 320 | 129 | 449 | 753 | 68 | 821 |
| | | Formula 4. | | | | | | | | | | | | |
| L. I. formula B | 16 | 0 | 767 | 179 | 946 | 396 | 254 | 650 | 137 | 140 | 277 | 507 | 65 | 572 |
| | 17 | 500 | 1,005 | 136 | 1,141 | 656 | 237 | 893 | 214 | 133 | 347 | 697 | 81 | 778 |
| | 18 | 1,000 | 1,140 | 88 | 1,228 | 870 | 180 | 1,050 | 275 | 124 | 399 | 715 | 80 | 795 |
| | 19 | 1,500 | 1,170 | 91 | 1,261 | 953 | 125 | 1,078 | 287 | 108 | 395 | 718 | 92 | 810 |
| | 20 | 2,000 | 1,080 | 81 | 1,161 | 1,004 | 135 | 1,139 | 300 | 96 | 396 | 661 | 73 | 734 |

TABLE II.—AVERAGE YIELD OF POTATOES PER ACRE FROM DIFFERENT AMOUNTS OF FERTILIZER.

| EXPERIMENTER. | No. of plats averaged. | Yield of Potatoes With | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No fertilizer. | | | 500 lbs. fertilizer. | | | 1,000 lbs. fertilizer. | | | 1,500 lbs. fertilizer. | | | 2,000 lbs. fertilizer. | | |
| | | Large. | Small. | Total. | Large. | Small. | Total. | Large. | Small. | Total. | Large. | Small. | Total. | Large. | Small. | Total. |
| | | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. | Bu. |
| Wm. A. Fleet...... | 4 | 107.7 | 18.9 | 126.6 | 144 | 17 | 161 | 171.9 | 15.5 | 187.4 | 191.5 | 14.2 | 205.7 | 188.7 | 15.1 | 203.8 |
| H. L. Hallock...... | 4 | 54.5 | 45 | 99.5 | 87.2 | 41.2 | 128.4 | 128.5 | 35 | 163.5 | 125.7 | 25 | 150.7 | 130.9 | 32.2 | 165.1 |
| W. L. Jagger ...... | 4 | 16 | 12.2 | 28.2 | 29.2 | 18.1 | 47.6 | 36.3 | 17.9 | 54.2 | 47.2 | 19.1 | 66.3 | 45.1 | 15.7 | 60.8 |
| R. H. Robbins...... | 2 | 81.9 | 11.2 | 93.1 | 109.6 | 13.5 | 123.1 | 115.8 | 14 | 129.8 | 119.2 | 15.2 | 134.4 | 117.8 | 11.7 | 129.5 |
| Average of all.. | 14 | 65 | 21.8 | 86.8 | 92.5 | 22.5 | 115 | 113.1 | 20.6 | 133.7 | 120.9 | 18.4 | 139.3 | 120.6 | 18.7 | 139.8 |
| Average increase of yield ........... | .... | ...... | ...... | ...... | 27.5 | ...... | 28.2 | 48.1 | ...... | 46.9 | 55.9 | ...... | 52.5 | 55.6 | ...... | 53 |
| Average yield, Fleet & Hallock....... | 8 | 81.1 | 32 | 113.1 | 115.6 | 29.1 | 144.7 | 150.2 | 25.2 | 175.4 | 158.6 | 19.6 | 178.2 | 159.8 | 23.6 | 184.4 |
| Average increase, Fleet & Hallock.. | .... | ...... | ...... | ...... | 34.1 | ...... | 31.6 | 69.1 | ...... | 62.3 | 77.5 | ...... | 65.1 | 78.7 | ...... | 71.3 |

TABLE III — PARTIAL COMPOSITION OF THE POTATOES.

| Laboratory number. | Number of plat. | AMOUNT PER ACRE AND KIND OF FERTILIZER. | FRESH MATERIAL. | | | | | | WATER-FREE MATERIAL. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water. | Dry matter. | Starch. | N. | $P_2O_5$. | $K_2O$. | Starch. | N. | $P_2O_5$. | $K_2O$. |
| | | *Formula* 1. | Per cent. | Per cent. | Per cent | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| 329 | 1 | No fertilizer ...................... | 81.13 | 18.87 | 13 | 0.34 | 0.111 | 0.39 | 68.9 | 1.81 | 0.588 | 2.06 |
| 330 | 2 | 500 pounds—potash as muriate .... | 79.43 | 20.57 | 14.1 | .33 | .195 | .42 | 68.7 | 1.61 | .463 | 2.02 |
| 331 | 3 | 1,000 pounds—potash as muriate... | 80.25 | 19.75 | 14 | .31 | .097 | .41 | 70.9 | 1.57 | .493 | 2.09 |
| 332 | 4 | 1,500 pounds—potash as muriate... | 82.13 | 17.87 | 12.1 | .33 | .100 | .49 | 67.5 | 1.82 | .559 | 2.72 |
| 333 | 5 | 2,000 pounds—potash as muriate... | 80.97 | 19.03 | 13.3 | .31 | .092 | .36 | 69.8 | 1.61 | .485 | 1.92 |
| | | *Formula* 2. | | | | | | | | | | |
| 334 | 6 | No fertilizer ...................... | 80.24 | 19.76 | 14.4 | .33 | .117 | .37 | 73 | 1.68 | .594 | 1.89 |
| 335 | 7 | 500 pounds—potash as sulphate.... | 78.98 | 21.02 | 15.7 | .33 | .117 | .40 | 74.8 | 1.59 | .555 | 1.89 |
| 336 | 8 | 1,000 pounds—potash as sulphate .. | 79.78 | 20.22 | 14.9 | .34 | .103 | .39 | 73.8 | 1.66 | .508 | 1.93 |
| 337 | 9 | 1,500 pounds—potash as sulphate .. | 80.01 | 19.99 | 14 6 | .33 | .099 | .43 | 72.8 | 1.66 | .497 | 2.13 |
| 338 | 10 | 2,000 pounds—potash as sulphate .. | 80.45 | 19.55 | 13.9 | .34 | .102 | .48 | 71.2 | 1.73 | .522 | 2.44 |
| | | *Formula* 3. | | | | | | | | | | |
| 339 | 11 | No fertilizer ...................... | 80.85 | 19.15 | 13.5 | .32 | .114 | .40 | 70.5 | 1.65 | .597 | 2.11 |
| 340 | 12 | 500 pounds—potash as muriate..... | 79.55 | 20.45 | 15.4 | .30 | .099 | .42 | 75.5 | 1.48 | .484 | 2.07 |
| 341 | 13 | 1,000 pounds—potash as muriate... | 80.83 | 19.17 | 13.4 | .30 | .091 | .46 | 69.7 | 1.57 | .489 | 2.42 |
| 342 | 14 | 1,500 pounds—potash as muriate... | 82.44 | 17.56 | 11.8 | .30 | .083 | .52 | 67.2 | 1.72 | .474 | 2.98 |
| 343 | 15 | 2,000 pounds—potash as muriate... | 82.33 | 17.67 | 11.8 | .35 | .107 | .52 | 66.8 | 1.97 | .604 | 2.97 |
| | | *Formula* 4. | | | | | | | | | | |
| 344 | 16 | No fertilizer...................... | 78.53 | 21.47 | 16.2 | .35 | .109 | .41 | 75.6 | 1.62 | .507 | 1.90 |
| 345 | 17 | 500 pounds—potash as sulphate.... | 78.88 | 21.12 | 15.7 | .32 | .103 | .43 | 74.5 | 1.51 | .488 | 2.04 |
| 346 | 18 | 1,000 pounds—potash as sulphate.. | 78.31 | 21.69 | 16.3 | .31 | .104 | .45 | 75.3 | 1.44 | .480 | 2.06 |
| 347 | 19 | 1,500 pounds—potash as sulphate .. | 79.14 | 20.86 | 15.2 | .33 | .107 | .43 | 72.7 | 1.59 | .511 | 2.06 |
| 348 | 20 | 2,000 pounds—potash as sulphate .. | 79.58 | 20.42 | 14.3 | .33 | .106 | .37 | 70 | 1.63 | .517 | 1.82 |

TABLE III. — PARTIAL COMPOSITION OF THE POTATOES — (*Continued*).

| Laboratory number. | Number of plat. | AMOUNT PER ACRE AND KIND OF FERTILIZER. | Fresh Material. | | | | | | Water-Free Material. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water. | Dry matter. | Starch. | N. | $P_2O_5$. | $K_2O$. | Starch. | N. | $P_2O_5$. | $K_2O$. |
| | | *Formula* 1. | Per cent. | Per cent. | Per cent | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| 349 | 1 | No fertilizer .................... | 80.17 | 19.83 | 13.4 | 0.29 | 0.122 | 0.57 | 67.4 | 1.48 | 0.613 | 2.88 |
| 350 | 2 | 500 pounds—potash as muriate..... | 80.29 | 19.71 | 13.3 | .30 | .116 | .54 | 67.7 | 1.52 | .591 | 2.72 |
| 351 | 3 | 1,000 pounds—potash as muriate... | 79.98 | 20.02 | 14.9 | .29 | .111 | .53 | 74.6 | 1.43 | .555 | 2.65 |
| 352 | 4 | 1,500 pounds—potash as muriate... | 79 | 21 | 14.8 | .35 | .119 | .62 | 70.5 | 1.65 | .566 | 2.94 |
| 353 | 5 | 2,000 pounds—potash as muriate... | 81.30 | 18.70 | 12.9 | .31 | .110 | .55 | 68.8 | 1.66 | .588 | 2.94 |
| | | *Formula* 2. | | | | | | | | | | |
| 354 | 6 | No fertilizer.................... | 79.27 | 20.73 | 15 | .26 | .126 | .58 | 72.5 | 1.28 | .610 | 2.78 |
| 355 | 7 | 500 pounds—potash as sulphate ... | 80.25 | 19.75 | 13.9 | .29 | .118 | .54 | 70.6 | 1.47 | .599 | 2.74 |
| 356 | 8 | 1,000 pounds—potash as sulphate .. | 80.04 | 19.96 | 14.7 | .31 | .115 | .54 | 73.5 | 1.55 | .576 | 2.70 |
| 357 | 9 | 1,500 pounds—potash as sulphate .. | 80.29 | 19.71 | 14 | .32 | .114 | .58 | 70.8 | 1.62 | .576 | 2.96 |
| 358 | 10 | 2,000 pounds—potash as sulphate .. | 79.45 | 20.55 | 14.9 | .31 | .108 | .57 | 72.4 | 1.50 | .526 | 2.97 |
| | | *Formula* 3. | | | | | | | | | | |
| 359 | 11 | No fertilizer .................... | 79.95 | 20.05 | 14.5 | .30 | .114 | .54 | 72.4 | 1.51 | .568 | 2.72 |
| 360 | 12 | 500 pounds—potash as muriate .... | 79.72 | 20.28 | 15 | .27 | .113 | .59 | 74.2 | 1.31 | .555 | 2.92 |
| 361 | 13 | 1.000 pounds—potash as muriate... | 79.50 | 20.50 | 15.3 | .26 | .105 | .56 | 74.8 | 1.28 | .514 | 2.73 |
| 362 | 14 | 2,000 pounds—potash as muriate ... | 80.72 | 19.28 | 14 | .25 | .105 | .57 | 72.6 | 1.32 | .544 | 2.98 |
| 363 | 15 | 1,500 pounds—potash as muriate... | 80.41 | 19.59 | 14.5 | .28 | .106 | .56 | 73.8 | 1.41 | .539 | 2.86 |
| | | *Formula* 4. | | | | | | | | | | |
| 364 | 16 | No fertilizer.................... | 78.76 | 21.24 | 15.4 | .28 | .113 | .54 | 76.4 | 1.33 | .531 | 2.56 |
| 365 | 17 | 500 pounds—potash as sulphate ... | 79.08 | 20.92 | 16.1 | .30 | .117 | .56 | 76.9 | 1.43 | .558 | 2.70 |
| 366 | 18 | 1,000 pounds—potash as sulphate .. | 78.67 | 21.33 | 16.4 | .30 | .115 | .56 | 79 | 1.39 | .538 | 2.62 |
| 367 | 19 | 1,500 pounds—potash as sulphate .. | 78.75 | 21.25 | 16 | .30 | .109 | .55 | 78 | 1.42 | .512 | 2.57 |
| 368 | 20 | 2,000 pounds—potash as sulphate .. | 78.64 | 21.36 | 16.2 | .30 | .100 | .68 | 79 | 1.41 | .467 | 3.20 |

## RELATION OF YIELD OF POTATOES TO THE AMOUNT OF FERTILIZER APPLIED.

The figures given below show the average results from all the experiments, and also from the two experiments, that, because of the freedom of the vines and tubers from disease, and other favorable conditions, proceeded in the most satisfactory manner.

TABLE IV.—INCREASE OF YIELD FROM DIFFERENT QUANTITIES OF FERTILIZERS.

| NUMBER OF PLATS AVERAGED. | | Amount of fertilizer per acre. | AVERAGE OF ALL EXPERIMENTS. | | AVERAGE OF FLEET AND HALLOCK. | |
|---|---|---|---|---|---|---|
| All experiments. | Fleet and Hallock. | | Increase large tubers. | Total increase. | Increase large tubers. | Total increase. |
| | | Pounds. | Bushels. | Bushels. | Bushels. | Bushels. |
| 14 | 8 | 500 | 27.5 | 28.2 | 34.1 | 31.6 |
| 14 | 8 | 1,000 | 48.1 | 46.9 | 69.1 | 62.3 |
| 14 | 8 | 1,500 | 55.9 | 52.5 | 77.5 | 65.1 |
| 14 | 8 | 2,000 | 55.6 | 53 | 78.7 | 71.3 |

These figures show very plainly that an addition of fertilizers above 1,000 lbs. per acre produced a very small increase of crop. The first 500 lbs. caused a marked increase of yield, as also did the second. Moreover, the rate of production was proportionate to the quantity of fertilizer used up to 1,000 lbs. per acre. The crop from 1,500 lbs. of fertilizer was somewhat larger than from 1,000 lbs., but not enough so to warrant the extra expenditure, as will be seen later. The production of merchantable tubers with 2,000 lbs. of fertilizer was practically the same as with 1,500 lbs.

## RELATIVE YIELD FROM THE POTATO FORMULA AND THE LONG ISLAND FORMULA.

The "potato" formula is supposed to supply the important elements of plant food in the proportions and amounts needed by the entire plant for a profitably large crop. The Long Island formula is the 4–8–10 fertilizer so largely in use by Long Island farmers.

It is interesting to note the relative yields from these two mixtures, the essential differences between which is that the former contains much more nitrogen and much less phosphoric acid than the latter, the potash being the same.

TABLE V.—RELATIVE YIELD FROM POTATO FORMULA AND LONG ISLAND FORMULA.

| AMOUNT OF FERTILIZER PER ACRE. | AVERAGE OF THREE EXPERIMENTS. | | | AVERAGE OF FLEET AND HALLOCK. | | |
|---|---|---|---|---|---|---|
| | Potato formula. | Long Island formula. | Excess from Long Island formula. | Potato formula. | Long Island formula. | Excess from Long Island formula. |
| | Bushels. | Bushels. | Bushels. | Bushels. | Bushels. | Bushels. |
| None ........ | 84.8 | | | 113.1 | | |
| 500 pounds.. | 99.3 | 125.3 | 26. | 125.5 | 163.8 | 38.3 |
| 1,000 pounds.. | 126.1 | 143.9 | 17.8 | 166.2 | 184.7 | 18.5 |
| 1,500 pounds.. | 133.8 | 147.9 | 14.1 | 166.8 | 189.5 | 22.7 |
| 2,000 pounds.. | 136. | 150.4 | 14.4 | 178.4 | 190.4 | 12. |
| Average .... | 123.8 | 141.9 | 18.1 | 159.2 | 182.1 | 22.9 |

The foregoing table of averages shows that there was a uniform and material difference in favor of the Long Island formula. As before noted the vines were reported as one-fourth larger from this mixture than from the other. The excess of crop from the Long Island formula seems to be greatest where the smallest amounts of fertilizer were applied, which may indicate either that the small application of the "potato" formula did not furnish the profitable maximum of phosphoric acid or that the large applications contained an undesirable quantity of nitrogen compounds. In either case, if future experiments substantiate the results for 1897, the claim that the composition of a crop should be the guide for mixing special fertilizers will be discredited.

## THE FINANCIAL SIDE OF THE EXPERIMENTS.

The potatoes from these experimental fields were sold at 75 cents per bushel for large (merchantable) and 25 cents for small, and the money values found in the following table are calculated from these prices.

TABLE VI.—FINANCIAL SIDE OF THE EXPERIMENTS.

*Average of All.*

| AMOUNT OF FERTILIZER PER ACRE. | Acre value total crop. | Value increase from each 500 pounds fertilizer added. | Bushel cost of potatoes from each 500 pounds fertilizer added. |
|---|---|---|---|
| | Dollars. | Dollars. | Dollars. |
| None | 54.20 | ........ | ........ |
| 500 pounds | 75.00 | 20.80 | 0.22 |
| 1,000 " | 89.97 | 14.97 | 0.33 |
| 1,500 " | 95.27 | 5.30 | 1.12 |
| 2,000 " | 95.15 | ........ | ........ |

*Average Hallock and Fleet Farms.*

| | | | |
|---|---|---|---|
| | Dollars. | Dollars. | Dollars. |
| None | 68.82 | ........ | ........ |
| 500 pounds | 93.95 | 25.13 | 0.20 |
| 1,000 " | 118.95 | 25.00 | 0.20 |
| 1,500 " | 123.85 | 4.90 | 2.23 |
| 2,000 " | 125.75 | 1.90 | 1.01 |

NOTE.—The cost of the fertilizer is assumed to be $25,00 per ton.

It is evident that if we consider the first year's crop only the application of one ton of fertilizer per acre, or even 1,500 pounds, was considerably less profitable than the use of 1,000 pounds. The fertilizer cost of the small increase of product caused by applying more than 1,000 pounds of fertilizer was much greater than the market value of the potatoes, even in this year of good prices.

On the other hand the use of 1,000 pounds was very profitable, the fertilizer cost of the increased yield on the Fleet and Hallock farms being only 20 cents per bushel. Even if the merchantable potatoes had been sold at 40 cents per bushel, there would still be a reasonable margin of profit. It should be kept in mind that these figures refer to the light soils and market conditions of Long Island.

## THE INFLUENCE OF THE POTASH SALTS UPON THE COMPOSITION OF THE POTATO.

Much investigation has been carried on to determine whether a liberal application of muriate of potash has a depressing effect upon the proportion of dry matter and starch in the potato. The testimony so far secured is conflicting. In many cases the quality of the tubers as expressed by the percentages of dry matter and starch has been found to be lower with the use of the muriate than where the sulphate was applied. In a recent number of *Die landwirtschaftlichen Versuchs-Stationen*, Pfeiffer and others review the data bearing upon this point and give results from well-planned experiments of their own. Their conclusions are that the muriate free from other compounds has no injurious effect upon the composition of the potato tuber, but that the depression in the proportion of starch which has been noticed is due to the impurities in the commercial potash salts, notably magnesium chloride. These authors even claim that the addition of chlorine to the soil may under some circumstances be beneficial to the quality of the tubers.

### THE PROPORTION OF DRY MATTER AND STARCH.

About one bushel of potatoes was sent to the Station from each one of the experimental plats on the Hallock and Fleet farms. Tubers to the amount of about ten pounds were carefully selected from each lot, were sliced and dried at a temperature between 50° and 60° C. Determinations were made in each sample of the dry matter, starch, nitrogen, phosphoric acid and potash. These results are given in detail in Table III and are summarized in the succeeding tables, Nos. VII, VIII and IX.

TABLE VII.—INFLUENCE OF THE POTASH COMPOUNDS UPON THE AMOUNT OF DRY MATTER IN THE POTATO.

| AMOUNT OF FERTILIZER PER ACRE. | HALLOCK'S FARM. | | | FLEET'S FARM. | | | Average of both farms. |
|---|---|---|---|---|---|---|---|
| | Potato formula. | Long Island formula. | Average. | Potato formula. | Long Island formula. | Average. | |
| *Potatoes grown with Muriate of Potash.—Plats 1–5 and 11–15.* | | | | | | | |
| | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| None .............. | 18.87 | 19.15 | 19.01 | 19.83 | 20.05 | 19.94 | 19.47 |
| 500 pounds ....... | 20.57 | 20.45 | 20.51 | 19.71 | 20.28 | 19.99 | 20.25 |
| 1,000 pounds ....... | 19.75 | 19.17 | 19.46 | 20.02 | 20.50 | 20.26 | 19.86 |
| 1,500 pounds ....... | 17.87 | 17.56 | 17.72 | 21 | 19.28 | 20.14 | 18.93 |
| 2,000 pounds ....... | 19.03 | 17.57 | 18.35 | 18.70 | 19.59 | 19 14 | 18.74 |
| Averages fertilized plats .... | 19.35 | 18.71 | 19 | 19.86 | 19.91 | 19.88 | 19.45 |
| *Potatoes grown with Sulphate of Potash.—Plats 6–10 and 16–20* | | | | | | | |
| None .............. | 19.76 | 21.47 | 20.61 | 20.73 | 21.24 | 20.98 | 20.80 |
| 500 pounds ....... | 21.02 | 21.12 | 21.07 | 19.75 | 20.92 | 20.33 | 20.70 |
| 1,000 pounds ....... | 20.22 | 21.69 | 20.95 | 19.96 | 21.33 | 20.64 | 20.80 |
| 1,500 pounds ....... | 19.99 | 20.86 | 20.42 | 19.71 | 21.25 | 20.48 | 20.46 |
| 2,000 pounds ....... | 19.55 | 20.42 | 19.99 | 20.55 | 21.36 | 20.95 | 20.47 |
| Averages fertilized plats .... | 20.19 | 21.02 | 20.6 | 20 | 21.21 | 20.60 | 20.61 |

TABLE VIII.—INFLUENCE OF THE POTASH COMPOUNDS UPON THE AMOUNT OF STARCH IN THE POTATO.

| AMOUNT OF FERTILIZER PER ACRE. | HALLOCK FARM. | | | FLEET FARM. | | | Average, both farms. |
|---|---|---|---|---|---|---|---|
| | Potato formula. | Long Island formula. | Average. | Potato formula. | Long Island formula. | Average. | |
| *Potatoes grown with Muriate of Potash.—Plats 1–5 and 11–15.* | | | | | | | |
| | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. |
| None | 13 | 13.5 | 13.2 | 13.4 | 14.5 | 13.9 | 13.5 |
| 500 pounds | 14.1 | 15.4 | 14.7 | 13.3 | 15 | 14.1 | 14.4 |
| 1,000 pounds | 14 | 13.4 | 13.7 | 14.9 | 15.3 | 15.1 | 14.4 |
| 1,500 pounds | 12.1 | 11.8 | 11.9 | 14.8 | 14 | 14.4 | 13.1 |
| 2,000 pounds | 13.3 | 11.8 | 12.6 | 12.9 | 14.5 | 13.7 | 13.1 |
| Average fertilized plats | 13.4 | 13.1 | 13.2 | 14 | 14.7 | 14.3 | 13.7 |
| *Potatoes grown with Sulphate of Potash.—Plats 6–10 and 16–20.* | | | | | | | |
| None | 14.4 | 16.2 | 15.3 | 15 | 15.4 | 15.2 | 15.2 |
| 500 pounds | 15.7 | 15.7 | 15.7 | 13.9 | 16.1 | 15 | 15.3 |
| 1,000 pounds | 14.9 | 16.3 | 15.6 | 14.7 | 16.4 | 15.5 | 15.5 |
| 1,500 pounds | 14.6 | 15.2 | 14.9 | 14 | 16 | 15 | 14.9 |
| 2,000 pounds | 13.9 | 14.3 | 14.1 | 14.9 | 16.2 | 15.5 | 14.8 |
| Average fertilized plats | 14.8 | 15.4 | 15.1 | 14.4 | 16.2 | 15.3 | 15.2 |

TABLE IX — PROPORTIONS OF THE IMPORTANT ELEMENTS OF PLANT-FOOD IN THE FRESH TUBERS.

| | Nitrogen. | | Phosphoric Acid. | | Potash. | |
|---|---|---|---|---|---|---|
| | With KCl. | With $K_2SO_4$. | With KCl. | With $K_2SO_4$. | With KCl. | With $K_2SO_4$. |
| | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. |
| None | 0.31 | 0.30 | 0.116 | 0.116 | 0.47 | 0.47 |
| 500 pounds | .30 | .30 | .106 | .113 | .49 | .48 |
| 1,000 pounds | .28 | .31 | .101 | .109 | .49 | .48 |
| 1,500 pounds | .31 | .32 | .097 | .107 | .54 | .49 |
| 2,000 pounds | .31 | .32 | .107 | .104 | .49 | .52 |
| Averages | .30 | .31 | .105 | .110 | .50 | .49 |
| | .30 | | .107 | | .49 | |

A still briefer summary of the percentages of dry matter and starch is the following:

DRY MATTER AND STARCH IN POTATOES DIFFERENTLY FERTILIZED.

| | Plats with Muriate of Potash. | | Plats with Sulphate of Potash. | |
|---|---|---|---|---|
| | Dry matter. | Starch. | Dry matter. | Starch. |
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Averages 16 plats | 19.45 | 13.7 | 20.61 | 15.2 |
| Averages adjacent plats not fertilized | 19.47 | 13.5 | 20.80 | 15.2 |

The potatoes produced where the sulphate of potash was added contained both more dry matter and more starch than did the potatoes grown where the muriate was used. As these figures are an average of 16 plats for each manner of treatment they would seem to be significant. Their force is diminished greatly, however, by the fact that the adjacent plats receiving no fertilizer differed in the same way and to the same extent. It would not be safe, therefore, to conclude from these data that the muriate is inferior to the sulphate of potash for potato growing.

## THE UTILIZATION OF PLANT FOOD.

It has been noticed in some cases that the percentages of certain plant food compounds taken up by a crop are increased by liberal manuring. This does not seem to be the case in these experiments as the figures in Table IX clearly show. Neither the kind nor the amount of fertilizer applied caused noticeable variation in the percentages of nitrogen, phosphoric acid and potash found in the tubers.

# METEOROLOGICAL RECORD

FOR

1897.

PRECIPITATION BY MONTHS SINCE 1882.

| YEARS. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In. | In. | In. | In | In. | In. | In. | In. | In. | In. | In. | In. | In. |
| 1882 | ..... | ...... | ...... | ...... | ...... | 3.69 | 2.42 | 2.37 | 1.25 | 0.62 | 1.22 | 0.55 | ...... |
| 1883 | 0.48 | 1.44 | 0.88 | 1.58 | 4.45 | 4.12 | 2.98 | 3.47 | 2.12 | 2.10 | 1.54 | 0.73 | 25.89 |
| 1884 | 1.83 | 2.01 | 2.54 | 0.83 | 2.49 | 2.01 | 2.33 | 1.44 | 3.17 | 1.67 | 1.01 | 0.97 | 22.30 |
| 1885 | 1.07 | 0.61 | 0.12 | 1.26 | 1.58 | 2.49 | 4.64 | 5.02 | 2.11 | 2.88 | 1.36 | 0.76 | 23.90 |
| 1886 | 1.13 | 0.95 | 1.13 | 4.13 | 1.92 | 2.92 | 4.41 | 2.86 | 2.31 | 1.39 | 3.48 | 1.24 | 27.87 |
| 1887 | 0.18 | 2.17 | 0.48 | 1.37 | 0.46 | 2.01 | 6.37 | 3.03 | 0.75 | 1.74 | 1.58 | 1.35 | 22.29 |
| 1888 | 0.78 | 1.04 | 1.43 | 3.09 | 2.79 | 3.88 | 0.99+ | 4.02 | 2.73 | 3.47 | 2.02 | 1.24+ | 27.48 |
| 1889 | 2.99+ | 0.25 | 0.66+ | 3.28 | 1.21 | 7.47 | 4.57 | 1.98 | 2.50 | 3.32 | 3.41 | 1.62 | 32.28 |
| 1890 | 2.16 | 1.45 | 2.16 | 2.20 | 5.49 | 5.26 | 1.07 | 4.34 | 5.81 | 4.54 | 2.40 | ...... | 36.88 |
| 1891 | 1.44 | 1.57 | 3.25 | 1.63 | 0.49 | 4.31 | 3.52 | 3.16 | 0.47 | 3.65 | 0.71 | 3.29 | 27.52 |
| 1892 | 0.57 | 0.88 | 0.55 | 0.67 | 4.04 | 3.95 | 1.89 | 4.77 | 1.12 | 1.34 | 2.67 | 0.72 | 23.17 |
| 1893 | 1.62 | 3.71 | 1.94 | 2.59 | 4.92 | 3.08 | 3.68 | 5.38 | 2.68 | 1.59 | 1.09 | 1.56 | 33.84 |
| 1894 | 2.21 | 2.71 | 1.36 | 2.43 | 7.03 | 1.77 | 1.50 | 1.22 | 4.61 | 3.59 | 0.43 | 0.47 | 29.36 |
| 1895 | 0.96 | 0.00 | 0.29 | 1.33 | 2.88 | ...... | ...... | 2.66 | 0.94 | 0.72 | 2.31 | 2.49 | ...... |
| 1896 | 1.19 | 2.28 | 0.84 | 0.41 | 2.31 | 3.71 | 4.12 | 3.33 | 4.27 | 2.26 | 2.18 | 0.71 | 27.61 |
| 1897 | 0.64 | 0.21 | 2.12 | 1.90 | 2.19 | 3.16 | 5.28 | 1.27 | 2.36 | 0.73 | 2.53 | 1.39 | 23.78 |

WIND RECORD FOR 1897.

| | January. | | | | February. | | | | March. | | | | April. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. |
| | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. |
| 1 | ...... | ...... | 20 | ...... | ...... | ...... | 20 | ...... | ...... | ...... | 19 | ...... | 18 | ...... | ...... | 6 |
| 2 | ...... | ...... | 24 | ...... | 11 | ...... | 5 | ...... | ...... | 6 | 3 | 12 | 6 | ...... | ...... | 17 |
| 3 | ...... | ...... | 24 | ...... | 21 | ...... | ...... | 3 | ...... | ...... | 12 | 12 | 17 | ...... | ...... | ...... |
| 4 | ...... | ...... | 17 | 5 | 2 | ...... | ...... | 10 | ...... | ...... | 4 | 18 | ...... | 11 | 12 | ...... |
| 5 | ...... | ...... | 3 | 12 | ...... | ...... | 22 | ...... | ...... | ...... | 22 | 2 | ...... | ...... | 17 | 6 |
| 6 | ...... | ...... | ...... | 24 | ...... | 11 | 13 | ...... | 14 | 1 | ...... | 9 | 1 | ...... | ...... | 22 |
| 7 | ...... | ...... | ...... | 21 | ...... | 4 | 3 | 17 | 6 | 14 | ...... | ...... | 13 | ...... | ...... | 6 |
| 8 | ...... | 6 | 12 | ...... | ...... | ...... | ...... | 24 | ...... | ...... | 24 | ...... | 8 | ...... | 8 | ...... |
| 9 | ...... | ...... | 12 | 6 | ...... | ...... | ...... | 24 | ...... | ...... | 24 | ...... | 6 | 11 | ...... | 2 |
| 10 | ...... | ...... | ...... | 24 | 15 | ...... | ...... | 4 | ...... | ...... | 9 | 15 | ...... | ...... | ...... | 24 |
| 11 | ...... | ...... | ...... | 24 | 6 | 12 | ...... | ...... | ...... | 3 | 2 | 16 | ...... | ...... | ...... | 21 |
| 12 | ...... | ...... | ...... | 24 | ...... | 20 | ...... | 3 | ...... | 2 | 11 | 10 | ...... | 8 | ...... | 15 |
| 13 | ...... | 8 | 2 | 6 | 2 | 3 | 2 | 13 | 3 | 4 | ...... | 17 | ...... | ...... | 24 | ...... |
| 14 | 11 | ...... | 4 | ...... | ...... | ...... | 12 | 12 | ...... | 5 | 9 | 10 | ...... | ...... | 1 | 22 |
| 15 | 4 | ...... | ...... | ...... | ...... | 6 | 2 | 5 | ...... | ...... | ...... | 24 | ...... | ...... | ...... | 18 |
| 16 | ...... | ...... | 7 | 7 | ...... | ...... | ...... | 18 | 13 | ...... | ...... | 8 | ...... | ...... | 11 | 11 |
| 17 | ...... | ...... | 23 | 1 | ...... | ...... | 12 | 11 | ...... | 3 | 9 | ...... | ...... | ...... | ...... | 17 |
| 18 | ...... | ...... | ...... | 24 | ...... | ...... | ...... | 24 | ...... | ...... | 20 | ...... | ...... | ...... | 7 | 17 |
| 19 | 5 | ...... | ...... | 11 | ...... | ...... | ...... | 24 | ...... | 13 | 1 | ...... | ...... | ...... | 10 | 14 |
| 20 | ...... | ...... | 24 | ...... | ...... | ...... | 17 | 6 | 2 | ...... | 13 | 9 | ...... | ...... | ...... | 20 |
| 21 | ...... | ...... | 10 | 14 | 1 | ...... | 6 | 17 | 3 | ...... | ...... | 16 | ...... | 9 | 7 | 2 |
| 22 | ...... | ...... | 7 | 13 | 7 | 8 | 9 | ...... | ...... | 8 | ...... | 6 | ...... | ...... | 24 | ...... |
| 23 | ...... | ...... | ...... | 24 | ...... | ...... | 2 | 21 | 6 | 6 | ...... | 10 | ...... | 1 | 15 | 6 |
| 24 | ...... | ...... | ...... | 24 | ...... | ...... | 4 | 18 | ...... | ...... | ...... | 17 | ...... | ...... | 1 | 12 |
| 25 | ...... | ...... | ...... | 24 | ...... | ...... | 11 | 13 | ...... | ...... | ...... | 24 | ...... | ...... | 9 | 15 |
| 26 | ...... | ...... | ...... | 24 | ...... | ...... | 1 | 19 | ...... | ...... | ...... | 24 | ...... | ...... | 5 | 19 |
| 27 | ...... | ...... | ...... | 13 | ...... | ...... | 1 | 23 | ...... | ...... | ...... | 24 | ...... | ...... | ...... | 24 |
| 28 | ...... | ...... | ...... | 24 | 5 | ...... | ...... | 17 | 4 | ...... | ...... | 20 | 5 | ...... | ...... | 13 |
| 29 | ...... | ...... | ...... | 24 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 11 | 2 | 9 | 5 | ...... |
| 30 | ...... | ...... | ...... | 24 | ...... | ...... | ...... | ...... | 5 | 3 | ...... | ...... | 2 | 1 | 2 | ...... |
| 31 | ...... | ...... | 14 | 7 | ...... | ...... | ...... | ...... | 11 | ...... | ...... | 3 | ...... | ...... | ...... | ...... |
| Total hours of movement | 20 | 14 | 203 | 404 | 70 | 64 | 142 | 326 | 67 | 68 | 182 | 317 | 78 | 50 | 158 | 329 |
| Per cent of time in each direction | 3.1 | 2.2 | 31.7 | 63 | 11.6 | 10.6 | 23.6 | 54.2 | 10.6 | 10.7 | 28.7 | 50 | 12.7 | 8.1 | 25.7 | 53.5 |

WIND RECORD — (*Continued*).

| | May. | | | | June. | | | | July. | | | | August. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. |
| | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. |
| 1 | ... | 11 | 13 | ... | ... | ... | ... | 24 | ... | ... | ... | 7 | 2 | ... | ... | 15 |
| 2 | ... | 20 | 2 | 2 | ... | 11 | 2 | 10 | ... | 1 | ... | ... | ... | 7 | 1 | ... |
| 3 | 6 | ... | ... | 14 | ... | ... | 12 | 8 | ... | 2 | 11 | ... | ... | 4 | 8 | 2 |
| 4 | 1 | ... | ... | 15 | 3 | ... | ... | 17 | ... | ... | 23 | ... | ... | 4 | 3 | 2 |
| 5 | 11 | ... | ... | 11 | 2 | 2 | 4 | 6 | 1 | 16 | ... | 5 | ... | 6 | 8 | ... |
| 6 | 10 | ... | ... | ... | ... | ... | 16 | ... | 6 | ... | ... | 11 | ... | ... | 7 | ... |
| 7 | 13 | ... | ... | 3 | ... | ... | 23 | ... | 13 | ... | ... | 4 | ... | 6 | 2 | ... |
| 8 | ... | 6 | 3 | 4 | ... | ... | 17 | ... | ... | 3 | 9 | ... | ... | ... | 21 | ... |
| 9 | ... | ... | 11 | 2 | ... | 5 | 2 | 1 | ... | 3 | 6 | 4 | ... | 4 | 10 | ... |
| 10 | ... | ... | ... | 23 | 1 | ... | ... | 18 | 2 | 5 | 7 | 3 | ... | 3 | 8 | 1 |
| 11 | ... | ... | 15 | 4 | ... | ... | ... | 15 | ... | ... | 16 | 4 | 1 | ... | ... | 16 |
| 12 | ... | ... | 12 | 8 | ... | ... | ... | 22 | 7 | ... | ... | 9 | ... | ... | ... | 22 |
| 13 | ... | 1 | 9 | 5 | 1 | ... | ... | 21 | 6 | ... | ... | 8 | ... | ... | ... | 20 |
| 14 | ... | ... | 10 | 12 | ... | ... | ... | 24 | 1 | ... | ... | 17 | ... | ... | 10 | ... |
| 15 | 4 | ... | 1 | 14 | 3 | ... | ... | 15 | 2 | ... | ... | 9 | ... | 2 | 15 | ... |
| 16 | 6 | ... | ... | 4 | 2 | ... | 8 | 10 | ... | 3 | 9 | ... | ... | ... | 6 | 17 |
| 17 | ... | ... | 8 | 7 | 9 | ... | ... | 2 | ... | 7 | 6 | ... | ... | ... | ... | 20 |
| 18 | 1 | ... | ... | 19 | 6 | 1 | ... | 5 | ... | 10 | 5 | ... | ... | ... | 5 | 13 |
| 19 | 7 | 11 | 2 | 2 | ... | 3 | 3 | 3 | ... | 3 | 13 | ... | ... | ... | 1 | 12 |
| 20 | ... | ... | 13 | 11 | 2 | ... | ... | 21 | ... | ... | 16 | ... | 3 | ... | ... | 18 |
| 21 | 4 | ... | ... | 20 | ... | ... | ... | 24 | ... | ... | 22 | ... | ... | 1 | 1 | 9 |
| 22 | ... | ... | ... | 17 | ... | ... | 5 | 12 | ... | ... | 7 | 14 | 8 | ... | ... | 5 |
| 23 | ... | ... | 19 | 3 | ... | ... | 11 | 7 | 1 | ... | 4 | 16 | 6 | 4 | ... | 4 |
| 24 | 3 | ... | 7 | 5 | ... | 6 | 12 | ... | ... | ... | ... | 24 | ... | ... | 1 | 5 |
| 25 | ... | ... | ... | 18 | ... | ... | ... | 22 | 6 | ... | ... | 12 | ... | ... | 8 | 16 |
| 26 | 10 | ... | ... | 7 | 3 | ... | ... | 20 | ... | 14 | ... | 1 | ... | ... | ... | 18 |
| 27 | 3 | ... | ... | 21 | ... | ... | ... | 20 | ... | 20 | 4 | ... | ... | ... | 16 | 5 |
| 28 | ... | ... | ... | 16 | 2 | ... | ... | 8 | ... | 6 | 16 | ... | ... | ... | ... | 16 |
| 29 | ... | ... | ... | 23 | ... | 8 | 4 | ... | ... | 3 | 2 | ... | ... | ... | 16 | 5 |
| 30 | ... | 3 | 13 | 2 | 3 | ... | ... | 16 | 1 | ... | 2 | 13 | 4 | ... | ... | 18 |
| 31 | ... | ... | 1 | 23 | ... | ... | ... | ... | ... | ... | 2 | 22 | 2 | ... | ... | 15 |
| Total hours of movement | 79 | 52 | 139 | 315 | 37 | 36 | 119 | 351 | 46 | 96 | 180 | 183 | 26 | 41 | 147 | 274 |
| Per cent of time in each direction | 13.5 | 8.8 | 23.8 | 53.9 | 6.8 | 6.7 | 21.9 | 64.6 | 9.1 | 19 | 35.7 | 36.2 | 5.3 | 8.4 | 30.1 | 56.2 |

## WIND RECORD — (*Concluded*).

| | September. | | | | October. | | | | November. | | | | December. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. |
| | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. | Hrs. |
| 1 | 5 | 2 | 2 | 5 | 9 | .... | .... | 8 | 1 | 5 | 7 | .... | .... | .... | 14 | 9 |
| 2 | 9 | .... | .... | 5 | 3 | 10 | 3 | .... | .... | .... | .... | 9 | .... | .... | .... | 5 |
| 3 | 7 | 1 | .... | .... | .... | 4 | 7 | .... | .... | .... | .... | 22 | .... | 11 | 2 | .... |
| 4 | .... | 3 | 6 | 2 | .... | .... | 16 | .... | .... | .... | 11 | 1 | .... | 8 | 13 | .... |
| 5 | 1 | .... | .... | 13 | .... | .... | 24 | .... | .... | .... | 24 | .... | .... | .... | 1 | 21 |
| 6 | 1 | 1 | 1 | .... | .... | .... | 4 | 18 | .... | .... | 3 | 21 | 1 | 5 | 6 | .... |
| 7 | 2 | 9 | 1 | .... | 9 | .... | .... | .... | .... | .... | .... | 18 | .... | .... | 15 | 7 |
| 8 | 2 | 1 | 3 | 1 | .... | .... | 16 | .... | .... | 3 | 4 | 3 | .... | .... | 14 | .... |
| 9 | .... | .... | 1 | 10 | .... | .... | 1 | 21 | .... | .... | 3 | 13 | .... | .... | 19 | .... |
| 10 | .... | .... | .... | 14 | .... | 8 | 6 | 2 | .... | .... | .... | 17 | .... | .... | 24 | .... |
| 11 | 10 | .... | .... | 4 | .... | .... | 24 | .... | .... | .... | 13 | 5 | .... | .... | 10 | 14 |
| 12 | 1 | 10 | 5 | .... | .... | .... | 10 | 13 | .... | .... | .... | 24 | 3 | .... | .... | 18 |
| 13 | .... | .... | 9 | 15 | .... | .... | .... | 8 | .... | .... | .... | 24 | 4 | 10 | .... | 4 |
| 14 | 18 | .... | .... | .... | .... | .... | 17 | .... | .... | 5 | 4 | 9 | .... | 15 | 4 | .... |
| 15 | .... | 5 | 3 | .... | .... | .... | 9 | 13 | .... | .... | 24 | .... | .... | .... | .... | 18 |
| 16 | .... | .... | 12 | 11 | .... | .... | .... | 24 | .... | .... | 9 | 15 | .... | .... | 4 | 20 |
| 17 | 8 | .... | .... | 10 | 10 | .... | .... | 14 | .... | .... | .... | 22 | .... | 3 | 5 | 8 |
| 18 | .... | .... | 1 | 12 | .... | 3 | 4 | 4 | .... | .... | .... | 18 | .... | .... | .... | 24 |
| 19 | .... | .... | 6 | 6 | .... | 2 | 9 | .... | .... | .... | 14 | .... | 6 | .... | .... | 5 |
| 20 | 3 | .... | .... | 15 | .... | 3 | 12 | .... | .... | .... | 22 | .... | .... | 9 | 10 | .... |
| 21 | .... | .... | .... | 17 | .... | .... | 11 | .... | .... | .... | 9 | 15 | .... | .... | .... | 14 |
| 22 | .... | 7 | 6 | .... | .... | .... | 15 | .... | 4 | 7 | .... | .... | .... | .... | .... | 10 |
| 23 | .... | 10 | 2 | .... | .... | 4 | 3 | .... | .... | .... | .... | 23 | .... | .... | .... | 19 |
| 24 | .... | .... | .... | 12 | 3 | 3 | .... | .... | .... | .... | 11 | 10 | .... | .... | .... | 24 |
| 25 | .... | .... | .... | 21 | 5 | .... | .... | 8 | .... | .... | 24 | .... | .... | .... | 13 | 7 |
| 26 | 3 | .... | .... | 21 | 1 | .... | .... | 2 | .... | .... | 21 | 3 | .... | .... | .... | 11 |
| 27 | .... | .... | .... | 13 | .... | 2 | 10 | .... | 3 | .... | .... | 13 | .... | .... | .... | 24 |
| 28 | .... | .... | 2 | 8 | .... | .... | 14 | 7 | .... | 7 | 7 | 2 | .... | .... | 6 | 8 |
| 29 | .... | 4 | 3 | 1 | .... | .... | .... | 24 | .... | .... | 12 | 12 | .... | .... | 18 | 2 |
| 30 | .... | .... | 6 | 10 | .... | .... | 1 | 14 | .... | .... | .... | 23 | .... | .... | 1 | 23 |
| 31 | .... | .... | .... | .... | .... | .... | 23 | .... | .... | .... | .... | .... | 10 | .... | .... | 7 |
| **Total hours of movement** | 70 | 53 | 69 | 226 | 40 | 39 | 239 | 180 | 8 | 27 | 222 | 322 | 24 | 61 | 179 | 302 |
| Per cent of time in each direction | 16.7 | 12.7 | 16.5 | 54.1 | 8 | 7.8 | 48 | 36.2 | 1.4 | 4.7 | 38.3 | 55.6 | 4.2 | 10.8 | 31.6 | 53.4 |

SUMMARY OF DIRECTION OF WIND FOR 1897.

| | Northerly, N. W. to N. E. | Easterly, N. E. to S. E. | Southerly, S. E. to S. W. | Westerly, S. W. to N. W. | Total. |
|---|---|---|---|---|---|
| | Hours. | Hours. | Hours. | Hours. | Hours. |
| January | 20 | 14 | 203 | 404 | 641 |
| February | 70 | 64 | 142 | 326 | 602 |
| March | 67 | 68 | 182 | 217 | 634 |
| April | 78 | 50 | 158 | 329 | 615 |
| May | 79 | 52 | 139 | 315 | 585 |
| June | 37 | 36 | 119 | 351 | 543 |
| July | 46 | 96 | 180 | 183 | 505 |
| August | 26 | 41 | 147 | 274 | 488 |
| September | 70 | 53 | 69 | 226 | 418 |
| October | 40 | 39 | 239 | 180 | 498 |
| November | 8 | 27 | 222 | 322 | 579 |
| December | 24 | 61 | 179 | 302 | 566 |
| Total hours of movement | 565 | 601 | 1,979 | 3,529 | 6,674 |
| Per cent of time in each direction | 8.5 | 9 | 29.6 | 52.9 | ........ |

## READINGS OF THE STANDARD AIR THERMOMETER.

| 1897. | January. 7 a. m. | January. 12 m. | January. 6 p. m. | February. 7 a. m. | February. 12 m. | February. 6 p. m. | March. 7 a. m. | March. 12 m. | March. 6 p. m. | April. 7 a. m. | April. 12 m. | April. 6 p. m. | May. 7 a. m. | May. 12 m. | May. 6 p. m. | June. 7 a. m. | June. 12 m. | June. 6 p. m. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 29 | 39 | 40 | 17 | 30 | 27 | 11 | 21.5 | 31.5 | 32 | 46.5 | 41 | 60 | 66.5 | 61 | 46.5 | 49.5 | 55 |
| 2 | 38 | 43 | 40 | 22 | 31 | 26 | 27 | 26.5 | 25 | 35 | 55.5 | 49 | 56 | 63 | 60 | 50 | 63 | 65 |
| 3 | 39 | 51.5 | 47 | 23 | 27 | 24 | 40 | 45 | 31 | 32 | 45 | 40 | 45 | 57 | 50 | 63.5 | 76 | 72 |
| 4 | 54 | 56 | 44 | 22 | 33 | 25 | 23.5 | 26.5 | 30 | 39 | 50 | 46.5 | 47 | 51 | 50 | 63 | 66.5 | 61 |
| 5 | 31 | 37 | 34 | 21 | 33 | 35 | 33 | 40 | 43 | 48 | 64 | 51 | 43 | 62 | 62 | 57 | 68.5 | 66 |
| 6 | 16 | 25 | 25 | 33 | 38 | 42 | 30 | 20 | 18 | 46 | 48 | 46 | 47 | 56 | 54 | 60 | 75 | 70 |
| 7 | 24 | 28.5 | 25 | 37 | 37 | 36 | 12 | 25 | 27 | 37 | 41 | 36 | 45 | 52.5 | 50 | 63 | 66 | 62 |
| 8 | 19 | 30 | 24 | 33 | 33 | 32 | 28 | 39 | 37 | 36 | 46 | 40 | 44 | 59 | 59 | 52 | 56.5 | 55.5 |
| 9 | 17 | 33 | 36 | 28 | 33 | 30 | 36 | 40 | 41 | 34 | 40 | 37 | 52 | 76 | 74 | 55 | 59.5 | 56 |
| 10 | 33 | 35 | 31 | 18 | 19 | 14 | 42.5 | 38 | 38 | 30.5 | 35 | 36 | 64 | 56.5 | 63 | 54.5 | 61.5 | 65 |
| 11 | 26 | 29.5 | 25 | 11 | 20 | 19 | 36 | 44 | 40 | 32 | 40 | 39 | 53 | 70 | 70 | 63.5 | 76 | 73 |
| 12 | 12 | 12 | 9 | 21 | 22 | 22 | 42 | 50.5 | 35 | 35 | 51 | 49 | 58 | 65.5 | 67 | 56 | 66 | 67 |
| 13 | 9 | 16 | 14 | 14 | 23 | 18 | 18 | 22.5 | 23 | 44 | 55.5 | 50 | 55 | 58 | 60 | 64 | 73 | 70 |
| 14 | 6 | 21 | 16 | 23 | 38 | 38 | 29 | 36 | 32 | 46 | 44 | 44 | 56 | 63 | 56 | 63 | 73 | 70 |
| 15 | 17 | 26 | 26 | 29 | 32 | 29.5 | 22 | 29 | 27 | 39 | 39 | 44 | 46 | 54 | 56 | 65 | 78 | 69.5 |
| 16 | 28 | 35 | 35 | 30 | 35 | 32 | 16 | 21 | 19 | 43 | 55 | 51 | 51 | 61 | 56 | 61 | 72 | 65 |
| 17 | 35 | 39 | 40 | 32 | 47 | 35 | 17 | 36 | 37 | 41 | 45.5 | 41 | 49 | 65 | 63 | 57 | 73 | 61 |
| 18 | 31 | 25 | 14 | 31.5 | 34 | 33 | 37 | 46 | 43 | 38 | 59 | 61 | 54 | 73.5 | 68 | 62 | 73 | 71 |
| 19 | 3.5 | 7 | 1 | 26 | 29 | 29 | 41 | 51 | 49.5 | 52.5 | 35 | 24.5 | 48 | 62 | 62 | 60.5 | 78 | 75 |
| 20 | 8.5 | 24 | 25 | 19 | 32 | 31.5 | 44.5 | 57 | 55 | 20.5 | 30 | 33 | 68 | 77 | 68 | 58.5 | 65 | 57 |
| 21 | 37 | 35 | 33 | 38 | 42 | 34.5 | 41 | 41.5 | 47 | 31 | 50 | 54 | 51 | 46 | 51 | 53 | 63 | 63 |
| 22 | 23 | 30 | 31 | 26 | 31 | 38 | 31 | 53 | 43 | 46 | 68 | 66 | 46 | 61 | 61 | 55 | 75 | 74 |
| 23 | 24 | 22 | 15 | 35 | 32 | 30 | 35 | 51 | 41 | 53.5 | 73.5 | 65 | 61 | 75 | 59 | 65 | 81 | 74 |
| 24 | 11 | 14.5 | 5 | 20 | 27 | 29 | 40 | 37 | 38 | 55 | 69 | 69 | 57 | 68 | 54 | 73 | 80 | 76.5 |
| 25 | 3 | 11 | 7.5 | 27 | 35 | 24 | 29 | 31.5 | 29 | 56.5 | 80 | 55 | 45.5 | 46 | 50 | 69 | 77.5 | 63 |
| 26 | 13 | 16 | 12 | 12 | 15 | 12 | 28 | 33.5 | 31 | 45 | 59 | 44 | 46 | 57 | 56 | 57.5 | 64 | 63 |
| 27 | 13 | 18 | 16 | 9.5 | 16.5 | 15 | 28 | 32 | 33 | 32 | 45 | 40 | 50 | 60.5 | 61 | 59 | 70 | 67 |
| 28 | 11 | 12.5 | 11 | 14.5 | 15 | 12 | 29 | 36 | 35 | 43 | 57 | 56 | 55 | 60 | 54 | 58 | 77 | 70 |
| 29 | 19 | 23 | 18 | ...... | ...... | ...... | 30 | 45 | 42 | 47 | 66 | 62 | 46.5 | 55 | 56 | 61 | 71 | 64 |
| 30 | 16.5 | 22 | 17 | ...... | ...... | ...... | 35 | 54 | 40 | 48 | 54 | 53 | 50 | 60 | 57 | 64 | 64 | 72 |
| 31 | 6 | 24 | 19 | ...... | ...... | ...... | 34 | 45 | 40 | ...... | ...... | ...... | 53 | 61 | 55 | ...... | ...... | ...... |
| Average | 21.1 | 27.1 | 23.7 | 24.0 | 30.0 | 27.6 | 30.5 | 38.0 | 35.5 | 40.6 | 51.6 | 47.4 | 51.5 | 61.2 | 58.8 | 59.7 | 69.9 | 66.6 |

READINGS OF THE STANDARD AIR THERMOMETER — (*Concluded*).

| | July. | | | August. | | | September. | | | October. | | | November. | | | December. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. |
| 1 | 66 | 80.5 | 75 | 64 | 71 | 71 | 63 | 71 | 64 | 57 | 81 | 63 | 49 | 51 | 50.5 | 24 | 30 | 30.5 |
| 2 | 68 | 76 | 78 | 62 | 79 | 77 | 60 | 71 | 66.5 | 50 | 61 | 57 | 46 | 46.5 | 46 | 10.5 | 30 | 24 |
| 3 | 70 | 87 | 84 | 67 | 85.5 | 84 | 53 | 68 | 61 | 40 | 60.5 | 57 | 42 | 46.5 | 47 | 26 | 27 | 27 |
| 4 | 75 | 87.5 | 87 | 70 | 81 | 72.5 | 51 | 73.5 | 68 | 38 | 67 | 63 | 39.5 | 61 | 54 | 32 | 38 | 40 |
| 5 | 77 | 91.5 | 81 | 63.5 | 73 | 70 | 57 | 85 | 81 | 46 | 71.5 | 66 | 46 | 60 | 57 | 34 | 33 | 32.5 |
| 6 | 74 | 83 | 82 | 63 | 79.5 | 75 | 60 | 86 | 79 | 57 | 58 | 55 | 48.5 | 43 | 41.5 | 22 | 27.5 | 30 |
| 7 | 73.5 | 89 | 82 | 61 | 82 | 77 | 64 | 73 | 75 | 48 | 45 | 44 | 40 | 46 | 42 | 33 | 37 | 36 |
| 8 | 73 | 90 | 89 | 67 | 80 | 75 | 63 | 84 | 77 | 35 | 55 | 54 | 37 | 42 | 45.5 | 34 | 40 | 38 |
| 9 | 77 | 93 | 83 | 65.5 | 78.5 | 75.5 | 63 | 92 | 85 | 46 | 49 | 42 | 41.5 | 53 | 35 | 38 | 54 | 48.5 |
| 10 | 76 | 95.5 | 92 | 67 | 75 | 73 | 69.5 | 95.5 | 88 | 32 | 55 | 52 | 36 | 46 | 38.5 | 48.5 | 56 | 54 |
| 11 | 76 | 92.5 | 69 | 67 | 71 | 71 | 66 | 67 | 63.5 | 57.5 | 67 | 65 | 39 | 46 | 41 | 53 | 60 | 44.5 |
| 12 | 65 | 65 | 65 | 59 | 77 | 63 | 51.5 | 77 | 72.5 | 67 | 62 | 62 | 34.5 | 37.5 | 33.5 | 35.5 | 37.5 | 35 |
| 13 | 63 | 71 | 77 | 57 | 71.5 | 74 | 67 | 70 | 76 | 44 | 59 | 52 | 32 | 34 | 31.5 | 34 | 40 | 37 |
| 14 | 64 | 75.5 | 70 | 61.5 | 87 | 82 | 56.5 | 65.5 | 60 | 45 | 70 | 72 | 32 | 38 | 35 | 39 | 43 | 40 |
| 15 | 65 | 82 | 75 | 71 | 71 | 75 | 49 | 70 | 69 | 61 | 86 | 78 | 39 | 43.5 | 46 | 38 | 39 | 41.5 |
| 16 | 66 | 82 | 79 | 64 | 80 | 69.5 | 62 | 92.5 | 84.5 | 76 | 83 | 77 | 57 | 46 | 37 | 37 | 44 | 44 |
| 17 | 69 | 77.5 | 72 | 58.5 | 68.5 | 64 | 66 | 65 | 57 | 41 | 46 | 40 | 32 | 35.5 | 30 | 28 | 34.5 | 39.5 |
| 18 | 72 | 83 | 76 | 59 | 72 | 70 | 45 | 61 | 62.5 | 31.5 | 55 | 49 | 28.5 | 33 | 29 | 20 | 22.5 | 22 |
| 19 | 68.5 | 78 | 80 | 60 | 67 | 62 | 59 | 58 | 59 | 43 | 55 | 53 | 28 | 32 | 34 | 14 | 17.5 | 15 |
| 20 | 70 | 77 | 72 | 56 | 66 | 63 | 48 | 50 | 45 | 45 | 57 | 56 | 38 | 51 | 49.5 | 17 | 23.5 | 26 |
| 21 | 71.5 | 83 | 81.5 | 55 | 73 | 68 | 41.5 | 55 | 55 | 49 | 49 | 50 | 45 | 60 | 46.5 | 25 | 26 | 25 |
| 22 | 69 | 86 | 85 | 58.5 | 77 | 68 | 44 | 66 | 61 | 48.5 | 53 | 49 | 28 | 33.5 | 29 | 26 | 30.5 | 25 |
| 23 | 67 | 69 | 71.5 | 55 | 67 | 63.5 | 50 | 59.5 | 51 | 40 | 53 | 54.5 | 27 | 24 | 17 | 21 | 21.5 | 16.5 |
| 24 | 66 | 73 | 74 | 59 | 70 | 69 | 52 | 57 | 59.5 | 38 | 61 | 54.5 | 20 | 31 | 28.5 | 3 | 11 | 7.5 |
| 25 | 69 | 74.5 | 74 | 64.5 | 70.5 | 68 | 51 | 74 | 66 | 47.5 | 57 | 50.5 | 34.5 | 34 | 37 | 12 | 25.5 | 24.5 |
| 26 | 67.5 | 80 | 68 | 60 | 69 | 67.5 | 55.5 | 77.5 | 59 | 41.5 | 53 | 53 | 51 | 58 | 58 | 29 | 31 | 30 |
| 27 | 59 | 61 | 63 | 57 | 77 | 75 | 45 | 56.5 | 49.5 | 40 | 62 | 58 | 30 | 27 | 26 | 24 | 27 | 19 |
| 28 | 60 | 67 | 67 | 60 | 72 | 68 | 41 | 52 | 52 | 50 | 67 | 63 | 23 | 35.5 | 33 | 11 | 21.5 | 18 |
| 29 | 65 | 63.5 | 65 | 61 | 81 | 77.5 | 43 | 67 | 64 | 42 | 42 | 40 | 35 | 37 | 26 | 16 | 26.5 | 28 |
| 30 | 63 | 78 | 77 | 59 | 70 | 66 | 51 | 79 | 74 | 34 | 40 | 41 | 20 | 25 | 23 | 38 | 40.5 | 34 |
| 31 | 70 | 79 | 74 | 57 | 73 | 67 | ...... | ...... | ...... | 41 | 57 | 52 | ...... | ...... | ...... | 31 | 30 | 23 |
| Average | 68.9 | 79.7 | 76.4 | 61.6 | 74.7 | 71 | 54.9 | 70.6 | 66.2 | 46.2 | 59.3 | 55.6 | 36.6 | 41.9 | 38.4 | 27.5 | 33.1 | 30.8 |

SUMMARY OF MAXIMUM, MINIMUM AND STANDARD AIR THERMOMETERS.

| | Maximum. | Minimum. | Standard. | | |
|---|---|---|---|---|---|
| | | | 7 a. m. | 12 m. | 6 p. m. |
| | Ave. | Ave. | Ave. | Ave. | Ave. |
| January | 31.4 | 15 | 21.1 | 27.1 | 23.7 |
| February | 33.2 | 19 | 24 | 30 | 27.6 |
| March | 42.6 | 25 | 30.5 | 38 | 35.5 |
| April | 55.2 | 34.9 | 40.6 | 51.6 | 47.4 |
| May | 65.1 | 45.7 | 51.5 | 61.2 | 58.8 |
| June | 72.9 | 51.8 | 59.7 | 69.9 | 66.6 |
| July | 83.2 | 63.9 | 68.9 | 79.7 | 76.4 |
| August | 78.8 | 56.4 | 61.6 | 74.7 | 71 |
| September | 75.3 | 49.4 | 54.9 | 70.6 | 66.2 |
| October | 65.1 | 40 | 46.2 | 59.3 | 55 6 |
| November | 47.2 | 32.1 | 36.6 | 41.9 | 38.4 |
| December | 36 | 22.4 | 27.5 | 33.1 | 30.8 |

READINGS OF MAXIMUM AND MINIMUM THERMOMETERS AT 7 A. M.

| | January. | | February. | | March. | | April. | | May. | | June. | | July. | | August. | | September. | | October. | | November. | | December. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. |
| 1 | 39 | 19 | 21 | 5.5 | 22.5 | —1 | 46 | 28 | 69.5 | 47 | 64 | 45.5 | 74 | 58 | 79.5 | 60.5 | 77 | 56 | 76 | 50 | 58.5 | 41 | 27.5 | 20 |
| 2 | 41 | 28 | 33 | 16.5 | 39 | 10 | 47 | 29 | 67.5 | 55 | 57 | 42 | 84.5 | 59 | 75 | 57 | 76.5 | 57.5 | 81 | 49 | 52 | 46 | 36 | 10 |
| 3 | 45 | 37 | 33 | 21 | 40 | 23 | 57.5 | 29 | 65 | 44 | 67.5 | 48 | 81 | 61 | 82 | 61 | 73 | 17 | 67 | 37 | 49 | 41 | 31 | 10.5 |
| 4 | 56 | 36 | 27.5 | 18.5 | 51 | 23 | 46 | 28 | 60 | 45 | 80 | 49.5 | 88.5 | 67 | 87 | 64.5 | 70 | 41 | 66 | 36 | 51 | 39 | 32 | 26 |
| 5 | 58 | 30 | 33 | 14 | 36 | 21 | 55 | 36 | 55 | 42 | 72 | 48 | 91 | 72 | 87 | 62 | 78 | 49.5 | 71.5 | 37 | 64 | 39 | 42 | 30.5 |
| 6 | 38.5 | 16 | 36 | 18 | 51 | 30 | 67 | 44.5 | 65 | 42.5 | 73 | 48 | 95 | 72 | 83.5 | 55.5 | 90 | 55.5 | 79 | 45 | 65 | 46 | 35.5 | 22 |
| 7 | 28 | 16 | 43 | 32 | 31 | 10 | 49.5 | 35 | 59 | 42 | 76.5 | 53 | 87 | 61.5 | 81 | 55 | 91 | 59 | 62 | 47.5 | 49 | 39 | 34 | 22 |
| 8 | 31.5 | 18.5 | 40 | 33 | 31 | 11.5 | 42.5 | 32 | 51 | 32.5 | 69 | 51 | 90 | 66 | 84 | 58 | 82 | 61 | 54 | 32 | 51 | 33 | 39.5 | 32 |
| 9 | 33.5 | 16 | 35.5 | 26.5 | 42 | 28 | 48 | 33 | 62.5 | 41.5 | 57 | 51 | 93 | 69 | 80 | 61 | 88 | 59 | 60 | 35 | 46 | 37 | 43.5 | 33 |
| 10 | 39.5 | 11 | 33 | 18 | 43 | 35 | 40 | 29 | 79 | 52 | 61 | 52 | 96 | 69.5 | 83 | 65 | 95 | 62.5 | 50 | 30 | 56.5 | 33.5 | 57.5 | 38 |
| 11 | 37 | 25 | 26 | 11 | 47 | 30 | 38 | 27 | 65 | 46 | 66.5 | 51 | 97 | 69.5 | 78 | 58 | 98 | 62.5 | 58 | 32 | 48 | 33.5 | 58 | 45.5 |
| 12 | 33 | 11 | 24 | 10 | 47.5 | 31 | 42 | 29 | 73 | 53 | 79 | 54 | 95 | 64 | 75.5 | 58 | 82.5 | 47 | 70 | 54 | 48 | 34 | 61.5 | 45.5 |
| 13 | 13 | 8 | 23 | 14 | 55 | 28 | 55 | 35 | 70 | 53 | 72 | 52 | 66 | 62 | 78 | 51 | 77 | 50 | 73 | 43 | 39 | 32 | 38.5 | 34 |
| 14 | 28 | 5 | 27 | 13 | 32 | 15 | 59 | 40 | 62 | 48 | 75 | 55 | 77 | 61 | 79 | 55 | 80 | 52 | 61 | 42.5 | 45.5 | 31.5 | 43.5 | 34 |
| 15 | 25 | 4 | 45 | 22 | 40 | 17 | 49 | 38 | 70 | 45 | 76 | 54.5 | 79 | 57 | 87.5 | 61 | 67.5 | 44 | 79 | 44 | 41 | 32 | 43.5 | 36 |
| 16 | 28 | 17 | 33.5 | 27.5 | 31 | 11 | 44.5 | 37 | 61 | 40 | 79 | 55 | 82.5 | 58.5 | 79 | 62.5 | 76 | 47.5 | 88 | 60 | 57 | 39 | 42 | 36 |
| 17 | 38 | 25 | 37 | 24 | 13 | 21 | 58 | 38 | 62 | 39.5 | 74 | 48.5 | 85.5 | 65 | 80 | 56.5 | 95.5 | 61 | 86 | 40 | 59 | 31.5 | 46 | 26.5 |
| 18 | 43.5 | 27 | 49.5 | 31 | 41 | 17 | 46 | 32 | 70 | 48 | 73.5 | 51 | 83 | 64 | 72 | 54 | 67 | 42 | 49 | 30 | 36 | 27 | 42 | 19.5 |
| 19 | 34 | 3 | 37.5 | 26 | 48 | 37 | 61 | 36 | 74.5 | 43 | 76 | 50 | 84 | 65 | 76.5 | 55 | 70.5 | 44 | 61 | 31.5 | 36 | 26 | 23.5 | 14 |
| 20 | 9 | —3.5 | 32.5 | 19 | 56 | 40 | 55 | 19 | 65 | 47 | 81 | 58 | 82.5 | 67 | 77 | 51.5 | 61 | 17 | 59 | 41 | 38 | 28 | 18 | 6 |
| 21 | 37 | 8 | 38 | 12.5 | 61 | 40 | 36.5 | 20 | 78 | 50 | 66 | 45 | 83 | 63.5 | 68 | 46 | 51 | 37.5 | 57 | 44 | 51 | 38 | 29.5 | 15 |
| 22 | 38.5 | 22.5 | 43.5 | 26 | 49.5 | 31 | 58 | 31 | 60 | 40.5 | 67 | 45 | 86 | 68 | 79.5 | 54.5 | 61 | 41 | 51 | 47 | 62.5 | 28 | 28 | 20.5 |
| 23 | 38.5 | 22 | 39 | 25 | 61.5 | 31 | 77 | 45 | 64.5 | 45.5 | 79 | 52 | 90.5 | 66 | 81 | 52.5 | 70.5 | 43 | 54 | 37 | 31.5 | 21.5 | 31 | 17 |
| 24 | 27.5 | 11 | 37.5 | 20 | 51.5 | 35 | 79 | 54 | 80 | 51 | 87.5 | 61.5 | 79.5 | 64 | 70 | 54 | 61 | 49 | 63 | 36 | 28 | 16.5 | 24 | 2 |
| 25 | 17 | 2 | 31 | 19 | 44.5 | 29 | 74 | 51 | 70 | 45 | 87.5 | 64 | 79.5 | 65.5 | 76 | 58 | 63 | 49 | 65 | 37.5 | 35.5 | 20 | 13 | 3 |
| 26 | 13 | 3 | 37 | 12 | 33 | 27 | 82 | 40 | 50 | 40 | 78.5 | 52 | 81 | 64.5 | 75 | 52.5 | 78 | 50 | 60 | 40 | 51 | 33 | 29 | 12 |
| 27 | 17 | 11 | 17 | 5.5 | 35 | 26 | 60 | 32 | 59 | 42 | 66 | 49 | 80 | 58.5 | 75 | 51 | 79 | 44 | 63.5 | 36 | 60 | 30 | 35 | 24 |
| 28 | 20 | 11 | 20.5 | 9 | 38 | 26 | 47 | 32 | 63 | 49.5 | 72 | 45 | 64 | 58 | 82.5 | 55.5 | 61 | 38.5 | 69 | 39 | 30.5 | 20 | 28 | 11 |
| 29 | 16.5 | 10 | ...... | ...... | 40 | 25.5 | 60.5 | 37.5 | 61 | 44 | 81 | 55 | 70 | 59.5 | 71.5 | 54 | 59 | 40 | 72 | 41.5 | 38.5 | 23 | 21.5 | 11 |
| 30 | 24 | 10 | ...... | ...... | 50 | 30 | 72 | 45.5 | 61 | 49 | 72.5 | 60 | 70 | 61 | 83 | 57 | 72.5 | 42 | 48 | 32.5 | 38 | 20 | 38 | 16 |
| 31 | 25 | 5 | ...... | ...... | 57 | 31 | ..... | ..... | 62 | 53 | ..... | .... | 83 | 62.5 | 74 | 51 | ...... | ...... | 49 | 33 | ...... | ...... | 41 | 30.5 |
| Average | 31.4 | 15 | 33.2 | 19 | 42.6 | 25 | 55.2 | 34.9 | 65.1 | 45.7 | 72.9 | 51.8 | 83.2 | 63.9 | 78.8 | 56.1 | 75.3 | 49.4 | 65.1 | 40 | 47.2 | 32.1 | 36 | 22.4 |

## READINGS OF SOIL THERMOMETERS.

| | One Inch. | | | Two Inches. | | | Three Inches. | | | Six Inches. | | | Nine Inches. | | | Eighteen Inches. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. |
| May 1 | 54 | 57 | 57 | 54.5 | 57.5 | 57.5 | 53 | 55 | 56 | 53 | 53.5 | 54.5 | 52.5 | 51.5 | 52 | 49 | 49 | 49 |
| 2 | 54.5 | 57 | 56.5 | 54.5 | 57.5 | 56.5 | 53.5 | 55.5 | 55 | 53.5 | 53.5 | 54 | 52 | 52 | 52 | 49.5 | 49.5 | 49.5 |
| 3 | 50.5 | 56 | 57 | 50.5 | 56.5 | 58 | 50.5 | 54 | 57 | 52 | 52 | 55 | 51.5 | 51 | 52.5 | 49.5 | 49.5 | 49.5 |
| 4 | 50.5 | 53.5 | 53.5 | 51 | 53 | 54 | 50.5 | 51.5 | 53 | 51.5 | 51.5 | 52.5 | 51 | 51 | 51 | 50 | 50 | 50 |
| 5 | 49.5 | 59.5 | 62 | 49.5 | 60.5 | 63 | 48 | 57 | 60.5 | 50.5 | 52.5 | 57 | 50 | 50.5 | 53 | 49.5 | 49.5 | 49.5 |
| 6 | 51 | 59.5 | 60.5 | 51 | 60 | 61.5 | 51 | 57.5 | 60 | 53 | 54 | 57.5 | 52.5 | 52.5 | 54 | 50.5 | 50.5 | 50.5 |
| 7 | 50.5 | 58.5 | 58 | 50.5 | 59 | 59 | 50.5 | 57 | 58 | 52.5 | 54 | 56.5 | 52.5 | 52.5 | 54 | 51 | 51 | 51 |
| 8 | 46 | 59 | 59.5 | 46 | 59 | 60 | 46.5 | 55.5 | 58 | 50 | 52 | 56 | 51 | 51 | 53 | 51 | 51 | 50.5 |
| 9 | 49.5 | 62 | 61.5 | 49.5 | 62 | 61.5 | 49 | 57.5 | 59.5 | 51 | 53.5 | 56.5 | 51.5 | 51.5 | 54 | 51 | 52 | 51 |
| 10 | 58 | 57.5 | 59 | 58 | 58 | 60 | 56.5 | 56.5 | 58.5 | 55.5 | 56 | 56.5 | 54 | 54 | 54.5 | 51.5 | 52 | 52 |
| 11 | 52 | 61.5 | 61.5 | 51.5 | 62 | 61.5 | 51.5 | 59 | 60 | 53 | 55 | 58 | 53 | 53 | 55 | 52 | 52 | 52 |
| 12 | 57.5 | 60.5 | 62 | 57.5 | 61 | 63 | 56.5 | 58.5 | 61 | 56 | 56.5 | 59 | 55 | 55 | 56 | 52.5 | 52.5 | 53 |
| 13 | 56 | 58 | 58.5 | 56 | 58 | 59 | 55.5 | 57 | 58 | 56 | 56.5 | 57.5 | 55 | 55 | 55 | 53 | 53 | 53 |
| 14 | 54 | 59.5 | 59.5 | 54 | 59.5 | 60 | 53.5 | 58 | 59.5 | 54 | 56.5 | 58 | 54 | 54 | 55 | 53 | 53 | 53 |
| 15 | 51 | 60 | 59 | 51 | 61 | 60 | 51 | 58.5 | 58.5 | 53 | 55.5 | 57.5 | 53.5 | 53.5 | 55 | 53 | 53 | 53 |
| 16 | 50.5 | 63.5 | 61.5 | 50.5 | 65.5 | 62 | 50 | 61 | 61.5 | 52 | 56 | 60 | 53 | 53 | 56 | 53 | 53 | 53 |
| 17 | 51 | 63.5 | 62.5 | 50.5 | 64 | 63 | 50.5 | 60 | 61.5 | 53 | 56 | 59.5 | 54 | 54 | 56 | 53 | 53 | 53 |
| 18 | 54.5 | 64 | 63 | 54.5 | 65.5 | 64 | 54 | 61.5 | 62.5 | 55 | 57.5 | 60.5 | 55 | 55 | 57 | 53.5 | 54 | 54 |
| 19 | 52.5 | 65 | 63.5 | 52 | 66 | 62.5 | 52.5 | 61.5 | 61 | 54.5 | 57.5 | 59.5 | 55 | 55 | 56.5 | 54 | 54 | 54 |
| 20 | 57 | 65 | 62 | 57 | 65.5 | 62.5 | 55.5 | 62 | 61 | 56 | 58.5 | 60 | 55.5 | 56 | 57 | 54 | 54.5 | 54.5 |
| 21 | 56 | 54 | 57 | 56 | 54.5 | 57.5 | 56 | 55 | 56.5 | 57.5 | 56.5 | 56.5 | 56.5 | 56 | 55.5 | 54.5 | 54.5 | 54.5 |
| 22 | 48.5 | 65 | 62.5 | 48.5 | 65.5 | 63 | 49 | 60.5 | 61.5 | 52 | 55.5 | 59.5 | 53 | 53 | 56 | 54 | 54 | 54 |
| 23 | 54.5 | 62.5 | 61.5 | 54.5 | 62 | 61.5 | 53.5 | 59.5 | 60.5 | 54.5 | 56.5 | 59.5 | 54.5 | 54.5 | 56.5 | 54 | 54 | 54 |
| 24 | 55.5 | 64 | 59.5 | 55.5 | 64.5 | 59.5 | 55 | 61.5 | 58.5 | 56 | 58 | 59 | 55.5 | 55.5 | 57 | 54.5 | 54.5 | 54.5 |
| 25 | 53 | 53.5 | 55 | 53.5 | 53.5 | 55 | 53.5 | 53 | 54 | 55.5 | 54.5 | 54.5 | 55 | 54.5 | 53 | 54.5 | 54.5 | 54 |
| 26 | 49 | 65 | 62 | 49 | 66 | 62 | 49 | 60.5 | 61 | 51.5 | 55.5 | 59.5 | 52.5 | 53 | 56 | 53.5 | 53.5 | 53.5 |
| 27 | 51.5 | 66 | 63 | 51.5 | 66.5 | 62.5 | 51.5 | 61.5 | 62 | 53.5 | 56.5 | 60.5 | 54 | 54.5 | 57 | 54 | 54 | 54 |
| 28 | 53.5 | 57.5 | 57 | 53.5 | 57.5 | 57 | 55 | 56 | 56.5 | 55.5 | 56 | 56.5 | 55.5 | 55 | 55.5 | 54.5 | 54.5 | 54.5 |
| 29 | 51.5 | 57.5 | 59.5 | 51.5 | 57.5 | 60 | 52 | 55 | 59 | 53 | 54.5 | 58 | 54.5 | 54 | 56 | 54.5 | 54.5 | 55 |
| 30 | 51.5 | 61.5 | 60 | 51.5 | 61 | 60 | 51.5 | 58 | 59 | 53.5 | 55.5 | 57 | 54 | 54 | 56 | 54 | 54 | 55 |
| 31 | 55 | 64 | 61 | 55 | 64.5 | 61 | 54 | 60.5 | 60.5 | 55 | 57.5 | 60 | 55 | 55.5 | 57 | 54.5 | 54.5 | 54.5 |
| Average | 52.6 | 60.3 | 59.8 | 52.6 | 60.8 | 60.2 | 52.2 | 57.9 | 59 | 53.6 | 55.3 | 57.6 | 53.6 | 53.6 | 55 | 52.6 | 52.7 | 52.7 |

READINGS OF SOIL THERMOMETERS — *Continued.*

| | ONE INCH. | | | TWO INCHES. | | | THREE INCHES. | | | SIX INCHES. | | | NINE INCHES. | | | EIGHTEEN INCHES. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. |
| June 1 | 53.5 | 55 | 57 | 53.5 | 54.5 | 57 | 53.5 | 53.5 | 55 | 55.5 | 55 | 55 | 55.5 | 55 | 55 | 55 | 55 | 55 |
| 2 | 50.5 | 64.5 | 63 | 50.5 | 64.5 | 62.5 | 50.5 | 60 | 61 | 53 | 56 | 59.5 | 54 | 54 | 56.5 | 51.5 | 54 | 54 |
| 3 | 58.5 | 66 | 67 | 58.5 | 65.5 | 67 | 57 | 63 | 65 | 55.5 | 60 | 62.5 | 56 | 57 | 59 | 56 | 55 | 55.5 |
| 4 | 62.5 | 68 | 66.5 | 62.5 | 68 | 66.5 | 61 | 65.5 | 65.5 | 60.5 | 62.5 | 64.5 | 59 | 59.5 | 60.5 | 56 | 56.5 | 57 |
| 5 | 59 | 69.5 | 67 | 59 | 70 | 66.5 | 58.5 | 65.5 | 65.5 | 59.5 | 62 | 64.5 | 59.5 | 59.5 | 61.5 | 58.5 | 58 | 57.5 |
| 6 | 58 | 70 | 66 | 58 | 69.5 | 65.5 | 57.5 | 65 | 65.5 | 59 | 62 | 64 | 59 | 59.5 | 61.5 | 58 | 58 | 58 |
| 7 | 60 | 64.5 | 62.5 | 60 | 64.5 | 62.5 | 59 | 62.5 | 61.5 | 60 | 61.5 | 61.5 | 59.5 | 59.5 | 60 | 58 | 58 | 58 |
| 8 | 56 | 58.5 | 58 | 56.5 | 58.5 | 58.5 | 56 | 57.5 | 57.5 | 57 | 58 | 58 | 58.5 | 57.5 | 57.5 | 58 | 57.5 | 57 |
| 9 | 57 | 60 | 59.5 | 57 | 60 | 59.5 | 56.5 | 58.5 | 58.5 | 57.5 | 58 | 58.5 | 57 | 57 | 57.5 | 56.5 | 56.5 | 56.5 |
| 10 | 57 | 62.5 | 64.5 | 57 | 62.5 | 64.5 | 56.5 | 60 | 63 | 57.5 | 58.5 | 61 | 57 | 57 | 58.5 | 56.5 | 56.5 | 56.5 |
| 11 | 58.5 | 73.5 | 57.5 | 58.5 | 75 | 62 | 57 | 69.5 | 66.5 | 58 | 62.5 | 69 | 58 | 58.5 | 60.5 | 57 | 57 | 57.5 |
| 12 | 61.5 | 69 | 69.5 | 61.5 | 69.5 | 69.5 | 61.5 | 67 | 68.5 | 62.5 | 64 | 66.5 | 61.5 | 61 | 63 | 58.5 | 59 | 59 |
| 13 | 61.5 | 72 | 70.5 | 61.5 | 73 | 71 | 60.5 | 69.5 | 70 | 61 | 64 | 67.5 | 61 | 61 | 63.5 | 59.5 | 59.5 | 59.5 |
| 14 | 61.5 | 75.5 | 71.5 | 61.5 | 76.5 | 71 | 60.5 | 72 | 70 | 62 | 65.5 | 68.5 | 62 | 62 | 65 | 60 | 60 | 60 |
| 15 | 62.5 | 77 | 69 | 62.5 | 77 | 69 | 61 | 72.5 | 68.5 | 62.5 | 66.5 | 67.5 | 62.5 | 63 | 64.5 | 61 | 61 | 61 |
| 16 | 62 | 76.5 | 72 | 61.5 | 76.5 | 71.5 | 60.5 | 71.5 | 70.5 | 62.5 | 66 | 69 | 62.5 | 62.5 | 65 | 61 | 61 | 61 |
| 17 | 60 | 72 | 67 | 60 | 73 | 67 | 60 | 68.5 | 66.5 | 62 | 63.5 | 66 | 62.5 | 62 | 63.5 | 61 | 61 | 61 |
| 18 | 61 | 76.5 | 73 | 60.5 | 77 | 72.5 | 60 | 72 | 71.5 | 61.5 | 55.5 | 69.5 | 61.5 | 62 | 65 | 61 | 61 | 61 |
| 19 | 61 | 74.5 | 72 | 61 | 74.5 | 72 | 60.5 | 70 | 70 | 61.5 | 65.5 | 68 | 63 | 63 | 65 | 61.5 | 61.5 | 61.5 |
| 20 | 64.5 | 73.5 | 68 | 64.5 | 73.5 | 67.5 | 64 | 69.5 | 67.5 | 64.5 | 66 | 67.5 | 64 | 64 | 65 | 61.5 | 62 | 61.5 |
| 21 | 57.5 | 69 | 66.5 | 57 | 68.5 | 66.5 | 57 | 65 | 66 | 60 | 62.5 | 65.5 | 61 | 61 | 63 | 61.5 | 61 | 61 |
| 22 | 58 | 73 | 70.5 | 57.5 | 72 | 70 | 57 | 67.5 | 69 | 59.5 | 63 | 67 | 60.5 | 60.5 | 63 | 61 | 60.5 | 60.5 |
| 23 | 61.5 | 75 | 73.5 | 61.5 | 73.5 | 73 | 60.5 | 69.5 | 71 | 61 | 65 | 68.5 | 62 | 62 | 64.5 | 61 | 61 | 61 |
| 24 | 67 | 79 | 73.5 | 67 | 78 | 73.5 | 65.5 | 73.5 | 72 | 65.5 | 73.5 | 70.5 | 64 | 64.5 | 67 | 62 | 62 | 62 |
| 25 | 67 | 77.5 | 74 | 67 | 76.5 | 74 | 66 | 72.5 | 73 | 66.5 | 69.5 | 72 | 65.5 | 66 | 68 | 63 | 63 | 63 |
| 26 | 62.5 | 73.5 | 69.5 | 62.5 | 73 | 69.5 | 62 | 69 | 68 | 64 | 67 | 69.5 | 65 | 64.5 | 66.5 | 63.5 | 63.5 | 63 |
| 27 | 60 | 72 | 70 | 60 | 71 | 69.5 | 59.5 | 67.5 | 69 | 62 | 65 | 68.5 | 63 | 63 | 65.5 | 63 | 63 | 62.5 |
| 28 | 59 | 74 | 71.5 | 59 | 72.5 | 71.5 | 59 | 68 | 70.5 | 61.5 | 65 | 69 | 63 | 62.5 | 65.5 | 62.5 | 62.5 | 62.5 |
| 29 | 63 | 68.5 | 65.5 | 62.5 | 67.5 | 65.5 | 62 | 66 | 65 | 63.5 | 65.5 | 65.5 | 64 | 64 | 64 | 63 | 63 | 62.5 |
| 30 | 66.5 | 67.5 | 71 | 66.5 | 67 | 71 | 65.5 | 66 | 70 | 65.5 | 65.5 | 68 | 64 | 64 | 65 | 62.5 | 62.5 | 62.5 |
| Average | 60.3 | 70.2 | 67.5 | 60.2 | 70.1 | 67.6 | 59.5 | 66.6 | 66.7 | 60.7 | 63.5 | 65.7 | 60.9 | 60.9 | 62.6 | 59.7 | 59.7 | 59.6 |

READINGS OF SOIL THERMOMETERS (*Continued*).

| | ONE INCH. | | | TWO INCHES. | | | THREE INCHES. | | | SIX INCHES. | | | NINE INCHES. | | | EIGHTEEN INCHES. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. |
| July 1 | 65 | 76.5 | 75 | 64.5 | 76 | 75 | 63.5 | 71.5 | 73.5 | 64.5 | 68 | 71.5 | 64.5 | 65 | 68 | 63 | 63 | 63 |
| 2 | 66.5 | 72 | 74 | 66.5 | 71.5 | 74 | 65.5 | 69.5 | 72.5 | 66.5 | 68 | 70.5 | 66 | 66 | 67.5 | 64 | 64 | 64 |
| 3 | 67.5 | 79.5 | 77 | 67 | 79 | 77 | 66 | 74.5 | 76 | 67 | 70.5 | 74 | 66.5 | 67 | 69.5 | 64.5 | 64.5 | 65 |
| 4 | 70 | 79.5 | 79 | 70 | 79 | 79 | 69 | 75.5 | 77 | 69.5 | 72 | 75 | 68.5 | 69 | 71 | 65 5 | 66 | 66 |
| 5 | 73 | 81.5 | 80 | 72.5 | 81 | 80 | 71.5 | 77 | 78.5 | 71.5 | 74 | 76.5 | 70 | 70.5 | 72.5 | 67 | 67 | 67 |
| 6 | 73 | 79 | 79.5 | 73 | 78 | 79.5 | 72 | 75 | 78.5 | 72 | 73.5 | 76.5 | 71 | 71 | 72.5 | 67.5 | 68 | 68 |
| 7 | 71.5 | 83 | 80.5 | 71 | 81 | 80 | 70 | 77.5 | 79 | 71 | 74 | 77 | 70.5 | 71 | 73 | 68 | 68 | 68 |
| 8 | 72 | 84 | 81.5 | 72 | 82 | 81 | 71 | 78.5 | 80 | 72 | 74.5 | 77.5 | 71.5 | 71.5 | 73.5 | 69 | 69 | 69 |
| 9 | 74 | 85 | 82 | 73.5 | 83 | 81.5 | 72.5 | 79.5 | 80 | 73 | 75.5 | 78.5 | 72 | 72.5 | 74.5 | 69.5 | 69.5 | 69.5 |
| 10 | 75 | 87 | 83.5 | 74.5 | 84 | 83 | 73.5 | 80 | 81.5 | 73.5 | 76.5 | 79.5 | 72.5 | 73 | 75 | 70 | 70 | 70 |
| 11 | 74 | 81 | 73·5 | 73.5 | 79.5 | 73.5 | 73 | 77 | 73 | 73.5 | 74.5 | 74 | 73 | 72.5 | 73.5 | 70.5 | 70.5 | 70.5 |
| 12 | 71 | 71 | 71 | 71 | 71 | 71 | 70.5 | 70.5 | 70.5 | 71.5 | 71 | 71 | 71 | 70.5 | 70 | 70 | 69.5 | 69 |
| 13 | 68.5 | 74 | 75.5 | 68.5 | 73.5 | 75 | 68 | 72 | 74.5 | 69 | 70 5 | 73 | 69 | 69 | 70.5 | 68.5 | 68.5 | 68 |
| 14 | 69 | 74.5 | 74.5 | 69 | 74 | 74 | 68.5 | 72 | 73 | 69.5 | 71 | 72 | 69 | 69.5 | 70.5 | 68 | 68.5 | 68.5 |
| 15 | 66.5 | 76 | 75 | 66.5 | 75 | 74.5 | 66.5 | 72.5 | 73 | 68.5 | 70.5 | 72.5 | 69 | 69 | 70 | 68 | 68 | 68 |
| 16 | 67 | 77.5 | 76 | 67 | 76.5 | 75.5 | 66.5 | 73 | 74 | 68.5 | 71 | 73 | 69 | 69 | 70 | 68 | 68 | 68 |
| 17 | 70 | 73.5 | 74.5 | 70 | 73 | 74 | 69.5 | 71.5 | 73.5 | 70 | 71 | 73 | 69.5 | 69.5 | 70.5 | 68 | 68 | 68 |
| 18 | 70 | 80.5 | 76.5 | 69.5 | 79.5 | 76.5 | 68.5 | 75.5 | 75.5 | 69.5 | 71 | 74.5 | 69 | 69.5 | 71.5 | 68 | 68.5 | 68.5 |
| 19 | 69 | 79 | 78 | 69 | 78.5 | 78.5 | 69 | 75.5 | 77 | 70 | 72 | 75 | 70 | 70 | 71.5 | 68.5 | 68.5 | 68.5 |
| 20 | 70.5 | 76.5 | 74.5 | 70.5 | 76 | 74.5 | 70 | 74 | 73.5 | 70.5 | 72 | 73 | 70 | 70 | 71 | 69 | 69 | 69 |
| 21 | 69 | 80 | 78.5 | 69 | 80 | 79 | 68 | 76.5 | 77.5 | 69 | 72 | 75 | 69 | 69.5 | 71.5 | 68.5 | 68.5 | 68.5 |
| 22 | 71 | 84 | 80 | 71 | 82.5 | 80.5 | 70.5 | 78.5 | 79.5 | 71 | 74 | 77 | 70.5 | 71 | 73.5 | 69 | 69 | 69 |
| 23 | 69.5 | 71.5 | 72 | 70 | 71.5 | 72 | 70 | 71 | 72 | 71.5 | 72 | 72 | 71 | 71 | 70.5 | 69.5 | 69 | 69 |
| 24 | 67.5 | 72.5 | 75.5 | 67.5 | 72,5 | 75.5 | 67 | 70.5 | 75 | 68.5 | 69.5 | 73.5 | 69 | 69 | 70.5 | 68.5 | 68.5 | 69 |
| 25 | 69·5 | 74.5 | 77 | 69.5 | 74.5 | 77 | 69 | 72 | 75.5 | 70 | 71 | 74 | 69.5 | 69.7 | 71 | 68.5 | 68.5 | 68.5 |
| 26 | 70 | 80.5 | 72 | 70 | 79.5 | 72 | 69 | 75.5 | 72 | 70.5 | 73 | 72.5 | 70 | 70.5 | 71.5 | 69 | 69 | 69 |
| 27 | 65 | 65 | 65 | 65 | 65 | 65.5 | 65.5 | 65 | 65 | 68.5 | 67 | 66.5 | 68.5 | 67.5 | 67 | 68.5 | 68 | 67.5 |
| 28 | 62 | 66 | 67.5 | 62 | 66 | 67.5 | 62 | 65 | 66.5 | 64 | 65 | 66.5 | 65 | 65 | 65.5 | 66.5 | 66.5 | 66 |
| 29 | 64.5 | 66.5 | 68 | 64.5 | 67 | 68 | 64 | 66 | 67 | 65 | 66 | 67 | 65 | 66.5 | 66 | 66 | 66.5 | 65.5 |
| 30 | 65 | 75.5 | 75 | 65 | 75 | 75 | 65 | 72 | 73.5 | 65.5 | 69 | 72 | 65.5 | 66 | 69 | 65.5 | 66 | 66 |
| 31 | 67 | 75 | 72.5 | 67 | 74.5 | 72.5 | 66.5 | 72 | 72 | 68 | 70.5 | 72 | 67.5 | 68 | 70 | 67 | 67 | 67 |
| Average | 69.1 | 76.8 | 75.6 | 69 | 76.1 | 75.5 | 68.4 | 73.4 | 74.5 | 69.4 | 71.3 | 73.4 | 69.1 | 69.3 | 70.7 | 67.8 | 67.8 | 67.7 |

READINGS OF SOIL THERMOMETERS — (*Continued*).

| | ONE INCH. | | | TWO INCHES. | | | THREE INCHES. | | | SIX INCHES. | | | NINE INCHES. | | | EIGHTEEN INCHES. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. |
| August 1 | 66.5 | 73.5 | 74 | 66.5 | 73 | 74 | 66.5 | 71 | 73 | 67.5 | 69.5 | 72 | 68 | 68 | 69.5 | 67 | 67 | 67 |
| 2 | 65 | 78.5 | 78 | 65 | 77 | 78 | 65 | 74 | 76.5 | 67 | 70 | 74.5 | 68 | 68 | 70.5 | 67.5 | 67.5 | 67.5 |
| 3 | 67 | 80.5 | 80 | 67 | 80 | 80.5 | 67 | 76.5 | 78.5 | 68.5 | 72 | 75.5 | 69 | 69 | 71.5 | 68 | 68 | 68 |
| 4 | 69 | 83 | 79 | 69 | 82.5 | 79 | 68.5 | 79 | 78.5 | 70 | 74 | 77 | 70 | 70.5 | 73 | 68.5 | 69 | 69 |
| 5 | 68.5 | 79 | 77 | 68.5 | 78.5 | 78 | 69 | 76 | 77 | 71 | 73 | 77.5 | 71 | 71 | 72.5 | 69.5 | 69.5 | 69.5 |
| 6 | 64.5 | 79.5 | 78.5 | 64.5 | 78 | 79 | 65 | 75.5 | 78 | 68 | 72 | 76 | 69 | 69.5 | 72 | 69.5 | 69.5 | 69.5 |
| 7 | 65 | 78 | 77.5 | 65 | 80.5 | 77.5 | 65 | 77 | 76 | 68 | 71.5 | 74.5 | 69 | 69 | 71.5 | 69 | 69 | 69 |
| 8 | 68 | 78 | 76 | 67.5 | 75.5 | 76 | 67 | 73 | 75 | 68 | 70.5 | 73 | 69 | 69 | 70 | 69 | 69 | 69 |
| 9 | 66.5 | 80 | 77.5 | 66.5 | 77 | 77.5 | 66 | 74.5 | 76.5 | 68 | 71 | 74 | 68 | 68.5 | 71 | 68.5 | 68 | 68 |
| 10 | 69 | 70.5 | 73.5 | 69 | 70 | 73.5 | 68.5 | 69 | 72.5 | 69.5 | 69 | 71.5 | 69.5 | 69 | 69.5 | 68.5 | 68.5 | 68.5 |
| 11 | 66.5 | 74 | 72.5 | 66.5 | 73 | 72.5 | 66 | 71 | 72 | 67.5 | 69.5 | 71 | 68 | 68 | 69 | 68 | 68 | 68 |
| 12 | 63 | 74 | 68.5 | 63 | 72.5 | 69 | 63.5 | 71 | 69 | 66 | 69 | 70 | 67 | 67 | 68.5 | 67.5 | 67.5 | 67.5 |
| 13 | 60 | 71 | 71.5 | 60 | 69 | 72 | 60.5 | 68 | 71.5 | 61 | 67 | 70.5 | 65.5 | 65.5 | 68 | 67 | 67 | 67 |
| 14 | 62.5 | 79.5 | 75.5 | 62.5 | 78.5 | 75.5 | 62.5 | 75.5 | 74.5 | 65 | 70 | 72 | 66 | 67.5 | 69 | 67 | 67 | 67 |
| 15 | 68 | 76 | 71 | 68 | 70 | 71 | 67 | 69 | 70.5 | 68 | 69 | 70 | 67.5 | 68 | 68 | 67 | 67 | 67 |
| 16 | 65 | 72.5 | 70 | 65.5 | 72 | 70 | 65.5 | 70.5 | 70.5 | 67 | 69 | 71 | 67 | 67 | 69 | 67 | 67 | 67 |
| 17 | 62 | 70 | 69 | 62 | 68.5 | 69 | 62.5 | 67.5 | 69 | 65 | 67 | 69 | 66 | 66 | 67.5 | 67 | 67 | 66.5 |
| 18 | 61 | 66.5 | 68 | 61 | 66.5 | 68.5 | 61 | 65.5 | 68 | 63.5 | 65.5 | 67.5 | 65 | 65 | 66 | 66 | 66 | 65.5 |
| 19 | 61.5 | 68.5 | 66 | 61.5 | 67.5 | 66 | 61.5 | 66 | 65.5 | 63.5 | 65.5 | 66 | 61.5 | 61.5 | 65 | 65.5 | 65.5 | 65 |
| 20 | 59 | 68 | 67.5 | 60 | 67 | 67.5 | 60 | 66 | 67.5 | 63 | 65 | 67 | 64 | 64 | 65.5 | 65 | 65 | 65 |
| 21 | 57.5 | 71 | 71 | 57.5 | 68.5 | 71 | 58 | 66.5 | 70 | 61 | 64 | 68.5 | 63 | 63 | 65.5 | 65 | 64.5 | 64.5 |
| 22 | 61.5 | 73.5 | 73 | 61.5 | 72 | 73 | 61.5 | 69 | 72 | 63.5 | 66 | 69 | 64 | 64.5 | 67 | 64.5 | 65 | 65 |
| 23 | 61.5 | 70.5 | 68.5 | 61.5 | 69 | 68.5 | 62 | 67.5 | 68 | 64 | 65.5 | 68 | 65 | 65 | 66 | 65 | 65 | 65 |
| 24 | 62.5 | 70.5 | 71.5 | 62.5 | 70 | 71.5 | 62.5 | 67.5 | 70.5 | 64 | 65.5 | 69.5 | 64.5 | 64.5 | 67 | 65 | 65 | 65 |
| 25 | 64.5 | 68.5 | 70 | 64.5 | 68.5 | 70 | 64.5 | 67 | 69.5 | 65.5 | 66.5 | 69.5 | 65.5 | 65.5 | 67 | 65 | 65.5 | 65.5 |
| 26 | 61 | 70 | 71 | 61 | 70 | 71 | 61 | 68 | 70.5 | 63.5 | 66 | 69.5 | 64.5 | 64.5 | 67 | 65.5 | 65.5 | 65.5 |
| 27 | 60 | 69 | 70 | 60 | 68.5 | 70 | 60.5 | 66.5 | 68.5 | 63 | 65 | 68 | 64 | 64 | 66 | 65 | 65 | 65 |
| 28 | 62.5 | 71.5 | 70.5 | 62.5 | 71.5 | 70.5 | 62 | 69 | 70 | 64 | 66.5 | 69.5 | 65 | 65 | 67 | 65 | 65 | 65 |
| 29 | 62 | 72 | 70.5 | 62 | 71.5 | 70.5 | 61.5 | 69 | 69.5 | 63.5 | 66.5 | 68 | 64 | 66 | 66 | 65 | 65 | 65 |
| 30 | 64 | 71.5 | 71 | 64 | 71.5 | 71 | 64 | 69 | 70.5 | 65.5 | 67 | 70 | 65.5 | 65.5 | 67 | 65 | 65 | 65 |
| 31 | 60 | 70.5 | 70 | 60 | 69.5 | 70 | 60.5 | 68 | 69 | 63.5 | 66 | 68.5 | 64.5 | 64.5 | 66 | 65 | 65 | 65 |
| Average | 63.7 | 73.3 | 72.5 | 63.7 | 72.5 | 72.6 | 63.7 | 70.3 | 71.9 | 65.8 | 68.2 | 70.9 | 66.5 | 66.6 | 68.3 | 66.7 | 66.7 | 66.6 |

READINGS OF SOIL THERMOMETERS — (*Continued*).

| | One Inch | | | Two Inches. | | | Three Inches. | | | Six Inches. | | | Nine Inches. | | | Eighteen Inches. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. |
| September 1 | 62 | 70 | 68 | 62 | 69.5 | 68 | 62 | 68 | 67.5 | 64 | 66 | 67.5 | 64.5 | 64.5 | 66 | 65 | 65 | 65 |
| 2 | 63 | 72 | 71 | 63 | 72 | 71 | 63 | 69.5 | 71 | 64.5 | 67 | 69 | 65 | 65 | 67 | 65 | 65 | 65 |
| 3 | 59 | 70.5 | 70 | 59 | 70.5 | 70 | 60 | 68 | 69.5 | 63 | 65.5 | 69 | 64 | 61 | 66 | 65 | 65 | 65 |
| 4 | 57 | 70.5 | 70 | 57 | 70 | 70 | 58 | 67 | 69 | 61 | 64 | 68 | 63 | 63 | 65 | 64.5 | 64.5 | 64 |
| 5 | 59.5 | 73 | 74.5 | 59.5 | 73 | 74.5 | 59.5 | 69.5 | 72.5 | 62 | 65.5 | 70 | 63 | 63.5 | 66 | 64 | 64.5 | 64 |
| 6 | 62.5 | 74.5 | 77 | 62.5 | 74.5 | 77 | 62.5 | 71 | 75 | 64.5 | 67 | 72 | 65 | 65 | 68 | 64.5 | 65 | 65 |
| 7 | 66 | 74.5 | 75.5 | 66 | 73.5 | 75.5 | 65.5 | 71 | 74 | 67 | 69 | 72 | 66.5 | 67 | 68.5 | 65.5 | 65.5 | 65.5 |
| 8 | 66.5 | 78 | 77 | 66.5 | 77 | 77 | 66 | 74 | 75.5 | 67.5 | 70 | 73 | 67 | 67.5 | 69.5 | 66 | 66 | 66 |
| 9 | 65 | 79.5 | 80 | 65 | 79.5 | 79.5 | 65 | 75.5 | 77.5 | 67 | 70 | 74.5 | 67 | 67.5 | 70 | 66.5 | 67 | 66.5 |
| 10 | 69 | 81 | 81.5 | 69 | 81 | 81.5 | 68.5 | 77 | 79 | 69 | 72 | 76.5 | 69 | 69 | 72 | 67 | 67.6 | 67.5 |
| 11 | 69 | 74 | 71.5 | 69 | 74 | 71.5 | 69 | 72.5 | 71 | 70.5 | 71.5 | 71.5 | 70 | 69.5 | 70 | 68 | 68 | 68 |
| 12 | 60 | 72 | 70.5 | 60.5 | 70.5 | 70.5 | 61.5 | 68.5 | 69.5 | 64.5 | 67 | 69 | 86 | 66 | 67 | 67 | 67 | 66.5 |
| 13 | 66 | 69 | 72 | 66 | 69 | 72 | 65.5 | 68 | 70.5 | 66.5 | 67.5 | 69.5 | 66 | 66 | 67 | 66 | 66 | 66 |
| 14 | 61.5 | 68 | 68 | 62 | 68 | 68 | 62 | 67 | 68 | 65 | 66 | 68 | 65.5 | 65 | 66 | 66 | 66 | 65.5 |
| 15 | 57 | 66.5 | 69.5 | 57 | 66.5 | 69.5 | 58 | 64 | 68 | 61 | 62.5 | 67 | 63 | 62.5 | 64.5 | 65 | 65 | 64.5 |
| 16 | 60.5 | 73 | 74.5 | 60.5 | 72 | 74.5 | 60.5 | 68.5 | 72.5 | 62.5 | 65 | 70 | 63 | 63.5 | 66.5 | 64 | 64.5 | 64 |
| 17 | 67.5 | 68.5 | 66.5 | 67.5 | 68.5 | 66.5 | 67 | 67.5 | 66.5 | 67.5 | 67.5 | 68 | 66.5 | 66.5 | 67 | 65 | 65.5 | 65 |
| 18 | 56 | 61 | 64 | 56 | 61 | 64 | 57.5 | 60 | 64 | 61 | 61.5 | 64.5 | 63 | 62 | 63 | 64.5 | 64 | 64 |
| 19 | 56.5 | 59 | 61.5 | 56.5 | 59 | 61.5 | 57 | 58.5 | 61 | 60 | 60 | 61.5 | 61 | 60.5 | 61 | 93 | 63 | 62.5 |
| 20 | 55 | 56 | 55.5 | 56 | 56 | 55.5 | 56 | 56 | 56 | 59 | 68.5 | 59 | 60 | 59.5 | 59.5 | 62 | 62 | 61.5 |
| 21 | 50 | 58.5 | 60 | 50.5 | 58.5 | 60 | 51 | 56.5 | 60 | 55 | 56 | 60 | 57 | 57 | 59 | 61 | 60.5 | 60 |
| 22 | 50.5 | 62 | 62 | 51 | 61 | 62 | 51.5 | 58.5 | 61.5 | 55 | 57 | 61.5 | 57 | 57 | 59 | 60 | 60 | 59.5 |
| 23 | 54.5 | 60 | 57 | 55 | 59.5 | 57 | 55 | 58.5 | 57.5 | 57 | 58.5 | 59 | 58 | 58 | 59 | 59.5 | 60 | 59.5 |
| 24 | 55 | 57.5 | 59.5 | 55 | 57.5 | 59.5 | 55 | 57 | 58.5 | 57 | 57 | 59 | 57.5 | 57.5 | 58 | 59.5 | 59.5 | 59.5 |
| 25 | 54.5 | 65 | 65 | 54.5 | 65 | 65 | 54.5 | 62.5 | 64 | 56.5 | 59.5 | 63.5 | 57 | 59.5 | 61 | 59 | 59 | 59 |
| 26 | 56.5 | 65 | 62 | 56.5 | 65 | 62 | 56.5 | 64.5 | 61.5 | 58.5 | 60.5 | 62 | 59 | 59 | 60.5 | 60 | 60 | 60 |
| 27 | 53.5 | 60 | 57.5 | 53.5 | 60 | 57.5 | 54 | 58 | 57.5 | 57 | 56.5 | 59.5 | 58.5 | 56 | 59 | 60 | 59 | 59.5 |
| 28 | 50 | 59 | 58.5 | 51 | 59 | 58 | 51 | 58 | 58 | 54.5 | 58 | 59 | 56 | 58 | 58 | 59 | 59 | 58.5 |
| 29 | 51 | 59.5 | 60.5 | 51 | 59.5 | 61 | 51.5 | 57 | 59.5 | 54 | 56 | 59 | 55.5 | 55.5 | 57 | 58 | 58 | 58 |
| 30 | 53.5 | 64 | 66.5 | 54 | 64 | 66.5 | 54 | 61 | 65 | 56 | 58 | 63 | 56.5 | 57 | 60 | 58 | 58 | 58 |
| Average | 58.9 | 67.4 | 67.6 | 59.1 | 67.1 | 67.5 | 59.3 | 65.1 | 66.7 | 61.6 | 63.3 | 66.2 | 62.3 | 62.4 | 64 | 63.3 | 63.3 | 63.1 |

READINGS OF SOIL THERMOMETERS — (*Concluded*).

| | One Inch. | | | Two Inches. | | | Three Inches. | | | Six Inches. | | | Nine Inches. | | | Eighteen Inches. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. | 7 a. m. | 12 m. | 6 p. m. |
| October 1 | 58 | 68 | 64.5 | 58 | 68 | 64.5 | 58 | 65 | 61 | 59.5 | 61.5 | 63.5 | 59 | 59.5 | 61 | 59 | 59.5 | 59 |
| 2 | 57 | 59.5 | 60.5 | 57 | 59 | 60.5 | 57.5 | 59.5 | 60.5 | 59 | 59 | 61 | 59.5 | 59.5 | 59.5 | 59.5 | 59.5 | 59.5 |
| 3 | 51 | 58 | 58 | 51.5 | 58 | 58 | 52 | 57 | 58.5 | 55.5 | 56.5 | 59 | 57 | 56.5 | 58 | 59 | 59 | 58.5 |
| 4 | 49 | 60.5 | 61 | 51 | 60.5 | 61 | 51 | 58 | 60 | 54 | 56 | 60 | 55.5 | 55 | 57.5 | 58 | 58 | 57.5 |
| 5 | 51.5 | 71.5 | 62.5 | 52 | 61.5 | 62.5 | 52.5 | 59.5 | 61.5 | 55 | 57 | 60.5 | 56 | 56 | 58 | 57.5 | 57.5 | 57.5 |
| 6 | 57.5 | 59.5 | 58 | 57.5 | 59.5 | 58 | 57 | 58.5 | 57.5 | 58 | 58.5 | 58.5 | 57.5 | 57.5 | 58 | 58 | 58 | 58 |
| 7 | 54.5 | 53 | 51.5 | 55 | 53.5 | 52 | 54.5 | 54 | 52.5 | 56.5 | 56 | 55 | 56.5 | 56 | 55.5 | 58 | 57.5 | 57.5 |
| 8 | 45.5 | 54.5 | 54 | 48.5 | 54.5 | 54 | 47.5 | 53 | 51 | 51 | 52.5 | 54.5 | 53 | 53 | 54 | 56.5 | 56.5 | 56 |
| 9 | 51.5 | 57 | 53.5 | 52 | 57 | 54.5 | 52 | 56 | 55 | 53.5 | 55 | 56.5 | 54 | 54 | 55.5 | 56 | 56 | 56 |
| 10 | 44.5 | 56 | 53.5 | 45.5 | 55.5 | 54 | 46.5 | 54 | 53.5 | 50 | 52.5 | 54.5 | 52 | 52 | 53.5 | 55.5 | 55.5 | 55 |
| 11 | 53.5 | 59.5 | 60 | 54 | 59 | 60 | [illegible] | 57 | 58.5 | 53 | 55 | 57.5 | 53 | 54 | 55.5 | 55 | 55 | 55 |
| 12 | 62.5 | 50.5 | 60.5 | 62.5 | 60.5 | 61 | 60.5 | 60 | 60.5 | 59.5 | 59.5 | 61 | 57 | 58 | 58.5 | 56 | 56.5 | 55.5 |
| 13 | 51.5 | 62 | 59.5 | 62 | 63 | 60 | 53 | 60.5 | 60 | 55.5 | 58 | 60 | 56 | 56 | 58 | 57 | 57 | 57 |
| 14 | 50.5 | 60.5 | 63 | 51.5 | 61 | 63 | 51.5 | 58.5 | 61.5 | 54.5 | 56.5 | 60 | 55.5 | 55 | 57.5 | 57 | 57 | 57 |
| 15 | 59.5 | 70.5 | 70 | 59.5 | 71 | 70 | 58.5 | 67.5 | 68.5 | 59 | 62 | 66 | 58 | 59 | 62 | 57 | 58 | 58 |
| 16 | 66 | 70.5 | 70 | 66 | 70 | 70 | 64 | 67.5 | 68.5 | 63.5 | 65 | 66.5 | 61.5 | 62 | 63 | 59 | 59.5 | 60 |
| 17 | 54 | 58 | 55.5 | 54 | 58 | 56.5 | 55.5 | 58 | 57 | 59 | 58.5 | 59.5 | 60 | 59 | 59 | 60 | 60 | 59 |
| 18 | 47 | 54.5 | 56 | 49 | 54.5 | 56.5 | 49 | 54.5 | 56.5 | 53 | 54 | 57 | 55 | 54.5 | 56 | 58 | 58 | 57 |
| 19 | 49.5 | 53.5 | 54.5 | 50 | 53.5 | 54.5 | 50 | 52.5 | 54 | 53 | 53.5 | 57 | 54.5 | 54 | 54.5 | 57 | 56.5 | 56 |
| 20 | 50.5 | 54 | 54.5 | 51 | 54 | 54.5 | 51 | 53 | 54 | 53 | 53.5 | 54.5 | 53.5 | 53.5 | 54 | 56 | 56 | 55.5 |
| 21 | 52 | 51 | 51 | 52.5 | 51 | 51.5 | 52 | 51 | 51.5 | 53.5 | 53 | 52.5 | 54 | 53.5 | 53 | 55.5 | 55.5 | 55 |
| 22 | 50.5 | 52.5 | 52 | 51.5 | 52.5 | 52.5 | 51 | 52 | 52 | 52.5 | 52.5 | 53 | 53 | 53 | 53 | 55 | 55 | 54.5 |
| 23 | 47 | 52.5 | 55 | 48 | 52.5 | 55.5 | 48 | 52 | 55 | 50.5 | 52.5 | 55 | 52 | 53 | 54.5 | 54.5 | 55 | 54 |
| 24 | 47 | 57.5 | 56.5 | 47.5 | 58 | 57 | 48 | 55.5 | 56 | 51 | 53 | 56 | 52 | 52 | 54 | 54 | 54.5 | 54 |
| 25 | 51 | 55.5 | 54 | 51.5 | 55.5 | 55 | 51.5 | 54 | 54.5 | 53 | 53.5 | 55 | 53.5 | 53.5 | 54.5 | 54.5 | 54.5 | 54 |
| 26 | 49.5 | 53 | 55.5 | 50 | 53 | 56 | 50 | 52 | 55.5 | 52 | 52.5 | 55 | 53 | 52.5 | 54 | 54.5 | 54.5 | 54 |
| 27 | 48.5 | 57 | 56.5 | 49 | 57 | 57 | 49 | 54.5 | 56 | 51 | 52.5 | 55.5 | 52.5 | 52.5 | 54 | 54 | 54 | 54 |
| 28 | 50.5 | 57 | 57 | 51 | 57 | 57.5 | 50.5 | 54.5 | 56.5 | 52.5 | 53 | 55.5 | 53 | 53 | 54 | 54 | 54 | 54 |
| 29 | 49.5 | 50.5 | 48 | 50 | 51 | 49 | 50.5 | 51 | 49 | 53 | 52.5 | 51.5 | 53.5 | 53 | 52 | 54.5 | 54 | 54 |
| 30 | 43 | 46 | 47 | 47.5 | 47.5 | 49.5 | 44.5 | 46.5 | 47.5 | 47.5 | 48 | 49.5 | 50 | 49 | 50 | 53 | 53 | 52.5 |
| 31 | 44.5 | 50.5 | 51 | 49.5 | 50.5 | 52 | 45 | 48.5 | 50.5 | 47.5 | 48.5 | 50.5 | 49 | 49 | 50 | 52 | 52 | 52 |
| Average | 51.5 | 57.2 | 56.9 | 52.4 | 57.3 | 57.3 | 52.1 | 56 | 56.8 | 54.2 | 55.2 | 57.1 | 54.8 | 54.8 | 55.9 | 56.3 | 56.3 | 56 |

## SUMMARY OF SOIL THERMOMETERS.

| | ONE INCH. | | | | TWO INCHES. | | | | THREE INCHES. | | | | SIX INCHES. | | | | NINE INCHES. | | | | EIGHTEEN INCHES. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 12 m. | 6 p. m. | Average. | 7 a. m. | 12 m. | 6 p. m. | Average. | 7 a. m. | 12 m. | 6 p. m. | Average. | 7 a. m. | 12 m. | 6 p. m. | Average. | 7 a. m. | 12 m. | 6 p. m. | Average | 7 a. m. | 12 m. | 6 p. m. | Average. |
| | Ave. | Ave. | Ave. | | Ave. | Ave. | Ave. | | Ave. | Ave. | Ave. | | Ave. | Ave. | Ave. | | Ave. | Ave. | Ave. | | Ave. | Ave. | Ave. | |
| May | 52.6 | 60.3 | 59.8 | 57.6 | 52.6 | 60.8 | 60.2 | 57.9 | 52.2 | 57.9 | 59 | 56.4 | 53.6 | 55.3 | 57.6 | 55.5 | 53.6 | 53.6 | 55 | 54.1 | 52.6 | 52.7 | 52.7 | 52.7 |
| June | 60.3 | 70.2 | 67.5 | 66 | 60.2 | 70.1 | 67.6 | 66 | 59.5 | 66.6 | 66.7 | 64.3 | 60.7 | 63.5 | 65.7 | 63.3 | 60.9 | 60.9 | 62.6 | 61.5 | 59.7 | 59.7 | 59.6 | 59.7 |
| July | 69.1 | 76.8 | 75.6 | 73.8 | 69.6 | 76.1 | 75.5 | 73.5 | 68.4 | 73.4 | 74.5 | 72.1 | 69.4 | 71.3 | 73.4 | 71.4 | 69.1 | 69.3 | 70.7 | 69.7 | 67.8 | 67.8 | 67.7 | 67.8 |
| August | 63.7 | 73.3 | 72.5 | 69.8 | 63.7 | 72.5 | 72.6 | 69.6 | 63.7 | 70.3 | 71.9 | 68.6 | 65.8 | 68.2 | 70.9 | 68.3 | 66.5 | 66.6 | 68.3 | 67.1 | 66.7 | 66.7 | 66.6 | 66.7 |
| September | 58.9 | 67.4 | 67.6 | 64.6 | 59.1 | 67.1 | 67.5 | 64.6 | 59.3 | 65.1 | 66.7 | 63.7 | 61.6 | 63.3 | 66.2 | 63.7 | 62.3 | 62.4 | 64 | 62.9 | 63.3 | 63.3 | 63.1 | 63.2 |
| October | 51.5 | 57.2 | 56.9 | 55.2 | 52.4 | 57.3 | 57.3 | 55.7 | 52.1 | 56 | 56.8 | 55 | 54.2 | 55.2 | 57.1 | 55.5 | 51.8 | 54.8 | 55.9 | 55.2 | 56.3 | 56.3 | 56 | 56.2 |

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L.

M.

## P.

S.