

FARMING FOR PROFIT

FRUIT
VEGETABLES
AND FLOWERS



FRANK D. GARDNER



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¹ From Year-Book, U. S. Dept. of Agriculture, 1912.

FARMING FOR PROFIT

FRUITS, VEGETABLES AND FLOWERS

A NON-TECHNICAL MANUAL FOR THEIR
CULTURE, MANAGEMENT AND IMPROVEMENT

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PREFACE

This book is written for growers of fruits, vegetables and flowers, and makes a popular appeal to all engaged in this branch of farming, whether amateurs or professionals. It is designed to be a handy reference work on the culture of vegetables, fruits, nuts, and flowers.

There are chapters on the principles of vegetable gardening, mushroom culture, medicinal and aromatic plants, principles of fruit production, nut culture, beautifying home grounds, and a lengthy treatise on diseases of garden and orchard crops, and their remedies.

Each department has been prepared by a specialist in the subject presented, and his name appears at the beginning of each chapter. Those unacknowledged have been prepared by myself. References are given here and there to books and pamphlets for those wishing more exhaustive information on specific subjects.

The illustrations have been secured from many sources. Due credit has been given these.

Special acknowledgment is due the publishers of this volume and the other volumes in the series for their conception, and for the many helpful suggestions in the presentation of its subject-matter.

Acknowledgment is also due Professor E. L. Worthen and Professor R. S. Smith, both of the Pennsylvania State College, for helpful suggestions and criticisms on soils and crop rotations. I wish also to especially acknowledge the valuable editorial assistance of my wife in the preparation of the manuscript.

FRANK D. GARDNER.



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PART I
HORTICULTURE, FORESTRY AND
FLORICULTURE

CHAPTER 1

THE PRINCIPLES OF VEGETABLE GARDENING

BY R. L. WATTS

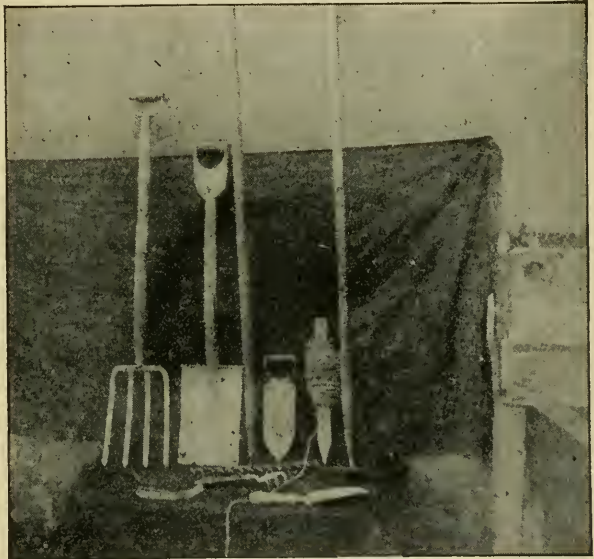
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A thorough knowledge of the underlying principles of vegetable gardening is exceedingly important, whether the vegetables are to be grown for the home table or for commercial purposes.

Soils and Locations.—Soils containing a considerable quantity of sand are best adapted to the growing of vegetables. Such soils are well drained, easily cultivated, and may be worked early in the spring. Sandy soils are warmer than clay soils, and for this reason crops mature earlier in them. They are especially desirable for crops requiring high temperatures, such as eggplants, peppers and melons.

Any soil, however, which satisfactorily produces general farm crops, will, with proper treatment, grow good garden crops. The clay soils are avoided so far as possible by market gardeners and Southern truck growers.

Southern or southeastern exposures are preferable for vegetable gardening because they are warmer and, therefore, conducive to earlier crops. Northern and western exposures are satisfactory for the later crops. Natural or artificial windbreaks are of advantage where there are cold exposures.



NECESSARY GARDEN TOOLS.¹

¹ Courtesy of New York State College of Agriculture, Ithaca, N. Y. From Cornell Reading Courses, Vol. II.

Tillage and Tools.—The importance of thorough tillage in the production of vegetables cannot be over-emphasized. It counts for high yields as well as high quality. The conservation of soil moisture should be kept constantly in mind. Vegetables are composed largely of water and enormous quantities of it are required in their growth. Fall plowing is often advisable, especially in clay soils which are to be planted early the following spring. Early spring plowing, followed by immediate harrowing, is favorable to the retention of moisture.

The prudent garden maker will possess at least a small assortment of carefully selected modern tools or implements. Of the hand tools, the hand seed-drill and hand wheel-hoe are great time and energy savers and should be employed in all market gardens and in most home gardens. A variety of hand hoes and rakes should also be available.

Stable Manures.—All classes of vegetable growers recognize the value of stable manure. It not only supplies plant food, but adds humus to the soil, thus making it more retentive of moisture and more favorable to chemical and bacteriological changes which are essential to plant growth. Horse manure is most universally employed. Market gardeners nearly always compost it in large piles, which are kept moist and turned one or more times before the manure is used. If the piles have rectangular sides and are kept moist there will be practically no loss of fertility during the process of composting. From four to six weeks of composting will kill all weed-seeds and leave the manure in the finest state of texture. Cow manure is most excellent for all classes of vegetables, but it is slower in action than horse manure. Sheep and poultry manures are rich in nitrogen and their texture makes them particularly desirable for vegetable gardening.

Cover Crops.—In vegetable gardening it is absolutely essential to maintain the supply of vegetable matter in the soil. If stable manures are not available, cover crops must be produced for manurial purposes. The legumes, such as vetch, cowpeas, soy beans and the clovers, are most desirable, provided they can be grown satisfactorily, because they materially add to the supply of soil nitrogen. Rye, oats and buckwheat, however, can often be used to great advantage. The usual practice is to sow the seed of cover crops before the last cultivation of vegetables which mature and are harvested during the fall months.

Commercial Fertilizers.—Commercial vegetable growers are seldom able to obtain, at reasonable prices, all the stable manure that they need for the maximum production of crops. In many instances they rely wholly upon green crops for humus, and purchase commercial fertilizers to supply plant-food. There is the most varied practice with reference to the kinds and amounts of fertilizer applied for the various crops. The character of the fertilizer depends upon the crops to be grown, nature of soil, previous treatment and seasonal conditions. If stable manures have been used in liberal amounts, say twenty to forty tons to the acre, and for truck crops like cabbage and sweet corn, it is seldom necessary to use more than half

a ton of fertilizer to the acre, containing four per cent of nitrogen and seven or eight per cent of each of the mineral elements—potash and phosphoric acid. As a rule, a complete fertilizer should be applied before the crops are planted, and thoroughly mixed with the soil by harrowing. If additional plant-food is needed after the crop is started, it may be applied along the rows. Nitrate of soda is largely used for this purpose. Applications may range from 100 to 250 pounds to the acre, and if desired may be applied at intervals of ten days to three weeks.

The Use of Lime.—Lime in soils aids the development of plants. Vegetable growers recognize the necessity, more than ever, of keeping their soils in a neutral or slightly alkaline condition, so that liming at regular intervals is probably a necessity on most soils, and especially those which receive large annual applications of acid fertilizers. Serious troubles are likely to develop in such soils and it is desirable to take preventive measures by liming the land. This is the best known treatment of soils to prevent clubroot which infects cabbage and other members of this family.

Seeds and Seed Sowing.—The utmost care should be exercised to obtain seed of the highest quality. Numerous experiments show that there is marked variation in the strains of our most common varieties of cabbage, tomatoes, lettuce, onions and other classes of vegetables. A superior strain may mean a profit of fifty to one hundred dollars more to the acre than one which is inferior. The most reliable seedsmen should be patronized. It may even pay to grow seed at home or to buy from specialists who have developed strains of unusual merit.

A fine, moist seed-bed is essential to germination, whether the seeds are sown under glass or in the open ground. The surface of the ground should also be smooth, so that the seeds will be covered with a uniform depth of soil.

Transplanting.—Vegetable growers find that transplanting is often a great advantage if not a necessity. It makes it possible to care for thousands of seedlings on a very small area. For example, it is easily possible to start 10,000 cabbage plants under a 3 x 6 foot hotbed sash, while ten sash are necessary to protect that number of seedlings after they have been transplanted.

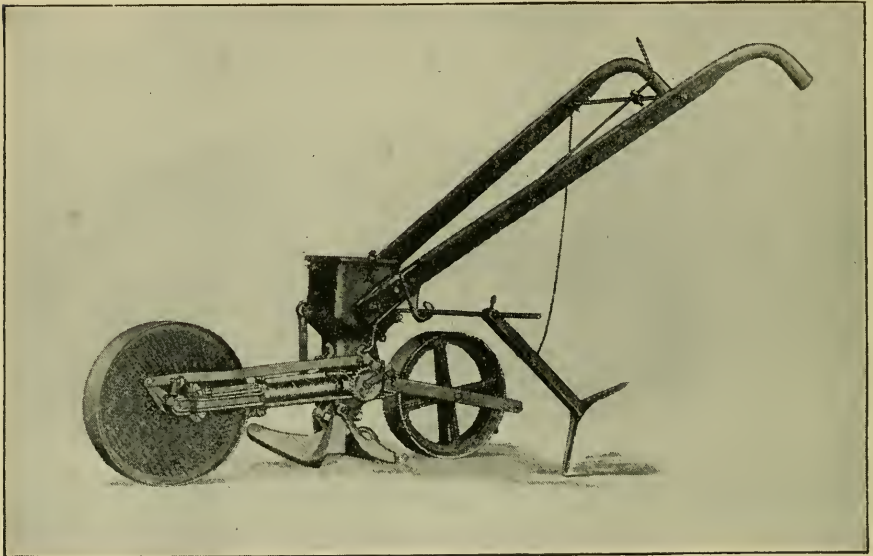
Vegetable plants should be transferred to their new quarters before they have become crowded and spindling. The time of sowing should be carefully planned so that this condition will be avoided.

Machine planters are largely used in field operations. If they are properly managed, they do the work fully as well as it can be done by hand. Whatever the method employed, the main essential is to bring a considerable quantity of fine, moist soil into close contact with the roots.

Starting Early Plants.—Soil to be used for starting early plants should be fine, free from stones and sticks and fairly rich. For cabbage or cauliflower, it should be taken from land that has not grown either those or other members of the cabbage family for seven or eight years in order to

avoid clubroot. The soil should also contain considerable humus, and some sand is a great advantage. If composted, two parts of loam, one part of rotten manure and one part of sand will give good results. It is always desirable to prepare and store the soil in the fall, so that it will be ready for use when wanted in February or March.

Flats or shallow plant boxes are a great convenience in starting early plants. They may be made of new lumber or of empty store boxes. Chestnut and cedar are very durable woods for this purpose. The thin pine boards of boot and shoe boxes are easily made over. A common plan is to rip soap and tomato boxes into sections, using any kind of thin lumber



ONE OF THE MANY GOOD TYPES OF SEED DRILLS.¹

for the bottom of the flats. Plant boxes need not have a depth of more than two inches, though deeper boxes require less attention in watering because they hold more soil, and, consequently, more water.

Seed sowing with such crops as cabbage and lettuce usually begins about the first of February in northern districts and earlier in the South. While the seed may be sown broadcast in flats or beds, the better plan is to sow in rows about two inches apart. This is ample space for all of the vegetables which are ordinarily started under glass. If ten to twelve good seeds are dropped to each inch of furrow, there should be a satisfactory stand of plants. The furrows should be about one-quarter inch deep for

¹ Courtesy of New York State College of Agriculture, Ithaca, N. Y. From Cornell Reading Courses, Vol. III.

seeds sown under glass, with the exception of celery, which should barely be covered. After the seeds are sown, the furrows may be closed quickly by drawing a small pot label or the thumb and index finger along the rows. The soil should be firmed with a block and thoroughly watered. If possible, the soil should be made so moist that no additional watering will be necessary until the plants are up.

Some fresh air should be admitted to the hotbed or greenhouse daily, unless the weather is unusually severe. This is essential to strong, stocky plants. High temperatures and excessive moisture, both in the soil and atmosphere, are conducive to the growth of weak, spindling plants which are liable to damp off, and if they do not die, are very tedious to transplant. A safe rule is not to water unless it is absolutely necessary and then to water thoroughly. If the flats are in hotbeds and the weather is severe, it will be necessary to protect the plants at night by means of mats those made of rye straw being the most satisfactory.

In three to five weeks from sowing cabbage and many other vegetables the seedlings will be large enough to transplant. This operation may be performed any time after the rough or true leaves make their appearance. Soil such as has been described for seed sowing will be found satisfactory for this purpose. The flats or shallow plant boxes are also exceedingly useful receptacles in which to care for the plants until they are taken to the field. It is desirable to place about an inch of rotten manure in the bottom of the flat before filling it with soil. The soil should be moist enough to work well, and it is important to press it well along the sides and in the corners of the boxes.

Cabbage, lettuce and other plants are set from an inch and one-half to two inches apart. If they are to be kept in the flats for an unusual length of time, more space should be allowed. The work of transplanting may be done rapidly by the use of a small, pointed stick, often called a dibble. This simple tool is used to make the holes as well as to press the soil against the small roots of the plants. Sometimes transplanting boards, with holes bored in check rows, are used, and then a dibble is employed to punch all the holes before any plants are dropped. This method provides for a uniform number of plants to each box.

If the soil is just moist enough to work well during the transplanting, it will not be necessary to apply any water until the plants are well established. This is a great advantage, especially if the plants are placed in cold-frames and the weather is very severe.

After the plants have been in the cold-frame from several days to a



A DIBBLE.¹
(One-fifth actual size.)

Very handy for making holes in which to set small plants.

¹ Courtesy of New York State College of Agriculture, Ithaca, N. Y. From Cornell Reading Courses, Vol. II.

week, some fresh air may be admitted daily. Straw mats should be used at night. The mats will also be found useful in shading the plants in hotbeds and cold-frames.

Plants should be hardened as much as possible before they are taken from the frames to the field. This is accomplished by gradually subjecting them to fresh air and by not watering more than is absolutely necessary. The latter factor is more important than fresh air and low temperatures.

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CHAPTER 2

VEGETABLES AND THEIR CULTURE

BY R. L. WATTS

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The Pennsylvania State College*

Asparagus.—The farmer's garden is not complete without this popular, hardy perennial, and it offers special inducements for cultivation near good local markets.

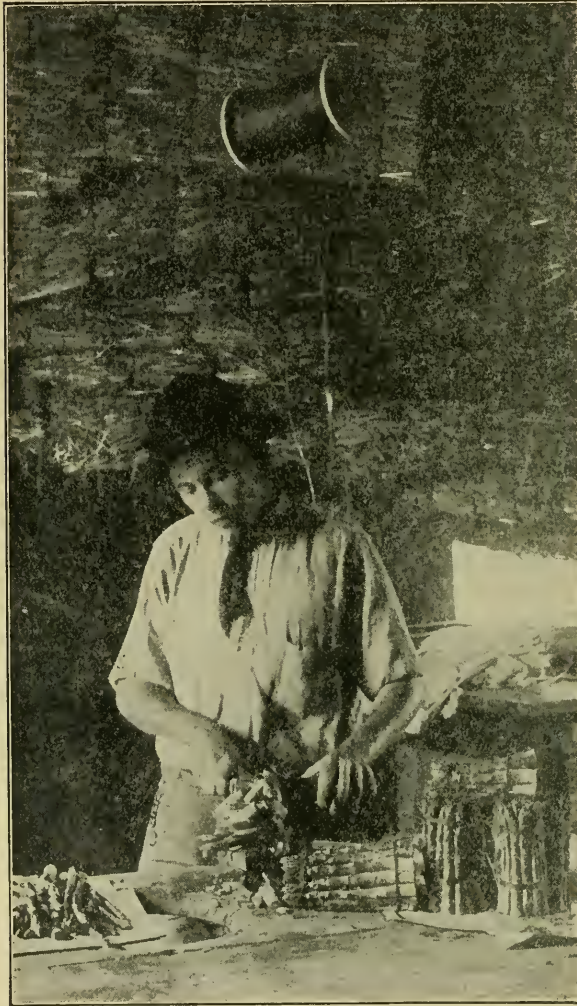
Numerous varieties are catalogued by our seedsmen and nurserymen but Palmetto is most largely grown. It is vigorous in growth, the shoots are large and the plants are regarded as more resistant to rust than other well-known varieties. Some meritorious new varieties are being developed at the Asparagus Experiment Station, Concord, Mass., and prospective growers should keep in touch with the work there and test for themselves the new sorts as soon as they are available.

It is universally conceded that asparagus thrives best in deep, rich, moist, sandy loams. Any soil, however, which will grow a satisfactory crop of corn will, with proper management, produce a good crop of asparagus. Thorough drainage is necessary. The character of the exposure is not important, though cuttings may be made earlier in the spring on southern slopes than on northern or western exposures.

It is exceedingly important to start with good stock. If a plot of even a few hundred plants is contemplated, it will pay to buy selected seed or roots from a specialist. The young plants are easily grown. A fertile plot should be chosen for the purpose and should be enriched still further by application of rotten stable manure at the rate of twenty-five tons to the acre. A good seed-bed should be prepared. Shallow furrows two feet apart should be made. The seeds should be dropped by hand at intervals of two or three inches and covered with an inch of soil. Radish seeds dropped eight to ten feet apart in the same drills with the asparagus will define the rows, since the radishes germinate within a few days, while the asparagus plants will not appear for about a month. It is quite an advantage to have the rows marked thus, so that the hand cultivator can be used before the asparagus plants are up.

Experiments at The Pennsylvania State College and elsewhere show that it pays to plant only the strongest roots or crowns. In other words, it is a good business proposition to grow two or three times as many roots as are actually needed for the plat in mind, and then plant only the largest. The selection or grading of the roots should be done late in the fall after the

foliage has fallen. They may be kept in good condition until spring by packing in barrels with a little moist sand or sawdust. The barrels are



BUNCHING ASPARAGUS READY FOR MARKET.¹

It pays to grade to a uniform size relative to color, length and size of bunches.

then covered with straw and a few inches of soil added to protect the roots against severe freezing.

The grower should bear in mind the fact that the asparagus plantation should last at least ten years; therefore the soil should be prepared with the utmost care. The land should be heavily manured, plowed and then harrowed until it is thoroughly pulverized.

Planting distances vary greatly. If blanched or white shoots are to be grown, there should be at least five feet between rows, in order to provide plenty of soil for ridging. If green shoots—and they are gaining in popularity on American markets—are to be grown, four feet between rows will provide sufficient space for the use of horse cultivators, though many growers

prefer a distance of four and one-half feet. Two feet between plants in the row is the most common distance, whether white or green shoots

¹ Courtesy of Department of Horticulture, Pennsylvania State College.

are to be grown. The crown of the asparagus comes nearer to the surface of the ground every year, because the new bulbs form somewhat higher than those from which the shoots of the previous season grew. This necessitates planting in trenches, which is also an advantage when the rows are to be ridged for the production of white shoots.

The roots should be planted just as early in the spring as the ground can be prepared. It is not desirable to make the trenches any deeper than the soil is ordinarily plowed. The fleshy roots are set on a tiny mound of soil, spread out and covered at first to a depth of not more than two inches. If conditions for growth are favorable, the new plants will soon appear and the trenches should be filled in gradually as the plants increase in height.

Thorough tillage is essential to the highest success. In new plantations it should begin early in the spring and continue until fall; old plantations should be cultivated as long as a horse and cultivator can be used without damaging the plants. It is especially important to disk the land as early as its condition will permit in the spring and again at the close of the cutting season, thus incorporating into the soil whatever manure has been applied.

No specific rule can be given for the fertilization of asparagus. One of the best methods is the application of ten tons or more of stable manure to the acre—late in the fall or early in the spring—supplemented with at least 1000 pounds of commercial fertilizer containing about 5 per cent of nitrogen, 8 per cent phosphoric acid and 6 per cent potash; half of the formula to be used early in the spring and half at the close of the cutting season. Intensive growers use at least a ton to the acre.

Some commercial growers cut approximately \$50 worth of asparagus to the acre the second season from planting. If vigorous crowns have been used and a satisfactory growth obtained, this practice is not regarded as harmful to the plants. The cutting period of the third year should not last more than three or four weeks, but after the third year the usual practice is to cut until about the first of July.

The length of the shoots depends upon the demands of the market. Ordinarily, they are cut about nine inches in length and tied into bunches four and one-half inches in diameter. Two thousand bunches to the acre is a good yield, but this number is often exceeded. Twenty cents a bunch is a fair average price.

The asparagus beetle is the most destructive insect pest. In small plantations it is best controlled by setting coops of young chicks near the plot. Arsenate of lead is effective and is often used in young plantations and in old plantations after the cutting season. Air-slaked lime will also kill the larvæ.

Rust is practically the only disease to be feared. If it appears anywhere in the patch, the affected plants should be cut and burned before the foliage drops in the fall. Burning the tops is not regarded as a desirable practice in plantations which are free from rust.

Bean.—The bean occupies a most important place among the farm garden crops. All classes of beans, being legumes, possess high nutritive value and may often be served as substitutes for meats with satisfaction to the consumer.

Improved Golden Wax is an excellent wax-podded variety. Burpee Stringless is a leading dwarf green-podded bean. Goddard is a bush variety largely grown as a green-shelled bean. Lazy Wife is a superb green-podded pole bean. Early Leviathan is one of the best early lima beans and King of the Garden is valued as a late lima. White Marrow is one of the best varieties to grow for soup and baking.

The bean requires a well-drained soil. Sandy loams are preferred, but it is grown successfully in all types of soils. Applications of phosphoric acid are usually beneficial. Extensive plantings should not be made in the spring until the ground is thoroughly warm. Chances may be taken, however, in planting bush wax and green-podded varieties for the home table before conditions are ideal, and replanting can be made if the seeds decay or the plants are killed by frost.

The rows of bush beans should be far enough apart to be cultivated with a horse, and the seeds dropped two to three inches apart in the rows. An excellent plan is to drop four beans to the hill, the hills being eight or nine inches apart. Pole beans are usually planted in hills 4 x 4 feet apart.

Beet.—The beet may be grown in any good garden soil. The smoothest and finest roots are grown in sandy loams. Liberal applications of rotten stable manure are always beneficial. Excessive applications of nitrogen should be avoided. Potash and phosphoric acid are often used to advantage. Crosby Egyptian, Eclipse, Early Model and Egyptian are the leading early varieties. Edmond Blood turnip is good to follow early varieties.

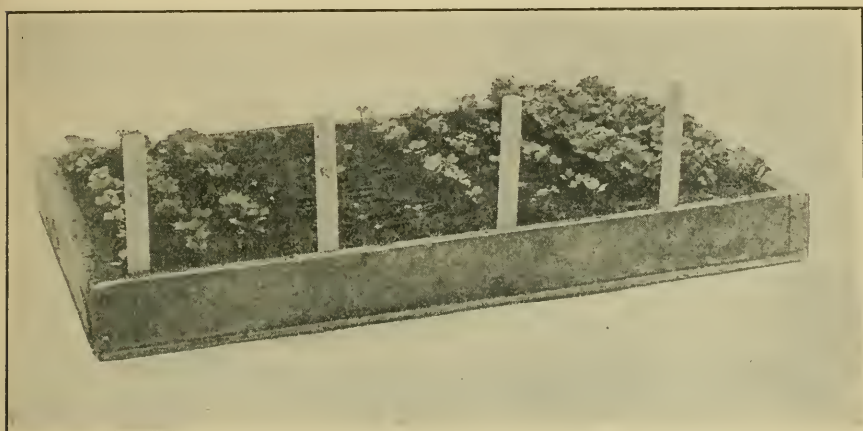
Seed for the early crop is sown in the spring as soon as the ground can be prepared. The seed-bed should be fine and as level as possible. Drills should be made a foot apart for wheel-hoe cultivation. About ten seeds to the foot of furrow should be sown. Plants of early varieties should be thinned to about three inches apart in the row, and late sorts to five or six inches. Clean tillage is essential. An earlier crop may be obtained by starting the plants in hotbeds and greenhouses and transplanting them to the open ground after danger from hard frosts has passed by.

Brussels Sprouts.—This is a member of the cabbage family which is grown for fall consumption. The seed should be sown at the same time as for late cabbage and under the same conditions. Plants should be thinned to an inch apart. They should be transplanted early in July to rich, moist soil. Clean tillage should be given. Toward the end of summer, when the plants are well grown, the leaves should be cut off along the stalk, except a tuft at the top. This will induce the growth of large buds or "sprouts" in the axils of the removed leaf-stems. Brussels sprouts is regarded as a more delicate dish than cabbage.

Cabbage.—This is universally regarded as one of the most important

farm garden crops. It fits in well with the general rotations practiced on American farms, and takes the place of potatoes after clover. It returns satisfactory profits wherever good markets are available.

Jersey Wakefield is the leading early variety. Charleston Wakefield, which is somewhat larger and a few days later, is also popular. Copenhagen Market is a round-headed early variety of special merit which has recently come into prominence. Early Summer, Succession and All Heart are very good midsummer varieties. Succession is also largely grown for late use, seed being sown later than for late varieties. Flat Dutch and Drumhead are well-known late sorts. Danish Ball Head is extensively grown for winter use. It possesses better keeping qualities than any other late variety. The heads are roundish and very solid.



FOUR STRAINS OF JERSEY WAKEFIELD CABBAGE.

Grown at The Pennsylvania State College, which show extreme variations in the germinating power of the seeds.

Cabbage requires a very rich soil for the best results. Stable manures are used extensively for this crop. Commercial fertilizers containing not less than four per cent of nitrogen and six to eight per cent of each of the mineral elements, are also applied at the rate of one-half ton to a ton to the acre.

Seed for the early crop should be sown in the hotbed or greenhouse about ten weeks in advance of planting in the field. In most northern sections the seed is sown about the first of February and the seedlings are transplanted to the cold-frame about the first of March. With proper frame management they will be well hardened and ready for the field April 10th or 15th.

The late crop is usually started in May. Danish Ball Head requires a full season and it is a mistake to sow too late, though local climatic conditions should be carefully considered.

Ordinarily, the best planting distance for Jersey Wakefield is 14 x 26, Charleston Wakefield 16 x 28, Succession 18 x 28, Danish Ball Head 18 x 30; and other late flat-headed varieties 24 x 36 inches. Close planting is conducive to small heads, and most of our markets prefer heads that are solid but not too heavy.

The early crop of the South is always marketed in crates of nearly one barrel capacity. Much of the crop in the North is sold by count, often by weight and frequently by the barrel. When the early crop is shipped in barrels it is important that they be well ventilated.

The late crop is stored in a great variety of ways. Although burying is troublesome, no other plan keeps the cabbage in better condition. The soil must be well drained.



A PLANT TRANSFERRED WITH PLENTY OF EARTH IS NOT CHECKED IN GROWTH.

Windrows of cabbage, three heads side by side and two heads above, should be placed so as to drain the water away from the cabbage. The cabbage is then covered as nearly as possible with a plow and the work finished with hand shovels. Four or five inches of soil is sufficient covering and then enough manure is added to keep out frost. In central Pennsylvania, for example, four inches of soil and four inches of manure will keep the cabbage in perfect condition, provided the location is protected on the north and west from hard winds. There is no advantage in burying cabbage with the roots on. The best plan is to cut the stems with

a sharp hatchet, leaving stubs four or five inches long for convenience in handling the crop.

Cabbage should be grown in a long-period rotation in order to avoid losses from clubroot, and the land should be kept well limed as a preventive measure against this most dreaded disease. The common green cabbage worm is best controlled by spraying with arsenate of lead.

Carrot.—The carrot is becoming more popular in America every year. It is easily grown in any rich soil, but attains its best development in sandy loams. By using early and late varieties and by making successive sowings, it is possible to have roots for sale and for the home table from June until late in the fall, and then the crop may be stored for winter use.

There are numerous varieties of carrots, but the best known early varieties are Early Short Scarlet and Early Scarlet Horn; for medium early, Model, Danvers Half Long Orange and Danvers Half Long Scarlet, Oxheart and Rubicon are popular. Long Orange is the leading late long-rooted variety.

For the early crop, seed should be sown as early in the spring as the ground can be prepared. It is customary to allow about a foot of space between rows for the early varieties and fifteen inches for the late. The early kinds may be thinned to stand two or three inches apart in the row,



STRAIN TESTS OF CABBAGE AT THE PENNSYLVANIA STATE COLLEGE,
SHOWING FIRST CUTTING.

Note that only two heads of cabbage were marketable at the first cutting in Row 13.

while the late sorts should be four to six inches apart. Fairly liberal applications of phosphoric acid and potash are considered valuable for the carrot. It is easily kept until late winter by storing in pits or in cool cellars, where the roots should be covered with moist sand or soil.

Cauliflower.—Cauliflower is considered the most refined member of the cabbage family. The heads are more delicate in quality than cabbage, kale or even Brussels sprouts. It is also more difficult to grow than cabbage. This crop has two marked tendencies: first, not to form heads; and second, for the heads to "bolt" or "button" instead of forming hard,

compact heads. The failure of this crop is very frequently attributed to the use of poor seed, and there is no question but that good seed is a most important factor in the growing of a satisfactory crop of cauliflower.

The early crop is started under glass and the plants are handled in the same way as cabbage. It is important, however, not to check the growth of the plants at any time, as this may cause "bolting" or "buttoning."

Seed for the late crop should be sown a trifle later than for cabbage. It is important to sow thinly so that every plant will have plenty of space for its full development.

Cauliflower should be planted in even richer soil than cabbage. It is especially desirable to use an abundance of rotten manure. Planting distances should be about the same as for early cabbage. When the heads are an inch or two in diameter, the leaves should be bent over them, or perhaps tied together over the heads, in order to protect the latter from rain and sunshine. The markets demand pure white heads.

Celery.—Celery occupies a most important place in American gardens, though it does not receive as much attention as it should. When the methods of culture are well understood, it may be grown with great ease, and no vegetable is more appreciated when it appears on the farmer's table. An immense quantity of celery which is grown in muck soils finds its way to our great markets. The crop is also well adapted to rich, sandy loams, but any soil which is properly fertilized will grow an excellent crop of celery. The two great essentials are a liberal supply of plant food and an abundance of moisture. Stable manure is universally regarded as the best fertilizer. It should be applied in a decayed condition and worked well into the soil as a top dressing rather than plowed under. Commercial fertilizers are also extensively used for this crop. As a rule the fertilizers employed by commercial growers contain four to six per cent of nitrogen and from eight to ten per cent of each of the mineral elements. A ton to the acre, mixed directly with the soil after plowing, is a very common application, and some growers use double this amount.

There are two general classes of celery: First, the so-called self-blanching, best represented by Golden Self-Blanching, which is more generally grown in this country than any other sort; and, second, the green varieties, such as Winter King, Winter Queen and Giant Pascal. The dwarf self-blanching varieties are most popular among commercial growers because they are easily blanched. Green winter varieties are better in quality than the self-blanching and are grown more largely for winter use.

Too much care cannot be exercised in purchasing celery seed. The grower should make certain that the stock is good, because many of the failures of celery growers are attributable to poor seed. The best seed of the self-blanching varieties is grown in France.

For the early crop, seed should be sown in hotbeds or greenhouses after the first of March. It is usually a mistake to sow earlier than this date, because the plants are likely to become crowded in the beds before

planting time in the field, a condition which may check their growth and cause them to produce seed shoots instead of marketable stock. On account of the very small size of the seed, there is always likelihood of sowing too thickly. The plants should be thinned if that happens, and in a month or five weeks transplanted one and one-half to two inches apart in flats or beds. In the latter a constant supply of moisture should be maintained until the plants are set in the field.



CELERY UNDER IRRIGATION, SKINNER SYSTEM.

Seed for the late crop should be sown in the spring as soon as the ground can be prepared.

When boards are to be used for blanching the early crop, it is customary to allow about two feet of space between rows and to space the plants three to five inches apart in the row. In most sections of the North, plants should not be set in the open ground before May 10th. The crop will stand considerable cold, but heavy frosts almost invariably check the growth

and have a tendency to cause the production of seed stalks. The late crop should have more space and it is not uncommon to allow four to five feet between rows, the distance depending upon the method to be used in blanching.

The mulching system of celery culture makes the early crop much more certain. The plan includes a mulch of three to five inches of fresh horse manure placed between the rows immediately after the plants are set out.



GOOD CELERY WELL PREPARED FOR MARKET.¹

middle of October and commercial growers begin to store the crop soon after the first of November. Various methods of storage are in common use. One of the best is to dig trenches ten or twelve inches wide and not quite as deep as the height of the plants. The plants are placed close together in the trenches and covered with boards, which are nailed together in the form of a trough. The boards afford ample protection until freezing weather occurs and then additional covering is provided by placing

This conserves soil moisture, prevents weed growth, renders tillage unnecessary and supplies food to the plants after each rain.

Boards are used almost entirely for blanching the early crop. They are placed along both sides of the rows and held in place by any convenient device at hand. From ten days to two weeks are required to blanch the crop. The boards may be used over and over again; with care they will last fifteen years.

The late crop is blanching by means of ridging with earth. This work should not begin until the cooler weather arrives in early September. The work of ridging proceeds until about the

¹ Courtesy of Department of Horticulture, Pennsylvania State College.

manure or straw over them. The plants should be dry when stored and they should not be unnecessarily exposed to sun and hard, drying winds.

Cucumbers.—Most farmers are familiar with the ordinary method of growing cucumbers. If hotbeds are available, it is best to start a few hills under glass. This is a very simple operation. A good plan is to fill quart berry baskets with soil containing a large proportion of rotten manure; drop about eight seeds in each basket and after the plants are up thin them to two or three. See that the boxes are not lacking in moisture at any time. The seed should be sown not more than four weeks in advance of the time suitable for planting in the field. Overgrown plants are a disadvantage. It is very much better not to use plants more than a month old. Whether the seed is sown under glass or in the open ground, the soil should be made very rich by using plenty of rotten manure. Planting distances vary, but 5 x 5 feet will be found satisfactory when the ground is very fertile. There are several strains of White Spine which are popular for general planting. For picklers, Chicago Pickling, Boston Pickling and Fordhook Pickling are popular.

The striped cucumber beetle is one of the most serious enemies of this crop. The most thorough means of prevention is to cover the plants with mosquito netting or with wooden frames with netting over them. Air-slaked lime, sprinkled on the plants, is usually effective as a repellent. Tobacco dust may also be used.

Eggplant.—The eggplant is often overlooked in the planting of the farmer's garden. This crop thrives best in a warm climate and for this reason many of the northern gardeners do not attempt to cultivate it. It may be grown, however, in all parts of the North, especially if the plants are started under glass and planted in rich, moist soil. It is also important to select an early variety such as Early Long Purple. The fruit of this variety is not as large as that of New York Improved or Black Beauty, but it will be found quite satisfactory for the home table. A high temperature is required for starting the plants; therefore it is best not to sow too early. They should be transplanted into two-inch pots and later into three or four-inch pots, and then the gardener can transfer them to the field without checking their growth.

Horse Radish.—There should be at least a few plants of horse radish in every farm garden. It is easily grown in any moist, rich soil. The crop is easily propagated by root cuttings, which are made when the roots are dug for market or for the home table; that is, the small lateral roots are trimmed from the large ones and saved for planting. It is customary to cut the roots intended for propagation square at the upper end and slanting at the lower end so that you will know which end to plant up when they are set in the garden.

Kale.—This crop is quite successful in some parts of the South and is seen occasionally in northern districts. It requires the same cultural conditions as cabbage. The most prominent varieties are Imperial Long

Standing, Dwarf German, Dwarf Curled Scotch and Fall Green Curled Scotch. Sowing should be made about midsummer in order that the plants may attain full size before cold weather. The plants are thinned to stand eight to ten inches apart, according to variety.

Kohl-Rabi.—This vegetable is also called “turnip-rooted cabbage.” It is easily grown in any rich soil. Plants may be started under glass, or the seed may be sown direct in the open ground and the plants thinned to about eight inches apart in the row. Green Vienna and Earliest Erfurt are the leading varieties. It is possible to have fresh roots in the garden from the middle of June until late fall, when they may be stored for winter use.

Leek.—This vegetable requires the same cultural conditions as onions. It is regarded as milder and more tender than the onion. The seed should be sown in the spring as soon as the ground can be worked. Market gardeners often transplant the seedlings in July, so that the crop will be ready to use in the fall. It is always an advantage to clip the tops at transplanting time.

Lettuce.—Most farmers are perfectly familiar with the methods which are ordinarily employed in growing lettuce. The usual practice is to sow the seed broadcast in small beds. A very much better plan is to sow in hotbeds or in a sunny window of the house and transplant the seedlings to the open ground after it is dry enough to work. This method will insure an earlier crop than is possible from sowing directly in the open ground. If it is desired to make sowing out of doors, the seed should be drilled in rows about a foot apart, and the plants thinned to stand from six to eight inches apart in the row. This will result in much finer heads than is possible by the broadcast method. There is a long list of varieties from which to select. Grand Rapids is grown largely under glass and is also suitable for culture out of doors. Wayahead is a comparatively new but most excellent head variety for out-door culture. Big Boston is one of the leading varieties for frame culture and for sandy and muck soils. All Heart and Sensation are also good varieties. Hanson, Iceberg and Brittle Ice are popular varieties of the “crisp-head” class.

Sandy soils are selected when an early crop is desired, though this vegetable may be grown with entire success on any soil properly fertilized.

Rotten stable manure is undoubtedly the best form of fertilizer. It may be used at the rate of twenty or more tons to the acre. Commercial fertilizers are also used extensively for the lettuce crop. The early crop may be started under glass as previously explained for cabbage.

Muskmelon.—The remarks made concerning the cucumber apply equally well to the muskmelon, although this vegetable requires better cultural conditions than the cucumber. By starting the plants under glass, practically every farmer could have a liberal supply of muskmelons. It requires more heat and a longer season than the cucumber, but plants which are well started by the time it is safe to plant them out of doors should mature a satisfactory crop, especially if the soil is well enriched

with rotten manure. This vegetable will not thrive in any northern section unless the soil is well filled with organic matter. The planting distances for muskmelons should be more liberal than for cucumbers. Among the varieties which are popular throughout the country may be mentioned Rocky Ford, Paul Rose, Netted Gem, Hackensack, Osage, Emerald Gem, Eden Gem and Burrell Gem.

Onion.—No vegetable is found so universally in the farmer's garden as the onion. Indeed, it is rare that the onion is omitted from the home garden. A long list of varieties is available. Among the best yellow kinds



ONIONS UNDER SKINNER SYSTEM OF IRRIGATION.¹

may be mentioned Danvers, Southport Yellow Globe and Strasburg. Weatherfield is the best known red onion and Southport Red Globe is a general favorite in many parts of the country. Silver Skin and Southport White Globe are popular white onions. The Egyptian (Perennial Tree Onion) is a valuable variety for fall planting in the North. Prizetaker is exceedingly valuable for starting under glass and transplanting in the open ground.

The onion thrives best in a moist, sandy loam, but may be grown with success in any rich soil. It is important to plant the seed in ground which is practically free from weed seeds. An excellent plan is to precede this vegetable with a crop like corn or cabbage which requires clean tillage.

¹ Courtesy of The Pennsylvania Farmer.

The soil may also be highly enriched the preceding year by the application of a large quantity of stable manure, and weed seeds should be completely destroyed by the time the onions are started. Commercial fertilizers are also largely employed for the onion. It is not uncommon to use a fertilizer containing four per cent nitrogen and six to eight per cent of phosphoric acid and potash, at the rate of a ton to the acre. The fertilizer should be well mixed with the soil before any planting is done.

The bulk of the mature bulbs which are sold on American markets is grown from seed sown in the open ground. The most common spacing between rows is a foot, and seed is sown sufficiently thick to give eight to twelve plants to a foot of furrow. Ordinarily four and one-half pounds of good seed to an acre will give the proper stand of plants. Seed more than a year old should never be used. The transplanting method, often referred to as the new onion culture, provides for sowing seed under glass and setting the plants in the open ground after danger of hard freezing has passed. Prizetaker is the leading variety for this purpose. The most common plan is to sow seed in January or February. After the tops attain a height of five inches they are clipped back every week to about four inches, and when planted in the field they are clipped to three or three and one-half inches. Bulbs of extra size for exhibition purposes may be obtained by starting the plants under glass in the fall, clipping the tops repeatedly, as explained, until they are set in the field, about May 10th in the North. Most farmers grow the bulk of their crop from sets which are planted as early in the spring as the ground can be worked. This is the most certain method of procuring a crop, though as large bulbs cannot be obtained as from the transplanting method. Clean tillage is absolutely essential to the success of a crop of onions, and this requires a certain amount of hand-weeding and hoeing between the plants. The mature bulbs for winter use are pulled after most of the tops have turned yellow and are partly dead. The bulbs are thrown together in windrows for a few days until partly dry and then placed in crates or bags which are hauled to sheds or well-ventilated buildings. Onions may be kept throughout the winter in a room where the temperature may be controlled, or allowed to freeze and then be covered with hay and kept in a frozen condition throughout the winter. The latter plan is very satisfactory and should be more generally used by farmers.

Bunching onions are most largely grown from sets, though many gardeners grow excellent green onions from seed sown in the open ground. The Prizetaker produces a particularly mild onion. Onion sets are grown by sowing the seed more thickly than is done for mature bulbs. There is no reason why every farmer should not grow his own sets. A good plan is to sow the seed very thickly in furrows which are about two inches wide and one-quarter inch deep. The plants come up so thickly that it is impossible for any of the bulbs to attain a large size. The sets are easily kept over winter in any dry room where alternate thawing and freezing does not occur.

Parsley.—There should be a supply of parsley in every farmer's

garden. It is found useful as a flavoring for soups and other dishes and also for garnishing purposes. Seed may be sown under glass and the plants grown in the same way as explained for cabbage. The crop may also be started out of doors, the rows being spaced a foot or fifteen inches apart and the plants thinned to stand one foot apart in the row. Parsley thrives in any moist, fertile soil. Rapid growth may be encouraged by top-dressing with nitrate of soda.

Parsnip.—Parsnips are grown successfully in various types of soil. It is a long-season crop, hence should be sown as early as possible in the spring, and the soil should be made as rich as possible by the application of rotten manure. The deep, sandy loams are preferred. Guernsey, Hollow Crown and Early Short Round are leading varieties. The rows should be from fifteen to eighteen inches apart and the plants should stand from six to seven inches apart in the row. The roots may be sold or used on the home table any time after they have attained full size, but the usual custom is to leave most of them in the ground until spring, because freezing improves their flavor. It is rare that the roots are damaged by the hardest winter freezing.

Pea.—The pea is universally popular in American farm gardens. It is highly appreciated because it is very early and also very nutritious. This crop should be started just as soon as the ground is dry enough to work. It is not uncommon to make plantings the latter part of March. The early, smooth varieties are considered hardier than the wrinkled kinds. Alaska and Extra Early are well-known varieties of the smooth type. Gradus, Thomas Laxton and Nott's Excelsior are popular wrinkled kinds. Most farmers plant a few rows of medium or late varieties, such as Improved Stratagem and Telegraph. These varieties are excellent in quality and very prolific. The pea thrives best in cool, moist but well-drained soil. When very late plantings are made it is desirable to plant in trenches; cover at first with about two inches of soil and, after the plants are up, gradually fill in the trenches until the ground is level. This deep covering is favorable to moisture conditions and the ground is also cooler about the roots, which is an advantage. The dwarf varieties, such as Alaska and Extra Early, do not need support, while the late kinds should be supported by means of brush or wire trellises.

Pepper.—The pepper requires practically the same conditions as the tomato, although more heat is beneficial to its growth. For this reason the plant thrives best in warm, sandy soils. An abundance of decayed organic matter is a decided advantage in northern districts, which are not very favorable to peppers. Among the mild-fruited varieties may be mentioned Bull Nose, Chinese Giant and Ruby King. The Neapolitan is a very early variety that is popular throughout the North. Long Red Cayenne and True Red Chili are popular pungent-fruited varieties. The seed should be sown under glass about the time tomatoes are started. The plants of most varieties should have eighteen inches between them

in the row and the rows should be far enough apart to use a horse cultivator.

Radish.—The radish is common to nearly all farm gardens. It does best in deep, rich, loamy soils. Though grown successfully when the seed is broadcast, it is better to sow in drills a foot apart and use enough seed to produce plants an inch or two apart; while late varieties should have two to five inches between plants in the row. Among the early varieties which are popular with home and commercial gardeners may be mentioned Earliest White, Round Red Forcing and Scarlet Frame. French Breakfast is a well-known radish, it is bright earmine above and clear white below. The first sowing should be made as soon as the ground can be worked and successive sowings should be made from week to week.

Rhubarb.—Rhubarb requires a deep, rich, moist soil. It is propagated commonly by roots. Annual applications of manure should be made in order to maintain the supply of organic matter in the soil and to furnish an abundant supply of plant food. Nitrate of soda may be used to advantage as a top dressing. It is ordinarily planted 3 x 4 or 4 x 4 feet apart. Victoria and Linnæus are leading varieties.

Salsify.—Salsify or "oyster plant" is not as generally grown as it should be in American gardens. This root crop requires the same cultural conditions as the parsnip. It is also a long-season crop and, therefore, the seed should be sown as early as possible in the spring. The roots are stored in the same manner during the winter as parsnips and will not suffer from freezing if left in the ground until spring.

Spinach.—Spinach is more largely grown in the South than in northern districts, although it should be a most important vegetable in all parts of the country. The usual practice is to sow the seed late in the fall, and the crop will be ready to harvest the following spring. In the North, the better plan is to sow very early in the spring. A successful method is to sow broadcast on the frozen ground and then cover the seed very lightly with fine, rotten manure. This vegetable requires a rich, constantly-moist soil to obtain the best results. Late plantings should be made in drills and the plants thinned to stand from five to six inches apart.

Squash.—The squash requires practically the same cultural conditions as cucumbers, but much more space is required. If the ground is a rich garden loam, the hills should be at least 10 x 10 feet apart, and more liberal spacing for the winter varieties will be an advantage in very rich soil. Summer squash need not be planted any farther apart than cucumbers, or even less space will meet their requirements. Early White Bush, Yellow Bush and Summer Crookneck are popular summer varieties. Hubbard, Warty Hubbard, Golden Hubbard and Boston Marrow are largely grown winter kinds. Squash must be stored in buildings where there is no freezing during the winter and a uniform temperature of 50° F. is most favorable to successful storage.

Sweet Corn.—Sweet corn requires the same conditions as field corn,

if a good crop is expected. Among the early varieties which are popular and largely grown may be mentioned Fordhook and White Cob Cory. Golden Bantam matures somewhat later than these varieties and is superior in quality. Popular midsummer varieties are Cosmopolitan and Sweet Orange. Country Gentleman and Stowell Evergreen are the best known late varieties. Experiments made at various experiment stations show that it pays to select seed for sweet corn with as much care as for field corn. If space is available it pays to start one or two hundred hills in soil under glass by sowing seed two weeks before it is considered safe to set the plants in the open ground. This will make an early crop and insure a good stand of plants.

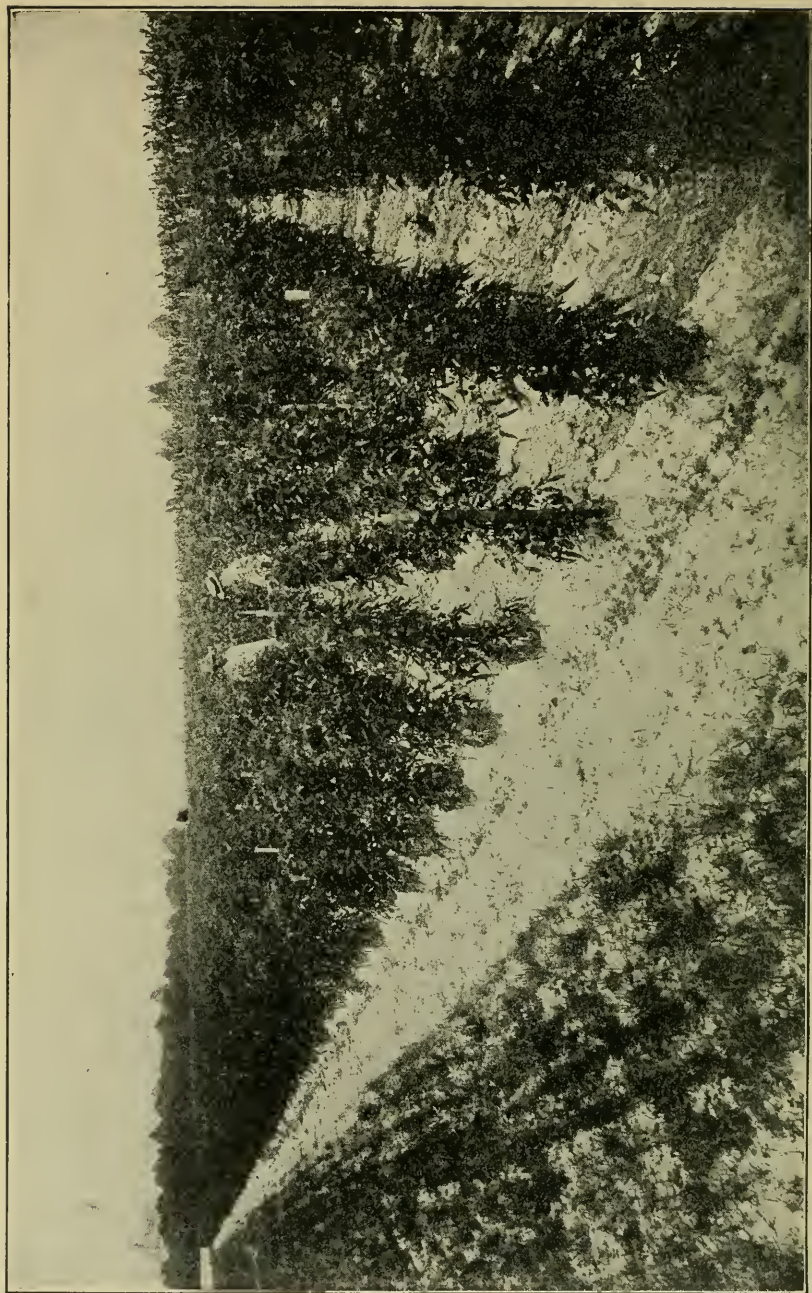


SOME COMMERCIAL TYPES OF SWEET POTATOES.¹

A—Black Spanish. B—A Long, Cylindrical Type. C—Jersey Group. D—Red Bermuda. E—Southern Queen.

Sweet Potatoes.—The sweet potato is not universally grown in the farm gardens of the United States. It thrives only in warm soils and prefers one which is sandy in character. There are numerous varieties of sweet potatoes, some of the most popular being Big Stem Jersey, Yellow Jersey, Red Jersey, Southern Queen, Georgia Yam, Red Bermuda, Florida and Pierson. It is propagated by slips and these are obtained by bedding the tubers in fine soil with the proper amount of heat and moisture. The tubers soon send out sprouts and produce rooted plants which are set in the field after all danger of frost has passed. Field planting should not be

¹From Farmers' Bulletin 324, U. S. Dept. of Agriculture.



TOMATOES SUPPORTED BY STAKES.¹

¹ Courtesy of Virginia-Carolina Chemical Company, Richmond, Va. From V.-C. Fertilizer Crop

attempted until the ground is thoroughly warm. The tubers require the same conditions for storage as squash.

Tomato.—This is unquestionably one of the most important crops of American home gardens as well as commercial plantations. It does well in a great variety of soil types. The sandy loams are preferred, though very heavy yields have been obtained in clay and silt soils. Earliana is the best known and most widely planted very early variety. It is fair in quality and very productive. Bonny Best matures soon after Earliana and is superior in some respects. Chalk Jewel and June Pink are also popular early varieties. Among the leading late varieties may be mentioned Stone and Matchless. Beauty and Trucker Favorite are desirable varieties of pink fruits. Good seed is highly essential to this crop and not a few of our commercial growers make careful selection from their own plantations. Seed for the early crop should be sown under glass not later than the 1st of March and, if extremely early tomatoes are desired, the 20th of February will not be too soon. The finest plants are obtained by first transplanting the plants one and one-half to two inches apart and then three or four inches apart, and finally into pots which vary in size from four to six inches. If the plants contain a blossom or two or perhaps a cluster of fruit when set in the field, a few ripe tomatoes should be available by the tenth of June and a large quantity should be available for market before the first of August. The plants should be hardened as well as possible before setting in the field, but no more water than is absolutely necessary should be applied. Such plants will stand a considerable amount of freezing in the field. Tomatoes of a superior quality may be obtained by training the vines to single stems. The usual practice is to make the rows about four feet apart and set the plants about fourteen to eighteen inches apart in the row. The plants are secured to stakes or wire trellises and the lateral branches are pinched out as fast as they appear. When a plant attains a height of four or five feet a trellis is always used and this causes the rapid development of fruit all along the stem. This method, however, should not be practiced unless there is plenty of labor to attend to the training.

Turnips.—Our farmers are familiar with the growing of turnips because they are produced not only for the home table but also to be stored during the winter for the farm stock. Roots most uniform in size are obtained by sowing in drills a foot to fifteen inches apart and thinning the plants to four to five inches apart. The roots are usually preserved during the winter by burying or covering with moist soil in pits. Some of the most popular varieties are White Milan, Red Purple Top, White Flat Dutch, Purple Top White Globe, White Egg and Yellow Globe.

Watermelon.—The watermelon requires the same cultural conditions as muskmelon. It should be planted in hills 8 x 10 feet to 10 x 10 feet apart. A bountiful supply of rotten manure should be used in the hills. Commercial fertilizers can also often be employed to advan-

tage. Planting should not occur until there is no danger of frosts. Among the varieties which are popular may be mentioned Kleckley Sweet, Kolb Gem, Cuban Queen, Halbert Honey, Dixie and Sugar Stick. Cole and Fordhook are very hardy varieties desirable for planting in northern districts.

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CHAPTER 3

THE FARM VEGETABLE GARDEN

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In the rural sections the vegetable gardens adjoining the homes of the farmers show marked differences. In some sections almost no attempt is made to supply the home table with home-grown vegetables. In other districts the gardens are of good size, well planned and uniformly well cared for throughout the whole season. Those who devote no attention to the home garden little realize the advantages missed through this neglect. The diet of these families is usually not well balanced. Meats and cereals probably predominate and the elements which are supplied in vegetable food are lacking. These elements are not so much concerned in furnishing energy and building body material as they are in supplying the flavoring and mineral requirements. Moreover, man, as well as animals, requires a certain amount of more or less bulky feed. These factors in the diet are seemingly of minor importance, but are, nevertheless, absolutely essential. Just as no animal can thrive without a small amount of salt, so the absence of these elements from the table results in the weakening of the whole system and the undermining of the general health. The old-fashioned idea that one must necessarily be in poor physical condition when spring opens, is based upon the absence of vegetables and fruits from the old-fashioned winter diet. Nowadays, when canning is much more economically practiced and when the products of the garden and orchard are to be had during every month of the year, the old-time spring tonic is less in demand.

The value of the home garden must be further considered in its contribution to the joy of living and to the relish of a good table. Much can be said in praise of the endless array of delicacies which may be provided by the skilful housewife who is in league with the skilful gardener.

The economic value of the products which the home garden offers has been investigated by a number of experiment stations. At the Illinois Station it was shown that the average annual gross return from a half acre amounted to \$105 through a period of five years, with an average cost, including all labor and materials, of \$30. Some contend that the ordinary farmer cannot afford to devote the requisite amount of time and energy to the cultivation of the garden. It makes demands upon him which conflict with the demands of his fields and crops. It is true that a delay of a day

in the planting of a field of oats may result in a very serious reduction in the yield. On the other hand, it is possible to so plan the work that both crops and garden receive the best of care. In fact, one is impressed with the correlation which exists between good farming and good gardening. It is largely a matter of management.

It is the aim of this article to offer some suggestions and general hints on garden making which may be of service to those trying to meet a given set of conditions. Rules are subject to numerous exceptions depending on conditions of soil, climate and exposure. These vary so widely that each must expect to work out his own salvation. An increasing measure of success from year to year is the reward to him who is willing to see and to think and to do the best that he knows, even though his knowledge in the beginning be exceedingly meagre.

Choosing a Site.—The gardener should carefully avoid the mistake of undertaking to cultivate a plot which is too large. A small area well kept and intensively managed will be much more satisfactory. It is safe to say that half an acre is the extreme for the ordinary family. Such a plot may be expected to yield an abundance for summer and autumn use, as well as for canning and storage. It is better to start with a garden too small than one too large.

On most farms, some choice as to location is possible. The garden should be near the buildings. It should be within easy reach of the housewife so that she may gather the products just as she is ready to use them. A distant garden seldom receives the care which is required. If the location is convenient, the hired men can make use of odds and ends of time which would otherwise be wasted. The cultivator which has finished its task a half hour before noon may loosen the crusted soil of many rows.

A southeasterly exposure is earlier and ordinarily offers protection from the severest winds. Roots of trees and shade of buildings should be carefully avoided.

If it is possible to choose from different types of soil, it is best to select a sandy loam. Heavy soil, the clays and clay loams, are lumpy when dry and are sticky and unworkable when wet. They cannot be cultivated early in the spring. On the other hand, the lightest sands ought to be avoided, in spite of the fact that they are loose and friable and may be tilled even when wet. They are not retentive of moisture or fertility. Of course, high fertility is of prime importance, but a soil may be improved in this respect more readily than in physical character. Freedom from weed-seed and disease must also be sought.

The Garden Plan.—Good planning is no less important in the garden than on the farm, although it is more often neglected here than in connection with the broader fields. During the winter the thoughtful gardener gathers about himself a supply of catalogues, a few good garden books and bulletins, together with paper, pencil and ruler. Furthermore, he refers to the concise but comprehensive notes which he has made during the

previous season and which enable him to take advantage of points which would otherwise have escaped his mind. It is better to till a garden which is smaller by a few square yards and to keep an adequate record than to neglect this most important part of the gardener's task. The returns in later years will amply repay for the time and energy involved.

The first task is to decide what is wanted, making a list of crops, having in mind the likes and dislikes of the family. This should provide for an even distribution of products throughout the season and an adequate supply to be canned or stored for winter use. It should also take into consideration adaptation to climate, soil and space available.

In most cases the rows should be laid out lengthwise of the garden, and the spacing for all but the most intensive crops should be wide enough for

Plowed area			
vegetables			
planted in			
rows $3\frac{1}{2}$			
feet apart.			
Strawberries			8ft.
Asparagus			8ft.
Rhubarb	Gooseberries	Currants	8ft.
Raspberries			8ft.
Raspberries	Blackberries		8ft.
Blackberries			8ft.
Grapes			8ft.

A FARM GARDEN LAID OUT FOR CONVENIENCE IN WORKING.¹

horse cultivation. At the same time, the possibility of a much smaller garden to be tilled with wheel hoe and hand hoe may well be considered. The permanent crops such as asparagus and rhubarb ought to be placed at one side to avoid interference with tillage operations. In this same section of the garden the hotbeds and cold-frames may well be placed. Early crops should usually be kept together in order that the space made vacant by their removal may be more conveniently utilized. Attention should also be devoted to the symmetry, balance and neat appearance of the garden.

Fertility.—The first requirement for garden soil, as well as for farm soil, is good drainage. In case of surplus water, tile drains should be laid. Many soils which are not recognized as being especially wet are very materially benefited by drainage.

The farm gardener enjoys at least one great advantage over the city

¹ Courtesy of The Macmillan Company, N. Y. From "Farm Management," by Warren.

gardener. He has available an ample supply of stable manure. This material is the main reliance for the maintenance of fertility. Manure supplies nitrogen, phosphorus and potassium, the only chemical elements which are frequently lacking, and if the quantity applied is sufficient to maintain the humus content of the soil, there will be an abundance of these three elements. Manure that has been in the pile for several months is ordinarily preferred, but fresh material may be plowed under each fall with the assurance that it will be fairly well decayed and ready to aid the plants by spring.

In case the garden soil is of a refractory character, special treatment will be necessary. Heavy soils may be improved by hauling sand or gravel, by the addition of ashes, by the use of lime and especially by liberal applications of manure.

The lime content of the soil must in any case be maintained. Applications of air-slaked lime or finely pulverized limestone at the rate of a ton per acre every two to four years, are usually sufficient. If hydrated or quicklime be used the quantities may be reduced by approximately a quarter and a half respectively.

Tillage.—Every farmer realizes the danger incident to the plowing of the soil when it is wet. If such an error is harmful in ordinary farm practice it is doubly disastrous in

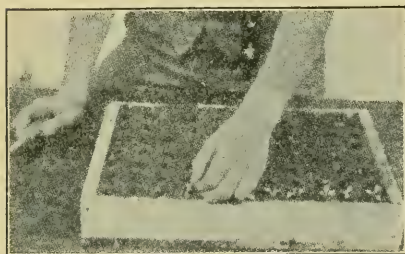
the garden. Vegetable plants insist upon favorable growth conditions. In case the soil is shallow, it ought to be gradually deepened from year to year. The plowing should be done in the fall and the soil should be left in furrows to benefit from exposure to the frosts of the winter. In the spring it may be gone over with the disk harrow and worked down, making use of such other tools as are best adapted to the type of soil involved.

It is wise to prepare a few raised beds or ridges in the autumn for the earliest plantings. These will be ready to work much earlier in the spring, although they will dry out more rapidly in midsummer. Their direction should be such that they will gain full advantage of the warm southern sun.

Garden Seed.—Few problems connected with the garden are more bewildering than the choice of varieties to be planted. Each seedsman



A—TRANSPLANTING BOARD AND
DIBBLE IN USE.



B—PLANTING THE SEEDLINGS. GROW-
ING EARLY PLANTS.

lands his own productions and impartial descriptions are seldom to be found. A variety well adapted to one locality may be utterly unsuited to another. Experience alone will enable one to meet this problem in a satisfactory way. Selections ought to be made and orders placed early in the season, in order to avoid disappointment and to allow time for testing. Many well-known seed houses are striving to supply good, clean, viable seed that is true to type. Packet seeds found in grocery stores may be more or less unreliable. Many local seed houses carry excellent stock, however.

To the gardener who is able to devote a bit of extra time to his plot, no hobby is more fascinating than the selection and saving of seeds from his own plants. There is always wide variation in excellence and these differences are inherited to a greater or less degree. By careful attention for a series of years, remarkable progress may be made in increasing the returns from a given area. Selections should be made on the basis of the individual plant rather than that of the individual fruit. The amateur plant-breeder should first clearly establish in his own mind a definite ideal. If he changes his ideal from year to year, no progress will be made. Considerable care should also be exercised in the harvesting, curing, labeling and storing of his seed crop.

Seed that will not start growth will certainly not produce a crop and such should be eliminated before the garden is planted by means of careful germination tests. A definite number of seeds may be counted out and planted in a small box of soil which should be placed under good growing conditions as regards moisture and temperature. Other tests which are less thorough may be made by the use of blotters, cloth, porous dishes and the like. These, however, indicate only whether seed will sprout or not. They do not afford knowledge as to whether the seed is able to establish in the soil a plant that is of sufficient vigor to grow independently of the supply of food material which is stored within the seed coats. The final test consists in growing the crop to maturity.

Growing Early Plants.—Every gardener is anxious to mature his crops at the earliest possible moment and to this end he is willing to employ special equipment and special methods. He selects the varieties which grow most rapidly and sows the seed long before outdoor planting is possible. He aims to have plants of such vigor and hardiness that they will make steady growth in spite of unfavorable conditions which they may encounter. These early plants enable him to more fully utilize the space of his garden, to care for both soil and plants more easily, to secure a better root system and in some cases larger yields.

Early plants may be started in window boxes in the house and may later be set directly in their permanent place, or the seed may be sown indoors and the seedlings transplanted to the cold-frame for hardening before they go to the garden. Whether in greenhouse or hotbed and cold-frame, the temperature should be relatively low, ventilation free, watering not too heavy and sunshine unimpeded. These conditions make for stock-

iness, hardiness, good root systems, vigor and freedom from disease. Conditions which are unfavorable in any of these respects encourage a soft and spindling growth and result in plants which do not yield as satisfactory results as plants from seed sown in the open.

Small greenhouses adjoining the farm home should be more common. The cost need not be heavy, as the construction may be exceedingly simple. The farmer may do the work himself at odd times. Old or second-hand pipe may be used for heating. The heating arrangement may be exceedingly simple, perhaps, using no pipe at all and merely setting a small stove in the middle of the house. In case it is not feasible to have a greenhouse, a hotbed may be used to excellent advantage. Cold-frames and hotbeds are described in the next chapter.

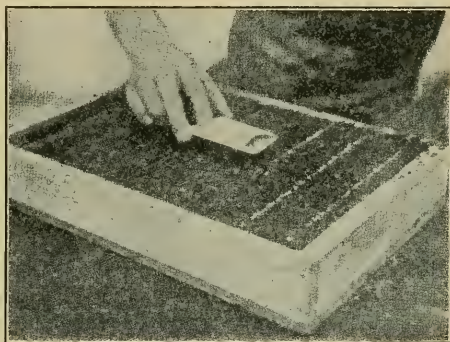
Seed Sowing.—Each vegetable has its own peculiarities as to time and manner of planting, and these peculiarities vary greatly with different climates and soils. Definite information upon these points, as well as upon many others, can be best secured from neighboring gardeners who have enjoyed long experience. The requirements for germination are moisture, warmth and air. Light is not necessary, although, of course, it is required immediately after seedlings break the ground. If the best results are to be obtained, the soil must be in excellent physical condition, especially for the smaller and more delicate seeds. These must also be sown a little more thickly than the more vigorous sorts, as is also the case when plantings are made very early in the spring when soil conditions are not strictly favorable and when damage by insects or diseases is feared. The skilful gardener should know his soil and his seed in order to sow just right both as regards thickness of sowing and depth of planting. Extreme thickness of sowing results in weak seedlings and requires much tedious work in thinning. Nevertheless, it is better for the novice to plant moderately heavily and to thus insure a good stand, even though some thinning is necessary after the plants have come up.

Particular attention must be devoted to the covering of the seed after it has been sown. The miniature plant enclosed within the seed coat depends upon the capillary movement of water in the soil for the moisture necessary for its growth. This movement is favored by thoroughly compacting the soil, and there is little danger of getting it too firm except in the case of heavy soils and of those which are rather moist at the time. Sowing in drills is preferred to broadcasting because it is easier to sow the seed at uniform depth. The seedlings help each other in breaking ground, and thinning and other work are more easily performed.

In the smaller gardens, seed is usually sown by hand. An envelope sealed at the side and cut squarely across the end is an excellent aid in this work. It is held the flat way and gently shaken with a movement lengthwise of the row, so manipulating it that the seed will drop evenly from the edge. Many gardeners, however, prefer to use the unaided fingers, working the seed over the second joint of the index finger by means of the thumb.

Mechanical drills are much more widely used in home gardens than ever before. Where fairly long rows are the rule, these implements are great time savers and in addition they may be depended upon to distribute the seed uniformly both as to thickness and depth. The drill requires as much skill for its adjustment as does the finger or envelope method. The scale on the machine which shows the approximate rate of sowing for the different seeds can be used only as a general guide, as there is wide variation in the size of seed of each vegetable.

Transplanting.—A seed consists of a miniature plant with its temporary food supply enclosed in such protecting covering as is necessary to insure safe removal to a situation far distant from the parent plant. This tiny plant is accordingly well adapted for a shift. However, the gardener in his eagerness for early fruition is not satisfied to let nature have her way. He must remove a plant which has discarded its protecting coat and which has already established its roots in the soil and begun to spread its branches in the air. This modification of nature's plan makes it necessary to exercise special precaution if he is to succeed. The soil should be in good physical condition and contain a reasonable amount of moisture. If possible, the work should be done on a cloudy day or in the evening so that the plant may recover from the shock before it is exposed to the unbroken rays of the sun. The little plants may be protected by special shading if it seems necessary. Care should be exercised



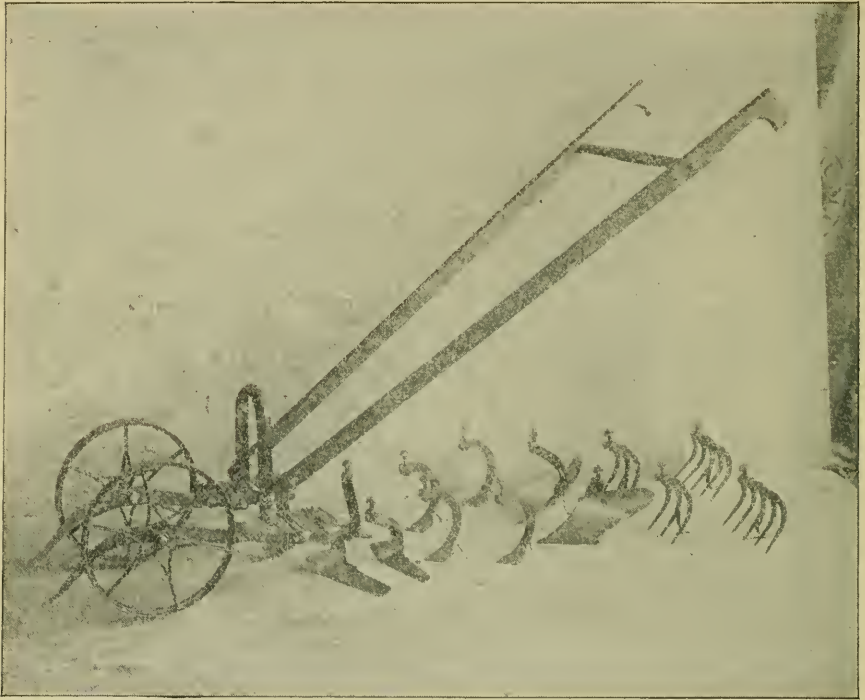
SOWING FROM SEED PACKAGE OR ENVELOPE.

to remove a good-sized ball of earth with the plant, thus establishing the foundling in its new place without serious disturbance of the roots. Plants should ordinarily be set just a little deeper than they stood in their previous place.

It is not wise to set warm-blooded plants like tomatoes and cucumbers exceedingly early, as they may be seriously stunted by cold weather, even though there be no frost. Nevertheless, some gardeners set out a few plants very early, expecting to replace them if necessary.

Cultivation.—The word cultivation is a general term used in two or three different ways. As here applied, it refers to the maintenance of a thin layer of loose soil upon the surface of the garden throughout as much as possible of the growing season. This mulch is of great value in retaining moisture, in keeping the soil in good physical condition and in checking the growth of weeds. In small gardens the hand hoe and hand weeder will serve every purpose without undue labor. Even more universally used than

the mechanical drill is the man-power wheel hoe, with its diversity of tools adapted for all sorts of soil stirring. Such implements are found useful, even though the rows be no more than forty feet long. In larger gardens, horse implements should be used as far as possible. In either case, it will be necessary to employ hand tools for maintaining the mulch between plants in the row. There is available a wider variety of tools and implements for cultivation than for any other type of garden work. These must be selected in accordance with the character of the soil, the crops, and the indi-



WHEEL CULTIVATOR AND ATTACHMENTS.¹

vidual fancy of the gardener himself. There are a number of crops which spread over the ground comparatively early in the season and prevent cultivation from that time on. An increasing number of gardeners are securing the same results by means of a mulch of fresh, strawy manure, distributed between the rows. This conserves moisture and prevents weed growth as effectively as cultivation.

Irrigation.—In spite of all these precautions, gardens often suffer from lack of water. It is not always possible to irrigate the rural garden,

¹ Courtesy of New York State College of Agriculture, Ithaca, N. Y. From Cornell Reading Courses, Vol. II.

but in some cases the plot may be so located that the water of a little stream may be so diverted as to flow between the rows when needed. An increasing proportion of country homes have water supply systems of their own. When this is the case, a line can be run to the garden for hose or overhead irrigation.

There is great danger that watering be done superficially, only the upper surface of the soil being moistened. This does more harm than good, as it dries out before it reaches the roots of the plants and at the same time it destroys the mulch which was fairly effective in conserving the moisture already present.

Pest Control.—No garden is free from the ravages of insect enemies and plant diseases. Each malady and each insect must be treated in its own way. Information as to methods must be sought in spray calendars or in special treatises upon such subjects. However, certain general principles must be borne in mind. As in the case of human ailments, an ounce of prevention is worth a pound of cure. The most important preventive measure is thorough cleaning up every fall. This removes from the garden the dormant forms of both insects and fungi, and so reduces the danger of infestation the next year. Crop rotation, or rather the refusal to grow the same crop on the same ground two years in succession, means much in the prevention of certain diseases. Plants which are making strong and vigorous growth are considerably less susceptible to attack than weaklings.

Cabbage, cauliflower, Brussels sprouts, kale and kohlrabi are all subject to clubroot. This disease is caused by a slime mould which lurks in the soil and which attacks the plant through the roots. When the roots are thus affected, they are unable to secure either plant food or moisture, and the plants soon die. The plants wilt slightly at first and more seriously as the disease progresses. The roots become swollen, knotted and misshapen. There is no clear-cut method of control, but rotation, liming, thorough cleaning up each year and care to avoid the introduction of the disease by means of manure, tools and purchased plants is advised.

With beans, special precaution must be exercised against the rust or anthracnose. It is well to save one's own seed, choosing only pods which are naturally free from spot. Cultivation should be avoided when the plants are wet.

For insect enemies, plant diseases and their remedies, see chapters on same in Part II of this book.

Quality of Vegetables.—Quality in many vegetables depends to a large extent upon the stage of maturity. Peas and beans are more palatable, tender and digestible if gathered at a rather early stage of maturity than if allowed to get too large. As a rule, the protein content will be higher and the loss in actual nutritious value is more than counterbalanced by the good qualities above mentioned.

Few people realize how rapidly sweet corn deteriorates in value after it has been removed from the plant. It should go directly from garden to

kettle. Garden beets, in like manner, lose considerable of their sweetness if allowed to stand long between time of pulling and cooking. Many of the garden vegetables suffer loss in a similar way.

Storage of Vegetables.—The character of storage that will give best results depends on the nature of the vegetable. Most vegetables, such as cabbage, root crops, potatoes and apples, keep best when stored under fairly dry conditions with some ventilation and a low temperature. The temperature cannot be too low so long as freezing is avoided. Low temperatures prevent the development of most fungous and bacterial activities which are directly responsible for various forms of decay.

There are a few of the vegetables, such as sweet potatoes and squash, that keep better at a temperature of about 50° F.

Literature.—The skilful gardener is always on the lookout for new ideas and new suggestions that will enable him to improve his garden from year to year. Many books have been published and a number of the experiment stations have issued bulletins dealing with the home lot. The following are a few references:

- "Home Vegetable Gardening," by F. F. Rockwell.
- "The Home Garden," by Eben E. Rexford.
- "The Vegetable Garden," by Ida D. Bennett.
- "Vegetable Gardening," by R. L. Watts.
- "How to Make a Vegetable Garden," by Edith Loring Fullerton.
- "Book of Vegetables," by Allen French.
- "Manual of Gardening," by L. H. Bailey.
- "Vegetables for Home and Exhibition." Beckett.
- "Garden Making," Bailey.
- "Principles of Vegetable Gardening." Bailey.
- "Farm and Garden Rule Book."
- "The Home Vegetable Garden." Farmers' Bulletin No. 255.
- "The Home Garden in the South." Farmers' Bulletin 647.
- "Hotbeds and Cold-frames." Cornell Reading-Course Bulletin No. 30.
- "Home-Garden Planning." Cornell Reading-Course Bulletin No. 34.
- "Planting the Home Vegetable Garden." Cornell Reading-Course Bulletin No. 58.
- "Summer Work in the Home Garden." Cornell Reading-Course Bulletin No. 92, and others.
- "The Home Vegetable Garden." Illinois Circular No. 154.
- "Farmer's Home Garden." West Virginia Bulletin No. 122.
- "The Farmer's Vegetable Garden." Illinois Bulletin No. 105.

CHAPTER 4

VEGETABLE FORCING

BY C. W. WAID

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Vegetable forcing is a term applied to the growing of vegetables in such a way that they mature or become suitable for use in a shorter time or at a different season than when grown under normal conditions. Cold-frames, hotbeds and greenhouses are used for this purpose.

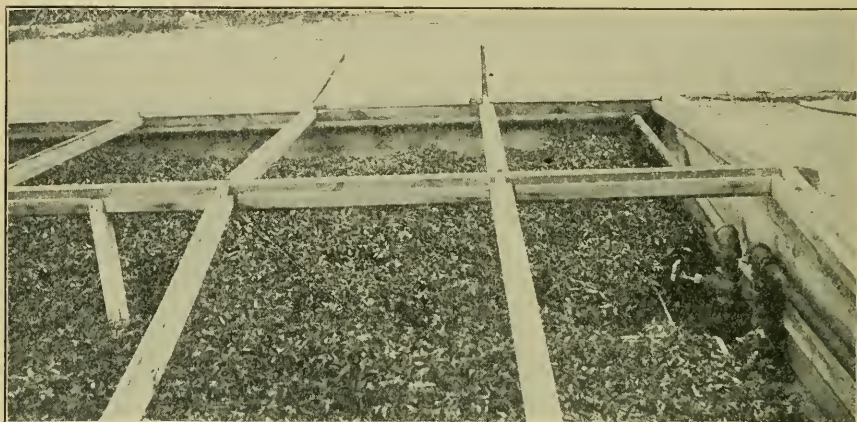
Cold-Frames.—Cold-frames are wooden or concrete structures covered with glass or cloth. They are entirely dependent upon the sun's rays as the source of heat and serve as a protection against cold winds and too rapid radiation of the heat at night. The frames are usually built to run east and west with the south side about a foot above the surface of the ground and the north side a foot or so higher than the south side. They are about six feet in width and of any desired length. When glass is used as a cover the panes are fastened in sash. The standard size of the sash is three by six feet.

It is not possible to maintain a uniform temperature in cold-frames during very cold weather. Their use is, therefore, confined to relatively mild climates or to short periods in the colder climates. They are best adapted to the growing of cool-season crops, the starting of plants for late transplanting or the hardening off of plants started earlier in the greenhouse or hotbed. A cloth cover is sometimes used in the place of glass as a matter of economy.

Hotbeds.—Hotbeds are similar in construction to cold-frames. The chief difference is that in addition to the heat secured from the sun's rays other means are used to supply heat in the hotbeds. The common source of artificial heat is fermented horse manure. Hot-air flues and steam or hot-water pipes are also used for this purpose. When steam or hot water is used to heat a greenhouse or residence the same system can be used to advantage in heating the hotbeds. Hotbeds are more satisfactory than cold-frames for the growing of early crops or the starting of early plants in a cold climate, as the temperature can be made more uniform.

To prepare a manure hotbed, the dirt is removed from inside the frame to a depth of from one and one-half to two and one-half feet. Horse manure from grain-fed animals should be placed in a compact pile at least three weeks before it is to be put in the pit. As soon as the manure begins to ferment it should be forked over and thoroughly mixed. All lumps should be broken. A second forking over may be needed before it is ready for the

pit, when it should be a steaming mass. Care must be taken not to let it overheat and burn, as this would reduce its value. When the pit is dug and the manure ready it should be placed in the pit a few inches at a time and evenly tamped. From one to two feet of solid manure is essential for best results; the greater amount being needed for the growing of heat-loving plants and for other plants as well in the colder sections of the country. Rich garden soil, preferably from a compost heap, should be placed over the manure to a depth of about six inches. The sash should be placed on the frame as soon as the manure and soil are put in to prevent the heat escaping too freely and to keep off the rain or snow. If the manure is well prepared it will raise the temperature of the soil so high at first that it will not be safe to sow seeds until several days later. The temperature of the soil should not be over 85° F. when the seeds are sown.



A DOUBLE SASH STEAM-HEATED HOTBED.

The Greenhouse.—Greenhouses are glass-covered structures, so built that the person who grows crops in them can work inside with ease. They are heated with hot-air flues, hot water or steam. When properly constructed it is possible to grow many kinds of crops to maturity in them at any season of the year. They are even more satisfactory than hotbeds for the starting of plants for early crops outside. It is possible for the gardener not only to give the plants better care in bad weather in the greenhouse, but he is not so much exposed, and thus can work more comfortably and to better advantage. The combination of a greenhouse, hotbeds and cold-frames is desirable when possible.

Growing Plants Under Glass.—The growing of plants under glass is very different from growing them in the open. To the inexperienced, it might seem easier to grow them inside than outside, because conditions are more nearly under the grower's control. This is not true, however, as the

comparatively high temperature, excessive humidity and artificial conditions in general encourage the development of tender plants which are subject to attack by various insects and diseases. Vegetable forcing is perhaps the most exacting of all lines of intensive gardening. To be successful in this line of work when it is followed as a business, an individual must be able to apply himself and must have a knowledge of the needs of the crops to be grown. If he is in love with this particular line of work, his chances of success are much greater than when he forces himself into it because he thinks there is money in the business. This need not discourage the man who wishes to have a small greenhouse and a few sash to assist him in getting more money from his outside crops. Many successful greenhouse men have started in this very way.



A GREENHOUSE SUITABLE FOR FORCING PLANTS.

One of the most important things to keep in mind when starting in the forcing business even in a small way, is to try to supply as nearly as possible the needs of the crop to be grown as to temperature, ventilation, plant-food and water. If these demands are met there will be much less trouble from diseases than when they are not properly looked after.

The following is a list of cool plants which require a night temperature of from 45° to 55° F., and a day temperature of from 65° to 70° F. on clear days:

Lettuce	Peas	Onions
Radishes	Beets	Celery
Rhubarb	Asparagus	Parsley
Cauliflower	Carrots	

The warm plants demanding a night temperature of 55° F. or above and a day temperature of 75° F. or more on bright days are tomatoes, egg-plants, peppers, cucumbers, muskmelons and beans.

Too much importance cannot be placed on ventilation. In cold-

frames and hotbeds poor ventilation is almost certain to induce the disease known as "damping off," while careful ventilation and watering will prevent it to a great extent. In a greenhouse such diseases as mildew and others which flourish in a moisture-laden atmosphere and high temperature will be much more liable to give trouble when the ventilation is insufficient than when it is given proper attention.

Watering is another important operation. As a rule, it is best to water only on bright days, and preferably during the forenoon to give time for the plants to dry off before night. The overhead system of watering is being used very commonly by progressive gardeners in the greenhouse and in hotbeds and cold-frames.

The most common source of plant-food in vegetable forcing is well-rotted stable manure. When this can be secured in sufficient quantity, little in the way of artificial fertilizers will be needed. In some cases the use of liquid manure or nitrate of soda in small quantities will produce good results. Wood-ashes, especially from the burning of hardwood and ashes secured from the burning of tobacco stems, can be used to good advantage.

It is not customary to make frequent changes of soil in the vegetable forcing business. Some soils have been in use for forty years and are still producing good crops. In some cases steam sterilization has been necessary to overcome certain soil diseases.

A brief treatment of this subject would not be complete without calling attention to the importance not only of good varieties but of good strains of vegetables for forcing. There is no line of gardening in which this matter is of greater importance. Much time and expense is incurred in the growing of plants under glass. It would certainly not be profitable to put so much expense upon varieties which even when well grown are inferior. Well-grown vegetables of good varieties and strains will demand the highest market prices. The forcing of vegetables is a profitable and pleasant line of work when properly done by the man who knows his business and delights in his work.

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CHAPTER 5

MUSHROOM CULTURE

BY H. M. WARE

Practical Mushroom Grower, Delaware

Over 5,000,000 pounds of the common mushroom (*Agaricus campestris*) are grown annually in the United States. Besides these, in 1914 we imported from Europe 9,188,177 pounds in cans, 30 per cent more than in 1910. Practically all of the \$3,000,000 worth of mushrooms grown or imported by this country in 1914 were sold in a few of our larger cities. Hundreds of smaller cities and towns throughout the country offer undeveloped markets for this product, a fact which does not indicate that the supply will soon exceed the demand.

The uncertainty of mushroom growing as a business was eliminated when Dr. B. M. Duggar discovered the "Tissue Method" of manufacturing spawn in 1902. As a direct result of discarding the "Chance" spawn imported from England and France, the American industry has developed rapidly.

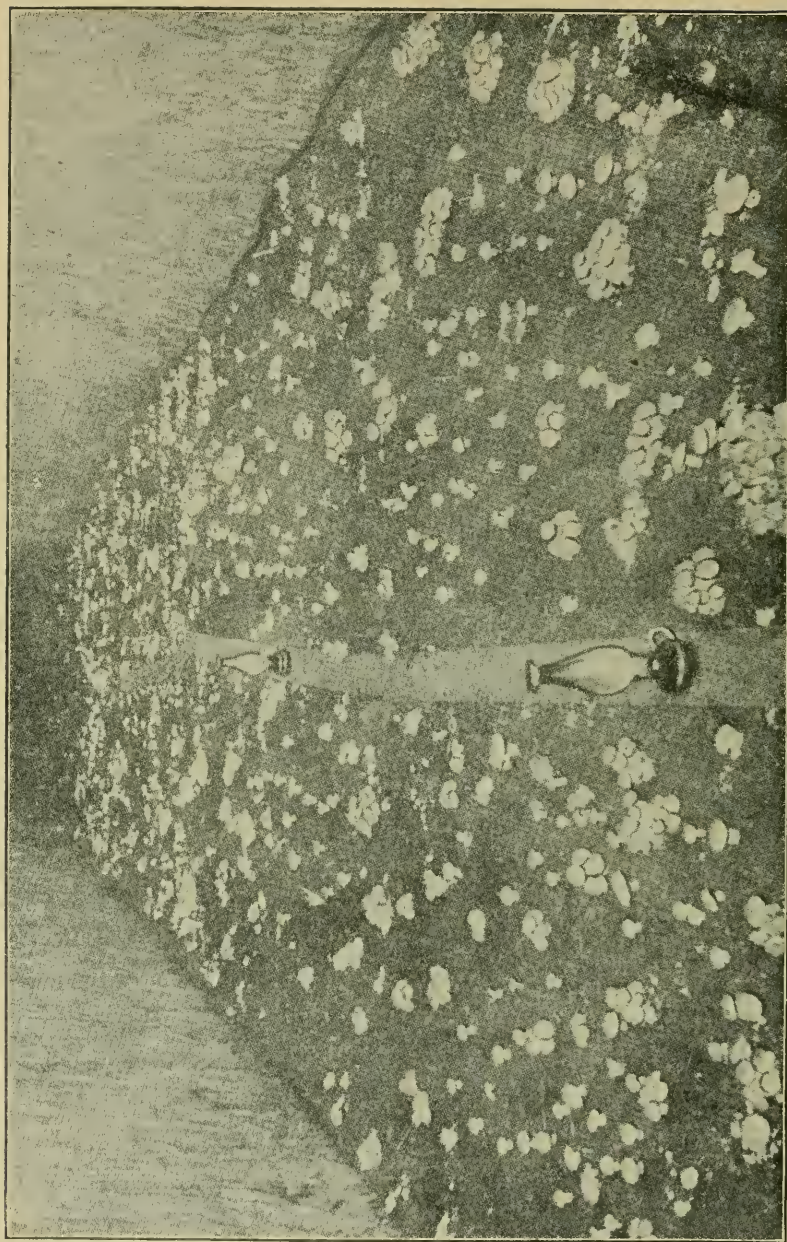
While it is true that the bigger the operation the lower will be the cost of production, nevertheless mushroom culture is adapted as a side line to many farms. When sold, mushrooms enter the same channels, wholesale or retail, as do other fancy products. Labor can be profitably employed in winter. The manure used in the houses is in ideal condition for application on the land. This point is better understood when it is considered that the composting of the manure is almost identical with the methods employed by market gardeners—that the fresh mushroom contains 90 per cent water and analysis has shown that, ton for ton, mushroom manure is more valuable than fresh stable manure, having lost little beside weight, water and weed-seeds.

It should be understood that much hard and some unpleasant work is unavoidable in mushroom culture. But that, with intelligent care in supplying the few essential details, success and a legitimate profit are assured.

The most common causes of failure are:

1. Poor spawn.
2. Heavy watering.
3. Unfavorable temperature.
4. Poor or improperly composted manure.

Houses.—The place in which mushrooms are to be grown must permit easy control of temperature, moisture and ventilation. While proper conditions may be afforded by caves, cellars or unused buildings, it will



A FINE BED OF MUSHROOMS GROWN FROM SPAWN OF PURE-CULTURE ORIGIN.¹

¹ Courtesy of the U. S. Dept. of Agriculture, Bulletin 85, B. P. I.

generally be found advisable to build especially for the purpose. But no one should build a mushroom house without first inspecting the plant of a successful grower. Permanent walls can be made of hollow tile or other material that will not readily decay. Air space in the wall must be provided to maintain even temperature.

When grown in winter mushrooms require artificial heat. Hot-water heating, the system most economically and easily run, is in general use by all large growers. Five hundred square feet of pipe surface (1000 feet of 1½-inch pipe) should be allowed to every 20,000 cubic feet of air space.

Preparation of the Compost.—

The best material is fresh horse manure, which contains plenty of the more resistant cereal straws. Care should be exercised to see that no disinfectant has been used. Build the pile with straight sides 3 or 4 feet deep throughout and 8 feet wide. This makes turning easy, and leaching of plant-food is prevented. In five days the pile should be turned; thereafter at weekly intervals, until rapid fermentation has stopped; usually in three or four weeks. Water the compost when turning and keep it moist. Heavy watering at first will do little harm, but when ready for the beds compost should be in such condition that when squeezed in the hand water will not readily drop from it.



TURNING THE COMPOST.

Some growers cover the piles with three inches of dirt before and after the first turning. Equally successful growers, however, use no dirt in the compost. Dirt seems only to shorten the time necessary for composting. When ready for the beds the manure has lost all objectionable odors, and the straw has changed from yellow to dark brown.

Filling the Beds.—The beds in common use are flat, 8 inches deep and 6 feet wide, built in tiers of shelves five or six beds to the tier. The boards used are generally chestnut, 1 inch by 8 inches by 12 feet. These are lapped loosely so they may be easily dumped.

The bottom beds should be filled first, so that the operator will have head room. They should then be firmed (*i. e.*, leveled by light pounding with back of fork); if not wet, the manure may be tramped. Firming

lessens evaporation and prevents burning during the secondary heating. When filled the house is closed, and in a day or two the temperature rises, sometimes to 120° F., then slowly drops to normal. One ton of manure will fill approximately 65 square feet of bed 8 inches deep.

Spawning.—Only the best American brick spawn should be used.



A TYPICAL RANGE OF MUSHROOM HOUSES.

Of the several varieties, the White and Cream are most desirable; white is more salable, cream more prolific and hardy. Spawning should begin when the temperature of the beds has dropped to 70° F. The bricks should be broken into eight or ten pieces $1\frac{1}{2}$ to 2 inches square and placed evenly on



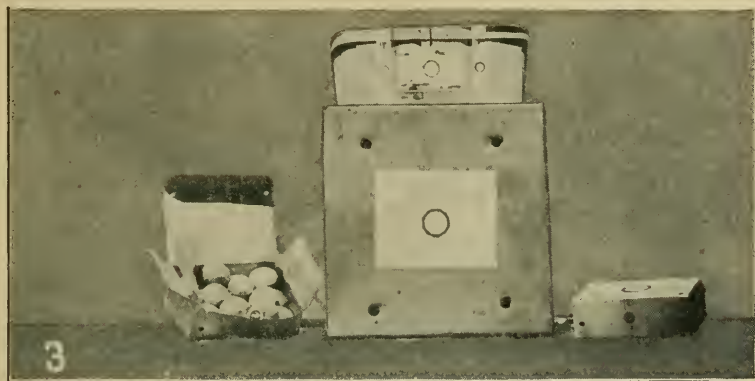
SIFTING THE CASING DIRT.

the beds. The pieces should then be inserted vertically one inch below the surface of the manure. After spawning, the beds should be firmed again.

Spawn should be kept in a cool, dry place. One brick costs from twelve to fifteen cents and will plant 8 square feet of bed.

Casing the Beds.—Two weeks after spawning, a piece of spawn should be dug up; if the mycelium appears as a mould running into the manure, the beds are ready to case. Casing consists in covering the beds with a layer of sifted loam 1 to 1½ inches deep. The loam causes the mushrooms to head, acts as a mulch and is the best medium for picking. The average farm wagon load of sifted loam will cover 250 square feet of bed.

Temperature.—Temperature is important because it regulates the competition of mushrooms with insects and with other fungi. It has been found that at 53° to 58° F. mushrooms grow slowly but strongly, while other growths are held in check. Even at freezing temperatures mushrooms lie dormant without apparent harm. Too much heat causes rapid



TYPES OF FANCY PACKAGES.

development, not only of mushrooms, but also of any other organisms present, so that the spawn soon “runs out.” The temperature should be kept near 56° F. and sudden changes should be avoided.

Water.—Water should be applied to the beds only as a spray. The surface should never be allowed to dry out, nor should it be soaked. It is better to apply a little water every day than to water heavily at longer intervals. The air should be kept as moist as proper ventilation permits.

Ventilation.—Ventilation is of great importance, but must be accomplished without draughts. Draughts quickly dry out the beds and cause the mushrooms to crack and darken, especially after watering. Overhead ventilators give the most uniform ventilation with the least danger.

Picking and Marketing.—The first mushrooms appear six to eight weeks after spawning. When in full bearing they should be picked every day. Picking is an art. The yield and returns may be materially reduced by lack of judgment in this single operation. Experience only can teach one to pick properly. It should be remembered that mushrooms gain no weight

after the veil begins to break and that an open mushroom is a third-class article on the market.

Mushrooms are a distinctly high-grade product. They deserve the most careful grading and care in the selection of a package. The standard grades in the New York market are Fancy, Choice, Buttons and Seconds. Too few growers use a label, their packages being known only by a number given in a commission house. The ventilated pound box will recommend itself for the retail trade. The four-pound splint basket is the standard wholesale package; these are tied in bundles of six for shipment by express.

After picking, delay and high temperatures are to be avoided. Even in cold weather some ventilation in the package is desirable.

THE FOLLOWING ARE THE MOST TROUBLESOME ENEMIES.
DISEASES.

ENEMY.	WHEN TROUBLESOME.	INJURY.	TREATMENT.
Fogging off.	Warm weather.	Young mushrooms turn brown.	Lower temperature. Ventilation.
Black spot.	Improper watering and ventilation.	Discolored caps.	Proper conditions.
Mycogone disease.	Infected spawn or compost.	Abnormal growths, misshapen, unsalable, highly infectious.	Careful sanitation. Formalin hydro gas fumigation.

INSECTS.

Mites.	High temperature.	Troublesome; may affect spawn.	
Springtails.	Carelessness in cleaning house.	Similar to fogging off.	Fumigation with carbon disulphide.
Larvæ of flies.	Poor manure. Warm weather.	Bore into mushrooms; unsalable.	Carbon disulphide. Low temperature.

Mushroom Enemies.—By providing suitable growing conditions and exercising the utmost care in cleaning the house after a crop has been grown, little trouble from insects or fungous enemies will be experienced. Every speck of old compost must be brushed out. The bed boards and every part of the house should then be whitewashed and if possible fumigated.

Yield and Returns.—The profitable life of a mushroom bed averages three to four months. A yield of one half pound per square foot will pay labor and expenses, but one pound per square foot should be produced under proper conditions.

The average wholesale price is 25 to 26 cents per pound. Mushrooms retail throughout the season from 35 to 75 cents per pound, depending alike on season and quality.

The cost of production depends mainly upon the yield and the cost of labor and materials in a given section. The large growers estimate the cost at 15 to 25 cents per pound.

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Wild Ones."

CHAPTER 6

MEDICINAL AND AROMATIC PLANTS

By W. W. STOCKBERGER

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The market demand for the products of medicinal and aromatic plants when compared with the demand for staple products such as cereals, fruits or vegetables, is relatively very small, and is not sufficient to make them promising crops for general cultivation. Many such plants which can be grown and prepared for market with little difficulty, bring but a small return, and hence their cultivation offers little prospect of profit. A number of high-priced medicinal plants must be given care for two or more years before a crop can be harvested, and, since expensive equipment is usually required for their successful culture and preparation for market, the production of such crops offers little encouragement to inexperienced growers who are looking for quick returns and large profits from a small investment of time and money.

Requirements for Medicinal Plants.—Several medicinal and aromatic plants, for which the demand is fairly constant, have been profitably grown on a commercial basis, but the success of the growers has been due largely to the care which they have taken to produce a uniform product of high quality. However, the production of drugs of high quality requires skilled management, experience in special methods of plant culture, acquaintance with trade requirements and a knowledge of the influence of time of collection and manner of preparation on those constituents of the drug which determine its value. Small quantities of drugs produced without regard to these conditions are apt to be poor in quality and so unattractive to dealers and manufacturers that the product will not be salable at a price sufficient to make their production profitable.

The agricultural conditions generally prevailing in the United States and in Canada are far more favorable to the growing of medicinal and aromatic plants as a special industry for well-equipped cultivators than as a side crop for general farmers.

The growing of medicinal plants in the United States has hardly passed beyond the experimental stage, and although several of these plants promise satisfactory profits in suitable localities, any general attempt to grow them on a commercial scale would soon result in over-stocking the market. However, the demand for such plants as anise, belladonna, car-

away, coriander, digitalis and sage is at present large enough to make them worthy of consideration.

Anise (*Pimpinella anisum*) is an annual plant grown for its aromatic seeds. It is cultivated on a small scale in Rhode Island, and is suited for localities similar in climate to that state. The best soil for anise is a light, moderately-rich and well-drained loam. The plant is very sensitive to unfavorable weather conditions, but in a good season the yield of seed should be from 400 to 600 pounds per acre. About 2000 acres should produce the average quantity of seed annually imported into this country. The price usually ranges from 6 to 8 cents a pound.

Belladonna (*Atropa belladonna*) is an important drug plant for which there is a steady demand. It has been cultivated in New Jersey, Pennsylvania and California, although not very successfully from a commercial point of view. It is apparently better adapted to the warmer states than to the colder regions where it is likely to winter-kill. Belladonna thrives best in deep, moist, well-drained loam containing lime. Sowing seed in the field usually gives very poor results, but sowing seed in the greenhouse and transplanting like tomatoes is usually successful. The cost of growing belladonna is high, owing to the large amount of necessary hand labor. Five hundred pounds of dry leaves per acre is considered a fair yield. At the end of the second year about 1000 pounds of dried root per acre may be harvested. The prices in the wholesale drug markets have been from 14 to 25 cents a pound for the leaves and from 9 to 18 cents a pound for the roots. Prices to growers have been proportionately less.

Caraway (*Carum carui*) is an annual, cultivated for its aromatic seeds, which are used medicinally and for flavoring. It grows and fruits well over a considerable portion of the United States, especially in the north and northwest, but its cultivation in this country has never assumed commercial proportions. Soil of a somewhat clayey nature and containing a fair proportion of humus and available plant-food is particularly suited to caraway, but the plant generally grows well in any good upland soil which will produce fair crops of corn or potatoes. The average yield of seed per acre is about 1000 pounds. At this rate about 2700 acres would be required to produce the quantity of seed annually imported. Anyone undertaking the cultivation of this plant might well consider growing dill and fennel also. Caraway seed is valued at about 6½ cents a pound.

Coriander (*Coriandrum sativum*) is also grown for its aromatic seeds and in its requirements and method of culture is very similar to caraway. The yield of seed is quite variable, but from 500 to 800 pounds per acre may be expected. If the average yield were 650 pounds per acre, 2000 acres would be required to produce the quantity of seed annually imported. The seed is valued at approximately 3 cents a pound.

Digitalis or Foxglove (*Digitalis purpurea*) is an important drug plant for which there is a constant demand. The leaves are used in medicine. Although widely grown in flower gardens as an ornamental, it has not yet

been grown on a large scale in this country as a drug crop. This plant thrives best in ordinary well-drained garden soils of open texture. Sowing the seed in the field is usually unsuccessful. For good results they should be sown in seed-pans or flats in the greenhouse. When danger of frost is past the plants should be hardened off and transplanted to the field. *Digitalis* does not flower until the second year, when the leaves may be collected. Probably 600 pounds of dry leaves per acre may be obtained under favorable conditions. The wholesale price of leaves ranges from 8 to 40 cents a pound, averaging about 15 cents.

The Common Sage Plant (*Salvia officinalis*) is easily cultivated and will grow in almost any well-drained fertile soil. There is a good demand for American leaf sage, which sells at a considerably higher price than the imported article.

The dry herb or leaves of a number of aromatic plants form marketable products for which there is a small demand, but as a rule these plants are grown for the essential oils which they yield. The principal essential oils produced in the United States from cultivated plants are: peppermint, spearmint, tansy, wormwood and American wormseed. The price of imported sage is 3 to 5 cents a pound. American sage is usually a little higher.

Ginseng (*Panax quinquefolium*) is a fleshy-rooted herbaceous plant native to this country and formerly of frequent occurrence in shady, well-drained situations in hardwood forests from Maine to Minnesota and southward to the mountains of Georgia and the Carolinas. It has long been valued by the Chinese for medicinal use, though rarely credited with curative properties by natives of other countries. Under cultural conditions, ginseng should be shielded from direct sunlight by the shade of the trees or by lath sheds. The soil should be fairly light and well fertilized with woods earth, rotted leaves or fine raw bone meal, the latter applied at the rate of one pound to each square yard. Seed should be planted in the spring as early as the soil can be worked to advantage, placed 6 inches apart each way in the permanent beds, or 2 by 6 inches in seed-beds, and the seedlings transplanted to stand 6 to 8 inches apart when two years old. Only cracked or partially germinated seed should be used.

Ginseng needs little cultivation, but the beds should be at all times kept free from weeds and grass and the surface of the soil slightly stirred whenever it shows signs of caking. A winter mulch over the crowns is usually essential, but it should not be applied until freezing weather is imminent and should be removed in the spring before the first shoots come through the soil.

The roots do not reach marketable size until about the fifth or sixth year from seed. When dug, they should be carefully washed or shaken free of all adhering soil, but not scraped. Curing is best effected in a well-ventilated room heated to about 80° F. Nearly a month is required to properly cure the larger roots, and great care must be taken in order to prevent moulding or souring. Overheating must also be avoided. When

well cured the roots should be stored in a dry, airy place until ready for sale. A market may be found with the wholesale drug dealers, some of whom make a specialty of buying ginseng root for export.

The price of cultivated ginseng root, as quoted in wholesale drug lists, has ranged during the past few years from \$5 to \$7.50 per pound.

A detailed account of ginseng culture is given in Farmers' Bulletin 551, entitled "The Cultivation of American Ginseng."

Peppermint (*Mentha piperita*) is frequently found growing wild throughout the eastern half of the United States, and can be grown under cultivation on any land that will produce good crops of corn. It is grown commercially with most success on the muck lands of reclaimed swamps in southern Michigan and northern Indiana. On good land the average yield of oil per acre is about 30 pounds, but as the yield is variable, approximately 15,000 acres of land are required to produce the annual market demand. It is valued at about \$2.50 per pound.

Spearmint (*Mentha spicata*) is very much like peppermint in its requirements, but can be grown successfully on a wider range of soils. On ordinary soils the yield of oil varies from 10 to 20 pounds per acre, but on muck lands the yield is usually only a little less than that of peppermint. The annual market requirement for spearmint oil is about 50,000 pounds. The oil has an average value of about \$3.30 a pound and the dry herb 3 to 4 cents a pound.

Tansy (*Tanacetum vulgare*) is a hardy plant which grows well on almost any good soil, but rich and rather heavy soils well supplied with moisture favor a heavy growth. The yield of oil varies, but about 20 pounds per acre is a fair average. The annual market requirement of this oil probably does not much exceed 3000 pounds. It is valued at about \$2.60 a pound.

Wormwood (*Artemisia absinthium*) is a hardy plant which can be grown almost everywhere, but commercially it is usually grown on fairly rich, moderately moist loams. It is cultivated on a small commercial scale chiefly in Michigan and Wisconsin. The annual production of oil is about 2000 pounds, which is apparently sufficient to satisfy market requirements. It is valued at about \$2.40 per pound.

American Wormseed (*Chenopodium anthelminticum*) is a coarse weed which grows well in almost any soil. The yield of this oil varies, but about 30 pounds per acre is a fair average and the annual production is about 5000 pounds. It is gaining in importance largely through its use as a remedy for hook-worm. The price ranges from \$1.40 to \$5.50 a pound.

Additional Equipment.—In addition to the usual agricultural equipment the producer of essential oils must provide a suitable distilling apparatus, since such oils are usually derived from plants by steam distillation. The cost of setting up a still will depend upon what facilities are already at hand and the size and efficiency of the apparatus installed. It may easily range from a small sum to several thousand dollars.

Where successful production of medicinal plants has not been demonstrated it should be determined on small experimental plats before undertaking commercial plantings.

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CHAPTER 7

PRINCIPLES OF FRUIT PRODUCTION, WITH SPECIAL REFERENCE TO THE HOME PLANTATION

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The establishment of home orchards is as important as ever, especially in sections where fruit is not now grown but is shipped in. With the wealth of information available through government and experiment station publications, no one who owns land suitable for growing general farm crops need hesitate to plant fruit for home needs. Even for the cold sections hardy varieties are available.

The Main Factors to Consider.—Temperature decides as to the species, and sometimes the variety, that may be grown. That of a region and even of an orchard is determined mainly by latitude, altitude, physical character of the country and distance from large bodies of water. In the spring, lakes and rivers keep the air cool because they are cold. Thus, they hold back bud development and aid the plants in escaping late frosts. In the fall they continue warm and thus lengthen the season. Other sections even nearby, but beyond the reach of breezes from the water, are more likely to be frosted.

Moisture in the soil may be secured through rainfall or by irrigation. In the East enough rain generally falls to care for the fruit interests, provided proper tillage methods are practiced; in the West, irrigation has largely solved the water supply problem. Of more importance is the relative humidity of the air; for where the air is dry, crop growing is more difficult than where it is fairly moist. In the northern prairie states, where the winter air is both cold and dry, many fruits fail because the air sucks moisture out of twigs and branches while the ground is frozen. In the East, where the cold spells alternate with moist weather, the twigs have a chance to secure moisture either from the soil or from the air.

Soil.—In general, currants and European pears usually do best on heavy soils; peaches and strawberries on lighter ones. But there are countless successes on soils of other character. Because of this, it is evident that the distinctions drawn between soils adapted to certain varieties are perhaps too fine; and yet there are varietal preferences that should be considered for commercial orchards. For home and local market plantation these distinctions are of less importance than for big business orchards.

Subsoil is of even more importance than surface soil in fruit culture, especially of tree fruits. Many good business orchards are on thin soils

that must be fed to keep the trees vigorous and productive. The secret is a deep, porous subsoil which insures good drainage and deep feeding; hence the ability of the trees to withstand seasonal vagaries. Since no business orchard should be planted without determining the nature of the subsoil, the prospective planter of a home orchard may well follow this practice.



GOOD NURSERY STOCK.¹

(Note the extent of roots and form of tops.)

The Parasite factor is mainly controllable. Not that there are no difficult enemies to handle, but preventive or remedial measures are available and mostly effective where properly applied.

Site for the home farm orchard is as important in its degree as location is to the commercial fruit grower. Site pertains to the position of the orchard on the farm, as a gentle eastward or northern slope. Much of the success of the plantation may be in choosing a well-drained, elevated site protected from strong winds. Such a site allows the cold air as well as the ground water to drain away, thus preventing frost injury to buds and blossoms. It also favors holding fruit by the trees, whereas a site exposed to high winds would favor dropping.

Aspect formerly attracted far more attention than today. It was believed that southern and eastern slopes favor earliness—and they do—but the effect is less than commonly believed. Business fruit growers plant on all slopes and get good results from all.

Windbreaks may or may not be a benefit. No one should plant a

¹ Courtesy of Maloney Brothers and Wells Company, Dansville, N. Y.

windbreak without first studying the problem from all angles. Often the best windbreak is the outside row of fruit trees, especially if of a variety that grows large and holds its fruit tenaciously.

Nursery Stock is nowadays so low priced that no one should consider growing his own trees. Fruit trees need special care as to propagation, and also require too much time to grow to orchard planting size; so when the best standard varieties can be bought for thirty cents or less, why run the risk of failure in growing one's own? In buying stock, it is wise to insist upon getting straight, clean trees without Y-crotches, free from insects and diseases, and in plump, robust condition when received. Under no condition should fruit trees older than two years be considered. Peach trees should never be over one year. Trees older than these do not produce fruit sooner or make better orchard trees than young ones. Most commercial fruit growers prefer one-year trees of all kinds because these can be trained more easily than can older trees. The trees also make better progress because they have not lost so many roots.

Southern vs. Northern Grown Nursery Trees.—In the South "June budded" trees are popular. There they may be planted in the fall; but for northern fall planting they do not mature early enough to get a start before winter sets in. Therefore, in the North they should be bought only for spring setting. They are not inferior to northern trees when planted in spring.

Time to Plant.—Fall planting has decided advantages over spring planting. There is a far better chance to get the varieties ordered because nurserymen are not then sold out; if four or more weeks will elapse before winter sets in, the trees may be planted and thus the work done when time is not so precious as in the spring; nurserymen usually charge somewhat less for stock delivered in the autumn. Whether or not planting can be done in the fall, it is a good plan to have the trees delivered before winter so as to have them on hand for spring planting at just the proper time, thus avoiding possible delays of shipment in spring. Such trees may be "heel-in" until spring.

To Heel-in Trees dig or plow a trench a foot or more deep, preferably running east and west. Make the north side vertical and the south with a long slant. Unpack the trees, prune the mangled and broken roots, and lay in the trench with their trunks on the slanting side. Bury both roots and tops with soil packed around the roots. Remove all litter that might favor mouse nests. In spring dig up and plant the trees as if just received.

Marking Out the Field.—This may be done by sighting, plowing or any other handy way that will get the rows straight. For convenience in handling it is a good plan in the home orchard to choose some unit measure that will suit all kinds of fruits. The rod is perhaps as good as any because peaches, sour cherries, plums, quinces, dwarf pears and apricots may be set that distance apart. Sweet cherries, standard pears and the smaller

growing apple varieties require two rods, and the wide spreading apple varieties three rods.

Mixed Plantings are not considered wise by commercial orchardists. Each kind of fruit is kept in a block by itself. This favors uniform treatment. In home plantings, however, such a plan is not always feasible; so that by giving a little extra attention the general farmer may have all his fruit crops together in one area. Bush fruits and strawberries will not do well after the trees come into bearing, but up to that time they may be grown between the trees. Where the rod is the unit of measure, two rows of bush fruits may be placed between the tree rows five feet three inches from the trees, thus making them six feet apart and allowing for the planting of one row of strawberries or truck between them. The strawberries will give one good crop, perhaps two, before the bushes will need the space and the bushes will give two to perhaps four crops before they will have to be removed to get best results from the trees.

If desired one row of grapes may run between the trees, thus leaving eight feet three inches between it and the trees. But since grapes do well for ten or more years, they had better be placed at the side of the orchard. Besides strawberries, various vegetables may be planted between the tree rows for two to five or six years. It is a good plan to place the bush fruits in checks so cultivation may be given in two directions from the start.

The Operation of Planting offers no difficulty. The holes should be dug large enough to take in the roots without serious bending, though bending is not of much consequence. The largest roots should be turned toward the prevailing wind. When the holes are dug the top soil should be laid in one pile and the subsoil in another. Then when the tree is placed in the hole—never more than two inches deeper than it stood in the nursery row—the top soil should be worked among the roots and tramped down hard. Finally, the subsoil should be placed on top, tramped down and a few shovelfuls of soil scattered loosely on top to check evaporation of water from the ground.

First Pruning.—After the trees have been planted they should be pruned. All puny, inferior twigs should be removed, only three to five well-placed ones being left at least a hand's breadth apart on the trunk. If these are two hand-breadths apart, so much the better, because there will be less danger of splitting when loaded with fruit or ice. The frame limbs should be cut back a half or more. Usually, the leader should be cut out to make the tree open-headed.

The lowest limb should be fifteen inches to two feet from the ground to favor low heading with all its advantages of easy pruning, spraying, thinning and harvesting, to say nothing of lessened wind damage. Extension tillage tools will cultivate close to the trunks when the trees get large. Until then, ordinary harrows and cultivators will serve every purpose. During the first year, leaves should never be pulled from the trunk and branches. The tree needs them to ripen its wood. If removed the trees

will develop longer limbs to get more leaves and these limbs will have to be cut off later to bring the tree within bounds. If there are twigs among the trunk leaves, they should be cut off the following spring.

How Fruit Buds are Borne.—Much of the success of fruit growing depends on intelligent pruning, and this on a knowledge of the way each plant produces its fruit buds. Apples and pears produce theirs mostly on short twigs in alternate years with leaf buds. These fruit spurs become gnarly as they grow old, but as long as they continue to bear they should be allowed to remain, unless the tree is producing too heavily. Then some may be cut out. Other trees that produce fruit more or less on spurs



BEFORE AND AFTER PRUNING.¹

are cherry, plum, apricot, almond, currant and gooseberry. Some produce their buds on the sides of the shoots, not on spurs. Of these the peach is the leader, though almonds, Japanese plums, and apricots also do this more or less. All these trees develop fruit buds one year and blossom the following spring. These fruit buds may be distinguished from leaf buds during winter because they are round-topped and plump instead of pointed and thin.

There is another group, the plants of which develop blossom buds in the same season as they blossom and bear fruit. Quince and medlar each bear blossoms on the ends of short green shoots developed in early spring. Raspberries, blackberries, dewberries and oranges produce their blossoms more or less terminally on lateral summer shoots. Grape, mulberry, olive

¹ Courtesy of The Macmillan Company, N. Y. From "The Principles of Fruit Growing," by Bailey.

and persimmon produce strong shoots or canes from branch buds which have wintered over. On these the blossom buds are borne. The loquat bears its blossom buds at the tips of terminal shoots of the same season.

Pruning for Fruit.—In pruning for fruit, it is evident that the plants in these various groups must be pruned differently. Apples, pears and other plants which hold their bloom buds over winter may be encouraged to bear by summer pruning about the time the shoots have ceased to extend. This tends to develop blossom buds. Pruning of these plants during the dormant season, on the other hand, tends to produce wood at the expense of fruit production. (Consult bulletins of the Tennessee Experiment Station on "Summer Pruning.")

Plants in the second general group are usually pruned in spring, when the number of buds left will indicate approximately how many fruits or clusters of fruits will be produced—one for each quince bud, two or three clusters of grapes for each grape bud, and so on. Pruning of these plants, therefore, is equivalent to thinning, for it limits the number of fruits to be set and helps improve the size and quality of the specimens.

Pruning Older Trees.—In pruning trees great care should be taken to make the wounds close to the main trunk or limbs. If a limb to be cut off is large, the saw should first be used beneath it a foot or so away from the crotch. When the saw sticks, a second cut should be made above so the limb will drop off easily. Then the stub may be cut off close to the trunk without danger of splitting or tearing the tree and making an ugly, slow-healing wound. Beyond the removal of branches that cross each other young trees properly started and trained should need little or no pruning unless they break down.

Tillage.—Orchards in sod have in commercial practice practically given place to tilled orchards. Where success attends sod treatment, some other factor is usually evident enough upon study of the situation. The experiment station at Geneva, N. Y., has reported that a sod-mulched orchard under ten-year experiment yielded higher colored, earlier maturing fruit than a tilled orchard of the same variety and otherwise handled the same way, but that the tilled orchard yielded heavily and uniformly, gave fruit of better quality, larger size, longer keeping, less dead wood in the trees and better foliage and growth. Sod lowers the water supply and soil temperature, decreases certain plant-foods, reduces humus and air supply in soil, impairs work of soil bacteria, and forms substances that impair tree health. Sod, however, has special use where tillage is impossible either because of the steep slopes or stony land.

Tillage should start with the preparation of the land for planting and be done yearly while the plants remain profitable. The advantage of this is that the roots are encouraged to go deeply and thus withstand dry weather as well as escape the plow. Each year operations should be begun as early as the land can be worked and continue until the twigs have reached their full length about midsummer. Between mid and late summer, tillage

should stop to give trees or shrubs a chance to ripen their growth to withstand the winter. Unless this is done, growth may continue too late in the fall, and the plants suffer during winter in consequence.

Fertilizing.—While it may be true that land which will grow any farm crops will grow fruit without manuring, yet most money is made from fruit crops fed to get higher quality, larger size, better color and the other points that make for higher prices. How much and what kind to apply will depend



PICKING APPLES IN THE ROGUE RIVER VALLEY, OREGON.¹

upon the character of the soil, the kind of crop and so on. Many farmers and fruit growers put the question to the land itself by trying experiments with various combinations of fertilizers until they find out the one best suited to the desired end. In general, it must be remembered that nitrogenous plant-food tends to be lost by seepage and also to produce wood rather than fruit; hence, it must be handled with greater caution than either potash or phosphoric acid, neither of which is lost to any serious extent from the soil; nor does either jeopardize the ability of the plants to withstand winter injury.

¹ Courtesy of Portland Commercial Club, Portland, Oregon.

Thinning is steadily gaining popularity in the East, mainly because it tends to produce larger, finer specimens, to make the trees more hardy and to establish regular annual bearing. Even the Baldwin apple, perhaps the most notorious biennial cropper, has been made to produce profitable crops fifteen out of seventeen consecutive years.

Spraying has now become so general that no one thinks of planting fruit without counting upon it. The first point to remember is that it must be done with discrimination; for a plant disease cannot be combated with an insecticide nor vice versa. Second, spraying for plant diseases must be preventive; no remedy is known for diseases which have gained entrance to the plant tissues. Third, sprays for insects must be suited to the kind of insects. Those that bite off and swallow pieces of plant tissue must be poisoned internally, and those that merely suck the juice from the plant killed by some substance which chokes, burns or otherwise destroys them through their skins. Experiment station literature is rich in information on methods of control.

Harvesting and Marketing are rapidly becoming more businesslike. Growers are recognizing the advantages from grading their fruit and selling each grade for what it is. They are also learning that the laws which specify standard sizes for packages are steps in the right direction, so are adopting the new standards with profit to themselves and their communities.

The Value and Importance of the Home Fruit Garden to the general farmer lies mainly in the variety of pleasures as well as in the addition to the diet supplied. Such a plantation should contain all kinds of fruits so the table may be supplied from the time strawberries first ripen till the last winter apples are used the following year when strawberries come in again.

Two or three rows of strawberries one hundred feet long, one each of black, red and purple raspberries, one of dewberries, and one or two of blackberries or loganberries should supply an average sized family throughout the year with fresh and canned fruit, jelly, jam and preserves. Twenty-five plants each of gooseberries and currants should suffice. By choosing early and late maturing grape varieties, such a family should be able to eat the product of twenty or thirty vines, perhaps more. A dozen or a score of plum, peach and cherry trees, early and late, as many each of dwarf and standard pears, perhaps half a dozen quinces, and forty or fifty apples trees beginning with a few summer apples, continuing through fall varieties and ending with at least half or perhaps two-thirds of the trees of varieties that reach their best between Christmas and May Day will supply the needs of the average family.

Quality First for the Home.—In all cases the choice of varieties for the home should fall on fruits of best quality, either for dessert, for cooking or preserving. For local markets fewer varieties, preferably the best known kinds of the section, should be given preference. Never choose for business purposes varieties that have not been fully tested locally, no matter how

famous they may be elsewhere. They may fail to come up to their standard established in some other sections.

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CHAPTER 8

SMALL FRUITS

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The small fruit interests of the United States are made up of a diversity of fruits adapted to a wide range of territory and conditions. The cash value of these crops approximates \$20,000,000 annually, two-thirds of which is derived from the strawberry, the most cosmopolitan of the small fruits. The second place is contested by the raspberry and the blackberry, both of which are important money crops, and the fourth crop of importance is the cranberry, which is restricted both by climate and by soil requirements. Each of the important small fruits is here given a brief but, it is hoped, clear and concise treatment.

THE STRAWBERRY

The garden strawberry is an American product. It adapts itself to a wider range of latitude and to greater extremes in environment than any other cultivated fruit. It is universally liked and is cosmopolitan in its adaptations.

Selection of Soil.—The soil best suited to the cultivation of the strawberry in the northeastern part of the United States is a sandy or gravelly loam. A warm, quick soil, although naturally poor, is to be preferred to a heavy, retentive soil well supplied with plant-food. The lacking plant-food can easily be supplied by the addition of fertilizers, while the physical characteristics of the soil can be modified only with great difficulty by cultivation, drainage and the addition of organic matter. Congenial soil and exposure are, therefore, important considerations.

Preparation of the Soil.—The land to be devoted to strawberries should, if possible, be planted in a cultivated crop, such as potatoes, beans or corn, at least one year previous to setting the plants, in order that the larvæ of such insects as wireworms, white grubs, cutworms, etc., may be as completely eliminated as possible.

Previous to setting the plants the soil should be deeply plowed in order that all organic matter of whatever nature on the surface may be completely turned under. Immediately following the plow the land should be thoroughly pulverized by the use of the harrow, and the surface should be reduced to a condition which would form an ideal seed-bed.

Fertilizers.—If the soil is not rich, for best results it should have a dressing of at least twenty cartloads of well-decomposed stable manure per acre, either plowed under or incorporated with the soil by surface culture after plowing. If stable manure is not available, plant-food should be supplied by a liberal use of fine-ground bone and chemical manures rich in nitrogen and potash. The use upon the plants at blooming time of highly nitrogenous manures, such as nitrate of soda, at the rate of about 100 pounds per acre often proves of great value. If it can be applied in solution it will give quicker results than if put on in the form of a salt.



A SPRAY OF GOOD STRAWBERRIES.
Uniformity in size and form increases the market price.

Selecting and Preparing the Plants.—Plants with small crowns, *i. e.*, a moderate growth of leaves, and with an abundant development of fibrous roots, are most desirable. If the crown and the roots of the plant are in good condition, the success of the plantation is assured, provided the ground has been well prepared and the work of planting is done with care.

Perfect and Imperfect Flowered Plants.—Strawberries occur with imperfect (or pistillate) flowers as well as with perfect flowers (those containing both stamens and pistils). It is important to give careful attention to this point in planting a plantation, as a patch made up of pistillate sorts alone will be unproductive, while many such sorts when

properly interspersed with perfect-flowered varieties have proved to be the largest fruited and most prolific sorts. A common practice is to set every fourth or fifth row with a perfect-flowered sort which blooms at the same period as the pistillate variety of which the plantation is chiefly composed.

When to Set the Plants.—The time to plant depends, in humid regions, more upon the rainfall than upon any other factor. If there are not timely rains at the planting season to give the plants an opportunity to establish themselves, the stand will be uneven, with the result that more work will be required to keep the land free from weeds and more trouble will be neces-



PLANTING A STRAWBERRY RUNNER.

On the right a plant correctly planted, showing roots spread out; on the left a plant put in in the wrong position with roots crowded together.

sary to fill the blank spaces with runners from the plants that survive. The plants that withstand the drought are checked and dwarfed. They seldom recover so as to make either satisfactory croppers or plant producers. It is most satisfactory and most economical, therefore, to choose that season which offers most advantages at planting time, other things being equal. It is impossible to specify the season for each locality or even for large areas, as local conditions of soil and climate necessitate different practices in localities only a short distance apart. In general there are only two seasons for planting—spring and autumn—but in some localities spring planting should be done in April or May by the use of the preceding season's plants, while in others it may be done in June from the crop of runners of the same season.

In irrigated regions planting can be done at whatever season the work will give best results in future crop production. In humid regions rainfall is a determining factor.

How to Set the Plants.—Success in transplanting strawberry plants depends, first, on the quality of the plant, and, second, upon the time and manner of doing the work. If the plants are good, the stand, other conditions being favorable, depends upon care in setting them. The success of this operation is measured by the degree of compactness of the soil about the roots of the plant. If the plant has many roots and these are thrust into a hole made by an ordinary dibble, it is more difficult to get the earth in contact with the roots than when the plant has fewer roots. The plant with the greatest number of feeding roots is, however, the most desirable if properly handled. Such plants should be set in a broad, flat hole where the roots can be spread out in natural form. By giving the crown of the plant a whirl between the thumb and finger to throw the roots out like the ribs of an umbrella and quickly putting it in place while the roots are still thrown out from the crown, the normal position of the root system can be closely approached.

Another very satisfactory method is to open a broad wedge-shaped hole by thrusting the blade of a bright spade into the soil and moving the handle forward. The roots of the plant are then spread in fan shape and placed in the hole back of the spade. The spade is then withdrawn and inserted about six inches further forward, and by a backward movement of the handle the earth is firmly pressed against the roots of the plant. Two persons—a man to operate the spade and a boy to place the plants—can set plants very rapidly in this manner. This practice is particularly well suited to localities with sparse rainfall, as it thoroughly compacts the earth about the roots of the plant and allows the roots to extend full length into the moist soil. Plants set in this way have their roots more deeply inserted in the soil than when the roots are spread out in umbrella fashion and as deeply as when set with a dibble. They also have the additional advantage of being spread out so as to have a larger percentage of their surface actually in contact with the soil than when set with a round dibble.

Depth to Set the Plants.—No plant which the gardener has to handle is more exacting in regard to depth of planting than the strawberry. As the plant is practically stemless, the base of the leaves and the roots being so close together, care is required to avoid setting the plant so deep that the terminal bud will be covered or so shallow that the upper portion of the roots will be exposed, either being a disadvantage which frequently results in the death of the plant.

Planting in Hills.—For the hill system of culture plants are set singly either 3 by 3 feet apart, or with the rows 4 feet apart and the plants 2 feet apart in the row, depending upon the character of the soil and the length of time the plantation is to be maintained. In Florida a common practice is to lay the land off in broad beds 8 to 12 feet wide, the rows of plants to

run lengthwise of the beds, the rows 24 inches apart, with the plants 18 inches apart in the rows. Such beds afford sufficient drainage and hold the mulch better than narrow beds or raised rows, and the space between the plants admits light to all sides of the plant—an advantage in coloring the fruits which can not be secured by the matted row system early in the season in the climate of Florida.

A common practice is to set the plants in single rows 4 feet apart, with the plants 12 inches apart in the row. The runners which develop from these plants are then allowed to take possession of the area for 6 to 9 inches on either side of the original plants, thus making a matted row 12 to 18 inches wide; this leaves 30 inches between the rows, which allows ample space for cultivation and gathering the fruit. This space can be reduced from 30 inches to as little as 18 inches where land is valuable and it is necessary to secure maximum returns; on thin soil, however, the greater distance is most satisfactory.

Renewing Old Beds.—There is one advantage in the narrow cultivated space. After the second crop has been harvested the runners can be allowed to take possession of the cultivated middle, and when the young plants become thoroughly established the original rows can be broken up with a narrow turning plow or a sharp cultivator. In this way a patch can be very satisfactorily and cheaply renewed, and by a liberal use of suitable fertilizers the rotation can be kept up on the same soil for several years. Some planters prefer to set the plants for the matted row in a double row at planting time. The practice is to establish two rows 12 inches apart, 6 inches on each side of the center of the matted belt, setting the plants 2 feet apart in each row and alternating the plants in the row, so that the plants actually stand a little over a foot apart as shown in the accompanying diagram:



Cultivation.—Clean and shallow culture are the watchwords of successful cultivators. By conserving moisture, cultivation tends to counterbalance the evil effect of drought. A better stand of plants can be maintained during a dry period on well-tilled ground than upon ground that is poorly cultivated. The mechanical effect of grinding the soil upon itself during cultivation reduces it to smaller particles, thus exposing more surface to the action of soil moisture, and, as a result, increasing the available plant-food of the soil. The benefit from preserving a soil mulch, with its consequent economy in the use of soil moisture, is sufficiently important to justify thorough tillage.

Objects of Mulching.—Covering the surface of the soil with dead or decaying vegetable matter is the meaning of the term mulching as here used. Mulching serves different purposes, depending upon the locality

in which the plants are grown. A mulch acts as a protection from cold, prevents freezing and thawing and the consequent lifting of the plants ("heaving out"); it retards growth in cold regions by shading the crowns and maintaining a low soil temperature longer than in soil not mulched; it acts as a conserver of moisture, discourages weed growth by smothering the young seedling, and finally protects the fruit from contact with the soil.

Materials for Mulch.—Whole or cut straw free from grains, strawy manure from the horse stable, and pine straw from the forest are among the more common mulching materials. In certain sections marsh hay, either from fresh or salt water marshes, is a common and very satisfactory mulching material.

When to Apply the Mulch.—At the North where the soil is likely to freeze and thaw several times in the course of the winter, it is the practice



AMERICAN QUART BOXES OF WELL-GRADED STRAWBERRIES.¹

"Fancy" on the right, "No. 1" on the left.

to put on the mulch as soon as the ground is sufficiently frozen to allow driving upon it with a loaded cart or wagon. Where the freezing of the soil is only superficial or only temporary, if at all, the mulch serves the purpose of a protection from wind more than from frost, and in such sections the mulch is put on as soon as active growth ceases, usually early in December, and is allowed to remain until after the crop is harvested.

Harvesting and Shipping.—The time of gathering the fruit, as well as the manner of handling, is governed by the use to which it is to be put. If intended for a local market, much riper fruits can be handled than when they are to be shipped long distances.

The most progressive growers of strawberries for local markets not only give particular attention to the ripeness of the fruit, but to assorting

¹From Farmers' Bulletin 664, U. S. Dept. of Agriculture.

and grading as well, only large, perfect berries being placed in the first grade and all small or soiled fruits in the second.

Receptacles.—Whether it is to be shipped in crates or refrigerator carriers or to be carried to the local market, for best results the fruit should not be rehandled after it is picked. The pickers should be trained to do the necessary assorting and grading as they pick the fruit in the receptacles in which it is to be marketed.

The light splint-wood basket, holding one quart, is the most popular and most universally used. Many different forms of box or basket have been designed, and various materials other than wood have been used in their construction, but up to the present none has met with general adoption.

THE RASPBERRY

The name *raspberry*, as used in the United States, embraces four distinct species of plants, three of which are of American origin, thus placing to the credit of our native plants three important and widely cultivated culinary fruits. The two types of fruits represented by these species are known popularly as red raspberries and black raspberries or "blackcaps."

The red-raspberry group, as represented in cultivation, includes not only the native red raspberry but the European red raspberry, or bramble, and a type intermediate between the native red and black raspberry, which bears a purple fruit and is frequently spoken of as the "purple-cane" raspberry or as the "Schafer group." The red-raspberry group, besides having varieties which produce the characteristic red fruits, has another set of varieties which produce amber or yellow fruit. These horticultural varieties are recognized and are considered distinct sorts, but are not separated botanically into different species.

The black raspberry is distinct both in habit of growth and in the makeup of its fruit. It is recognized botanically as a species distinct from the three which enter into the red-raspberry group. The habits of this plant and the quality of its berries are such that it has gained an important place in certain sections of this country as a commercial fruit.

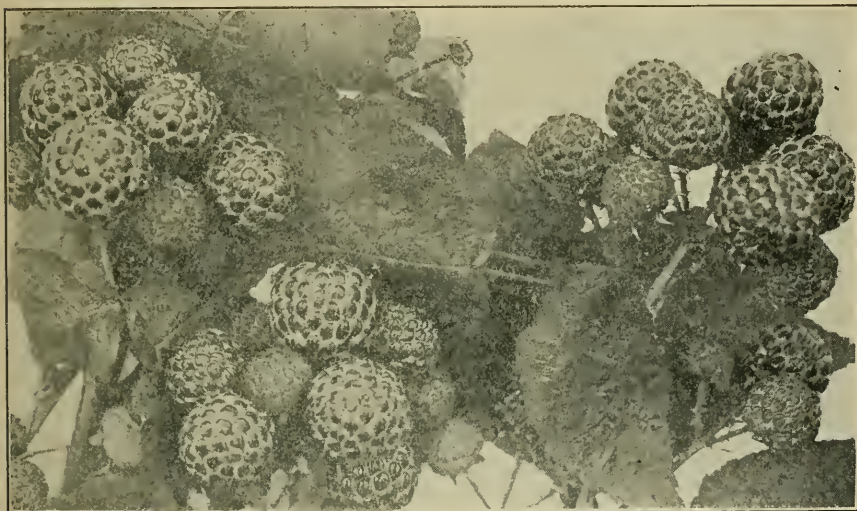
The fact that the varieties of the red-berry type have to be marketed from the bushes as soon as ripe confines their cultivation to the vicinity of large centers of consumption, where climatic and soil conditions favor their development. The black-raspberry industry, however, can be profitably and successfully carried on in regions more remote from the centers of consumption, because of the fact that a large proportion of the fruits are evaporated and are sold in a dry state, there being ready sale for them when handled in this way.

Red Raspberries.—The red-raspberry group includes varieties which bear fruits of various shades of red, amber, yellow and purple, the last-named division being a hybrid between the red and the black types.

Selection and Preparation of Soil.—The soil upon which red raspberries thrive best is a sandy or clay loam of a glacial drift formation. They thrive well upon moderately rich, deep soils and yield largest returns under these conditions.

The preparation of the soil for red raspberries should be the same as for any small fruit, preferably one or two seasons' preparatory tillage in a "hoe crop," which will to a very large extent rid the land of weeds. Such crops as potatoes, beans, cowpeas and plants of this nature are good preparatory crops.

Planting.—The distance to plant will depend very largely upon the purpose for which the plantation is intended. If it is a commercial plan-



LAND THAT WILL PRODUCE GOOD FARM CROPS WILL PRODUCE BUSH FRUITS.¹

tation upon soil which is not especially valuable, the plants should be 3 feet apart in the row, and the rows not less than 6 feet apart. This will allow of cultivation in both directions for two or three years, and will permit the use of horse-power implements, and consequently will lessen greatly the cost of tillage. On city lots or in a home fruit garden, where it becomes desirable to combine in the same plantation raspberries and other fruit-bearing plants, the distance can be somewhat lessened, but even under these conditions the plants should not be set closer than 2 feet apart in the row and the rows not less than 4 feet apart.

In home fruit gardens small holes can be opened with a spade, the plant roots spread in the ordinary fashion for planting larger plants, and the

¹ Courtesy of The Pennsylvania Farmer.

earth returned; but in all cases it should be the aim to firm the earth well over the roots of the plants as they are set.

Cultivation.—Clean cultivation is necessary with red raspberries, because, as above stated, they are themselves of a weedy nature, and, in order to hold them within bounds, implements which cut all the superfluous shoots and root sprouts from the cultivated area should be used. During the early life of the plantation it would be found most economical to keep



A YOUNG PLANTING CASE OF RASPBERRY
SHOWING FIBROUS ROOTS.

the plants in check-rows so that cultivation by horse-power can be accomplished in two directions. Later, however, as the plantation grows older, it will be found advantageous, both in yield of fruit and for economy, to allow the plants to form a hedge or matted row, and to practice cultivation in one direction only. The space between the hedges should be plowed at least once each year, and whether this shall be done in the spring or in the autumn will depend upon the locality.

Fertilizers.—The liberal use of stable manure (20 tons per acre) will produce large yields of fruit, but the use of a complete fertilizer, containing nitrogen 4.5 per cent, phosphoric acid (available) 7.7 per cent, potash 13.3 per cent, at the rate of 500 pounds per acre gives a greater net profit at less outlay.

Pruning.—Red raspberries require attention to direct their growth and fruit production, at two seasons of the year. They should be pruned in the summer, during the growing season, to regulate the height of the canes and induce the formation of

fruiting wood for the following season, and again during the winter or early spring for the purpose of eliminating the canes which bore last season. This will allow all the energy of the root of the plant to be directed to the production of fruit and the formation of the next season's bearing wood.

The summer pruning, which is not generally practiced with red raspberries, consists in topping the young shoots when they have attained a height of from 18 to 20 inches. This induces the development of side shoots and the production of additional sprouts from the root. Both these types

of growth are desirable in order to insure a large growth of wood as the plants can carry to advantage.

The winter pruning is a process of elimination. All canes which have served their purpose as fruit producers are removed, as are all dead or diseased canes, thus reducing the demands upon the roots of the plant and directing the energy to the wood intended for fruit production.

Harvesting the Fruit.—Because of the soft character of this fruit, it can be successfully harvested only by hand picking. Small receptacles holding not more than a pint, and preferably those made of wood, are best suited for handling this crop. Under favorable conditions, the yield of the better sorts of red raspberries, particularly of the native red and purple cane types, is very large, and where they can be placed upon the market quickly after being picked they are a very profitable crop.

Black Raspberries, or Blackcaps.—The black raspberry, or blackcap, because it lends itself to several methods of harvesting and marketing, is capable of a wider range of commercial cultivation than any of the types of the red raspberry, although it is not capable of withstanding so severe climatic conditions.

Propagation.—The black raspberry does not throw up root sprouts, and is propagated only from stolons or layers. In order to secure new plants the tips of the branches are bent over and slightly covered with earth during the month of August, after which they take root readily. The rooted tips are usually left attached to the parent stalk until the following spring, when the branch is cut 6 or 8 inches above the surface of the ground, the roots being lifted, tied in bunches and stored for use or carried to the place where they are to be replanted.

Character of the Soil.—Black raspberries grow best on a soil which is fertile and naturally well drained, rather than one which is moist. Strong loams of a clayey or gravelly nature are preferred to the lighter sandy soils.

Preparation of the Soil.—The same general preparation of the soil as outlined for the red raspberry is necessary for best results with the black raspberry. Preparatory treatment with cultivated crops in order to rid the land as thoroughly as possible of weeds is desirable.

Planting.—The distance at which black raspberries are usually set in commercial plantations is 3 feet apart in rows which are 8 feet apart. The same method of planting as described for red raspberries—that is, opening a furrow with the plow, placing the roots at the proper distances in the row and covering with a turning plow—is very convenient and satisfactory.

Cultivation.—Clean cultivation is equally as desirable for the black raspberry as for the red raspberry, because weeds between the rows interfere with the later operations in the berry field. While cultivation should not be carried on so late in the season as to interfere with the harvesting of the fruit, it should be sufficiently thorough and continued late enough to keep the ground free from weeds.

Winter Protection.—In some portions of the Northern states the raspberry can be successfully fruited only by giving it some form of protection during winter. One of the simplest methods of affording such protection is to bend the canes of the plant all in one direction along the line of the row and fasten them either by placing earth upon them or pegging them down. The roots are slightly loosened on one side of each plant and the canes are bent over the roots of its neighbor. After the tops have been properly placed a mound of earth is thrown over them. If after cold weather sets in the earth covering is deemed inadequate, additional protection may be provided by a layer of straw, strawy manure or corn fodder.

Fertilizers.—Stable manure in moderate quantities, supplemented by a fertilizer carrying 4 to 5 per cent of nitrogen, 10 to 12 per cent of phosphoric acid and from 6 to 8 per cent of potash, will prove beneficial. Such a fertilizer, if applied at the rate of from 300 to 500 pounds per acre, should so increase the yield as to make its use profitable.

Pruning.—Because of its manner of fruit bearing, the black raspberry requires care in annual pruning; in fact, pruning must be done at two seasons of the year in order to accomplish the best results. The young shoots as they appear from the roots in the spring should be tipped or disbudded when they reach the height of 18 inches. It is better to go over the plantation frequently, making three or four trips in all, in order to tip the canes when they are about the height mentioned, rather than to delay the operation until some of them have reached a height of 2 to 2½ feet. The early pinching or disbudding induces the development of more numerous lateral branches. Shoots which have been allowed to harden and to grow 2 or 3 feet in height will form few lateral branches. If tipped when 18 inches high, a cane should produce four, five, or six lateral branches. If allowed to attain a height of 3 feet and then cut back to 18 inches, it is probable that not more than two or three lateral branches will be formed; and, since these lateral branches form the fruit-bearing wood of the succeeding season, it is very desirable that the greatest possible number of branches be secured to insure a heavy crop of fruit. It is evident, therefore, that summer pruning predetermines the crop for the succeeding year more than does any other single cultural factor.

The second pruning, which is also important, consists in removing the canes which bore the last crop of fruit. This work can be done at any time after the crop has been harvested, but preferably during the spring following the crop. If the work is done in the spring the lateral branches borne by the canes which developed from the roots of the mother plant should at the same time be shortened to about 8 to 12 inches in length. From each bud of these short branches annual growth will be made which will terminate in a fruit cluster.

Harvesting.—Black raspberries to be marketed as fresh fruit for immediate consumption are always hand picked and placed in either pint or quart boxes similar to those used for strawberries. Those to be dried or

evaporated, or to be marketed as dried raspberries, may be either hand picked or harvested with a mechanical contrivance called a "bat." This consists of a frame of light lumber a few inches deep backed up by strong cloth against which the ripe fruit strikes as it is jarred from the bushes by tapping them gently with a light stick or "bat," while the cloth-covered frame is held under the plants in such a position as to catch the fruits as they fall. Such fruits, after drying, are run through a fanning mill to separate leaves and stems, after which they are hand picked in much the same manner as beans, to remove all imperfect and green fruits, as well as those which still hold the receptacle.

THE BLACKBERRY

The blackberry in the United States is a native bramble of wide distribution over the eastern and northern part of the country. The fruit of the wild blackberry was an important factor in the supply of condiments provided by the early settlers. The esteem in which this fruit was held led to the cultivation of some of the wild plants producing berries of superior size or flavor, or those ripening in advance of the main crop, or such as lagged behind and thus extended the season for the fresh fruit. Such selections from the wild blackberries and their seedlings furnish the cultivated sorts of today. What may yet appear is suggested by some of the remarkable hybrids which have already been produced in this genus such as the Logan berry. The chief considerations in the selection of a location for a blackberry plantation are the facilities for harvesting and marketing the crop and the moisture condition of the soil. The fruit of the blackberry is highly perishable and will not endure rough handling in harvesting or long journeys over rough roads.

Few crops are more adversely affected by a lack of adequate moisture during the period of development and ripening than the blackberry, but an excess of moisture during the dormant period is equally as detrimental.

Soil.—The blackberry is not exacting as regards the general type of soil and will do fairly well on a clay, clay loam or sandy loam. The largest yields are on deep, rich soils which provide an extensive feeding area for the roots of the plants.

The preparation for blackberries should be such as to provide a deep, mellow root area and the best possible protection against rank growths of annual weeds. A hoe crop such as corn, beans or potatoes, if properly tended, leaves the area in the best possible condition for the small fruits.

While the roots of the blackberry are perennial, the canes or branches are practically biennial. The shoots spring up and grow one season from the fruiting canes of the following season, after which they die and should be removed to make room for the new growth of the following year. The fruit is borne only on wood of last season's growth in the standard high bush blackberries and dewberries, but the Himalaya and ever-bearing

types have perennial canes and do not therefore lend themselves to this type of renewal.

Propagation.—The plantation of the standard blackberries can be increased in either or both of two ways, as follows: The plants, in addition to throwing up strong shoots or canes from the crown, throw up suckers or root sprouts, which may be allowed to develop and later be lifted as independent plants, or lateral roots of strong plants may be dug during the autumn or early spring and placed in sand much the same as are ordinary cuttings, except that blackberry root cuttings are cut to pieces 2 to 3 inches in length and should be entirely covered with sand or light soil to the depth of 2 to 3 inches. Nurserymen propagate their supply of plants largely by the root-cutting method. In one season root cuttings of this sort should produce strong plants for transplanting. The dewberry and certain blackberry hybrids take root at the tips, the same as do black raspberries, and new plants are secured by covering the tips of each plant with earth towards the end of the annual growth period.

Planting, Tillage and Fertilizers.—Blackberries are for the most part rank-growing plants and require liberal distances in and between the rows. A common planting plan is 4 feet in the row and 8 to 10 feet between the rows. In general, the best time for establishing a blackberry plantation is in the spring and, as growth normally starts early, the work of planting should be done as early as soil conditions will permit.

As the blackberry plants will not fully occupy the land the first season, it is customary to use some inter-crop, such as potatoes or beans, to contribute towards the cost of maintenance.

The tillage of the blackberry plantation should be such as to hold weeds and suckers in check and maintain maximum moisture and growth conditions, but cultivation should cease early enough to induce the plants to ripen their wood thoroughly before winter.

If the soil on which the blackberry plantation has been established appears to require fertilizer, experience dictates that the best results will in general be secured by the use of liberal applications of stable manure.

Pruning and Training.—The blackberry plant normally produces long, slender, non-branching shoots. These, where the soil is strong, grow long and produce less fruit than those which have been pruned. A common practice is to pinch the terminal bud of each shoot as soon as it reaches a height of $2\frac{1}{2}$ feet with moderate growing varieties, or 3 feet with robust growing sorts. This induces the formation of lateral branches which increases the number of buds from which fruit-bearing twigs will develop the following spring. The pruning causes the main stem of the shoot to thicken and stiffen and consequently make it better able to carry a large crop of fruit without a trellis. The lateral branches which are induced to develop on the pinched-back shoots should be shortened to 10 or 12 inches before growth starts in the spring.

Harvesting.—The fruit should be harvested as soon as well colored,

and only firm, sound berries should be sent to market. A few over-ripe fruits in a box will shorten the marketing period of the whole box, as will rough handling in picking or transporting the fruit to market. Quart boxes are as large a receptacle as blackberries can be successfully marketed in, but the crates may run from 12 to 36 quarts capacity.

THE CURRANT

There are three general groups of currants cultivated to a greater or less degree in various parts of the United States. In general, however, the culture of the currant is confined to the northern half of the country,



CURRANTS SHOULD FIND A PLACE IN EVERY HOME GARDEN.¹

as none of the forms are able to withstand heat as well as they do cold. Of the three types represented by the common red, the Black and the Crandall, the Red is by far the most important from a commercial standpoint and is the form most generally cultivated. The other two are sparingly grown for special purposes. As currants are in little demand as fresh table fruits, but are almost universally used for the preparation of jellies, jams, preserves or for canning in mixture with sour cherries or red raspberries, they are restricted commercially. This should be borne in mind in planning a small fruit plantation. While the currant should be found in every home fruit plantation throughout the northern tier of states on

¹ Courtesy of The Pennsylvania Farmer.

account of its hardiness, and early and persistent fruit production, it would be an easy matter to carry the commercial production beyond profitable limits. Then, too, the currant is a fruit that is relatively expensive to pick, as the work must all be done by hand.

Soil Requirements.—The currant thrives best on a deep, moist, yet well-drained loam or sandy loam, but will thrive and produce on a great variety of soils, provided they are arable and neither too wet nor too dry.



WHITE CURRANTS.

The soil should be well prepared by deep plowing and thorough fining for the reception of the young plants. In addition, it is well to give the land a year of preparatory treatment with crops which will tend to put it in good physical condition, and at the same time eliminate weeds, either through clean culture or by the use of a crop which is dense enough to smother the weed growth. Currants are usually set in rows 6 feet apart and the distance between the plants in the rows varies from 3 to 5 feet. If it is desirable to maintain cultivation in both directions throughout the greater portion of the life of the plantation, the plants should be allowed either 4 or 5 feet in the row. Strong one or two-year-old plants should be chosen and the planting can be done either in the autumn or spring, according to the prevailing practice of the locality.

The usual care exercised in

pruning the roots and tops of fruit trees at transplanting time should be carried out with the currant. The fruit-bearing habit of the plant should be carefully observed and the later pruning carried on in such a way as to provide as much bearing wood as the plant will carry and yet not overburden it or allow wood of too great age to accumulate in the bush to the detriment of high production or quality of the fruit. Wood more than three years of age should be removed. A little fruit is borne on the base of shoots of last season's growth, but the main crop is borne on wood two or three years of age.

Culture and Fertilization.—Clean culture so as to protect the plants from weed competition and for the purpose of conserving moisture should be the aim. Strong, vigorous plants are more profitable and are better able to resist the attacks of enemies and diseases. Stable manure, bone meal or other high grade fertilizers should be used to maintain the plants in a high state of growth and vigor.

Enemies and Diseases.—If the plants become infested with the currant worm, as the red sorts are almost certain to be, the plants should be thoroughly sprayed with a solution of Paris green, 5 ounces to 30 gallons of water, or dusted with white hellebore. If mildew is troublesome, Bordeaux mixture should be used. As a rule, however, currants are not as seriously affected by mildew as are the gooseberries.

Harvesting the Fruit.—Currants should be carefully picked so as to maintain the little grape-like clusters of fruit intact. Berries torn or stripped from the stems do not keep or ship as well as those carefully handled. The most popular receptacle for shipping currants is the quart strawberry box, but carefully picked currants will carry well in 4 or 10-pound climax baskets with scale board covers.

GOOSEBERRY

The gooseberry of Europe was early brought to this country by the colonists, but, like the grapes which they brought, it was not suited to the new conditions. An acceptable substitute was found in the wild gooseberry of the realm, and from these wild plants, or their seedlings, have developed the most valuable of the sorts adapted to eastern United States. The European sorts have proven better suited to the extreme northwest conditions in the United States and are there cultivated to a limited extent. In general, however, the basis of the commercial gooseberry industry is the American varieties.

The cultural range of the gooseberry coincides in general with that of the currant, but it is able to withstand a slightly higher temperature than the currant and its southern limit of cultivation extends somewhat farther than that of the currant.

Soil.—The gooseberry thrives well on a considerable diversity of soils, but rich, moist, well-drained loams or clays offer the most congenial conditions for the plant. Under a favorable environment the plants should continue in good condition long enough to produce seven to ten crops of fruit, after which the plants will be well spent.

Preparation of Land.—The area to be planted in gooseberries should receive at least one season of preparatory treatment if practicable, before the plants are set. This should consist of a crop which is well tilled and kept free of weeds, or one which, by reason of its density and rank growth, will smother the weeds.

Plants for Setting.—While the gooseberry can be propagated with a fair degree of success from cuttings as well as by layering and mounding,

it will, in general, be found best either for the home fruit garden or for the commercial plantation to purchase strong one or two-year-old plants of the desired sort from a reliable nurseryman.

Planting.—As a rule the plants should be set in check rows so as to permit of cultivation in both directions. Satisfactory distances are 6 feet between the rows and 4 to 5 or 6 feet between the plants in the row. Planting can be facilitated by opening a dead furrow along the line of the row and by marking the field in the opposite direction so as to indicate the points in the row where the plants are to stand.



WELL-SET BRANCH OF GOOSEBERRIES.¹

Cultivation.—Gooseberries form their root system near the surface of the ground. Cultivation should conform to the habits of the plants and be shallow enough not to be injurious to them. The main purpose of cultivation should be to conserve moisture, particularly early in the season while the fruit is forming and ripening.

Fertilizers.—Few tests have been made to determine the fertilizer requirements of the gooseberry. In general well-composted stable manure will prove to be a satisfactory fertilizer. On extensive plantations where fertilizers are evidently required it will be best to inaugurate a simple test to determine the combination and amount best suited to the needs of the particular plantation.

¹ Courtesy of The Pennsylvania Farmer.

Pruning.—The natural habit of the plant is to form a bush. Pruning should therefore be directed to checking the growth of rampant shoots at the proper time and to removing old branches which have served their purpose as bearing wood.

Enemies and Diseases.—The gooseberry suffers as severely from the currant worm as the currant itself and is only a slightly less desirable host plant. Paris green or hellebore should be applied the same as for currants.

The great drawback to the successful cultivation of the European gooseberry in eastern United States is, as has been pointed out, its susceptibility to mildew. This disease is so severe and so difficult to combat that resistant sorts are generally grown, although the mildew can be held in check by thorough applications of Bordeaux mixture or ammoniacal carbonate of copper.

Harvesting.—Gooseberries, because of their habit of growth, can be successfully harvested only by hand-picking. Those intended for pie making, which is one of the chief uses of the fruit, are picked before they have colored and ripened. They are, in other words, picked green, as it is the green fruit that is most prized for pie purposes. The usual receptacle for gooseberries is the one-quart splint box.

The ripe fruit is often seen in the American market. The preferences of the market should be determined in advance and the fruit harvested in the condition demanded, whether it be green or ripe.

THE CRANBERRY

The cranberry is one of the native fruits which has contributed an important product as well as a large share to the aggregate return from small fruits. Its restricted region of cultivation and the peculiar environment required by it place it outside the general list of garden small fruits, and in an exclusive class. The fact that it thrives only in swampy areas in high latitudes and elevations exclude it from this discussion. The general requirements of the crop are discussed in Farmers' Bulletin 176, of the United States Department of Agriculture.

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CHAPTER 9

GRAPES AND GRAPE CULTURE IN THE UNITED STATES

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The grape has always been and continues to be man's best standby in fruits. It is one of the most important and most extensively grown fruits in the country.

Since the year 1900, the viticultural industry of this country has more than doubled itself, now showing as a year's commercial result in round numbers, shipments of 15,000 cars of table grapes, 50,000 cases of canned



A TYPICAL VINIFERA VALLEY VINEYARD IN CALIFORNIA

grapes, 250,000,000 pounds of raisins, 7,000,000 gallons of brandy, 50,000,000 gallons of wine and unfermented juice, etc. The vineyard acreage exceeds 500,000 acres, the viticultural industry representing, in conservative figures, an investment of \$300,000,000 and giving employment to 150,000 persons.

There are three distinct viticultural regions in the United States which segregate themselves by the grape species grown in them for commercial purposes. These are: (1) The vinifera region in which the vinifera varieties grown for all the various purposes, is located almost entirely west of the Rocky Mountains and so much of it in California that it might almost be said to be a California industry. At least seventy-five per cent of the entire grape output of the United States is from fruit of the vinifera varieties. Nearly one hundred per cent of the raisin and grape brandies and about eighty per cent of all other grape products produced in this country come from California.

(2) The American Native grape regions in which improved varieties

of American *Euvitis* are grown for table grape, wine and unfermented grape juice purposes. This is scattered over the entire United States east of the Rockies and west of the Alleghany Mountains, but carried on extensively in the States from the Hudson River west and north of the Ohio River and that border on the Great Lakes and in the more centrally located States of the Mississippi Valley. The great bulk of American champagnes and dry wines and unfermented juices come from this region.

(3) The Muscadine region, in which improved varieties of *Rotundifolia* and *Munsoniana* are grown for commercial purposes. This region is found in the South Atlantic and Gulf States and along the lower Mississippi Valley, extending from Maryland, south to Texas on the west, thence north along the Mississippi River to Southeast Missouri and Tennessee.

There are more native grape species in this country than in all the other countries of the world combined, and America in her native grapes has not only given to the world new fruits, but by judicious use of such species will make it possible to successfully grow varieties of some of them in all parts of the United States.

Soil.—Soil, location and site will differ greatly with the object in view. Some varieties of grapes may be grown on almost any soil. Usually those lands are selected that can be prepared and planted with the least labor, that are the easiest to cultivate and which produce the largest crops. Quality and quantity, however, in most cases do not go hand in hand. The best soils for *Vinifera* and American *Euvitis* is a gently sloping, well-drained, calcareous loam, of sufficient depth, with porous subsoil; gravel or small stones in a soil are not a detriment. Some prefer a sandy soil with a gravelly substratum. The best soils for Muscadine grapes are the well-drained, siliceous soils found bordering the coast and river banks throughout the Atlantic tidewater section, known as sandy ridges, as hammock and trucking soils. It should be open and well drained, but not necessarily very deep, provided the subsoil is not too heavy, as Muscadines have a shallow spreading root system.

Whether it be intended to grow *Vinifera*, American *Euvitis* or Muscadines, the place should have a good water supply, be of easy access to market, and free from late spring frosts. The cellar, pasteurizing or packing house should be centrally located on the place, preferably so that the grapes can be hauled down grade, or at least on a level:

Preparation of the Soil.—The soil should be well prepared, cleared of large stones, stumps and other obstructions. When a thin hardpan occurs closer than $3\frac{1}{2}$ feet from the surface, it should be broken by blasting. Any wet spots should be carefully drained. If it be a virgin soil, raising a crop of grain on it the season previous to planting helps materially to put it in good shape. The soil should not only be thoroughly and deeply plowed, but subsoiled as well, then thoroughly harrowed and the clods crushed with a drag or roller.

Fertilizers.—On partially exhausted or poor soil, such manures and fertilizers should be applied as will supply the deficient ingredients. A liberal application of barnyard manure is usually advisable. If the soil lacks in fruit-producing qualities, potash is needed; if more plant-growth is desired, nitrogenous fertilizers should be applied.

Choice of Varieties to Plant.—As to varieties of grapes to plant, each locality largely determines for itself, grape growing being perhaps more dependent on selection of varieties with reference to soil, climate, location and other conditions than any other fruit. The writer has often seen such



PICKING AND HAULING WINE GRAPES

radically different results with the same variety—planted in vineyards only a short distance apart—that it hardly seemed possible that they were the same variety. It should first be determined for what purpose it is desired to grow grapes and select varieties suited for such purpose and even then best results can only be expected where soil, climate and other conditions best suited for the variety and purpose are chosen. Usually it will be well to select such varieties as have proven valuable for such purposes in the immediate vicinity. Should a grower embark in an entirely new district where grape growing has not been tried, he will have an opportunity for displaying good judgment and perhaps growing, from seed, new varieties adapted to the locality, thus becoming a path-finder for those who follow in his lead.

The *Vinifera* varieties commercially grown for the different purposes in this country are Alexandria, Alicante, Bouschel, Black Hamburg, Burger, Cabernet, Sauvignon, Carignane Chasselas de Fontainebleau, Cinsaut, Dodrelabi, Emperor, Flame Tokay, Green Hungarien, Grenache,

Listan, Malaga, Mission, Mondeuse, Mourastell, Muscadelle du Bordelais, Olivette blanche, Olivette noir, Pedro Ximines, Petit Syrah, Pinot de Chardonnay, Purple Damascus, Saint Macaire, Sauvignon Vert, Simillon, Sultana, Sultanina, Sylvaner, Traminer, Valdepenas, Velt-liner, Vermentino and Zinfandel. As vinifera varieties are not phylloxera resistant and no way has been found to eradicate it from vineyards, it is conceded the only way to successfully combat the phylloxera in all soils which cannot be cheaply and sufficiently flooded to kill it, is to establish vinifera vineyards on phylloxera resistant stocks.

Of American Euvitis varieties. At present nine-tenths of the planting are of Concord. The next most important variety is the Delaware.



A TYPICAL VINIFERA HILLSIDE VINEYARD IN CALIFORNIA

Other varieties, grown more or less extensively, are Agawam, Barry, Brighton, Brilliant, Campbell, Carman, Catawba, Champenel, Cleverer, Clinton, Cynthiana, Diamond, Diana, Dutchess, Elvira, Eumelan, Goethe, Herbemont, Herbert, Isabella, Ives, Jefferson, Lenoir, Lindley, Moores, Missouri Riesling, Montefiore, Niagara, Noah, Nortons, Pierce, Salem, Wilder, Winchell, Wooden and Wyoming.

Of Muscadine varieties. The Scuppernon is today more extensively grown than any other variety. The other catalogued varieties being Eden, Flowers, James, Memory, Mish and Thomas.

Propagation.—In ordinary practice, grape vines are propagated from seed, from cuttings, by layering or by grafting. Seedlings should only be used when it is desired to originate new varieties.

Cuttings should always be made from young, well-matured wood and preferably from medium-sized, short-jointed wood. To make cuttings, cut close below the lower bud, making the cut somewhat slanting, and leave about an inch of wood above the upper bud. If a small piece of the old wood or a whorl of buds can be left at the butt end of the cutting, so

much the better. The length of the cuttings may vary from eight to twenty inches, depending on the climatic and other conditions of the locality in which they are to be planted. Keep dormant until they are planted. Plant in spring after the ground has become warm enough.

Layers.—All varieties of vines may be propagated by layers. Muscadines are nearly always propagated in this manner, but with other species layering is only resorted to with varieties which do not root easily from cuttings. In layering, choose canes of last season's growth, preferably those that start near the base of the vine. Canes may be layered either in fall or in spring.

Grafting.—Bench nursery and vineyard grafting are resorted to in



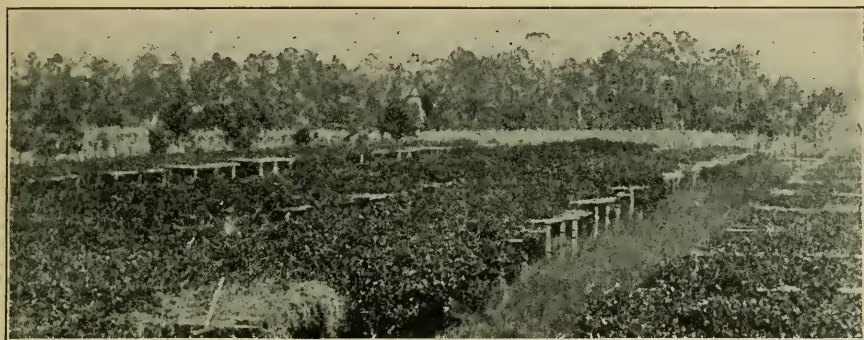
AMERICAN EUVITIS PRUNED AND TRELLISED

general vineyard practice. Bench grafting is done on benches or tables, usually indoors during the winter. Cuttings of resistant varieties that root easily or good young plants are usually bench grafted. The grafting of vines growing in the nursery is called nursery grafting. This is usually resorted to with varieties resistant to phylloxera, that do not grow readily from cuttings. They are grafted with vinifera or non-resistant varieties and the resultant vines planted in the vineyard. In vineyard grafting, the vines growing where they are to remain are grafted.

Some of the important practical advantages of grafting are: (1) Changing worthless vines into valuable ones. (2) Insuring non-resistant varieties by grafting them on resistant stocks. (3) Obtaining quickly plenty of wood for grafting purposes, by grafting new or scarce varieties on strong vines. (4) Producing resistant vineyards, by grafting valuable resistant direct producers on roots of growing vines to make roots of their own.

Planting, Plowing and Cultivating.—In California, where most of

the Vinifera regions of the United States are located, the practice has been to plant the vines seven feet apart each way, no trellis, but simply stakes being used as supports. This enabled the growers to plow and cultivate lengthwise and crosswise. Now the tendency is to plant farther apart, some planting 8 x 8, others 6 x 10, others 9 x 9, others 8 x 10 and 8 x 12 feet apart. Since the Sultana and Sultanina grapes for seedless raisins and some of the choicer varieties of table grapes are extensively grown for shipping purposes, better results with such being had by growing them on trellis, trellis are coming into general use with them. The vineyards are all plowed twice each year. In the first plowing, the soil is usually thrown away from the vines and in the second plowing it is thrown up to them again. The vineyards being cultivated frequently early in the season, the cultivation being abandoned after the spring rains are over.



TYPICAL ROTUNDIFOLIA ARBORS

The American *Euveitis* varieties grown in the States east of the Rocky Mountains are usually planted in rows 8 feet apart, with the vines 8, 10, even 12 feet and more apart, in the rows. A plain trellis of posts, 24 to 30 feet apart, is used, the end posts being firmly braced, to which sometimes only two, but generally three strands of No. 10 or 12 wire are fastened, the first, second and third wires being 24, 40 and 56 inches, respectively, from the ground. Of late years many use a modification of the Munson trellis. In this, pieces of 2 x 4 inch joist or their equivalent 20 inches long are firmly spiked to the side or on top, when posts are sawed off at the right height ($4\frac{1}{2}$ to 5 feet above the ground) for the purpose. The two outer wires are stretched on the ends of the cross joist and the lower wire is either stapled against or run through the posts at the desired distance below (about six inches). The vineyards are plowed twice and cultivated frequently. Too late cultivation, however, is apt to keep the vines growing too late in the season, causing unnecessary growth, which does not ripen.

In growing Muscadines for commercial purposes the system of train-

ing almost exclusively followed is an overhead arbor. When planted in sufficient number to be called a vineyard, the vines are usually set 10 x 20, 15 x 15, or 20 x 20 feet apart. In the overhead system, a durable post, reaching seven feet above the ground, is planted at each vine. Rows of well-braced posts are set at the ends of the rows on all four sides of the vineyard. From the tops of these posts, governor wires are run along the tops of the inside posts in both directions, two feet apart. Parallel with the governor wires other wires are run across these, so as to regularly cover the entire area. Some growers construct the arbors entirely of wood, using slats instead of wires. In training the vines to such arbors, a single trunk should be allowed to grow from the ground alongside the post and



VINIFERA VINES PRUNED TO CANES IN CALIFORNIA

when it has reached the top, it is pinched in or cut off, to cause it to throw out shoots which are allowed to grow and spread over the arbor. After this, the general practice is to do no more pruning under the supposition that the vines naturally prune themselves. It is also a mooted question with the growers whether Muscadines should or should not be cultivated. Experiments by the United States Department of Agriculture in recent years not only go to show that other methods should be employed and that the vines should be regularly cultivated, but far better fruiting results and better fruit will be had by different training and thorough pruning methods.

Pruning.—Details of the many methods practiced in pruning grapes cannot be discussed in this paper. In California, two principal methods are practiced, commonly called cane and spur pruning. Of these two methods there are all kinds of combinations and modifications. The same

holds true with the methods employed east of the Rocky Mountains with American Euvitis, it being in the training methods and not the pruning that they differ. All the systems have the same underlying principle, namely, the grape usually bears its fruit on shoots of the previous year's growth. Therefore, the pruning should be so as to renew the wood at a given point from year to year, through this regulating its production and keeping the plants thoroughly shaped and under constant control.

With a thorough knowledge of the nature of the vine, it is easy to prune correctly. However, the nature of no fruit-bearing plant is so little understood by horticulturists. Many horticulturists easily learn to prune other fruit-bearing plants, but fail to master the vine and the same statement is equally true of grafting it.

Diseases and Insects.—Of serious insect enemies of the grape east



VINIFERA VINES PRUNED TO SPURS IN CALIFORNIA

of the Rocky Mountains should be mentioned the Grape root-worm, Grape vine flea-beetle, Grape berry-moth, Grape curculio, all of which can be combated with arsenical sprays.

Against the rose chafer, arsenical sprays, clean culture of land and hand extermination at times become necessary.

Against the Grape leaf-hoppers, clean culture of land, turning sheep into the vineyard immediately after the vintage to pasture on grape leaves and other rubbish and when the hoppers are nymphs, spraying with whale oil soap and nicotine, are among the most effective remedies.

Of grape diseases especially destructive east of the Rocky Mountains are black rot, downy mildew, powdery mildew and anthracnose. All of these are controlled by systematic spraying with Bordeaux mixture.

In California, some seasons, considerable damage is done by the Grape leaf-hopper and powdery mildew. The so-called California vine disease, which has in the past wiped out thousands of acres of California vineyards, is now seldom heard of.

The grape phylloxera has been and continues as the most serious menace to vinifera vineyards. Against this the vineyards are completely insured, by establishing them on resistant stocks.

Picking Grapes.—Grapes for all purposes, except those converted into raisins and dried grapes, are picked in boxes or trays and taken either to the winery, syrup juice or canning plants or packing house.

For wine, syrup and unfermented juice purposes, the vintage begins when the grapes have about reached the ripening stage and continues until all are harvested and those picked last are overripe and beginning to shrivel. The higher the sugar content of the grapes, the richer the unfermented juice and the finer the quality of the wines made from them.

Table grapes for shipping purposes and grapes for canning and other culinary purposes are picked at the stage of ripeness, which the purposes they are used for demand; in each instance, however, earlier than for wine, syrup and juice purposes.

In the packing houses, table grapes for shipping purposes are carefully picked over, all decayed and inferior berries being carefully removed. In the American Native grape region, they are then packed, shipped and sold in grape baskets.

In California, there are two distinct lines in the table grape business, namely, grapes that are packed, shipped and sold in crates and sold as generally are those from the American Native grape regions, without being stored and as soon as the shipments reach their destination.

The other line of California table grapes are the late ripening storage grapes, which are packed with specially prepared red wood sawdust into either drums or small barrels, holding from 30 to 50 pounds of grapes. These may be shipped and sold directly, or after being picked, are sometimes placed in cold storage in California before shipment in refrigerated cars, or shipped in such cars and placed in eastern storage houses on their arrival, to be sold at the most opportune time. This line of packed grapes already cuts into the shipments from foreign countries, reaching this country as so-called Malaga grapes packed in cork dust. It is only a matter of relatively short time when all such Malaga grapes will be grown in and supplied by California.

Almost all the raisins and dried grapes are produced in California, in the raisin belt of which the climatic conditions are ideal for such purpose. The summers are usually rainless and the nights so free from dew or moisture that a piece of tissue paper, after lying out all night, is crisp and stiff the next morning without a particle of moisture showing. There are some showers in October. Frequently it rains enough in November to cause considerable damage to partly dried raisins or grapes.

In California, picking raisin grapes commences the middle of August, the season often lasting into November. It takes from three to four pounds of grapes to make one pound of raisins or dried grapes. The time necessary for drying and curing a tray of raisins is about three weeks,

depending on the weather, the earliest picked grapes drying in ten days and the later ones often taking four weeks or more. The method of drying is very simple. The bunches are cut from the vines and placed on shallow trays, 2 feet wide and 3 feet long and 1 inch high, on which the grapes are allowed to sun dry, being turned from time to time by simply placing an empty tray upside down on the full one and then turning both



PICKING AND DRYING RAISIN GRAPES IN CALIFORNIA

over and taking off the top tray. Some dip and scald the grapes, to cleanse the fruit, to hasten its drying and to give the fruit a lighter color.

The layer and seeded raisins are mostly made from the Alexandria grape. The seedless raisins from the Sultana and Sultanina. The seeding, grading, packing and shipping of raisins have become separate branches of the industry.

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CHAPTER 10

THE POME FRUITS

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These fruits, which include the apple, pear and quince as the principal members, constitute the most important group of fruits in temperate climates. In the United States, as indicated in the thirteenth census, their combined value during the year preceding this census was \$91,659,335, or nearly two-thirds of the total value of all orchard fruits. The latter total was \$140,867,000. Among the pome fruits, the apple is by far the most important. Its value in America in the above-named year was \$83,231,492, or more than 90.8 per cent of the total for the group. The pear comes second in value with a total production of \$7,910,600, or 8.63 per cent of the total for the group, while the quince showed a value of only \$517,243, or but little more than one-half of one per cent of the group total.

THE APPLE

Origin.—All the true apples have descended from a wild form in Europe known as *Pyrus malus*. Most of the crab-apples have come from the wild *Pyrus baccata* of Siberia, which is commonly known as the Siberian crab. The Yellow and Red Siberian are probably as close to the original type as any varieties now grown. Most of the so-called crabs now in cultivation are hybrids, and are known botanically as *Pyrus prunifolia*. The Hyslop, Transcendent, Florence, Sweet Russet and Whitney are of this type. They are supposed to be hybrids between the true crabs and true apples. (See Budd and Hansen, *Horticultural Manual*, Vol. 1, pp. 161-62.)

The other source of crabs is the native American form, known as *Pyrus coronaria*, and especially the large western type which has been further distinguished by the name of *Pyrus ioensis*. The fruit of the latter often attains a diameter of two and a half inches or over, and keeps easily until the following summer. It is much like the quince in quality, however, and is suitable only for culinary uses. The principal varieties from this source are the Soulard, Kentucky Mammoth, Mercer and Howard. They are of chief value to the northwest section of the Mississippi Valley and northward. At present the number of apple varieties is very large. In America alone between 1804 and 1904 over 7200 distinct varietal names of apples were published, besides 383 named varieties of crabs. It is needless to say that the great majority are worthless.

Cultural Range.—In eastern America the apple is grown commercially

from the plateaus of Georgia and Alabama on the south to Quebec and Nova Scotia on the north and east. On the Pacific Slope it succeeds well from the south-central portion of California to British Columbia. Between these regions it is grown more or less between parallels 33 and 46 degrees north latitude, except where the moisture is insufficient. With proper selection of varieties and care, good home orchards or moderate-sized commercial plantings can be grown successfully over practically all this region. The range of the crabs extends farther north.

Propagation.—Apples are propagated by root or whip grafting in



WELL LOCATED APPLE ORCHARD.¹

winter on whole or piece roots, by crown grafting in the spring or by budding in late summer or early autumn. There is little or no difference between these methods so far as the growth of the resulting trees in the orchard is concerned.

The seeds to produce the roots used as stocks come largely from France, though some are also produced in Vermont. The former come from the so-called French crab, which is nothing but the wild native apple or *Pyrus malus* of France. The seedlings from them are produced chiefly in the soil of the Kansas River Valley.

In the central northwest these stocks are not sufficiently hardy, and

¹Courtesy of The Macmillan Company, N. Y. From "How to Choose a Farm," by Hunt.

seedlings of the crab hybrids or of the pure *Pyrus baccata* are much preferred as the root stocks for those sections. Budding or crown-grafting is best when these stocks are used.

Dwarf apple trees are formed by grafting or budding on French Paradise stock, and semi-dwarfs by working on doucin stock. They are much used in Europe, but thus far have found little favor in America.

Location and Soil for the Orchard.—Many orchards are permanently handicapped by unsuitable locations, and many of their defects might easily have been avoided by proper foresight and care. The chief characteristics of the suitable location are good topography, proper soil, a convenient water supply and ready access to market or good shipping points if the orchard is to be commercial. A good topography is one that is moderately rounded or sloping and is enough higher than its immediate surroundings to give good drainage of cold air and water. Too much slope, however, is always objectionable, and a grade of two or three per cent is usually sufficient, especially if some sharper depression is near. The direction of the slope is of little or no importance, except possibly near the northern or southern limits of culture, in which cases the southern or northern slopes, respectively, are generally best.

The suitability of the soil seems to depend largely upon the character of the subsoil, as good orchards occur on all classes of top soils, from dense clays to light sands. A good subsoil is comparatively open and porous for about one to three feet below the surface, and then becomes compact enough to hold the moisture fairly well, but not so well as to give the trees "wet feet." For the first six or eight inches, a loamy soil with a moderate admixture of sand and gravel is usually very good. The so-called ironstone soils, or those derived from many of the red shales or sandstones, are often excellent. The presence of old and productive trees under similar conditions in the neighborhood is also a valuable indication.

Not all these conditions are needed, however. Many good home orchards have been made with some of the conditions less favorable, and their advantages are sufficient to warrant some risk in securing them.

Varieties.—The proper selection of varieties for the location involved is extremely important. Fortunately, much assistance can now be secured from the pomologists, horticulturists and horticultural societies of the various states, and also from the publications of the U. S. Department of Agriculture, such as Bulletin 151 of the Bureau of Plant Industry. Personal preferences and local experience should also be considered, whenever available in reliable form, and the following general advice should be useful.

For the home orchard or local market, a much wider range and greater number of varieties are desirable and generally available than for the commercial orchard. Among the early varieties, named in the order of ripening, the Yellow Transparent, Oldenburg and Wealthy are among the best, and they thrive practically across the continent. They are chiefly valuable

for culinary use, and are all early bearers. For dessert use, the Early Harvest, Benoni, Maiden Blush, Gravenstein and Jefferis cover about the same season and are almost as widely adapted, at least for home orchards.

For the later varieties, more attention should be given to the section in which they are to be grown. In the general belt from New England to Ontario and Michigan, the McIntosh, Hubbardston, Northern Spy, Tompkins King, Baldwin, Rhode Island Greening and Roxbury are the leading sorts, although many others are also grown. This is known as the Baldwin belt. The varieties in it and those later are named approximately in order of maturity.

In the next area south, extending roughly from New Jersey and Virginia to Kansas and Oklahoma, the leaders are Grimes, Jonathan, Rome Beauty, Stayman Winesap, York Imperial, Ben Davis or Gano, Black-twig or Paragon, and Winesap. It is known as the Winesap belt. The first two or three varieties used in it are also frequently valuable in the Baldwin belt, and *vice versa*. The Red Astrachan, Primate, Summer Rambo, Fall Pippin, Smokehouse and Delicious also do well in many parts of both of these regions.

Still farther south, from North Carolina to Texas, the White Juneating, Red June, Horse, Kinnard, Buckingham, Terry, Buncombe and Shockley are the principal sorts. In the Colorado-Utah section, the leading varieties are much the same as those in the Winesap belt, with the Summer Pearmain, White Pearmain and Yellow Bellefleur in addition.

In the central northwest, or the general district including Wisconsin, Minnesota, the Dakotas and their immediate surroundings, only the hardiest varieties will succeed. For this district the first three early varieties named above are among the best. Others available are Tetofski, Borovinka, Charlamoff, Alexander, Hibernial, Gideon, Peerless, Okabena, Plumb Cider, Northwestern, Newell and Patten. This is rather a formidable list, both in names and quality, but in the latter respect the Wealthy, Peerless and Patten are best.

For the favorable mountain valleys of western Montana, Idaho, British Columbia, Washington, Oregon and Nevada, the following varieties are prominent in one or more sections: Gravenstein, Fall Pippin, Ortley, McIntosh, Grimes, Jonathan, Banana, Esopus, Wagener, Rome Beauty, Stayman Winesap, Delicious, Winesap and Yellow Newtown.

In California and northward along the coast, the more valuable sorts are the Red Astrachan, Red June, Gravenstein, Fall Pippin, Grimes, Jonathan, Esopus, Tompkins King, White and Blue Pearmains, Wagener, Yellow Bellefleur, Missouri Pippin, Gano, Yellow Newtown and Winesap.

These lists, supplemented with state and local inquiry to fit the immediate places concerned, should enable one to make satisfactory plantings almost anywhere in the apple-growing region of North America.

Purchase and Handling of Nursery Stock.—After deciding upon the varieties, the best way to get the trees is by direct order from responsible

nurseries. It is immaterial where the nursery is located, provided the trees it furnishes are true to name, thoroughly healthy, entirely dormant, fully matured before digging, and free from all evidence of faulty storage or improper handling of any kind. The wood should not show any conspicuous blackening at the heart, and the roots should show entire freedom from woolly aphids, crown-gall, hairy root or borers.

One-year-old trees of good medium size are usually best, and in no case should they be older than two years from the bud or graft. One-year trees usually cost less, are more easily shipped and transplanted and their heads can be properly formed, which is not always the case with older trees.

It is well to order early, although the trees may be held at the nursery subject to shipment at planting time. Fall planting is often advisable where the winters are not too severe; otherwise, planting should be done in the spring as soon as the soil is fit. When received the trees should be examined and "heeled in" if practicable, with the dirt packed closely about the roots and the tops sloping toward the south or southwest to reduce the danger of sun-scald. Before planting, the roots should be shortened back to about six or eight inches and those broken or bruised should be removed with a smooth cut above the point of injury.

Laying Out the Orchard.—The orchard may be laid out either on the square or the hexagonal plan. The latter gives about $15\frac{1}{2}$ per cent more trees to the acre at the same distance apart, or $15\frac{1}{2}$ per cent more space for each tree at the same number per acre. The former, however, is rather better for inter-cropping, spraying, etc., and in general is rather more simple to care for.

A good planting distance is 40 by 40 feet for the permanent trees, with a semi-permanent or filler set in the center of the square. In the case of the smaller-growing varieties, the central trees may often remain indefinitely, without disturbing the general plan of the orchard. Where inter-cropping is desired, the permanents may be set at 32 by 48 or thereabouts, and then have the semi-permanents placed in the centers of the long sides, with very satisfactory results. The latter plan allows two more trees to the acre than the square at 40 by 40, or a total of 56 trees, including both fillers and permanents.

The number of trees allowed per acre for any distance in the square or rectangular arrangement may be readily found by determining the number of square feet in the square or rectangle formed by the nearest four trees, and then using this number to divide 43,560, the number of square feet in an acre. To find the number needed in the hexagonal arrangement, find the number allowed by the square plan at the specified distance and then increase this number by 15.47 per cent.

The square or rectangular arrangement can be laid out readily by plowing straight, deep furrows for the rows and then drawing a chain or other drag across them at the distances required for the trees. The hexagonal plan is best laid out by means of a couple of light wires or chains, with

one end of each fastened to a single 2½-inch ring and with a similar ring attached to the free end of each. These chains or wires must be exactly equal in length, and they should just reach over stakes set at the distance desired for the trees.

Planting the Trees.—The avoidance of all unnecessary root-exposure and thorough firming of the soil about the roots are the principal secrets of success in tree planting. The soil on the immediate surface, however, should be left rather loose. If the trees or soil are inclined to be dry, the roots may well be soaked in water for several hours before planting, but water is seldom or never needed in the holes themselves. Set the trees from one to three inches deeper than they stood in the nursery.

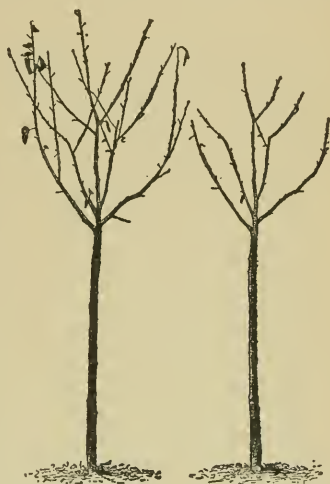
Little or no fertilization is needed at planting as a rule. A good mulch of strawy stable manure, however, will often help greatly. It or any other mulch should be accompanied by proper protection against mice, and a screen of galvanized wire with two meshes to the inch and about eighteen inches square will probably prove most satisfactory for this in the long run.

Forming the Heads.—If one-year "whips" are used, the only pruning needed at planting time is to cut them off at the height of twenty to thirty inches. As soon as possible thereafter, four or five branches should be selected to form the general framework. The lowest of these limbs should be about 25 to 30 inches above the ground, as the original height of this limb is the permanent one.

The other three or four frame-work limbs should be selected above, at intervals of six or eight inches, if possible, and with an even distribution around the trunk so as to balance the top properly. This selection is probably best made in the early part of the season's growth, at which time the extra limbs should be rubbed off. In the open-center type of tree, which is preferable for most varieties and localities, the central leader should be eliminated at this time and should be kept from reforming later.

This is usually sufficient for the first season or two, unless some of the limbs get too long or begin greatly out-growing the others; in which case they should be headed back.

At the beginning of the next season some of the frame-work limbs will need heading back to keep the tree in balance and avoid too rangy a growth. Each of the primary limbs should develop two good branches during the season following their selection, and all the others should be rubbed off



A PROPERLY PRUNED YOUNG APPLE TREE.¹

¹Courtesy of The Macmillan Company, N. Y. From "The Principles of Fruit Growing," by Bailey.

early. These branches in turn should produce not more than two branches each for the general frame-work, after which the tree-head may be considered formed.

Later Pruning.—The above work should be completed usually by the middle of the third season. After this the pruning should be reduced as much as possible until the trees come into bearing. A little thinning out in the dense places, removal of the crossing or plainly superfluous limbs, and an occasional heading back of the extra-vigorous branches will be



APPLE ORCHARD FAVORED BY TYPE OF SOIL.¹

sufficient and all that should be given if rapid growth and early fruiting are desired.

The fruit spurs should always be saved and also the early blossoms, unless they become too numerous, in which case the fruit should be thinned. A little fertilizing of the right sort will avoid any possible injury from early fruiting and the early formation of the bearing habit is usually desirable.

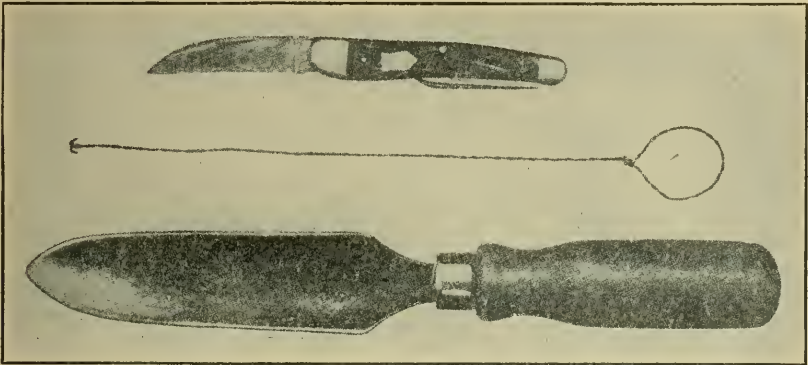
In all pruning, make the cuts close to the parent branch and avoid trimming the limbs to poles. Also keep all blighting twigs off of the main limbs, so far as possible, to avoid the formation of the cankers in which the winter is passed by the blight organisms.

Soil Management.—Where tillage is advisable, the most practical

¹Courtesy of The Macmillan Company, N. Y. From "How to Choose a Farm," by Hunt.

method of orchard development is the use of tilled intercrops followed by a winter cover. Potatoes, corn, vegetables or buckwheat are usually satisfactory for the intercrops, and rye or rye and vetch are good for the winter cover. When buckwheat is used, the rye and vetch combination can be sown at the same time, as it does not grow much until the buckwheat is taken off. In the other cases, the winter cover should be sown after the intercrop is removed, which should not be later than the 15th or 20th of September for best results.

Where the above plan is not desirable, the mulch system is generally best, especially for the home orchard. Strawy stable manure, at the rate of six or eight tons per acre annually, is probably the best mulch, unless the blight becomes too prevalent. Any other kind of vegetation is satisfactory, however, and it should be put on frequently and heavily enough to keep



TOOLS FOR USE IN REMOVING ROUNDHEADED APPLE-TREE BORER FROM BURROWS.¹

down most of the grass or other growth above the principal root-feeding area. Its chief function is moisture conservation, though it naturally also adds some plant-food as it decays. Any such mulch should extend out at least as far as the tips of the branches, and a clear space of at least six to twelve inches should be maintained immediately around the trees.

In many places all the mulch needed for the first eight or ten years can be grown between the trees by the use of alfalfa or other similar plants. When it begins to fail, manure or other outside resources should be drawn upon.

Fertilization.—The necessity for fertilization is largely a local problem. In general, young trees respond to it much less than those in bearing. In either case one of the safest and best applications that can be made is stable manure. On mature trees it can be applied at the rate of 6 or 8 tons annually per acre, while on young trees it may be reduced to as little as 50 or 100 pounds per tree.

¹Courtesy of U. S. Dept. of Agriculture, Farm Bulletin 675.

When the manure is not available, similar benefits may often be secured with an application of about 500 pounds per acre of a commercial fertilizer carrying about 5 or 6 per cent of nitrogen, 8 per cent of phosphoric acid (P_2O_5), and 3 or 4 per cent of potash (K_2O). This is enough for bearing trees and it should be supplemented by a mulch or tillage to conserve the moisture. For younger trees, the application should be reduced approx-

imately in proportion to the reduction in area covered.

The area of application should be about the same as that described above for mulches, and the best time for the fertilizer is probably somewhat after the fruit has set. The manure may well be applied any time during late winter or early spring. In any orchard it is always best to leave a few typical trees unfertilized until the actual value of the fertilization is determined.

Protecting the Trees.—The chief enemies of young trees are mice, rabbits, borers and the San José scale. The screens described above are the surest protection against the first two, though poisoned syrup or shot-guns may also be useful.



A POWER SPRAYER ADAPTED TO LARGE TREES.
A gasoline engine gives uniformly high pressure.

For the borers, a protective covering, such as the lime-sulphur concentrate more or less mixed with sediment or lime, is often very helpful if renewed frequently enough. It can be readily applied either with a brush or a coarse spray nozzle and the trunk should be thoroughly coated to a height of eighteen inches or more. It should be kept in good shape from about the middle of June to the middle of September, after which the trees should be gone over carefully and any borers that may have entered in spite of the coating should be cut out or killed with a wire.

The scale is readily handled by thorough spraying during the dormant season with lime-sulphur at a density of 1.03 as indicated by the specific gravity hydrometer, or a dilution of about one part of the best commercial concentrates to nine parts of water.

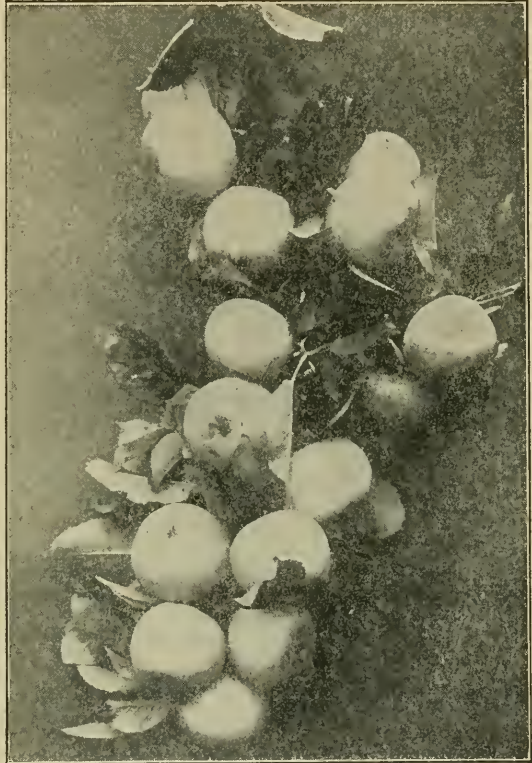
Spraying During the Growing Season.—The materials needed are lime-sulphur, lead arsenate, and nicotine solution. The first is used at a density of about 1.008, which is obtained by diluting good home-made concentrates about 1 to 30 or the best commercial lime-sulphurs at about 1 to 38. The second material is used at the rate of 2 or $2\frac{1}{2}$ pounds of the paste, or half as much of the powder, in 50 gallons of spray. The third is used at the rate of about an ounce of the 40 per cent nicotine preparations to 5 gallons of spray, which gives a diluted strength of about .05 of one per cent of nicotine. All these materials may be combined in a single application, or they may be applied separately as the case demands.

With these materials, the principal pests are controlled as follows:

1. If both scale and plant lice are present, defer the scale application *until the first green begins to appear in the buds*, and add the nicotine solution above named for the aphids or plant lice, which are then just hatched.

2. Spray with the sulphur and arsenate *when the blossoms are just showing pink, or slightly before*. This is for scab, canker worms or the bud-moth. Also valuable against aphids and red-bugs if the nicotine solution is added.

3. Repeat No. 2 immediately after the petals fall, to fill the calyx cups.



A GOOD CLUSTER OF APPLES, BUT WITH SOME SCAB SHOWING.

A little more thinning and spraying would have been useful here.

This is the most important single spray. It is to control the apple worm, scab, curculio and the later species of red-bug if present.

4. *Repeat No. 3 in about two or three weeks.* This is for the same enemies as in No. 3 and is also useful against the apple maggot if present.

5, 6 and 7. In orchards infested by bitter-rot or apple-blotch, make



PICKING AND PACKING APPLES.¹

three applications, preferably with Bordeaux mixture (3-3-50), at intervals of about three weeks, beginning eight or nine weeks after petals fall.

8. In the absence of sprays 5, 6 and 7, and where the second brood of apple worms, late scab or late summer caterpillars is bad, *repeat No. 2 about August 1st*, or somewhat earlier in the southern sections, depending upon the time of emergence of the codling moth. With the third and fourth

¹ Courtesy of Penn State Farmer, State College, Pa.

applications well made, this one is rarely needed, although much depends on the locality and season.

This schedule of sprays is all that is needed in the worst infested orchards, and it is seldom that more than those numbered 1, 3 and 4 need be given.

Thinning.—Whenever the crop on a tree is too large for normal maturity, it should be thinned. This should be done as soon as the June drop is largely over, or when the fruit has become about an inch in diameter. All defective fruit should be removed first and then the remainder thinned to a distance of at least four or five inches between fruits, unless they are on opposite sides of the limb and the limb as a whole is not well loaded. Grape shears or similar implements are sometimes used for this, but with a little practice and by using the proper twist the work can probably be done faster without them and with as little damage to fruit spurs and fruit.

Fruit Picking and Storage.—The highest color and best eating quality in apples are generally secured by letting them ripen on the tree as far as possible. This can be done with the early apples and especially with those to be used at home. Too much ripening, however, interferes seriously with long keeping, and hence with the later varieties the best time for picking is when they are "hard ripe," *i. e.*, when they have reached their full size and redness, but have not yet begun to soften nor to show the yellow colors, except possibly in occasional specimens. In many cases two or more pickings are desirable to permit the immature fruits to develop.

Other ways of improving the keeping quality are to avoid bruises and broken skins and to transfer the fruit at once to cool conditions. Leaving the apples in piles in the sun is exceedingly hard on keeping quality. In storage the best temperatures range from about 30° to 35° F., though a range up to 40° or 45° F. usually does little or no damage. Well insulated cellars or storage rooms fitted with a good system of ventilation, which can be opened at night and closed in the daytime, are likely to be very serviceable except possibly in the southern third of the apple region. In that territory it may be necessary, to make use of commercial storage, at least temporarily, in order to insure satisfactory keeping of the fruit.

THE PEAR

Origin.—Practically all the present varieties of pears have come directly from the wild *Pyrus communis* of Europe and Asia. This fruit has been grown probably as long as the apple, but it was not until the great work of Von Mons of Belgium, in the early part of the nineteenth century, that any important dessert varieties were produced. The better varieties are now among the most delicious of fruits.

The other ancestor involved in a few of the commercial sorts is the Japanese or sand pear (*Pyrus sinensis*) of Asia. It is of no value in itself except for hardiness or ornamental use. Crosses between it and *communis*, however, have resulted in the hardy hybrids, of which the Kieffer, LeConte

and Garber are most important. Although low in quality, they are usually very productive and are much used for canning. About 2300 names of pear varieties have appeared in American publications between 1804 and 1907. (See Bulletin 126, Bureau of Plant Industry.)

Propagation.—The pear is propagated in the same ways as the apple, but the stocks are different. In stocks, the pear has a very wide range of affinities. Those chiefly used are the seedlings of the small Snow pear (*Pyrus nivalis*) of Europe. This stock results in trees of the normal size.



PEAR TREE IN BLOSSOM.

Note unusually spreading form of this tree. This is desirable, although difficult to secure in many varieties.

Some varieties do not unite well with the quince and they are "double-worked" by first using one that does. The Japanese quince is not satisfactory as a stock for any variety.

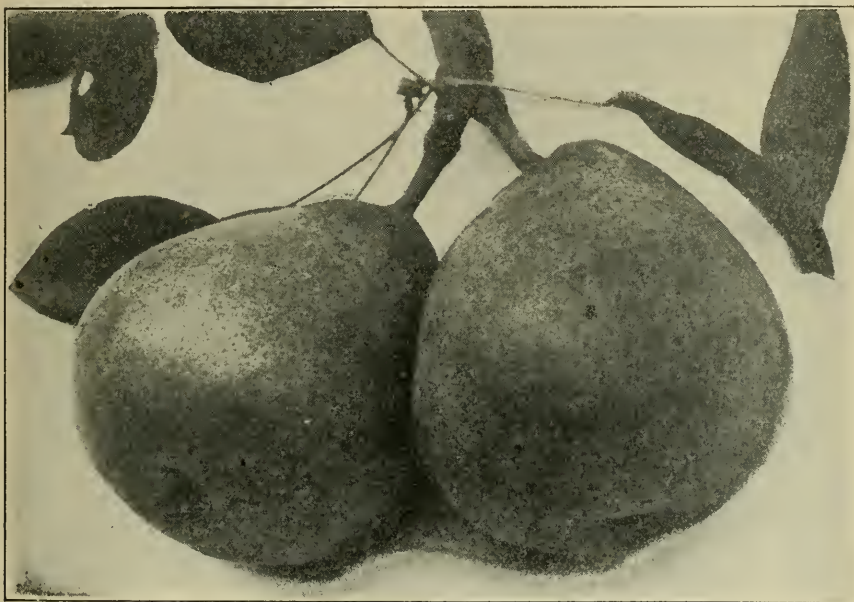
In the South, cuttings of the Kieffer pear are used to some extent, and in the more rigorous sections, the mountain ash (*Sorbus*) and even the shad bush (*Amelanchier*) have been used as stocks with fair success.

Cultural Range.—The pear resists cold about as well as the apple. Its great susceptibility to fire blight (*Bacillus amylovorus*), however, greatly restricts its profitable growth. In general, it does best in the Baldwin and Winesap belts in the East, and in the general territory from Colorado west and northward to the Pacific Coast.

Varieties.—The leading varieties in the eastern section, named

Dwarf pear trees are produced by budding on to quince stocks. The latter are secured from the Angers quince by mound layering. Some varieties, and particularly the Angouleme, are much benefited by this process. Such varieties are often planted with the stock below the surface to reduce injury from the round-headed borer, which attacks the quince, but rarely the pears.

approximately in order of ripening, are: Clapp Favorite, Bartlett, Seckel, Sheldon, Anjou, Angouleme, Kieffer, Lawrence and Winter Nelis. In the West, the same varieties are used, excepting the Kieffer, and with the addition of Flemish, Comice and Easter Beurre. In the South the three hybrids mentioned above are about all that have shown any profit. Very few varieties will succeed on the rich soils of the Mississippi Valley, but the LaMotte, Seckel, Dwarf Angouleme and Kieffer are most likely to succeed. It is always best to use more than one variety and to mix them somewhat in the planting, in order to insure satisfactory pollination. Further advice can



GOOD SPECIMENS OF WINTER NELIS.

The fruit, however, appears more nearly round here than it really is.

be secured from local and state sources, and from Farmers' Bulletin 208 of the U. S. Department of Agriculture.

Location, Soil and Culture.—Since blight is its worst enemy, the pear orchard should be located where the trees will not grow too rapidly. A fairly high and airy situation, with a well-drained and moderately fertile, clay or clay-loam soil, is therefore most desirable. For the same reason the amount of tillage and fertilization should be kept low or be eliminated entirely if the blighting becomes severe. The mulching method is often used with especial success on the pear, if not applied too heavily.

Trees, Planting and Pruning.—These are largely the same as described above for the apple. Pears, however, are planted closer. A distance of

20 by 20 feet is about right for the standard-sized trees, and 12 by 12 feet for the dwarfs. In forming the tops, it is customary to leave a central leader with most varieties of pears. Severe attacks of blight, however, are likely to be more serious in such trees than in those with three or more leaders, as in the open-centered tree. It is also important to keep all fruit spurs and sappy sprouts off the main branches, and to avoid any large amount of pruning at any one time. Special promptness is needed in pruning out and disinfecting blighted twigs whenever they appear.

Protection and Spraying.—The same general plans as stated for the apple will take care of the pear. The scab is especially bad on some varieties, *e. g.*, Flemish, but it can be readily controlled by lime-sulphur or Bordeaux mixture (4-4-50) applied just when the blossoms are showing pink. Most apple insects are less serious on the pear, but it has another important enemy in the pear psylla.

This insect attacks the buds and young leaves, sucking out the sap and blackening and often killing them. It is a very tiny insect, and when magnified looks like a minute cicada. It can be controlled by thorough spraying early in the spring, with nicotine solution and soap, at the rate of an ounce of the former and three or four ounces of the latter to five gallons of water. The rough bark should be scraped away before making this application. Lime-sulphur, at winter strength, just as the buds are swelling, is also effective in killing the eggs.

Picking the Fruit.—The pear is one of the few fruits that are improved by ripening off the tree. Both the grittiness and softening at the core are much reduced by this process. The "hard ripe" stage described for the apple is therefore especially applicable in picking the pear. After picking it should be stored at once in a cool place, free from drafts and preferably dark, to avoid wilting and bring out the full flavor of the fruit.

THE QUINCE

The quince has come down from the wild *Cydonia vulgaris* of Asia. It is still closer to the original type than any other orchard fruit. It is practically inedible raw, but has been used for at least 2000 years in marmalades and jellies. It is also used largely in preserves, canning and in flavoring other fruit products. It is especially adapted to home planting, as it is grown very little in a commercial way.

Cultural Range and Varieties.—The quince is less resistant to cold than the pear and is about equally susceptible to blight. Hence it is available in the less severe portions of the pear range.

In general, the leading variety is the Orange. The Champion is probably next, with the Rea, Missouri and Meech often useful. In the South the Chinese does best and in California the Pear is preferred.

Soil and Cultural Methods.—A heavy, retentive clay loam, with good drainage of both air and surplus water, is apparently best for the quince. Two-year-old trees are probably best, and they are set from twelve to fifteen

feet apart. The quince is very shallow rooted; hence all deep tillage must be avoided, and winter covers are always desirable. The general method of culture and fertilization suggested for the pear are also advisable for the quince.

Pruning.—Quince blossoms and fruit are produced on the ends of twigs of the current season's growth. These twigs are developed largely from the terminal buds of spurs or branches, or from buds near the tips of the latter; hence too much cutting back may readily remove all the fruit-bearing wood of that season. The pruning of the quince, therefore, should be confined largely to the removal of dead or inferior wood, thinning out the dense places and heading back the extra vigorous shoots, to promote the development of fruit spurs and keep the trees in balance generally. Blight-twigs also need as prompt attention here as in the case of the pear.

Enemies.—The worst insect enemies of the quince are the quince curculio and the round-headed apple-tree borer. The latter can be controlled as described for the apple, although more attention is likely to be needed. The former is the chief cause of the "wormy" and knotty fruits. It is very difficult to control, but the best methods are: (1) thorough spraying with lead arsenate, at the rate of one ounce of the paste to a gallon of spray, when the first injury appears and again a week later; and (2) picking and destruction of all infested fruit about a month before the normal picking time.

The chief diseases are fire blight, leaf blight (*Entomosporium maculatum*) and rust (*Gymnosporangium germinale*). The first is controlled as in the pear, the second by spraying as for apple scab and the third by removal of all red cedars, or at least all diseased specimens, for a distance of at least one-half mile of the quince trees.

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CHAPTER 11

STONE FRUITS

By F. C. SEARS

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Sites and Soils.—As a class the stone fruits do best on relatively high lands, principally on account of the effects of elevation on temperature. When peaches are injured by cold it is usually either by extremely low temperature in the winter or by frosts during the blossoming period. With cherries and plums the damage almost always comes at blossoming time. As all of these fruits bloom early, they are particularly liable to frost injury and it becomes necessary to guard against it.

Both these types of injury can be lessened and often largely prevented by placing the orchards on sites which are higher than the surrounding lands, thus allowing the cold air to drain away onto the lower levels. Occasionally the lower sites bring their crops through in better shape than the high ones. An instance of this kind was the winter of 1913-14 when extremely low temperatures were accompanied by very high winds. This combination did much more damage to orchards on high lands than to those on low lands. But on the average higher sites are much to be preferred.

As to the direction of the slope, two points are worth considering. A northerly slope retards the blossoming and so helps to escape spring injury. But, as just suggested, it may increase the danger from severe winter temperatures. Consequently, if one is in a section where the former type of injury is most likely to occur a northerly slope is to be preferred. But if the damage is generally done by low winter temperatures, a southerly slope is best.

For soils the stone fruits are not very exacting. Peaches prefer relatively light soils, but will do well in almost any soil up to a moderately heavy clay loam. Plums and cherries, especially the former, do best on medium to fairly heavy soils, heavy sandy loams to medium clay loams. Good soil drainage is absolutely essential.

Nursery Stock.—Medium grades of nursery stock of the stone fruits, from four to six feet tall, are to be preferred. This is especially important in peaches, for these are always set at one year old and where one wants to head them at all low and start a new top, the very heavy trees do not give as good results. Plums and cherries may be set at either one or two years from the bud. Where the soil is fertile and has been well prepared, one-year-old trees are to be preferred, particularly if one wants to head

them low. But if the soil conditions are not good, then two-year trees are to be preferred, as the one-year trees will not usually form as good heads under poor soil conditions. Locally grown trees are always to be preferred if one can get good stock. They come fresher, the freight is less and it is easier to adjust differences with the nurseryman. On the other hand, there is probably nothing in the idea that either northern grown or southern grown stock is to be preferred. Southern stock will do just as well in the North, or northern grown in the South, if it can be landed at the orchard in good condition.

Varieties.—The variety question is always important and always difficult to decide. It can generally be decided best by referring to local authorities, but a few general considerations are worth keeping in mind.



A TYPICAL PEACH-ORCHARD SITE, ALLEGHENY MOUNTAIN DISTRICT, MORGAN COUNTY, W. VA.¹

Good air drainage and proper exposure are important.

With peaches the important considerations are color of flesh, color of skin, quality, juiciness, whether they are clingstone or free, hardness of fruit buds and season of ripening. There is a very strong prejudice (it is nothing more) in favor of yellow-fleshed peaches, especially for canning. It is best to respect this prejudice if possible, but many varieties which are leaders in all other respects have white flesh. It is often possible to educate consumers locally on this matter of color and convince them that in many cases the white varieties are to be preferred, but in the general market one is almost certain to be most successful with yellow sorts. Quality and juiciness are always desirable, though from the commercial standpoint the latter can be overdone, as very juicy peaches do not ship as well. Clingstones are never as popular, but some of the best commercial sorts among the early varieties are clings or semi-clings. Hardiness in the fruit

¹ From Farmers' Bulletin 431, U. S. Dept. of Agriculture.

bud is all-important in sections subject to low winter temperatures, and there is a very marked difference in this respect among different varieties. Greensboro, for example, will come through with a full crop when the fruit buds of Elberta will be largely killed and those of Crawford entirely so. As a class, the so-called Chinese Cling group, which includes such varieties as Greensboro, Carman, Belle of Georgia and Elberta, has much more hardy fruit buds than the Persian group, which includes such varieties as

Early and Late Crawford and Old Mixon. As to season of ripening, it is well, of course, to have somewhat of a succession, particularly for local trade, but the very early and still more the late sorts are likely to be more profitable than mid-season varieties.

With plums one should consider the quality, the uses (whether for jelly, canning, preserving or eating in a fresh condition), the size and the color.

With cherries the all-important question is whether to grow the sweet varieties or the so-called sour cherries. As a class, the sour cherries are much more generally successful. In addition, there are the questions of size, quality and color.

With any of these fruits the number of



TYPICAL SWEET CHERRIES.

varieties set must depend very largely on whether they are to go to local or distant markets. If the latter, then it is very important to restrict the number of varieties sufficiently to allow of shipping in car lots.

While realizing, as already suggested, that the variety question is very strongly local, the following lists may be helpful, including as they do those varieties which are most generally successful and popular:

PEACHES

Early Crawford	Champion	Belle of Georgia
Greensboro	Hieley	Elberta
Carman		

PLUMS

Burbank	Wild Goose	Bradshaw
Abundance	Reine Claude	Shropshire Damson
Lombard	Red June	

CHERRIES

(Sour)

Early Richmond	Montmorency	English Morello
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(Sweet)

Black Tartarian	Windsor	Schmidt's Bigarreau
Yellow Spanish	Bing	Gov. Wood
Napoleon		

Planting.—Spring planting will be found most generally successful, particularly in those sections subject to variable winter climates. On the other hand, where soil conditions are ideal (soil well prepared and well drained both on the surface and beneath), planting in the autumn will give excellent results. A serious difficulty, of course, is getting the nursery stock in time to plant in the autumn and still have it well matured before it is dug by the nurseryman.

Peach trees are set all the way from 13 to 20 feet apart. A good average distance is 18 feet. The type of land and the variety will determine the best distance.

Plums can, on the average, be set closer than peaches, because they are more upright growing trees, but such sprawling growing varieties as Burbank will need fully as much room as any peach.

Sour cherries average about the same as plums, and sweet cherries somewhat larger.

In pruning the trees at setting there are two general methods used: In the case of one-year trees, they are simply cut back to the desired height, which varies with different growers from 6 to 30 inches, on the average perhaps 24 inches. With two-year trees, the head being already established, it is necessary to cut back the main branches rather severely. Generally from one-third to two-thirds of the last year's wood is removed.

Soil Management.—Stone fruits rarely succeed well in sod. Peaches practically never do, and cherries very seldom. Plums *can* be grown in sod, but are usually much better under cultivation. There is much less chance for discussion as to the relative merits of sod and cultivation in the stone fruits than with apples and pears. An additional reason for cultivating peaches is the fact that borers are much more troublesome where grass and weeds are left about the trees.

If the orchard is to be cultivated, the season's campaign would be to plow it as early in the spring as possible, and for this work nothing is more

satisfactory than one of the "orchard gang" plows (usually a gang of three small plows). After plowing the soil is "fitted" in good shape with the disk and other harrows, and then is kept in good condition with some type of cultivator up to about July 1st. The essential points of such a cultivator are that it shall cover enough ground to do the work cheaply, that it shall leave the soil in good condition and that it shall work well under the trees without necessitating that the team get close to them. This latter point is particularly important with stone fruits, since they are almost universally headed very low. About July 1st the cover crop is sown in the orchard and the season's work on the soil is finished. The date of sowing this crop varies greatly with different growers and under different conditions. Where



BLOCK OF YOUNG PEACH TREES WITH STRAWBERRIES AS AN INTER-CROP.

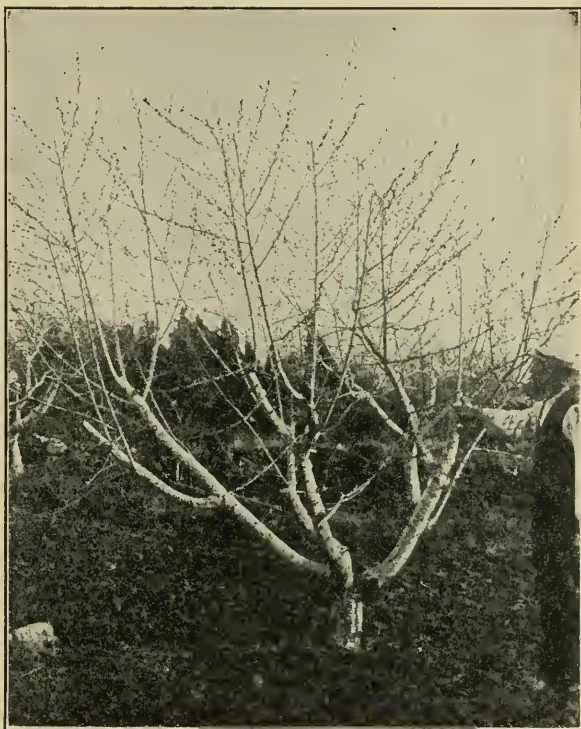
trees are carrying a large crop of fruit and the soil and season are dry, cultivation may profitably be kept up considerably later in order to conserve the moisture, but it must always be borne in mind that moisture is saved in this way one season at the expense of the next season, because the longer the sowing of the cover crop is delayed the less growth it will make, and consequently the less humus it will add to the soil the following year. The chief functions of this cover crop are to prevent washing (and this is especially important in peach orchards, since they are usually on high and rolling lands), to check the growth of the trees in autumn and to add humus to the soil. If the cover crop is a legume, a large part of the required nitrogen may be secured. One of the best crops for this purpose is barley. Another is dwarf rape. Either may be combined with one of the clovers

to advantage. Vetch is an ideal crop where the seed can be secured at a reasonable price. Some growers raise their own seed, sowing winter vetch with rye and cutting and threshing the combination the following season. One bushel of rye and a peck of winter vetch makes a good combination for this purpose. In this connection, it is very desirable to get all the humus possible into the soil before the orchard is set, since it is frequently difficult to get as much growth as desired from the cover crop and consequently the supply of humus in the soil soon runs low.

Fertilizers.—The fertilizer needs of stone fruits, as with other fruits, have not been worked out as fully as could be desired, yet it has been pretty well shown that reasonably liberal fertilizing is profitable. Practically all commercial peach growers fertilize their orchards and most of them very liberally. Plums and cherries are probably fertilized less freely on the average than peaches, largely perhaps because size with them is less important. There must be enough nitrogen added in some form so that, together with what can be gained through cover crops,

the trees will be induced to make a good medium, well-ripened yearly growth. Peach trees ought to make from one to two feet on the leaders and plums about the same. Sweet cherries will stand perhaps a little more and sour cherries less. The foliage ought also to be kept in good vigorous condition. To accomplish this will require varying amounts of fertilizer and the orchard man must use his judgment as to what is required.

The following are formulas which are used by good growers, but even in different parts of the same orchard, and certainly in different



PEACH TREE WITH WELL-FORMED FRAMEWORK, HEAVILY CUT BACK FOR RENEWAL PURPOSES.¹

¹ Courtesy of Dept. of Experimental Pomology, Pennsylvania Experiment Station.

years, the applications may need to be varied. The formulas given are per acre:

1. 250 pounds high-grade sulphate of potash.
100-600 pounds basic slag.
Nitrate of soda as needed to produce proper growth—Usually 100-200 pounds per acre.
2. 100 pounds nitrate of soda.
100 pounds dried blood.
350 pounds slag.
100-200 pounds high-grade sulphate of potash.
3. 25- 50 pounds dried blood.
40- 80 pounds tankage.
90-180 pounds bone meal.
130-260 pounds basic slag.
80-160 pounds high-grade sulphate of potash.

This is a more complicated formula than the others, but is used by a very successful grower.

Pruning.—The most intelligent pruning of any kind of fruit tree requires that one should understand thoroughly the manner in which the fruit is borne by that tree. This is perhaps more emphatically true of the peach than of any other fruit, but is certainly a safe general principle. We will therefore consider this point first.

The peach bears only on last season's wood, the buds occurring normally in clusters of three on such shoots, the center one being a leaf bud and the two outside ones fruit buds. Shoots of medium size give the best results. If, for any reason, a peach tree makes a very rank growth it will be found that fewer fruit buds are produced on such wood and they are apt to be less hardy. In seasons when a large part of the fruit buds are killed by severe cold it almost always happens that the few buds which come through safely are on the smaller branches. The pruning of the peach, therefore, ought, first of all, to aim at keeping up a supply of new wood, and, except when one is trying to grow a new top on the tree, it should never be so severe as to give a very rank growth.

The following will be found a fairly satisfactory outline for the pruning of a bearing peach tree:

1. Do not allow the pruning of the tree as a whole to be severe enough to start a very strong wood growth.

2. Take out altogether any very high and very strong leaders. This is necessary because the fruiting wood tends to get very high if these leaders are allowed to remain. Less rank leaders may be headed back less severely or allowed to remain entirely.



PEACH TWIG, SHOWING ARRANGEMENT OF LEAF AND BLOSSOM BUDS.

3. Take out all dead or injured branches. It is sometimes a question whether one can afford time to take out all of the many small dead branches which are always to be found in the center of the tree, but as many of them as possible should be removed.

4. Thin the balance of the top as needed, taking out preferably no branches larger than one's thumb. The amount of this pruning is going to depend, of course, on how much has been taken out in other ways and on the type of tree. The amount of pruning should be varied somewhat according to the outlook for a crop that season. If the fruit buds are all killed it is a good opportunity to cut back rather severely and lower the tree down if necessary.

If part of the buds are killed, it may be best to prune very lightly in order to save as much of the crop as possible. On the other hand, if there are plenty of live fruit buds the pruning may be fairly severe, as this helps to thin out the fruit.

Plums and cherries bear essentially alike, the fruit being produced on short lateral spurs and small twigs, and also to a considerable extent (especially with the sour cherries and the Japanese plums) on the last year's wood as with peaches. These

spurs bear for several years, perhaps three to six, and then die away and need to be replaced by new wood. The pruning of such trees therefore should be moderate and should aim to keep the trees fairly open to encourage new growth. The following outline may serve as a guide for most trees of these two fruits:

1. They require relatively little pruning.
2. Cut back leaders if too high. This is especially important with cherries, since the picking of high trees is more expensive than with any other fruit.

3. Cut out dead, broken and diseased branches. This is particularly important with plums which are often badly attacked by the black knot.



A PROPERLY PRUNED PEACH TREE.¹

¹From Farmers' Bulletin 632, U. S. Dept. of Agriculture.

4. Take out crossing branches.
5. Thin the balance of the top slightly.

The following outline may be taken as reasonably accurate for pruning young trees of stone fruits—say trees two to four years old:

1. Examine critically the head of the tree. It should have three to six main branches and no sharp forks.
2. Shorten leaders that are running too high. Only very high leaders that throw the tree out of shape, or such as have made an exceptionally long growth the past season, need to be cut back.
3. Cut out bad (sharp) forks on all main branches.

4. Save all small shoots.

5. Take out only very large crossing branches.

6. Prune strong-growing trees less and weak-growing ones more.

In pruning these fruits, especially the peach, a large pair of hand shears will be found most satisfactory. A ten-inch pair of the French wheel-spring shears will be found equal to almost any emergency, and much of the work can be done more rapidly with shears than with a saw. The operator will need a saw, however, for the heavier work and one of the following dimensions will be found very satisfactory:

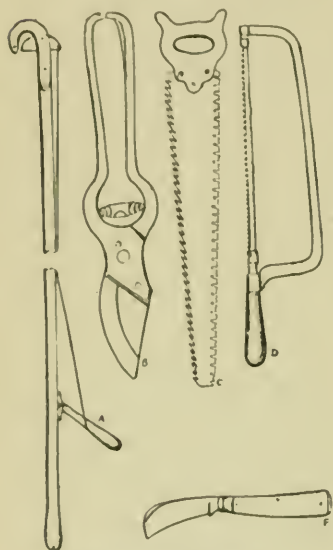
Length.....	20 inches
Width at butt.....	2 $\frac{3}{4}$ "
Width at point.....	4 "
Seven and one-half teeth per inch.	

Such saws may have to be made to order. Any hardware manufacturer will make them and they should always be of the best steel.

Probably the ideal time to prune these fruits is about a month or six weeks before they start into growth. But where one has

much pruning to do, it is often necessary to greatly extend the time. It is largely a question of the economical use of farm labor. There are usually few expert pruners on the farm in comparison to the pruning to be done and it becomes necessary to keep these men at work over a relatively long period.

Diseases, Insects and Spraying.—Since the matter of diseases and insects has been treated fully in the general chapters on these subjects, it is necessary here only to give a very brief summary of the subject.



PRUNING TOOLS.

- A—Waters' Tree-Pruner.
 B—Pruning Shears.
 C—Two-edged Pruning Saw.
 D—California Pruning Saw.
 E—Pruning Knife.

Among fungous diseases, the following are deserving of special consideration:

1. The brown rot which attacks all of the stone fruits and is to be dreaded far more than anything else. It attacks not only the fruit but the twigs as well, spreading to the latter from the former, and hence diseased fruits should be removed from the tree as soon as possible. It can be controlled largely by spraying.

2. Peach leaf curl, often serious but thorough spraying before the buds swell will practically eradicate it.

3. Black knot of plums and cherries. Often very serious but can be controlled by spraying and by cutting out and destroying the knots.

4. Peach scab. Often a troublesome disease, sometimes seriously so, but thorough spraying will usually control it, even in the worst seasons.

Among insects three are worth mentioning:

1. The plum curculio, which attacks both plums and peaches and is often a very serious menace, not only for its own attacks, but because it helps the spread of brown rot.

2. The peach borer, an ever-present pest where peaches are grown at all extensively. Digging out is the most commonly accepted method of combating.

3. The cherry aphid, often a serious pest and, like all aphids, difficult of control.

There are a number of other pests in both classes that are sometimes troublesome, occasionally very seriously so, but the above mentioned are the real standbys.

Thinning the Fruit.—A prerequisite to harvesting a satisfactory crop is thinning the fruit. Nothing is simpler to do and few things connected with fruit growing are more important. Cherries are not thinned, but peaches and plums ought always to be. The best time to do this is after the "June drop" has occurred, that is, after all the fruits which will fall "naturally" have fallen. The fruits will then be about the size of the first joint of one's thumb, and a safe rule, and one easily followed by those doing the thinning, is to thin so that no two fruits touch. In practice this works out so as to bring the fruits a good distance apart and the operator does not spend any time in wondering whether he ought to take off another fruit in order to bring them the required distance apart.

Thinning will help the crop wonderfully in several ways. Probably the most important is that it gets rid of all the small, defective fruits, leaving a crop which it is an inspiration to pick and a pleasure to sell. The work of sorting is reduced to a minimum because there are really very few poor fruits left. Moreover, one gets almost as much fruit in the aggregate, sometimes quite as much. The trees, too, will bear more regularly because they are relieved of the burden of maturing these extra fruits. And lastly it reduces greatly the loss from brown rot, because the rot can spread from one fruit to another where they are touching, and moreover

an outbreak of it frequently starts where the moisture is held between the fruits at their points of contact. It requires a good deal of "hustle" to make a good "thinner," but boys who have that requisite will thin fully as well as, and more cheaply than, men.

Go over the trees systematically. Take off all defective fruits whether they touch or not. Don't be afraid of the cost. It will be paid back many times over in the better fruit and is really a small item. Peach trees that will bear four or five baskets can be thinned for not over three or four cents each. The writer has had this done in his own orchard.

Harvesting and Marketing.—To begin with, one must decide on the proper degree of ripeness. This is going to vary greatly with varieties and distance to market. Let the fruit get as nearly ripe as possible and still stand up well in transit, for stone fruits are never so good as when



PICKING PEACHES.¹

allowed to ripen fully on the trees. Peaches ought to be picked for local markets as soon as they show signs of ripening on the shady side, that is when they begin to look edible. A little practice will soon teach one. Plums can be somewhat soft before picking, while cherries are picked just before they are fully ripe. Color and taste (of a few samples) should be the guide. All the above are for local markets. The more distant the market the greener the fruit must be when picked.

Have convenient receptacles into which to pick. For plums and peaches the ordinary round Delaware peach basket holding sixteen quarts is good. A strap with a hook at each end can be thrown over the shoulders and hooked into the rim of the basket so that it will hang just in front of the picker, leaving both hands free to pick. Cherries are often picked in the same way or may be picked directly into quart baskets if they are to be sold that way.

¹ Courtesy of Department of Experimental Pomology, Pennsylvania Experiment Station.

Do not allow the pickers to bruise the fruit in handling. This is a very important rule and one difficult to enforce. In handling the larger fruits like peaches and large plums, take the fruit in the hollow of the hand and grip it firmly with the entire hand. Never take it between the thumb and finger. With plums and cherries always have the stem attached. This means that the stem must be gripped by the finger and thumb.

Never pick these fruits when wet. This rule has very few exceptions. Fruit which is picked while wet looks badly and keeps worse. Brown rot is almost certain to develop in it.

So much for picking. Next for packing. Have a convenient packing room. If possible have the fruit brought in on one side, packed in the middle and delivered for marketing on the other side. There is then less confusion. Have a table for the packers and seats if they want them. They can work just as fast sitting down. See that the sorting is done rigidly. Nothing discourages customers like finding a few poor number two peaches in the middle of a basket of firsts. Be extremely careful that the best fruits do not gravitate to the top of the baskets. It is probably legitimate to turn the blush side up on the face, but this is as far as it is wise (not to mention honest) to go in facing.

Plums and peaches are sold for the wholesale market in the round Delaware basket of various sizes, and, for a more select trade, in the six-basket Georgia carrier or crate. The latter will not pay for cheaper grades on account of the greater cost of packing. To a limited extent these fruits are also sold in the Climax baskets. For strictly local trade both these fruits may be sold in the little baskets of the Delaware type with wire bails, holding two and five quarts.

Cherries are most commonly sold in strawberry baskets and crates, also in Climax baskets and for the large and finer sorts in boxes or cartons.

The desirability of roadside marketing where there is any great travel past the orchard should not be overlooked. The stone fruits lend themselves especially well to this type of traffic and one who has never tried it will be agreeably surprised at the amount of fruit which can be turned into cash in this way. Moreover, it offers an outlet for the over-ripe, soft grades which would not stand transit to market.

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CHAPTER 12

CITRUS FRUITS AND THEIR CULTIVATION

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History.—The various species of the genus *Citrus* are natives of India and the Malay Archipelago. The date of the importation of citrus fruits to America is not known. They were apparently introduced into Brazil and the West Indies at a very early date, probably some time in the latter part of the sixteenth century. They were brought by the Spaniards to Florida at a comparatively early date and were apparently spread by the Indians over the state.

The commercial cultivation of oranges in Florida began in the early part of the nineteenth century; while in California the commercial planting cannot be considered to have started much prior to 1880. The first earload of oranges was shipped from California to St. Louis by William Wolf-skill in 1877.

Citrus Species and Varieties.—The genus *Citrus* belongs to the family *Rutaceæ*, which is represented in the United States by the prickly ash *Xanthoxylum*), the hop-tree (*Ptelea*) and the like. The representatives of the family are mainly natives of tropical and sub-tropical countries. Following are the principal species and varieties cultivated in the United States.

The Sweet Orange (*Citrus sinensis*).—This is the species most generally cultivated throughout the world, and is the fruit commonly referred to as the orange. It has given rise to numerous cultivated varieties and exhibits a very wide range of variation in form, size, flavor, season of maturity and the like. Certain varieties have had marked influence in building up the industry in different sections.

This is particularly true of the Washington Navel in California. This variety originated in Brazil about 1820 near Bahia. It gradually became known for its good quality and seedlessness, and in 1876 twelve budded trees were imported into the United States by William Saunders of the United States Department of Agriculture. Other trees were propagated from these and sent to various of the orange-growing states for trial. The majority of these trials were apparently failures or attracted no notice. Two trees, however, were sent to Mrs. Luther C. Tibbet, at Riverside, Cal., in 1873, and were carefully cared for by her until they came into bearing. The stock of this variety in the world has been mainly taken from descend-

ants of the Tibbet trees. It has been sent from California to Australia and South Africa, where it has become an important variety.

The next most generally grown orange in California is the Valencia, a late-maturing variety that can be held on the trees until July and August in interior sections of the state and until October or November in cool sections near the coast. This variety is also grown extensively in Florida as a late-maturing sort, but requires to be shipped considerably earlier than in California.

The orange plantings in California are made up largely of Washington Navels and Valencias with a few trees here and there of other varieties, such as Mediterranean Sweet, St. Michael, Blood, Joppa, Nugget, Ruby, etc.



EVER-BEARING ORANGE TREE.

In Florida a much larger number of varieties are grown, no two standing out as prominently as do the Navel and Valencia in California. The following are the leading sorts in their class in Florida, though other sorts are almost as extensively grown: Early varieties—Parson Brown, Boone, Early Oblong; mid-season varieties—Pineapple, Homosassa, Jaffa, Majorca, St. Michael, Ruby, Maltese; late varieties—Valencia, Bessie and Lue Gim Gong.

The Sour Orange (*Citrus aurantium*).—The sour orange is grown in the United States mainly as a root-stock on which other varieties are budded. A few varieties are cultivated to a limited extent for their fruits. Certain varieties are grown in some countries for manufacturing purposes.

The Lemon (*Citrus limonia*).—The lemon is grown extensively in California and to some extent in Florida. The commercial production in Florida has in recent years almost disappeared, primarily due to the damage caused by the disease known as scab. The principal varieties of the lemon are the Eureka, the Lisbon and the Villafranca. Of these, the Eureka, a nearly seedless variety that originated in California, is much the most extensively planted.

The Pomelo or Grapefruit (*Citrus decumana* or *Citrus grandis*).—

This fruit is grown extensively in Florida and the West Indies and to some extent in California. While the pomelo has been known for many years, it was first grown on an extensive commercial scale in Florida, first being introduced as a commercial fruit about 1885. The varieties most commonly grown are selected Florida seedlings, though one or two varieties, as the Pernambuco and the Royal, are importations respectively from Brazil and Cuba. Probably the most widely planted varieties in Florida are the Duncan, Josselyn, Walters, Pernambuco and Marsh. The Marsh, which is a nearly seedless variety is the most extensively planted of any variety in California.

The Lime (*Citrus limetta*).—The lime is grown throughout the citrus regions of the United States and the West Indies, but is produced commercially only in southern Florida and the West Indies. The demand for these fruits has rapidly increased in recent years and is assuming some importance. The principal varieties grown are the Mexican and the Tahiti.

The Mandarin Orange (*Citrus nobilis*).—This fruit, referred to frequently as the "kid glove orange" because of its loose, easily removable skin, is grown to a considerable extent in certain regions of the United States. It is in general rather more cold-resistant than the common orange, and this has led to its propagation to considerable extent in the Gulf states. The Satsuma or Unshiu, an early maturing sort of fair size, is grown rather extensively in northern Florida and southern Georgia, Alabama, Mississippi, Louisiana and Texas. The Dancy tangerine is grown to some extent in Florida and California and occasionally in some other states.

The Citron (*Citrus medica*).—The citron, the candied or preserved peel of which is a staple article of commerce, is not grown to any extent in America. A grove of about fifteen acres at Riverside, Cal., is the largest and only grove known to the writer in the United States. Another minor citrus fruit cultivated to some extent as an ornamental and for preserving is the kumquat (*Citrus japonica*).

Citrus Regions and their Production.—While the various citrus species are of tropical origin, the commercial development of citrus growing has taken place almost wholly in subtropical countries. The most important countries in the order of their production are the United States, Spain, Italy, Japan and Palestine. The normal citrus crop of the world is now equal to about 90,000,000 to 100,000,000 boxes of California capacity or from 230,000 to 250,000 carloads of California size.* The normal production of the United States is now about 78,000 carloads; Spain, about 68,148 carloads; Italy, 58,000 carloads; Japan, 10,896 carloads; and Palestine, probably about 9000 carloads. Small quantities of citrus fruits are, of course, produced in many other tropical and subtropical countries.

*"The World's Production and Commerce in Citrus Fruits and their By-Products," by F. O. Wallachlaeger. Bulletin No. 11, Citrus Protective League of California, Los Angeles, 1914.

According to the thirteenth United States census, there were in the United States in 1910, 11,486,768 bearing citrus trees and 5,400,402 of non-bearing age. The production in 1909 reached a grand total of 23,502,128 boxes valued at \$22,711,448. This production was divided as follows: California, 17,318,497 boxes; Florida, 5,974,135 boxes; Louisiana, 153,319 boxes; Arizona, 32,247 boxes; Texas, 10,694 boxes; Mississippi, 3779 boxes; Alabama, 1201 boxes. A few boxes are also produced in Georgia and the Carolinas. The increase in yield and acreage since 1909 has been very great in California and Florida, so that the above data are very much below the present production.

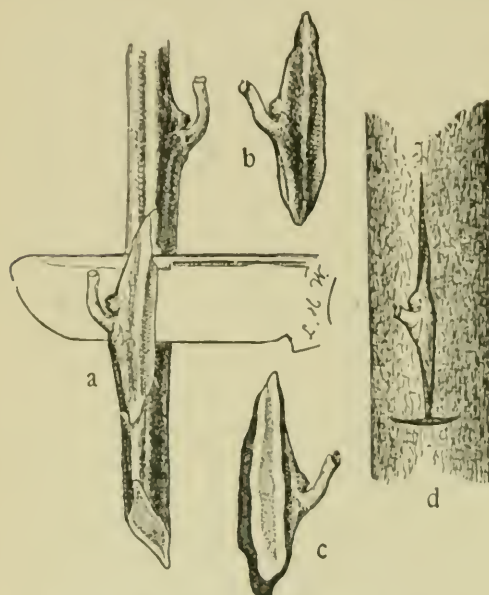
Propagation of Citrus Varieties.—In the early days of the citrus industry, many seedling trees were grown in commercial groves. Now all groves are planted with stock budded with varieties of known excellence. It is important that the proper stocks be used. Orange and lemon varieties



GOOD ORANGE SEEDLINGS.

are most extensively budded on sour orange stock, largely because of the resistance of this stock to foot-rot or gum disease. Wherever there is danger from this malady, the sour orange stock should surely be used. Sweet orange stock is also used widely, both in Florida and California. Trees on sweet stock probably in general grow rather more rapidly and rather larger than on sour stock, but the susceptibility of sweet stock to the gum diseases renders its use more limited. In dry, well-drained soils in Florida and in the dry interior regions of California it is a very satisfactory stock. Pomelo and Florida rough lemon stocks have some advocates, but have not been generally used. The Trifoliolate orange is probably the best stock for the Satsuma and some oranges grown in the Gulf states, but has not given satisfaction in general. It has a very marked dwarfing effect on the Eureka lemon and some other varieties.

Orange Seedlings.—Sour orange seed for stock purposes is in general obtained from Florida; sweet orange seeds are usually taken from any sweet seedling grove. Seed must not be allowed to dry out. The seed is usually sown about one inch apart in a bed or may be drilled in rows. It is a good plan to cover the seed about one-half inch deep with clean river sand. It is desirable in most places to cover the seed-bed with a partial shade of some sort, as of cheesecloth or a lath shed. The seedlings are usually dug when they are about a foot high and transplanted to the nursery. Before transplanting the tops are cut back to about 7 or 8 inches above the crown.



SHIELD BUDDING WITH ANGULAR WOOD.¹

A—Cutting the bud. B—Bud cut ready to insert. C—Bud showing cut face. D—Bud inserted, bark on right side only being raised.

should be used. The nursery should be thoroughly cultivated, and the trees must be pruned occasionally to lead them to develop a single trunk for 6 or 10 inches above the ground. It usually requires from 16 to 18 months to grow trees to the right size for budding, an ideal size being a diameter of from three-eighths to one-half inch at about 3 to 5 inches above the soil.

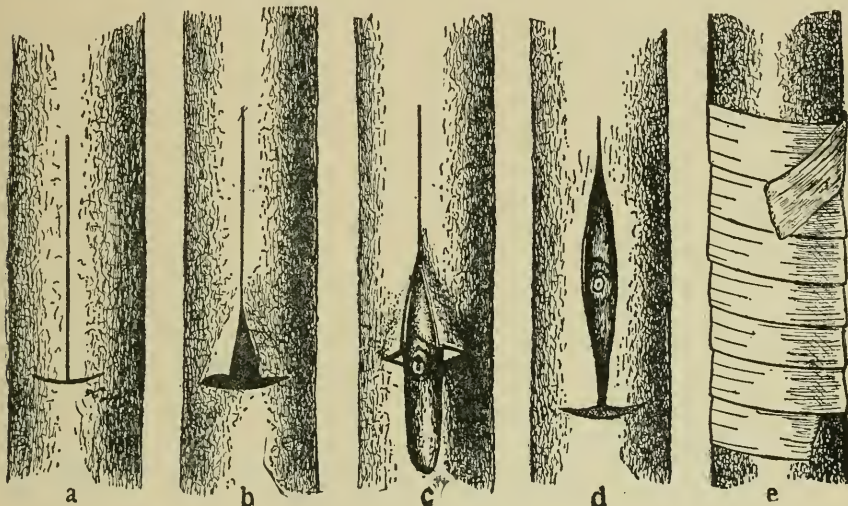
Budding the Nursery Stock.—Trees should be budded from 4 to 8 inches above the ground. Budding is done mainly in the spring or in the fall. In the latter case, it is expected to keep the trees dormant until spring. Budding is almost universally done by the so-called eye-budding method,

The Orange Nursery.—The nursery should be on a good porous soil that contains enough clay so that the trees can be balled if this method of transplanting is desired. The seedlings are set about 10 to 12 inches apart in rows $3\frac{1}{2}$ to 4 feet apart. The planting is usually done with a spade or dibble. Care must be taken not to let the roots get dry, and each tree should be set as nearly as possible at the same relative height it occupied in the seed-bed. The soil must be well firmed around the roots, and the plants should be watered as rapidly as planted. Small seedlings and those with imperfect roots should never be planted. Only the best and largest seedlings

¹ From Farmers' Bulletin 539, U. S. Dept. of Agriculture.

using a cut of an inverted T shape and pushing the buds up, being careful to have the leaf-scar of the bud downward. In citrus propagation, especially in the dry, arid sections of the Southwest, it is desirable to use strips of waxed cloth to wrap the buds, covering the buds entirely with the wrapping. The wrapping must remain on until the buds are thoroughly healed on, which will require about three weeks. The California method of forcing the buds is to cut the tops entirely off about an inch or so above the bud. In Florida the trees are cut half off above the bud and lopped over into the row, being allowed to remain until the sprout is a foot or so high.

Care of the Nursery Stock.—As the buds develop into sprouts, stakes must be set beside them, and the sprouts tied to the stake at frequent inter-



SHIELD OR EYE BUDDING.¹

A—Incision on stock. B—Incision with lower ends of bark raised for inserting the bud. C—Bud partly inserted. D—Bud inserted ready to wrap. E—Bud wrapped with waxed cloth.

vals to insure straight trees. A single sprout is usually allowed to grow until it is about three feet high, and then it is headed back to about 30 inches or slightly lower. In forming the crown, three or four main branches are allowed to grow, and it is important for the strength of the tree that these should be on different sides of the young tree and 3 or 4 inches apart. Trees are set at one year or two years from the bud. In California and Arizona, owing to the dry conditions, nursery trees designed for shipment are usually balled. A trench about a foot wide and 14 inches deep is dug alongside of the row of trees, and the tap-root cut and the trees lifted with a ball of earth remaining around the roots. The ball and roots are then

¹From Farmers' Bulletin 539, U. S. Dept. of Agriculture.

wrapped in burlap to hold the soil in place. When trees are to be removed for only a short distance, they may be planted with free roots, as is usually done in Florida. Great care must be exercised at every point to keep the roots moist, and they must be thoroughly watered after planting.

Planting the Orchard.—The site for a citrus orchard must be carefully selected to insure success. The warmest regions should be taken for the lemon and the slightly colder regions for the orange and pomelo. In California, the sloping sections next to the hills are usually considered the best and warmest, as they give good air drainage. In Florida lands in the southern part of the state or with water protection to the north are usually the warmest. The selection of a good site with reference to warmth is highly important.

The orange grows successfully on a wide range of soils, but a good, fine, sandy-loam soil is usually preferred. It is important to have well-drained land. Citrus fruits cannot be successfully grown in wet, soggy soil.

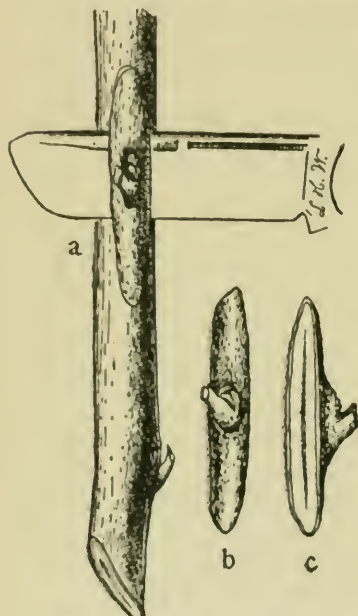
The laying out of the grove is always important and in irrigated countries requires very great care, as it is of the highest importance to be able to water the grove uniformly, and this cannot be done unless the irrigation furrows run at a uniform and proper slope.

Leveling or grading the land is rarely desirable, as this removes the surface soil from some places and makes it for some time unfit for tree growth.

The land for planting should be plowed deep and gotten in thoroughly good condition, finely pulverized and moist. Orange trees are usually planted from 20 to 25 feet apart, most commonly

about 22 feet. Sometimes they are planted 20 feet apart one way and 22 or 24 feet apart the other way. Lemons and pomeloes are usually given rather more space than the orange.

There are four methods of arranging the trees known as the rectangular, triangular, quincunx and hexagonal. Of these the rectangular or square is the simplest and mostly commonly used. Planting in squares 20 by 20 feet gives 108 trees to the acre, and planting 22 by 22 feet, a very common distance, gives 90 trees to the acre. The land to be planted must be laid



SHIELD OR EYE BUDS.¹

A—Method of cutting bud from round twig. B—Bud cut ready to insert. C—Face of bud showing the cut surface.

¹ From Farmers' Bulletin 539, U. S. Dept. of Agriculture.

out accurately and the location of each tree staked. Before digging the holes a notched board with stakes or some other device should be used to insure the exact location and level of the tree in setting. The holes are dug of the size and depth necessary to accommodate the trees. The trees to be set should have their tops cut back severely and all but a few leaves removed. In arid regions, if the trees are not balled, it is not a bad practice to remove all of the leaves.

In planting the trees care should be exercised to plant them at nearly the same level as they were in the nursery. To insure this they must be set about 4 inches higher ordinarily to provide for settling. Many growers prefer to plant five or six inches higher than the level of the ground, having the trees on a slight ridge. This the writer believes to be a good practice. Balled trees are usually planted with the sacks surrounding the roots, these being opened at the bottoms and the strings cut. The sacks rot away in a short time. When trees with free roots are planted, the soil must be well sifted in around the roots and firmly pressed down. Thorough watering must immediately follow the planting. The watering of young trees is facilitated by forming small basins around the trees into which the water can be run.

It is important to protect the trunks of young trees from the sun in order to prevent sun-burning. This is usually accomplished by loosely wrapping several thicknesses of newspapers around them or by means of regular protectors that may be purchased for this purpose.

Cultivation.—Young orchards must be thoroughly cultivated around the trees. It is a common practice for two or three years to grow a strip about ten feet in width of alfalfa, beans or some other crop between the rows of trees, keeping a cultivated and irrigated strip immediately around the trees. As the grove comes into bearing, the normal cultivation of the whole area is taken up.

Many different systems of cultivation are followed in different places. In Florida the common practice is to grow a leguminous cover crop, such as beggarweed or cowpeas, in the grove during the summer, this being plowed or disked in, in the fall, followed by more or less frequent, shallow cultivations until the early summer when the cover crop is again sowed.

In California the most common practice is to grow a cover crop of some legume in the grove during the winter, from September to the first of March. The plants most commonly used for this purpose are the bitter clover (*Melilotus indica*) and the vetch (*Vicia sativa*). Of these the bitter clover is much the best. The purple vetch (*Vicia atropurpurea*), recently imported, is far superior to the ordinary vetch for this purpose, and will doubtless be much used when a sufficient supply of seed becomes available. The cover crop is plowed under to a depth of seven to ten inches during the early part of March before the trees begin to bloom and while the ground is still in condition and moist from the winter rains. Following this the land is harrowed and disked both ways. Very thorough working with the disk

is believed to be preferable to plowing both ways across the grove, as is sometimes done. After this thorough disking the land is harrowed again and then left until it is necessary to furrow out for the first irrigation. In harrowing, either a knife harrow should be used, or if a spike-toothed harrow is used the teeth should be sloped backward in order not to pull up the cover crop.

The first irrigation is delayed if possible until after the blooming period, but the trees must not be allowed to suffer for water. After the irrigation, as soon as the soil has dried sufficiently, the land is harrowed and disked both ways and again harrowed. This should leave the surface soil thoroughly pulverized, and with a dry dust mulch. No other cultivation is necessary until after the second irrigation.

During the dry summer period an irrigation is necessary about every month. Following each of these irrigations, the land should be harrowed as soon as dry enough and about a week later cultivated both ways with some narrow, shoveled cultivator, running to a depth of 4 to 6 inches. These alternating periods of irrigation followed by cultivation are continued during the summer until the winter cover crop is sown in the fall.

In both Florida and California, the practice of mulching a portion or all of the land in the grove is gaining in favor.

Irrigation.—In the citrus regions of California and Arizona, irrigation is necessary and is one of the most expensive and difficult of all the various grove operations. Water in these sections is, however, the limiting factor of production, and an ample supply must be provided. Water is taken directly from flowing streams, is pumped from underground basins, or is taken from large, artificial storage reservoirs, filled mainly during the winter rains. Different locations and soils require different amounts of water. A porous, gravelly soil requires more water than a heavy clay or adobe soil, the latter being more retentive of moisture although more difficult to wet. Groves near the coast where there is more moisture in the air require less water than those in the drier interior regions. In general, enough water must be provided to be equal, when combined with the natural rainfall, to a depth of 35 to 45 inches. In a single irrigation it is ordinarily expected to apply enough water to cover the entire surface irrigated to a depth of about three inches. The supply of water usually provided for citrus orchards is one miner's inch to every four to eight acres.*

In the furrow method of irrigation the water is distributed over the grove by means of several furrows, usually four to six, between each row of trees. These furrows, which are made by a special furrowing tool or plow, should have a uniform fall, preferably not exceeding a grade of one-half of one to three per cent. The water should run through them slowly to give the best results. While these furrows are usually run straight, not infrequently they are curved in between the trees to water the middles. The

* The miner's inch most commonly used in California is the amount of water that will flow through a 1-inch square opening under a 4-inch pressure head. This equals 9 gallons per minute. The statute inch is $11\frac{1}{4}$ gallons per minute.

length of the furrows or of the "run" ordinarily ranges from 400 to 700 feet. While 600 and 700-foot runs are common, this is too long to give the best results.

In the basin system of irrigation, square or round basins, about eight to twelve inches deep, are formed around the trees, into which the water is run either by means of a single central furrow, from which it is turned into each basin successively, or by means of steel irrigation pipes fitted together like joints of a stove-pipe. In making the basins the soil should be left for a radius of about two or three feet around the base of the tree, so that the water will not come in contact with the trunk.

The water is brought into the grove usually either by open cement flumes or by buried cement pipes. These are run across the rows along the upper edge of the grove to be irrigated. With the open flume, gates are put in at intervals to discharge the water wherever a stream is desired. With the covered cement pipe flumes, a standpipe is placed at the end of each row of trees in which several gates are inserted according to the number of furrows or streams desired to be taken from it.

The length of time necessary to run the water is determined by the rapidity of penetration. The application should be continued until the water has penetrated to a depth of three or four feet.

Fertilization.—The great majority of soils on which citrus trees are grown require manuring to maintain the fertility, and yet no subject is so little understood as the fertilizer requirements. If the soil fertility is sufficient to provide for good growth in the beginning, then the addition of the materials removed by the crop, it would seem, should be sufficient to maintain the fertility. The following table shows the average percentage of nitrogen, phosphoric acid and potash in orange and lemon fruits and the pounds of these materials removed by a ton of fruit.

FERTILIZER ANALYSIS OF THE FRUIT OF ORANGES AND LEMONS.
(Computed from Bulletin No. 93, University of California
Agricultural Experiment Station.)

	Nitrogen (N)		Phosphoric Acid (P_2O_5)		Potash (K_2O)	
	Per cent.	Pounds per Ton.	Per cent.	Pounds per Ton.	Per cent.	Pounds per Ton.
Oranges.....	0.190	3.80	0.058	1.16	0.219	4.38
Lemons.....	0.151	3.02	0.058	1.16	0.253	5.06

Such a table as the above is suggestive only as a guide to fertilization, and the same may be said regarding soil analyses. The test of a fertilizer on the soil and the crop is the only safe guide.

In Florida a fertilizer containing about 3 to 4 per cent of nitrogen, 6 to 8 per cent of phosphoric acid and 8 to 12 per cent of potash is commonly used. In California the proportions commonly recommended are 4 per

cent nitrogen, 8 per cent phosphoric acid and 4 per cent potash. In general, young trees are thought to require more nitrogen and a relatively smaller proportion of phosphoric acid and potash.

In Florida there is a tendency to avoid so far as possible the use of organic manures, such as stable manure, blood, cottonseed meal and the like, owing to the effect such materials apparently have in the production of the disease "die-back" or exanthema. Sulphate of ammonia, sulphate of potash and superphosphate are very largely used.

In California, on the contrary, the tendency is to use organic sources to supply the various elements so far as possible. Experimental results indicate that organic matter and nitrogen are the most important elements to be added in the fertilization of citrus soils in California and minimize the importance of potash and phosphoric acid. Eight-year experiments show no gain over checks by the use of sulphate of potash with oranges and very slight gains with lemons. Similar experiments with superphosphate show but slight gains over check plots, while nitrogen plots give marked increase in growth and yield. California growers in general prefer stable manure to any other fertilizer and are also using large quantities of alfalfa hay and bean straw, both plowed under and as a mulch to supply nitrogen and organic matter.



PRUNING AND ROOT TRIMMING OF CITRUS TREE AT TIME OF PLANTING.

the necessary nitrogen can be produced in this way at very slight expense.

Pruning.—Ordinarily orange trees are pruned very little beyond the removal of dead brush and water-sprouts, but this results in the formation a very dense tree with the fruit distributed over the surface. The inte-

rior fruit is in general superior, and the removal of some of the interior limbs keeping the tree somewhat open is probably a desirable practice.

Lemon trees are generally pruned regularly. They should be cut back severely from the first and allowed to develop but slowly. The tendency of the lemon is to throw out long branches, which fruit at the end and are likely to bend over and break off or to be in the way. The principal purpose should be to cut back this rapid growth and develop a strong, stocky tree that will be open enough to bear considerable fruit on the interior branches. The lateral, crooked branches are much more fruitful than the upright, straight branches.

Trees are pruned at almost any season of the year, but the best time is in the spring after the danger of freezing is passed.

Frost Protection.—Many citrus-growing sections are occasionally visited by severe freezes that may cause a loss of the crop and even severely damage the trees. It has thus been found desirable, particularly with lemons, to provide some form of artificial protection.

In California this protection has been secured by the use of orchard stoves, burning crude oil, abundant quantities of which are available from nearby oil fields at reasonable prices. The principle of orchard heating, recognized as the most desirable, is to get the greatest amount of heat possible with the least soot and smoke. Direct, radiated heat is desired rather than a smudge.

In Florida oil heaters have been used to some extent, but there the burning of wood piled in the grove and other devices are also used.

Diseases.—The number of diseases affecting citrus trees is probably as great as those affecting any other similar group of plants. For many of these satisfactory treatments are known, but there are several maladies which are serious that are not as yet thoroughly understood. Only a few of the most important diseases can be mentioned.

The general group of gum diseases is important in most citrus-growing regions. Lemon gummosis, caused by the brown rot fungus (*Pythia-cystis citrophthora*) causes considerable damage in California and is also present in Florida. This disease, which causes the exudation of gum and the decay of the bark on lemon trunks, is effectively controlled by cutting out the diseased parts and painting the injured surface with Bordeaux paste. Maldigomma or foot-rot, a closely related disease that occurs mainly in Florida, is controlled by use of the sour orange stock which is resistant to the malady, and may be cured usually by removing the dirt from around the crown roots, cutting out the diseased areas and painting them with Bordeaux paste. Another type of gummosis is the *scaly bark*, common both in California and Florida mainly on the limbs and trunks of orange trees. This disease is not understood at present, but is checked by cutting out and sterilizing diseased areas with Bordeaux paste.

Exanthema or die-back, a disease common in Florida and occurring to some extent in California, is apparently due to malnutrition, but is not

understood. When caused by use of organic manure, such as blood, stable manure and the like, it is cured by stopping fertilization and cultivation for a period and mulching the tree. When caused by lack of drainage, tile drainage of the area frequently results in a cure.

Mottled leaf, a very common and injurious malady in California, is an obscure disease, the cause of which is not yet known. Very extensive investigations of this disease are now in progress.

Citrus canker, a very serious malady caused by a bacterium (*Pseudomonas citri*), has recently become epidemic in Florida and the Gulf states. It is now known to occur in Japan and the Philippine Islands and was apparently introduced into Florida from one of these sources. An extensive campaign is now being waged to eradicate this disease by burning all infected trees.

Verrucosis, or scab, and melanose are two important fungous diseases occurring in Florida that have not appeared as yet in California. Wither-tip, caused by the fungus *Colletotrichum gloeosporioides*, is common both in California and Florida. It is controlled by pruning accompanied by spraying with Bordeaux mixture.

Many fruit rots caused by such fungi as the cottony mold (*Sclerotinia libertiniana*), brown rot (*Pythiacystis citrophthora*), blue mould (*Penicillium italicum*) and green mould (*Penicillium digitatum*), cause considerable loss in the packing-house and in shipment. These are controlled by careful handling, by the use of disinfectants in the wash water and the proper sterilization of the fruit boxes and packing-house machinery and the like. (For other diseases see Part II.)

Insects.—Insect pests are very numerous in all citrus sections and require the systematic use of control methods to insure the financial success of the industry. By far the most serious pests are the scale insects of which there are numerous kinds.

In California the most common scale insects are the black scale (*Saissetia oleæ*), the citricola scale (*Coccus citricola*), the red scale (*Chrysomphalus aurantii*) and the purple scale (*Lepidosaphes beckii*). The control of these scale pests is aided to some extent by various parasites, but fumigation with hydrocyanic acid gas about once every two years, or more often if necessary, is almost universally practiced.

The cottony cushion scale (*Icerya purchasi*), which at one time was so serious as almost to threaten the life of the citrus industry in California, has been so thoroughly controlled by the introduction of the Australian ladybird beetle that it has ceased to be considered a serious pest.

In Florida the most common scale insects are the purple scale (*Lepidosaphes beckii*), the long scale (*Lepidosaphes gloverii*), the Florida red scale (*Chrysomphalus aonidum*), the chaff scale (*Parlatoria pergandii*), the soft brown or turtle-back beetle (*Coccus hesperidum*), the black scale (*Saissetia oleæ*) and the hemispherical scale (*Saissetia hemisphaerica*). In the control of these insects in Florida, more reliance is had upon parasitic fungi and insect

enemies than in California. While fumigation is used to some extent, when any treatment is used it is usually spraying with paraffin oil emulsion. Good's caustic potash whale oil soap, resin wash or kerosene emulsion.

The white fly (*Aleyrodes citri*), probably the most destructive insect pest in Florida, occurs in only one place in California and has not there become widely spread. It is controlled by fumigation or by spraying with paraffin oil emulsion, resin wash or kerosene emulsion.

The mealy bug, red spider, rust mite, thrips, aphid and numerous other insects cause damage both in California and in Florida and in other citrus sections, but are of minor importance.



PICKING AND PACKING ORANGES.

Picking, Packing and Marketing of Fruit.—The methods of picking, packing and marketing of citrus fruits are probably more highly developed than in any other fruit industry. The picking is in large measure done by carefully trained special picking gangs connected with the packing houses, rather than by the growers themselves. This insures the most careful work and handling and the employment of uniformly good methods.

The curing, grading and packing is also done by specially trained men working continuously under inspection to insure careful handling at every point. The special machinery devised for washing, drying, grading, sizing and boxing has reached a high degree of perfection and is almost universally used in the citrus sections of the United States. The watchword of all packing houses is *careful handling* to avoid bruising or puncturing the skin of the fruit and thus prevent decay.

The marketing methods have been developed with similar thoroughness, and a very large proportion of the fruit of California is marketed under the direction of a co-operative organization of the growers known as the California Fruit Growers' Exchange. This is probably the most successful co-operative organization of growers in the world.

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CHAPTER 13

NUTS AND NUT CULTURE IN THE UNITED STATES

BY C. A. REED

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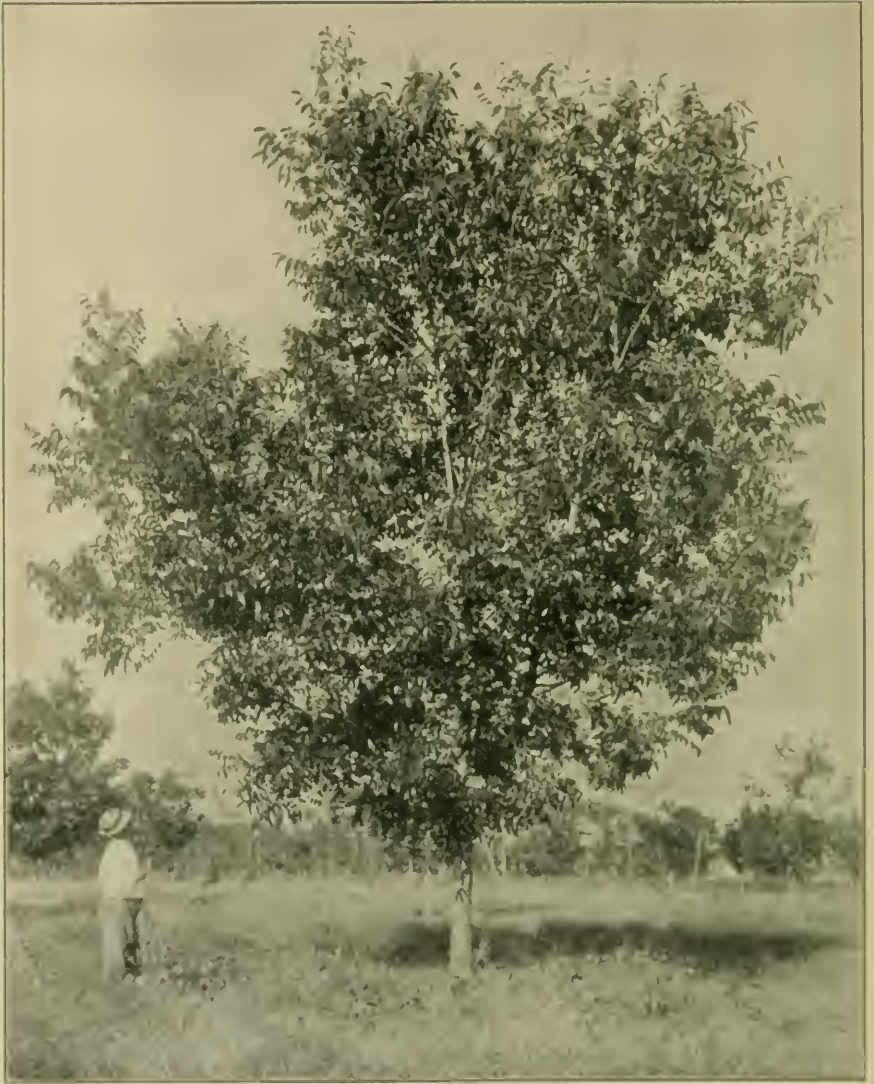
THE PRINCIPAL NUTS

The group of trees which bear edible nuts of commercial importance in this country includes a considerable number of species, some of which are important in both hemispheres. The most important of the world's nuts are the cocoanut, the peanut, the Persian (incorrectly called the English) walnut, the almond, the Brazil nut, the pecan, the hazelnut (filbert), the cashew, the pinon, the chestnut and the pistachio nut. Of these, with the exception of the Brazil nut (nigger-toe, Para nut, cream nut, castanea, etc.), which is strictly tropical in its requirements of culture, all are being grown to a greater or less extent, in continental or insular United States. The pili (pe-lee) of the Philippines and East Indies, characterized by its reddish-brown (artificial) color, its triangular form tapering to a point at each end, its very thick, hard shell and its single kernel, is now becoming fairly familiar in our principal nut markets. The pili nut is said to be very nutritious and pleasing to the taste when properly matured, but as it commonly appears in this country, it is inferior in quality to the majority of the better known nuts.

A choice nut occasionally seen in the American markets is the Paradise nut, a near relative of the Brazil nut, which also is indigenous to the lowlands of northern Brazil. Paradise nuts are somewhat longer than are Brazil nuts, but in the main are triangular in form. They are of a light buff color, irregularly grooved lengthwise, and have a close-fitting cork-like shell which encloses a single, delicately flavored kernel of fine texture.

Both the pili and the Paradise nuts are like the Brazil nut in that their tropical natures apparently preclude any likelihood of their ever becoming commercially important in any part of the United States proper.

The culture of the cocoanut, together with the drying and shipping of its dried flesh or copra, forms one of the leading industries throughout all tropics. The cocoanut produces the world's most important nut food supply. To some extent the cocoanut palm is grown in southern Florida, but thus far more largely as an ornamental and a curiosity than for commercial purposes. During the winter season cocoanuts are locally in lively demand as souvenirs among the tourists, who place postage and the addresses of northern friends on the smooth outer surfaces of the thick



SCHLEY PECAN TREE.
In its seventh year and beginning to bear. Cairo, Ga.

husks and send the nuts through the mails. The expense of removing the husk from the nut has thus far made commercial cocoanut growing in this country in competition with the cheap labor of the tropics practically out of the question. Nevertheless, it is not unlikely that the devising of special machinery will soon overcome this problem, and that a more or less thriving industry will develop in the marshy borders of southern Florida. A few commercial cocoanut plantings recently set may be found off the Florida coast from Miami and near Cape Sable in Monroe County; but it appears altogether unlikely that the growing of cocoanuts will ever be of importance to American farmers outside of the southern parts of Florida, Texas and California.

The cashew nut likewise is of tropical nature. Trees of this species are rarely seen in the United States except in experimental plantings in Florida and in California. The nuts are borne singly at the apex of fleshy, pear-shaped fruits which form in clusters and which are known as cashew apples. The nuts are of much the shape of lima beans, but are both larger and thicker. In color they are between a purplish and an ashy-gray. They have a thin but stout, smooth-surfaced shell, within which is a secondary shell, also thin, and which encases the kidney-shaped kernel.

Between the two shells of this cashew nut there is a thin dark-brown fluid of an extremely caustic property similar to that of poison ivy and sumac, to which the species is closely related. Roasting entirely dispels this poison, and as the nuts are invariably prepared in this manner before being placed on the market, the consumer is in no danger of being poisoned. The kernels are among the most palatable of all nut products now found in our markets.

For the present, the cashew can hardly be said to be of commercial promise in any portion of this country.

The pistachio is much more hardy than is the cashew. To a considerable extent the two are now being grown in sections of southern California and west Texas, and single trees have been known to survive for a number of years in climates where zero temperatures are by no means uncommon. Thrifty trees are reported from Kansas and one tree several years of age near Stamford, Conn., was in a thrifty condition when seen by the writer in 1914. However, it is essentially a dry-land tree suited to the milder portions of the temperate zones. The nuts, which are encased in a thin leathery covering, form in loose clusters. They have thin but very stout, smooth shells which usually split open on one side of the suture while being roasted. To a considerable extent, the kernels, which are of greenish color and delicate flavor, are consumed with no preparation other than that of roasting and salting, but more largely they are ground and used in ice creams and other confections. The pistachio tree is a slow grower, requiring several more years to come into bearing than is the case with almond, Persian walnut or pecan trees. Propagation is by budding and grafting.

The Peanut.—The peanut is probably a native of tropical America.

It does well in light-colored, fertile, sandy loams in the warmer portions of the United States. Its principal centers of production in this country are in Virginia and the Carolinas, although it is common in the entire South, west to California. The peanut is common in the markets both in the shell or shelled and salted. Peanut butter and peanut oil are now among the most valuable of our common nut products. An average yield of peanuts is about 34 bushels an acre.

The Pinon (*Pin-yon*).—The seeds of a number of pines of western and southwestern United States, variously known as pinons, Indian or Pine nuts and pignolia, form a very important article of food for the Indians



FRANQUETTE WALNUT ORCHARD, NEAR SANTA ROSA, CALIFORNIA.
This is the famous Vrooman Orchard.

and the Mexicans of the Southwest, who gather the nuts in enormous quantities. In this country the pines bearing edible nuts are not cultivated; the entire crop being obtained from the native trees in the mountains, which usually appear at altitudes of from 5000 to 7000 feet. The home product is largely consumed by the gatherers, and in the local markets of the West. The nuts are brownish in color, usually mottled with yellow, from an eighth to a quarter of an inch in length and have a thin but strong hard shell. The kernels are very fine in texture, rich in quality, of pleasant flavor and highly nutritious. The shelled seeds of the stone pine of southern Europe, greatly resembling puffed rice in form and color, form an important product in the nut markets of our Eastern cities.

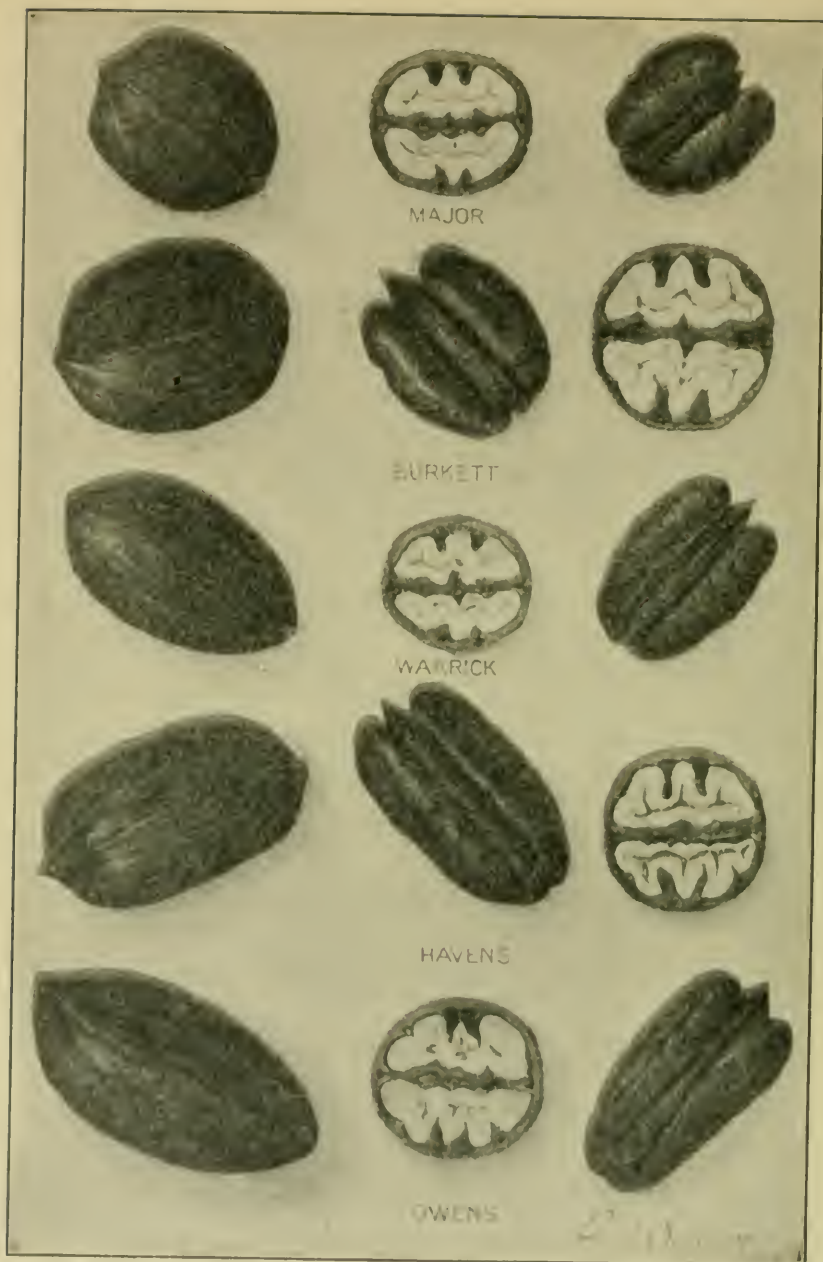
The Persian Walnut.—For many centuries this nut, a native of Persia,

has been under cultivation in southwestern Asia and in Europe, but with approximately a half century of serious cultivation in this country it has attained its greatest degree of perfection on our Pacific Coast. In the Old World, and until recently in the United States, propagation has been by seedage, but modern American orchards are comprised exclusively of budded or grafted trees. For its best development the species requires a deep, fertile, loamy soil, moist but well drained. However, it readily adapts itself with proportionate results to conditions less favorable. At the present time the chief centers of production in the United States are southern California near Los Angeles, the Sacramento Valley in northern California and the Willamette Valley of western Oregon. Varieties suitable for general culture in the southeastern quarter of this country have not yet appeared. In that area of the Eastern states lying between lower New England and the Potomac River on the Atlantic Coast and extending west to the Mississippi River, local varieties originating with trees reputed to be hardy and prolific bearers of desirable nuts are being given a fairly general trial. These are being propagated by budding on the black walnut stocks. To date, the chief eastern varieties are the Rush, Nebo, Barnes, Potomac, Holden, Hall, Lancaster and Boston. Thus far none of these have been given sufficient trial to determine their commercial value. For the present, planting should be limited to experimental numbers.

The most popular varieties of walnuts in southern California are the offspring of the Santa Barbara type, established during the late sixties by Mr. Joseph Sexton of Santa Barbara, with seed supposed to have come from Chile. Southern California walnuts are not sold under variety names, but under such trade appellations as "budded," "numbers one," "two," "three," etc.; the term "budded" applying to the large sizes which will not pass through inch squares of a wire mesh.

The leading varieties of northern California and Oregon are from French stock first introduced into this country by Mr. Felix Gillet of Nevada City, Cal., whose work closely followed that of Mr. Sexton, and these to a large extent are sold under their variety names. At present the more important are the Franquette and Mayette, direct introductions, and the Concord, San José and probably the Chase, seedlings of original introductions.

The Pecan.—The pecan is by far the most important nut indigenous to this country, and although at present its annual production is less than one-half that of the Persian walnut, the increased attention now being paid to the native bearing trees and enormous number of planted orchards in the south Atlantic and eastern Gulf states combine to make it fairly certain that this will soon become the leading nut grown in America. Its native range includes much of the lowlands of the Mississippi River and its tributaries from Davenport and Terra Haute on the north, south to near the Gulf and a large area extending southwest across Arkansas, Louisiana, Oklahoma and Texas to near the Rio Grande. Its requirements



MAJOR, BURKETT, WARRICK, HAVENS AND OWENS PECANS.¹

¹Year-Book, 1912 U. S. Dept. of Agriculture.

of soil and moisture are much the same as are those of the Persian walnut. However, it appears to be somewhat more exacting in its moisture requirement, for although being intolerant of improper drainage, it is less able to sustain itself proportionately in drier soils.

The pecan is propagated by budding and grafting on stocks of its own species. Under the most favorable conditions seedlings grown from nuts planted in midwinter may be budded when eighteen months old, and transplanted in orchard form by the end of the next season, or by the time the roots have been in the ground for three years.

Thus far a total of approximately one hundred varieties have been recognized in the South. The majority of these already have been eliminated. At present, the principal sorts of the south Atlantic and Gulf section, including Louisiana, are the Stuart, Schley, Curtis, Van Deman, Alley, Pabst, Money-maker, Bradley, President, Russell, Delmas and Success. The leading varieties of central and southwest Texas are the San Saba, Halbert, Colorado, Sovereign and Kincaid.

The varieties of neither of these groups appear readily to adapt themselves to the climatic conditions of the other, nor do they seem capable of satisfactorily adjusting themselves to conditions in any of the inland states.

Varieties which have originated in southwestern Indiana and neighborhood, and which, therefore, now are thought to be well worthy of conservative planting in sections of fairly comparable conditions, are the Major, Niblack, Indiana, Posey, Busseron, Butterick, Greenriver and Warrick. However, for the present these should not be planted in latitudes greater than that of Vincennes, with the expectation of regular crops of nuts. If set in suitable soil the trees should thrive and live to a great age much farther north, but crops of nuts even from the forest trees are quite irregular beyond that point.

The Almond.—Culturally speaking, this nut is not of much interest to a great part of the United States. Its exactments for cultural success preclude its general planting over any large portion of the United States. It requires a fertile, moist, yet very well-drained soil and a dry atmosphere in a section quite free from late spring frosts. The commercial plantings of this country are in the Sacramento Valley of California, where the orchards are usually equipped with fire-pots as a protection against frost at blossoming time, and in northwestern Utah. A number of large young orchards just beginning to bear are on the highlands of Klickitat County in south central Washington near the Columbia River. The principal varieties are the Nonpareil, I. X. L., Ne Plus Ultra, Drakes and Languedoc.

The almond is propagated by budding on stocks preferably of its own species, although peach stocks answer nearly as well.

At least one variety of hardshell almond (the Ridenhower, of southern Illinois) is being propagated by eastern nurserymen for variety planting about the home grounds in sections adapted to the more hardy varieties

of peaches. However, in no way does this almond compare with those in the market.

Nuts of Minor Importance.—In this class belong all of our native tree nuts, with the exception of the pecan. Our native hickories, the shagbark (*Hicoria ovata*), the shellbark (*Hicoria luciniosa*) and the pignut (*Hicoria glabra*), the butternut (*Juglans cinerea*), the American hazel (*Corylus americana*), the beech (*Fagus grandifolia*) and certain foreign nuts, especially the Chinese chestnut (*Castanea mollissima*), and the Asiatic walnuts (*Juglans sicboldiana* and *Juglans mundshurica*), afford most inviting fields for the breeder and improver of nut trees.

The most of these species are capable of culture in the Eastern states from lower New England south to the middle Atlantic and west to the Mississippi. It is quite probable that this group also offers the most fruitful possibilities in nut culture in the states lying between this section and the Rocky Mountains.

In general, prospective growers of nut trees should obtain their stock from reliable nursery concerns, and in so far as obtainable, budded or grafted trees only should be planted. These are not now obtainable to any extent of the group just mentioned, although several varieties of hickory and black walnut are now being propagated by a few nursery concerns.

Nut trees should be ranked in the class with other kinds of fruit trees, and must be given the same degree of attention. Under the most favorable conditions commercial returns may be expected with almonds in from 6 to 8 years from the time of setting the trees; with Persian walnut trees in from 8 to 10 years; and with southern pecans in from 10 to 12 years. Almond trees may be set at from 28 to 30 feet apart, while walnuts and pecans should be set not nearer than 60 feet.

Each species of nut tree has its insect pests and fungous diseases, each of which is more or less serious. With the almond, the present most serious pest doubtless is the red spider; with the walnut, it is the walnut blight; and with the pecan, it is the rosette; although each species of tree has its other serious enemies.

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CHAPTER 14

MISCELLANEOUS TROPICAL FRUITS*

The Pineapple.—As a tropical fruit the pineapple ranks second to the orange and banana. Originally a wild fruit, very small in size, it has by constant cultivation and improvement been developed into one of the choicest fruits in existence. Some varieties now produce very large fruit, weighing as much as twenty pounds.

Pineapples thrive best in Porto Rico, Cuba, Hawaii and the tropical islands, but can be grown easily in southern Florida and even further north, if not exposed to frost.

The pineapple resembles the cabbage in that it grows on a short, leafy stalk from one to three feet high. The plant is very leafy, the leaves of most varieties being edged with spines.

Propagation.—Pineapples are propagated by means of ratoons, suckers, slips and very seldom, when only for experimental purposes, by the seed. A ratoon is an individual plant formed among the roots of the mother plant and appearing beside it from under the soil. A sucker is an individual plant coming from the side of the stem above the soil. A slip is the small plant that appears below the fruit on the fruit stalk. The small plants that grow on the apex of the fruit are known as the crown slips. There is no difference in the kind of plant produced by either the ratoon, the sucker or the slip. However, the sucker and the slip are to be preferred, because plants from ratoons will die easily if not handled properly. The main thing is to select a well-matured slip or sucker. Suckers have an advantage over the slips, inasmuch as they are several months older and, of course, they bear sooner. Whether suckers or slips are selected to be planted, they should be trimmed by cutting the base and stripping off the lower leaves. One inch and a half to two inches of stem should be left exposed. It is better to let them dry a little before planting. This is called curing.

Soil.—The pineapple will grow in a great variety of soils, but thrives best in light, deep, well-drained, sandy soils. Damp and heavy soils are unfavorable. The plant is a gross feeder and calls for a liberal supply of nitrogenous fertilizers. Experiments carried on in Porto Rico have demonstrated that the plant responds to commercial fertilizers. A small plant, although in poor soil, has attained astonishing proportions after the fertilizer has been applied. So, when enough plant-food is available and the roots may obtain all the air they need, the pineapple can be successfully grown on a wide range of soils.

*In preparing this chapter the author was assisted by Mr. F. G. de Quevedo, formerly of Porto Rico, now teacher of Spanish in Pennsylvania State College.



THE PINEAPPLE PLANT IN FRUIT.¹

1—Main stalk. 2—Ratoon. 3—Sucker. 4—Head of fruit. 5—Slip. 6—Fruit.
7—Crown slip. 8—Crown.

¹Courtesy of U. S. Dept. of Agriculture. From Porto Rico Bulletin No. 8.

From one to two thousand pounds per acre of blood and bone or cottonseed meal will improve the size and quality of the fruit, and maintain the fertility of the land. The following summary taken from Bulletin 104 of the Florida Experiment Station, will serve as the best guide for the fertilizing of pineapples.

(a) Fine-ground steamed bone and slag phosphate are best as sources of phosphoric acid; cottonseed meal, dried blood and castor pomace are best as sources of nitrogen; high-grade and low-grade sulphate of potash are best as sources of potash.

(b) Nitrate of soda, acid phosphate and kainit have not proven satisfactory. (While sulphate of ammonia was not used in the experiment, this material has in general practice been found unsuited to pineapple culture.)

(c) In case of shedded pineapples it has been found that it is profitable to use from 2250 to 3750 pounds per acre annually of a complete fertilizer.

(d) Analyses of a large number of fruits (Red Spanish) covering a period of four years show that the eating quality of the fruit is not affected by the kind of fertilizer used.

(e) The sugar content of the fruit (Red Spanish) is slightly increased by the heavier fertilizer applications.

(f) The large fruits contain a slightly higher percentage of sugar than the small ones.

(g) The analyses of a large number of pineapple plants show that they contain sufficient fertilizing materials, nitrogen, phosphoric acid, potash, lime and magnesia to make them of considerable value as a fertilizer.

(h) With an increase of nitrogenous fertilizers there was found an increase of nitrates in the soil.

(i) Nitrates are most abundant at the immediate surface. After a depth of one foot is passed the amount is very small.

(j) Where the surface of the ground is not protected, the nitrates are much less abundant than where there is a covering of plants and decaying leaves.

Preparation of Soil.—The essentials for the pineapple are a limited water supply, abundance of air for the roots and plenty of available plant-food. The selection and preparation of the soil should meet these requirements, as fully as possible. Sandy soils or sand, naturally most nearly meet the physical requirements. Such soil should be thoroughly plowed and freed from noxious weeds and grass before starting the plantation. If the soil is level and inclined to be wet after excessive rains, it should be made into rather wide beds on which the plants are set. The plants are set in rows 15 to 18 inches apart and as many as 20 rows to the bed. The advantages of this close setting lie in economy in the use of fertilizers, the support which the plants give to each other, and the thoroughness with which they shade the ground and prevent the growth of weeds and grass after they are fully established. With this system of planting, there should

be ample room to pass between the beds for the purpose of carrying the fruits from the field when they are mature. There should also be roadways crossing the beds at intervals of a few hundred feet sufficiently wide to allow the passage of a wagon.

When planted on heavier soils the single-row or double-row systems of planting is preferred. This allows for horse cultivation by means of which



PINEAPPLES PLANTED IN AN ORANGE GROVE.¹

This provides a revenue from the land while the trees are coming to the bearing age.

weeds and grass are subdued and the soil kept loose to facilitate thorough aeration.

Pineapple plants bear but one fruit, after which they die. The new crop is secured from the slips and suckers from the mother plant. Like most crops, pineapples will not succeed by continuous cultivation on the same land. A rotation of crops is therefore advised. On soils that are especially well adapted to the pineapple three consecutive crops can be grown before the soil is devoted to other crops.

Cultivation.—The cultivation should aim to maintain a loose condition of soil and prevent the growth of weeds and grasses. Hand cultivation will be necessary in case of level, sandy soils planted in beds as above

¹Courtesy of U. S. Dept. of Agriculture. From Porto Rico Bulletin No. 8.

mentioned. The looser the sand the less stirring will be required and the greater the saving in labor. When planted in the single-row system the cultivation should also aim to support the plants from tipping over as much as possible. The fruits being borne at considerable height and being of considerable weight, cause the plants to tip. In this position the fruits are subject to sun-scald on one side which gives them a poor appearance when placed upon the market.

Varieties.—The leading varieties are the Cayenne, a conical, slightly yellow, aromatic, juicy fruit, weighing as much as ten pounds: Queen, an exceptionally aromatic fruit, very desirable and very extensively cultivated; it is a good keeper, ships well and weighs as much as eight pounds per fruit: Spanish, medium in size, juicy, good quality and early, fruits weigh as much as six pounds and are a favorite on many of the markets. There are many other varieties that are good for local consumption, but not all of them possess good shipping qualities.

Marketing.—The keeping qualities of pineapples depend largely upon the care with which they are handled. They are susceptible to injuries, especially bruises, and should be handled as carefully as strawberries or other perishable fruits. Stiff bushel baskets are recommended for collecting the fruit from the plants. Some of the varieties may be removed from the plants by giving the fruit a quick jerk across the knee. Others, like the cabezonas, must be cut off. In all events, the stem must never break into the fruit. Cutting with a long stem is advised.

The fruit is best shipped in crates. It should be graded to uniformity in size and appearance. Care should be exercised to so pack that the spines on the crowns will not puncture the fruit.

The Avocado is a tropical tree, adapted to climatic conditions in southern California and a considerable portion of Florida. Most of the varieties are injured by frost, but the more hardy ones will stand a few degrees below freezing. The tree is an evergreen with large, leathery leaves. It attains a height of from 25 to 60 feet, depending upon the variety and local conditions. The wood is brittle and easily broken by winds. The flowers and fruit are easily blown from the trees. For this reason the trees should be grown in sheltered locations or artificial windbreaks should be provided.

The fruit varies in size, shape and color. While it is usually pear-shaped, it not infrequently is round or oval. The color ranges through light-green, dark-green, brown, purple and red. The center of the fruit contains a single, large, round seed. The yellowish-buttery, fleshy portion between the seed and the skin is the edible part. It is rich in protein and oil, the percentage of the latter ranging from 10 to 30 per cent of the pulp.

Professor J. E. Higgins, in Bulletin No. 25 of the Hawaiian Experiment Station, describes the fruit as follows: "Its unique character reduces to a minimum its competition with other fruits, while its rich, nut-like flavor is almost universally enjoyed among those who have known it long enough to become familiar with its peculiar charm. It is a fruit and yet so unlike

other fruits as to suggest a class of its own, and for this reason it has been called a 'salad fruit.' But this term seems too limiting, because it is used in so many other ways. There are many ways in which it might be served. The simplest treatment is to cut open the fruit longitudinally, remove the seeds and serve, affording everybody the opportunity to add salt, pepper, vinegar, olive oil, lime juice or other seasoning in any combination to suit the individual taste. Some prefer it as a dessert with sugar and cream, or with wine and lemon or orange juice. It may be served on the side with



THE TAFT AVOCADO FRUIT.¹

soup, and in this way is delicious. It is true that the taste for the avocado is an acquired one, yet there are few, if any, food products which so quickly overcome any prejudice and become so highly esteemed. The novice may pronounce the first fruit worthless, but the second is tolerable, the third good, the fourth better, the fifth a delight and after that the difficulty of learning to like them usually gives place to that of getting them often enough."

The avocado is adapted to a wide range of soils. It demands good drainage and plenty of organic matter. The trees do well

in the southern coast district of California and in various sections of Florida. The geographic limits of successful avocado culture are at present undetermined.

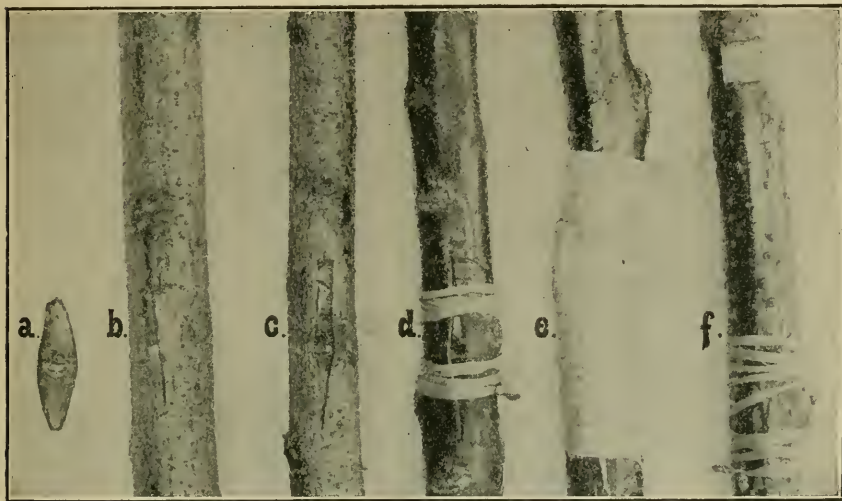
The avocado responds to judicious applications of fertilizers. The texture and flavor as well as the yield of fruit are improved by fertilizers. Excessive amounts of nitrogen should be avoided.

The trees are propagated from the seeds. These must be fresh, as they soon lose their vitality when exposed to the air. It has been a common practice to produce bearing trees from the seedlings without grafting. The seed should be planted in the soil either in pots, in nursery rows or in

¹ Courtesy of University of California, College of Agriculture, Berkeley, Cal.

permanent position in the orchard. They should be planted so that the upper portion of the seed protrudes slightly above the surface of the soil. Best results are usually obtained by planting in pots and transferring the seedlings to the field when they are of the proper size.

When the trees are not to be grafted the seed should be selected with much care, only the largest seeds from trees that produce the best quality of fruit being used. Even this care will not insure a uniform good quality in the new orchard. Like all seedlings, they seldom come true to the parent stock. Best results are, therefore, obtained by propagating through some



METHOD OF BUDDING THE AVOCADO.¹

form of cuttings, selecting the scions from trees that are prolific and produce fruit of good quality.

Until recently it has been thought impossible to successfully bud the avocado. Careful study of the subject and numerous experiments have resulted in a successful method of budding, following what is known as the shield budding method. This is similar to that practiced in the budding of citrus trees. The success seems to depend chiefly upon the character of growth from which buds to be inserted are selected. Buds from what is called second flush in growth have been found superior to those in any other stage of development.

It is often desirable to re-work good-sized trees. This may be successfully accomplished by budding into new wood forced out for the purpose. The trees are usually cut back severely in the spring and the cut stubs

¹ Courtesy of U. S. Dept. of Agriculture. From Porto Rico Bulletin No. 8.

covered with wax or paint to prevent decay. Of the new shoots that start, only a few are allowed to grow and when these attain a size of three-quarters of an inch in diameter they are ready for budding in the manner above described.

Pruning should take place during the early growth of the trees to establish low heads and the proper form. After well grown, trees require very little pruning. The wood, being quite soft, will not stand abuse from pruning instruments. All cuts should be smoothly made and, on all larger branches, should be protected with a covering of paint or wax to prevent decay.

The seedling trees come into bearing between the fourth and eighth years, the average bearing age being about six years. The life of the tree in Florida and California is as yet not determined, although there are records of trees eighty or more years old in some parts of the American tropics. It will be safe to estimate the bearing life at not over twenty-five years.

Like the deciduous fruits, the avocado has a tendency to fruit in alternate years. This is generally due to setting more fruit than can be properly matured. Thinning is therefore advised. This will encourage larger size and better quality of the fruits that are allowed to remain and will not overtax the tree so as to prevent its bearing a crop the following year. Individual trees of the thin-skinned Mexican variety in southern California have produced as many as 5000 small fruits annually. Such fruits have little commercial value, but are of considerable value for their seeds, which are used for nursery purposes. Of course, these should all be grafted or budded before being set in orchards.

All fruits that are to be placed upon the market should be hand picked and handled with the greatest care. Orange clippers are advised for this purpose, about three-eighths of an inch of the stem being left on each fruit. The fruits, if to be shipped, should be carefully wrapped and packed in small packages, so that they will carry without injury. Fruits of fine quality in good condition on the large city markets in the United States sell for 30 to 75 cents each. The kind of fruits to ship will depend upon market demands and the shipping qualities of the different varieties.

The industry of growing avocados is comparatively new and a list of the most desirable varieties for different purposes is not available. At least twenty-five different varieties of California origin have come to notice. It is doubtful if the commercial variety of the future has yet appeared. At least, none have been found that may be considered good shippers.

As a fruit the avocado exceeds in food value all other species. A test of the food value of twenty-six varieties gave an average of 984 calories per pound of edible fruit. This is important, as it is more than twice the maximum noted for any other fruits. The fuel value is not far from twice that of average lean meat. Of course, they are much lower in protein.

The avocado is worthy of careful experimentation in those localities where climate will permit of its growth. It doubtless has great possibilities, although the demand for the fruit at present is limited.

The Mango.—It originated in India. There it has been cultivated for many centuries and the fruit is as important to the people of that country as is the apple to the people of North America.

The fruit of the mango is not well known outside of the regions in which it is grown. It is strictly a tropical fruit and under favorable condi-



FRUIT OF THE MANGO. SEED ON THE RIGHT.¹

tions the tree attains a height of sixty feet or more and produces fruit for several decades. In the United States it is grown chiefly in the southern part of Florida. When in a dormant state the trees will withstand a temperature of seven or eight degrees below freezing, but if growing rapidly when freezing weather occurs, the trees are killed back to the ground.

It does best on fairly deep, rich, well-drained soils, but requires a liberal amount of moisture.

Mango trees are usually propagated from seeds. As with any other fruit, trees produced in this way are not true to the parent stock. More

¹Courtesy of U. S. Dept. of Agriculture. From Annual Report of Porto Rico A. E. S., 1912.

recently, methods of grafting by inarching and patch grafting have come into use. The usual method of budding deciduous trees has not given satisfaction with the mango.

Inarching has long been in use in India. It has been adapted in Florida with many modifications.

The mango seeds are generally planted in pots four or five inches in diameter and eight to twelve inches deep. These may be made from cypress shingles or by using the internodes of rather large bamboos. The seeds are laid flatwise in the soil and covered to a depth of about an inch and a half. The pots must be watered at frequent intervals.

Best results are secured if seedlings are kept under partial shade. When they have attained a height of ten to twelve inches they are ready to be inarched. The pots are brought near the tree from which scions are to be secured. If the tree is so tall that its branches cannot be bent down to the ground, it will be necessary to provide a scaffolding to support the pots. The tree selected for this purpose should be one bearing the best quality of fruit. Branches for inarching should be in such condition that the bark will peel freely. A strip of bark about three inches long is removed from the side of the stock. A similar strip is also removed from the scion and the two are brought together so that the cut surfaces will fit closely and are securely held by wrapping. In about two weeks a cross-cut may be made in the stock two or three inches above the union and in the scion, just below the union. After two more weeks, these cuts may be deepened. At the end of six weeks all plants should be carefully inspected. If a good union has been effected the plant may now be severed from the tree and the top of stock removed. The plants should now be transferred to a plant house or the shade of a tree, where they should remain until one good flush of growth has matured. They are now ready to set in the field.

Budding the mango by the square patch method is also successful. For this purpose the stock or branch should be an inch or more in diameter. A patch of bark one and one-half inches long and three-quarters of an inch wide is removed with a sharp knife or chisel. Next the desired bud with an equal amount of bark attached is secured and fitted securely to the stock. The bud should be held in place with raffia or other wrapping material. The wrapping should not be too tight. A suitable form of grafting wax should be used to smear the cut edge and keep out water. The whole stem for several inches above and below the bud should be covered with waxed cloth, leaving only the bud open to view. Budding should take place when the sap is moving freely.

Mango trees should be planted about thirty feet apart each way. They should be properly cared for so as to form low-headed trees with strong branches from which the fruit can be easily gathered.

It is advisable to inter-till and during the early stages of growth inter-cropping may often take place.

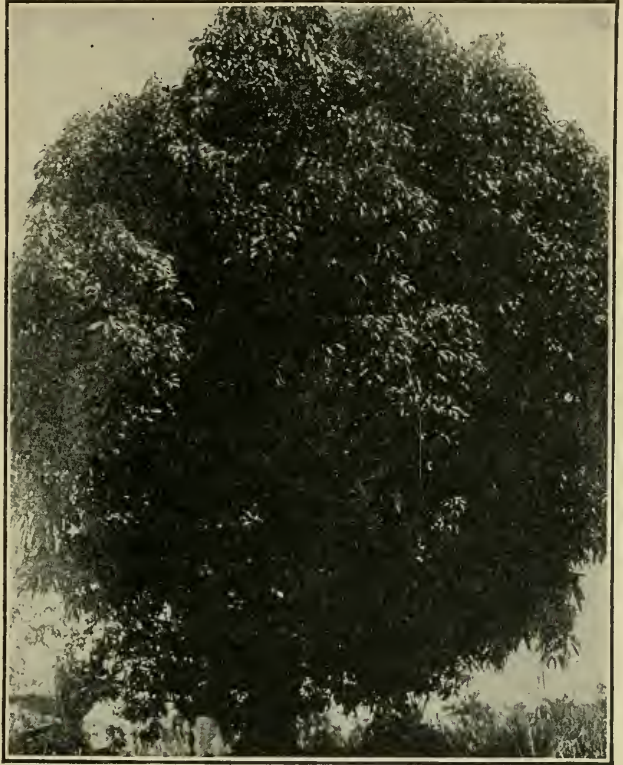
The trees begin to bear from five to nine years of age.

For immediate use the fruit should be allowed to ripen on the tree. If it is to be stored or shipped long distances it should be gathered before it fully ripens. If hand picked, wrapped in paper and packed in small packages, it will keep for several weeks. The keeping period may be lengthened by cold storage.

The fruit is best prepared for eating by placing on ice, until thoroughly chilled. In this condition it may be readily peeled and sliced. The fruit is used chiefly in the fresh state, although in the tropics where grown it is frequently used for sauce or made into pies and has great possibilities for various forms of preserves.

The Banana.

—The banana is strictly a tropical fruit. It is a large herb, with a perennial root stalk. The top grows rapidly and reaches a height of from ten to thirty feet, depending on variety. It requires from twelve to fifteen months from time



A TOP-WORKED MANGO TREE IN FRUIT.¹

of planting to the maturity of the fruit. Each plant bears one cluster of fruit, and upon its maturity the plant dies. Numerous shoots arise from the base of the original plant. Most of these are removed for use in establishing a new plantation, but some are left to take the place of the old plant.

Within the past thirty years the banana has become popular in the markets of the North and is quite extensively used. It excels in the ease

¹Courtesy of U. S. Dept. of Agriculture. From Annual Report, Porto Rico Agricultural Experiment Station, 1913.

with which it is handled. On the plantation a cluster of from 100 to 200 fruits, equal in amount to a crate of other fruits, is severed from the plant with one stroke of the machete. The fruits are protected by a tough skin which readily separates from the rather dry meat.

The banana is cultivated in practically all tropical countries. Those countries leading in banana production are Jamaica, Costa Rica, Cuba and Honduras. The commercial supply for North America comes chiefly from the West Indies.

There are countless varieties of bananas, but very few of these are of commercial importance. Many of the most delicious ones are of local value only because of small size or poor shipping qualities. The varieties usually met with in the markets are the large yellow fruits, and, less frequently, the red ones.

The clusters of fruit are cut from the plant when quite green and hung up in a dark room to ripen. When shipped to distant markets, the fruit is sent directly from the plantations to the fruit steamers, and ripen while in transit. They generally reach their destination before they are sufficiently ripe to use.

The banana is grown in Florida and the southern portion of the Gulf states. It is found as far north as Charleston, S. C. In the extreme northern limits it is grown chiefly as an ornamental plant. In the southern half of Florida it has been grown commercially to a limited extent. For central Florida the Orinoco and Hart varieties are best. These are both early and hardy. In the southern part of the state the Dwarf Jamaica variety is successfully grown. If freezing weather occurs, the base of the plants to a height of two or three feet may be protected with earth or straw. If the tops are frozen they should be removed by cutting just below the frozen portion. A new growth will start almost immediately from the center of the stalk and will mature fruit before the close of the season.

With few exceptions the banana is seedless, and must therefore be propagated by planting suckers or sprouts. These are generally removed from the mother plant when several feet in height. By cutting the top of the sucker back to a foot in height it will keep for several weeks. These are set in the new plantation at intervals of ten to fifteen feet apart each way. The larger the variety, the greater should be the distance between plants.

Bananas require a fertile, well-drained soil, well supplied with humus. They develop best in a humid climate. Their extensive and tender foliage necessitates protection from strong winds. The soil between the plants should be cultivated to subdue weeds and grass and to conserve soil moisture until the plants are large enough to shade the ground.

The Fig.—While the original home of the fig tree is around the Persian Gulf, the tree will grow and thrive in any warm climate. It is very hardy and noted for its longevity, often remaining productive for a hundred years.

The fig can be cultivated in the warmer parts of the United States and

will withstand considerable freezing. The young shoots are easily frosted, but, owing to its hardy constitution, a tree though severely frosted will send forth new shoots and will often bear fruit the following season. A heavy frost, however, while the sap is flowing freely, is apt to be fatal.

The warm interior valleys of Arizona and California, being dry, are much more favorable for fig culture than the Gulf states. The rainfall of the Gulf states, occurring at the time of fig ripening, often causes the fruit to burst and decay before maturity. The fresh fig is a delicious fruit, but on account of its perishable nature, has not been widely cultivated for commercial purposes.

The fig tree will grow and thrive in a variety of soils. It is a gross feeder and requires much moisture for its long spreading roots. Where frosts are liable to occur, rich, moist lands should be avoided, as this kind of soil promotes a late luxuriant growth, which is very easily killed by frost.

The fig is propagated by means of suckers and cuttings. Seldom is it propagated by seed, as seedlings have a tendency to revert to their wild state. Trees from seedlings require three years before beginning to bear, and several more years to come into full fruitage. Trees from cuttings may bear a few figs the first year and will be in full fruitage in two or three years. Cuttings six or eight inches long should be made from young, well-seasoned wood. These should be made in the spring before the sap begins to run, and hung inverted for a time until the ends are calloused over.

The trees mature more rapidly if the cuttings are planted in their permanent position. They should be planted in a deep hole, filled in with rich compost, and liberally watered. Cuttings, transplanted after growth has begun, are often retarded two or three years in growth. Barren trees may be successfully grafted.

Fig trees planted in orchards should be fifteen or twenty feet apart. This distance is sufficient for the Southern states, but in the Pacific Coast region, where the trees grow to a greater size, thirty to forty feet is a better distance. The low-branching varieties are best, as they are not so easily injured by winds.

Except to remove dead or decayed limbs, the fig tree requires very little pruning. In young orchards the cultivation must be shallow in order to avoid injury to the surface roots. Fertilizers scattered broadcast and worked into the earth near the trees are beneficial in the early stages of growth.

The Guava.—The guava, a native of tropical America, has spread to all tropical countries. In character of growth and fruit it most nearly resembles the quince of temperate regions. It is sometimes called the apple of the tropics.

The plant is a shrub, seldom attaining a height of more than twelve feet. The vegetative growth is easily killed by frost, but is renewed quickly from the roots. For this reason it can be successfully grown in sub-tropical localities.

The fruit varies greatly in size and color, ranging from an inch in diameter to the size of large apples. When ripe, it is white or yellow, with a sub-acid pulp of the same color as the skin. The color sometimes deepens into crimson. The fruit contains many small seeds. It is used chiefly for making jelly and preserves.

The guava is propagated from seeds and cuttings.

Recently this fruit has received considerable attention in Florida, where it finds a place in nearly every fruit garden. Where frosts occur, the tops may be protected during the winter by laying them down and covering them with straw and earth.

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CHAPTER 15.

THE FARM WOODLOT

BY F. F. MOON

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Need of Forestry.—To properly solve the land problem of any nation each acre should be put to its best permanent use. Field crops should be grown upon the tillable areas and the land which is too steep or stony for cultivation or too sterile for ordinary field crops should be made to produce repeated crops of timber. That is why the practice of forestry, which is "the raising of repeated crops of timber on soils unsuited to agriculture," is necessary to secure the proper use of *all* the land.

Forestry is not a part of agriculture. It is separate, but co-ordinate and interdependent. Agriculture has first call upon the land and selects the fertile and level areas for tillage. Forestry takes the remaining portion and raises the timber indispensable to our civilization. Both are concerned with crops, since the forester regards his timber-covered areas as fields to be sown (either by nature or artificially), tended and finally reaped, for forestry means *using* the products of the forest and does not mean locking up the woodlands for park purposes, as some people think.

The practice of forestry upon the non-agricultural soils is absolutely essential for three reasons:

- (1) Timber is absolutely indispensable to our civilization.
- (2) There are large areas of land which can never be used for agriculture.
- (3) The indirect influence of the forest in moderating climatic extremes, in controlling run-off, etc., is necessary to the successful practice of agriculture and to the health and comfort of the people.

1. Next to food, shelter is most important. According to Fernow, over half our population live in wooden houses, and two-thirds use wood for fuel. The same authority estimates that 95 per cent of all the timber consumed in the United States is for necessities.

Our per capita consumption of wood is unusually high, and on the increase. (It is twice what it was fifty years ago.) We consume six times as much timber per capita as in Germany, and twenty times as much as in Great Britain.

2. Agriculture can never be practiced on a large part of this continent, and this land must not be allowed to lie idle. Of the 1,900,000,000 acres

of land in the United States, 550,000,000 acres are now covered with forests (65 per cent of the original forest area) and 415,000,000 acres are devoted to agriculture. Agricultural experts have estimated that within the next fifty years the forest area of this country will have been reduced to about 360,000,000 acres, and that the present area of forest land held in the form of farm woodlots (190,000,000 acres) will have diminished to 90,000,000 acres. So that with the exhaustion of virgin supplies of timber, the farm woodlot will be relatively much more important fifty years hence than it is at the present time.

3. The indirect influences exerted by forest cover are much greater than is generally supposed. Recent investigations have indicated that the rains in the interior of a continent are largely dependent on the presence of large bodies of timber situated in the track of prevailing winds.

In some parts of the Middle West the value of windbreaks in checking the force of hot southern winds may exceed their value as a source of timber, fuel and fencing. The influence of forest cover upon run-off—the drying up of springs, the increase in spring floods after extensive forest denudation—are well known. Water experts claim that the gradual lowering of the water in the soil is dependent to a large degree upon the absence of sufficient forest area.

Value of the Woodlot.—The value of a good woodlot to a progressive farmer is hard to measure in dollars and cents. It serves the following ends:

- (1) It furnishes timber for home construction purposes, fuel, fence posts, etc.
- (2) It should now, as in the past, furnish winter employment to horses and men. Domestic timber, telephone poles or railroad ties for the market, etc., can all be taken out during the winter months to the vast improvement of the bank account and woodlot.
- (3) A good woodlot is like a bank account—it can be drawn on in time of need. After a fire, the barn may be largely rebuilt from home timbers, and in case money is badly needed, some logs or poles may be sold to tide matters over. A good farm woodlot is a fine nest egg.
- (4) It vastly improves the appearance of the home place and makes it more salable.

Aside from sheltering the homestead and barns from wintry blasts, the woodlot covers the steep, rocky slopes or the marshy spots that would otherwise be most unsightly. Viewed from every standpoint—revenue, year-round farm management, appearance, real estate value and comfort—the woodlot is a splendid asset to an up-to-date farm.

Managing the Woodlot.—The average woodlot at present is suffering from the wrong point of view. It has been grazed and grazed again, burned, culled and culled again until in many cases the compact soil cannot support

the growth of any desirable species or specimens. With the enormous stand of timber covering the agricultural land in colonial times, it is no wonder that the forest was attacked vigorously and even ruthlessly by the early settlers. It covered lands needed for tillage and it harbored enemies, beasts and redskins, of equal ferocity. With the end of the virgin timber supply less than five decades away, the farm woodlot is destined to play a still more important rôle in supplying the local markets with necessary timber. The reduction in the forest area and the increase in the value of forest products will make the woodlot more profitable each succeeding decade. Since a crop of timber cannot be grown over night, now is the time to start for the benefit of the next generation.



A WELL-PROTECTED FARM HOMESTEAD.

By protecting farm buildings with trees, comfort of the family is vastly increased and farm economy better maintained.

To make specific recommendations for the management of the farm woodlots in different parts of the country is impossible, for climate, soil conditions, species and markets are all different. General points only can be covered and if further details are necessary, bulletins from the Federal Forest Service at Washington or State Forest Office, or Manuals on Woodlot Management may be sent for.

At the outset the forest should be regarded as a crop of trees. It is sown by nature and is harvested only once every forty to sixty years, but if the crop idea is kept in mind the cultural methods to be pursued will be very easy to follow. The woodlot contains tree weeds, as well as desirable

species, and the weeds as usual, should be exterminated. The laws of plant growth, as understood by the average farmer, apply to trees in the forests as well as to the plants in the field. There is only so much growing energy—light and heat, moisture and plant food—available for each acre of forest. This energy should be confined to a few valuable trees and not scattered among the several hundred additional weed trees that stand



FIELD AND WOODLOT.

Upon the fertile, level lands field crops should be raised, while the steep, rocky hillsides unsuited to agriculture should be made to yield corps of timber.

upon each acre. It should be the aim to raise a crop of valuable timber and not forest weeds.

Improvement Cuttings.—Under ordinary circumstances no improvement cuttings are attempted until the material to be cut is large enough to pay the cost of removal. Cuttings to improve the composition are sometimes made in very young stands where intensive management is possible. Such cuttings, or *cleanings* as they are called, are ordinarily beyond the pale of woodlot management, as the average farmer cannot afford to make the investment (\$1.50 to \$3 per acre in young sprouts) which such cleanings

would cost. Therefore, it is better to postpone the cutting until the undesirable specimens reach cordwood size (say twenty-five to thirty years), when a *thinning* may be made.

The general idea in such a thinning would be to remove competing trees which take light, food and moisture from the straight, thrifty trees of more desirable species. Every farmer knows which trees are valuable



A WOODLOT AFTER THINNING.¹

By removing dead and diseased trees and those of less desirable species, the remainder of the stand will greatly increase its growth rate.

in his neighborhood and which individuals are not thrifty. In the Eastern states, for example, such trees as ash, basswood, tulip-poplar, red oak, etc., are generally favored over the slower-growing and less desirable beech, maple, black oak, horn bean, etc. Rapid-growing conifers, like pine and spruce, are to be preferred to slower-growing and less valuable species like hemlock and white cedar. As a rule, conifers should be encouraged upon poorer soils, since they make less demand upon the site for plant food and moisture.

A method of thinning a woodlot which foresters term the French method, can be used in many stands to advantage. The idea is to select from 200 to 250 trees per acre, depending on the species, soil, etc., to form your final crop, and to remove all weed trees or defective specimens which are in any way interfering with the growth of these selected trees. By cutting away the trees crowding and competing with them, all of the growing energy will be forced into the straight, thrifty stems which remain, with the result that the succeeding years' growth rings will be laid on the trees of greatest value. In this way railroad ties may be secured at thirty-five years, whereas if left untouched, they would not reach sufficient size until forty-five or fifty years.

For the final result, the technical quality of the species (including local demand), the growth rate and the condition of the individual tree determine whether or not it should be removed. Briefly summarized, the points to be kept in mind in making a thinning are as follows:

1. Leave straight, fast-growing, thrifty trees of most valuable species.
2. Avoid making holes in the canopy that will not be filled within five years by the natural growth of the crowns. (Excessive exposure of the soil to sunlight causes drying out of the soil, a rapid growth of weeds and diminished volume growth.)
3. In case of doubt, leave a tree, as it may be taken out at the time of the next thinning.

Reproduction Cuttings.—The previously described cuttings are designed primarily to hasten growth and to improve the composition of the stand. The reproducing of the stand is not intended, although a heavy improvement cutting in a woodlot old enough to produce seed may result in a fine stand of young seedlings the next spring. This is by accident rather than by design.

In certain of the Middle Western states where grazing is permitted in the woodlot as a matter of course, where fires and bad cuttings have exhausted and compacted the soils, reproduction cuttings are out of the question. Only weed trees or old and decrepit specimens of desirable varieties are still standing. The best, the only way, in cases like this, is to cut clean and replant with species suited to the region.

Where the soil is in good shape and good seed trees are found, a light cutting to prepare the soil, followed two or three years later by another thinning to give more light to the seedlings on the ground, will provide sufficient stand of reproduction. The thinnings, to be successful, require considerable care in removing the defective trees and specimens whose seed is not wanted. Great care should be exercised to prevent excessive light coming in at first, as weeds may then choke out desirable seedlings. After the seedlings have gotten started the trees overhead are gradually removed, the cuttings being located where light is needed for proper development of the young growth. When the leaves of the seedlings turn a yellowish-green, more light is needed and a few nearby trees should be cut.

In regions where the sprout hardwoods are found (chestnut, oaks, maples, etc.), reproduction may be secured by clear cutting, allowing the woodlot to spring up from stumps. The best time for sprout reproduction is under thirty years of age, but ordinarily good sprouting species will retain this quality until fifty or sixty years of age. This type of management, *coppicing* as it is called, should not be practiced too many times in succession, as the soil becomes exhausted and the vitality of the stand lowered.

Pruning.—In certain parts of the East farmers have attempted to secure a higher quality of lumber by artificially pruning coniferous stands.



GOOD WORK IN PILING BRUSH.

Advocates of this plan claim that the clear lumber thus produced will bring a sufficiently larger yield to pay for the cost of this intensive process. On the other hand, men who have sawed second growth white pine, which was artificially pruned, claim that loose knots are produced by too rapid drying of the stub. If pruning is desirable to improve the looks of a piece of woodland—to open up a vista beneath the crowns—it may be done, but let the cost be charged against landscape improvement and not added to the cost of the forest crop.

Planting.—Where it is desired to cover an unsightly area or abandoned pasture with trees, planting may be resorted to, as the proper species are

immediately started at the correct distance. The question is often raised, "Why is not nature's method followed and seed scattered broadcast on the soil?" The answer is this: It has been found after repeated experiments that broadcast seeding is not only extremely expensive on account of the high price of seed, but the results obtained are decidedly uncertain, owing to the activity of squirrels or field mice and the frequent drying out of the seed. Placing young seedlings in the ground six feet apart is more certain and cheaper in the long run. Planting six feet apart each way, an acre containing 1210 trees can be planted at a cost of \$7 to \$10, depending on price of labor and whether seedlings or transplants are used.

If the woodlot has been very much run down as a result of injudicious cuttings, excessive grazing or repeated fires, it may be desirable to plant under the openings with fast-growing, shade-bearing species. In this case it is desirable to first make as heavy a thinning as circumstances will permit, and then, after the timber has been removed, plant the open spaces immediately with the chosen species before grass and weeds take possession of the soil. Underplanting a run-down woodlot of broad-leaf trees with four-year transplants of spruce or pine is a splendid way of injecting new blood. The trees will cost about one cent each in the ground, and from three to four hundred per acre is generally sufficient.

Financial Results.—The best measure of the success of any farm activity is the financial yield obtained, and it is safe to say that the difficulty in marketing the forest crop and the long waits between receipts are largely responsible for the slight attention paid the woodlot. Forest management must be financially profitable before it will be accepted by the farmer.

At the present time forest products are not sold as easily as grain, potatoes or fruit, and this fact often causes discouragement. While the average farmer will scan the market reports very closely to find out the prevailing price for his field crops, the same man is apt to sell the standing timber on his woodlot to the first mill owner who offers him real money. If the selling of forest products can be simplified and the farmer can be assured a reasonable return from his non-agricultural acres, it is certain that the practice of forestry by the individual owner will advance rapidly. These small holdings are destined to play a more important part in supplying local timber markets in the coming generation, but it is necessary that proper marketing facilities be provided in order that the owners receive a fair return.

When an offer is made for "all the timber on the woodlot," great care should be exercised before it is accepted. Such a sale usually results in parting with the cream of the trees at a meagre price and leaving the land in the possession of forest weeds, for the local mill man generally "skins the lot." It is far better to designate by axe marks the mature trees and those that should be removed for the good of the remainder, and thus sell a known amount at a fixed price per thousand board feet on the stump.

A sale contract covering methods of cutting, payments, fire protection, provision against waste and excessive damage should be drawn.

The New York State College of Forestry at Syracuse has provided a selling service for the private timberland owners of the state. Two years ago a study of the wood-using industries was made in connection with the Federal Forest Service, and at that time considerable data concerning stumpage prices, costs of manufacture and value of manufactured products, etc., were secured. This information is on record in a card catalog, and when a farmer or small land owner writes for information concerning the management of his woodlot and a possible sale, he is put in touch with the nearest manufacturer, and the dimension and grades in demand and average selling price given him. By this means the College of Forestry is acting as a clearing house for information and is endeavoring to secure a fair price for the man who raised the forest crop. In the extension of this scheme of co-operative marketing of forest products lies the future profitable management of non-arable lands by the farmers of this country.

As previously stated, forestry must be financially profitable, else it will not be practiced by the business men of this country. The farmer, however, is in the best possible position of all owners of forest land to practice forestry, for he has the land, he has an annual income from his arable land, and finally, he has the winter season to work in his woodlot.

European experience proves beyond a doubt that forestry does pay good dividends—from \$2.50 to \$7 per acre per year *net revenue*—while from the woodlots of this country, a revenue of \$109,000,000 in 1899 and \$195,000,000 in 1909 was obtained.

Forest plantations will yield from four to five per cent compound interest upon the value of the land, plus the cost of planting. Thus it can be proven conclusively that the practice of forestry is a paying proposition at present stumpage values, while the reduction in the timbered area will cause an increase in these values and much higher yields will be obtained.

Summary.—The farm woodlot should be treated as a *producing portion of the farm*, and the following points should be borne in mind:

1. Tend your woodlot during the slack periods. It will pay handsomely.
2. Cut your firewood and fence posts where cuttings are needed, and not where it is easiest to cut.
3. Do not permit fires to run rampant through the woods. It kills the little trees and checks the growth of the big ones.
4. Do not permit extensive grazing in the woodlot. If more pasture is needed, clear-cut the best land and sow to grass. You can't raise good grass and good timber on the same piece of land.
5. Use the same energy and business sense in selling a crop of trees as you would in selling a crop of apples. Know how much you

have and about how much it is worth. If you can't get your price, hold on, as your woodlot keeps on growing in bulk and value while you sleep.

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CHAPTER 16

BEAUTIFYING HOME GROUNDS

By A. W. COWELL

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How ridiculous would be the man who proceeded to build his house by first buying up a lot of lumber, bricks, pipes and paint, and then going ahead to put them together without first having a very definite working plan! Too often that is the way the home surroundings are arranged and ornamented—and don't they appear so? Whether of houses or homes, which is a broader term and includes the house and all its immediate surroundings, it is essential to good results to have a definite working plan and stick to it. If you cannot plan it yourself, you will save time and money by obtaining expert advice.

The Survey.—To make such a plan for the grounds, first measure up the boundaries of the area and note all the features contained therein, including buildings, standing trees with their approximate spread, steep banks, rocks, swampy places and other natural features, besides roads and walks. Next, indicate the fine views and the views of undesirable character that should be eliminated. This accomplished, you are ready to plan changes and alterations and record your desires and ideals. Using an ordinary foot ruler, adopt an eighth or a sixteenth of an inch to represent a foot of your actual measurements and thus accurately draw on paper the survey you have made. Draw the new scheme on the same scale. It is likely that practical and ornamental considerations will be thought of together in this way. This study of the place as a whole should aim at a systematic arrangement, an effective appearance, and provide for convenience and comfort. Beautification should start back in the practical first arrangement of buildings, roads, paths, windbreaks and screens, and not be confined to the little patch of ornamented front lawn.

Planning for Convenience.—Speaking of the farmhouse, one located upon the north side of an east and west public road will most nearly approach the ideal in matters of arrangement of parts. The house should stand not less than 150 nor more than 400 feet from the road, somewhere near the center of the farm lands; for all operations begin and end at the house, and it should, therefore, be most conveniently centered. It should face the south. Behind it at a distance of about 150 feet, or less, if fire hazard is minimized, may stand the barns and other service buildings arranged perhaps most conveniently for work around a hollow square or

barn court. A windbreak upon the west and north of this group of buildings, while sheltering them, will likewise protect the house and home garden and orchard from prevailing winds. To reach this court, the entrance drive would pass the house, preferably upon the west side, but not nearer than fifty feet—a little spur being provided from it for the house visitors. For convenience, arrange the buildings with the chicken house nearest the kitchen, and for comfort place the hog pen or other more obnoxious necessity farthest to the northeast.



A CONVENIENT AND ATTRACTIVE FARMSTEAD.¹

Provide a vegetable garden, hedged in if possible, very near the house and let it be tastefully laid out and contain the small fruits such as currants, raspberries, strawberries, grapes, asparagus and rhubarb; possibly dwarf fruit trees as well as kitchen vegetables and hardy flowers for cutting. Such a garden need not, in fact, it *should* not, be relegated to the back of the place, but may lie toward the front road and form the east side of the remaining area of the house lawn. All of this makes for convenience of operation of the farm plant and affords opportunity to ornament it with the greatest ease and effectiveness. But it is only an ideal, and most places are

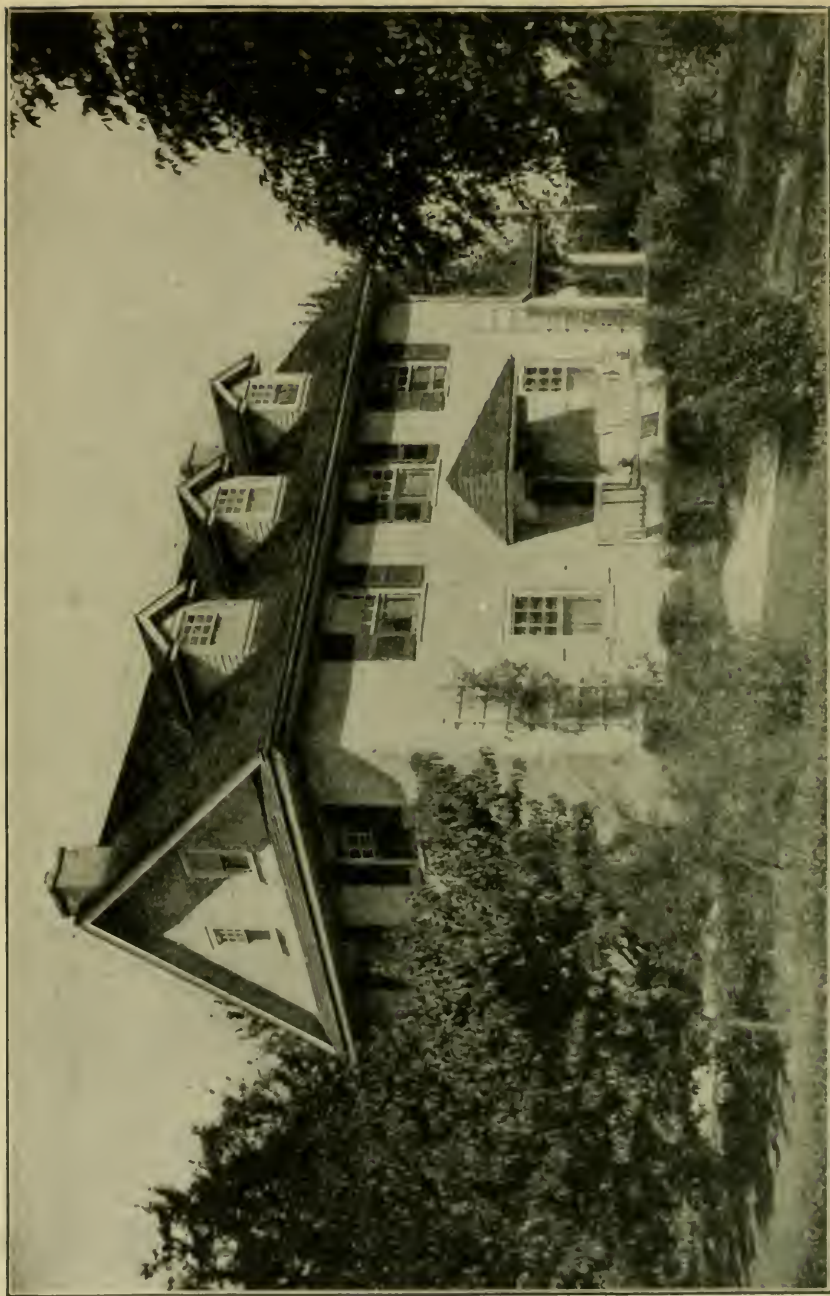
¹ Courtesy of Doubleday, Page & Co., Garden City, N. Y. From "Farm Management," by Card.

very unlike it. Others may profit by such a picture and it will give them something to work toward along the line of home ornamentation.

Formal Ornamentation.—Before planning and planting for ornamentation, have a landscape ideal. If the place is in the city surrounded by straight streets, shade trees in avenue rows, massive architecture and other conventions of one kind or another, the formality of straight walks, terraced lawns, clipped trees and bushes, and even architectural gardens and statuary is quite in keeping. The object is to provide a setting appropriate to the building and in harmony with its environment. Formal landscape treatment requires expert knowledge beyond the scope of this chapter. Simple “old-fashioned” flower gardens with box-bordered paths, and rose gardens with grass walks laid out in simple geometrical fashion can be successfully designed by the amateur, but they should be set away by themselves and in close relation to the house or other buildings, or else isolated and secluded from any general view.

Informal Ornamentation.—For farm homes in the open country it is much more effective and harmonious to arrange the home grounds with naturally sloping lawns, convenient curving paths and trees and shrubs grown in their natural form in groups and masses. The simplicity of nature’s masses of foliage as seen in copses and fence rows, of her trees standing in splendid dignity alone or in groups of soft outline; her wood edges that are irregular in outline and of material of different heights rising from the ground line to high trees of the background; her colors, so subdued and so gracefully blended together—these should be our ideals. A close observation of natural landscape in general, and little bits here and there in particular, may properly instruct us in the proper arrangement of the simple home grounds as regards the planting. Very few homes depend for their charm upon their natural surroundings. More often is all natural beauty destroyed when man takes possession and adapts the land to his economic necessity. But hints for the changes and for the embellishment as well should be taken from the place itself and its environment if it is to be in harmony with its site and become what we call “charming.”

In the plan, considerations of convenience rule, but beauty may be served also. The paths, which are not in themselves things of beauty, however well constructed they may be, should if possible be kept out of the center of the picture, and should not divide the open lawn more than necessary. They should pass from house to road toward the side of greatest travel, which satisfies the consideration of convenience while also creating a graceful curve in course of the path and leaving unbroken the central area. Do not interrupt any path by a flower bed, flag pole or fountain, except in pleasure gardens, and do not cause its course to become circuitous and tiresome in order merely to introduce curves. Where the distance is less than fifty feet, introduce no deviation from a perfectly straight course. Walks should not be lined by ribbons of flower beds, but



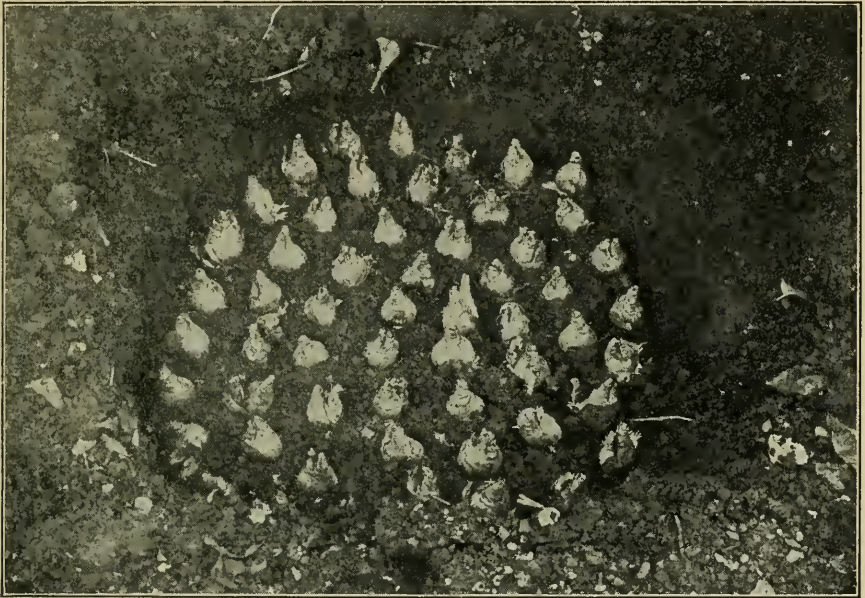
AN EXAMPLE OF GOOD INFORMAL ORNAMENTATION.¹

A small country place in which trees, vines, flowers and shrubbery are used to good effect.

¹ Architect, D. Knickerbocker, F. A. I. A.

a few good specimens or a group of bushes or a tree may properly stand in the bend of a path.

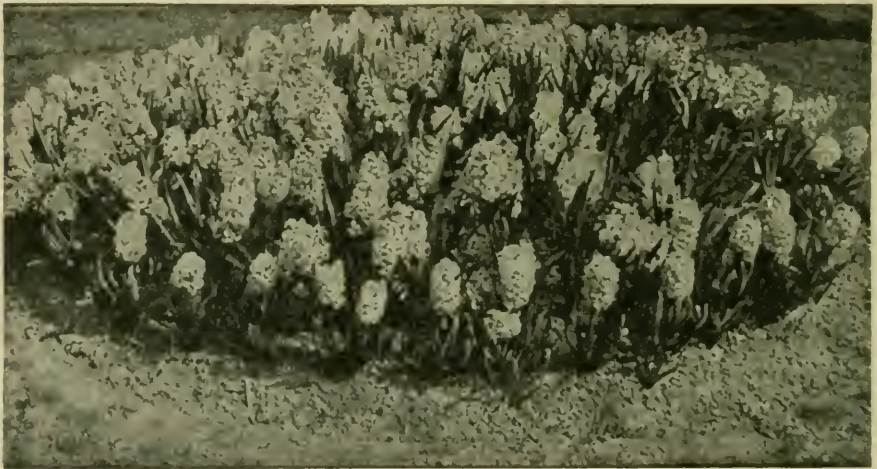
Lawn Planting.—The lawn also should serve the considerations of practicability with beauty. It should therefore be rather open and unbroken. It should be somewhat enclosed by a frame of shrubbery, but it must not, without defeating both considerations, be planted all over with trees and bushes standing alone. This is a "spotty," not effective use of material and is hard to maintain. Arrange the bushes—they may be wild ones taken from the woodside, flowering kinds from the nurseryman, or both—planted in groups together, in bordering beds at sides of



A DESIRABLE METHOD OF PLANTING DAFFODILS, SHOWING THE BULBS BEFORE COVERING.

the lawn area. Such a bed should be dug over, no grass should be maintained between bushes, and its outline against the lawn planned in long, flowing curves like that of the native woodland. Set the tall-growing species generally toward the center or rear of the bed, allow the bushes to grow together in a natural way, cut out the dead wood, but do not trim them into rounded formal shapes. There should be a bed made against the base of the house and other buildings. Plant this with shrubs of a moderate height of growth and of good bushy habit. More homes look bare and uninteresting, almost inhospitable, because of the lack of this planting which lends a warming influence to the building, than from any

other reason. Against unattractive objects or views noted in the preliminary survey should of course be arranged a heavy plantation. It may take on a little different character and contain many trees, especially the smaller growing kinds, as well as evergreens and closely planted shrubs. Do not forget the softening influence of clinging vines in helping to harmonize houses and landscape and to afford privacy to porches and service buildings. Shade trees do not clothe the earth and in this dissertation are left to the last for the reason that shrubbery and vines and grass are all-important in home ornamentation; shade trees are not so often forgotten or so badly used by the amateur planter. Arrange them in groups, not rows, of different species, and for lawn specimens, endeavor to preserve the lower limbs. Street and roadside trees are of a different ideal.



HYACINTH BED.¹

Use of Flowers.—The use of flowers and flower beds in home ornamentation is not to be discouraged, although it harbors much danger in chances of introducing colors and material difficult to place and to harmonize with most natural landscape. If the advice be confined to that type of flowers called “old-fashioned” hardy plants, the matter is simplified. They add charm to most shrubberies and lawns when planted along in front of the shrub beds, arranged in and out among the shrubs. The other class of flowers known as “bedding plants,” which includes geraniums, cannas, coleus, salvia and so forth, is more difficult to blend, more foreign to simple places and more predominant in its color note. Such bedding can be best used directly against the house, but never in beds, stars, crescents and bologna sausage shapes, in the middle of the lawn,

¹ Courtesy of The Countryside Magazine, New York City.

and seldom in front of shrubbery, as effectively or so practically as hardy perennials of the other class.

These are all principles and ideals to observe in drawing a plan for home ornamentation. As to detail, each place is a problem unto itself, to be solved with due regard to two services—convenience of use and landscape charm. Nature is a good instructor in principles. From her examples in field and wood we learn of the “open center” of lawn with borders of massed foliage, of the beauty in flowing, rounded outline, both of foliage and of ground. We cannot copy nature, but we can and should derive much inspiration and many ideas in the uses of trees, shrubs, vines, flowers and grasses, and how to combine them into good groups and masses. A few uses and combinations follow. They are merely catalogued. Perhaps they will suggest details in the comprehensive plan.

SUGGESTED MATERIALS

Street Trees for roadside or driveway should consist of one species upon one road, but different species upon different roads.

Maples.—Sugar, Red, Norway, distances, 45–35–40 feet.

Oaks.—Red, Pin, Scarlet, Mossy Cup, distances, 45–30–35 feet.

Elm.—American, the ideal American tree, distances, 45 to 60 feet.

Linden.—American Basswood, European or Crimean, distances, 45–35–32 feet.

Plane.—European (or Oriental), distance, 35 feet.

Ash.—American white, distance, 35 feet.

Gingko.—Chinese Maidenhair Tree (narrow streets only), distance, 25 feet.

Trees for lawn planting, besides those mentioned for street use:

Oaks.—White, English, Golden, Pyramidal.

Maple.—Weir's Cut-leaf, Purple, Norway, Cork-barked, Tartarian.

Elm.—Cork-barked, Scotch, Japanese.

Linden.—Silver, Weeping Silver, Broad-leaved.

Mountain Ash.

Empress Tree (*Paulonia*).

Larch.—European and Japanese.

Bald Cypress.—An excellent.

Magnolias.—Chinese species.

Buckeye.

Japanese Maples.

Pine.—White, Swiss, Dwarf Mountain, Austrian.

Fir.—Douglass, Colorado Silver.

Spruce.—Englemann, Colorado Blue, Eastern, Norway.

For screen planting, to obscure objectionable views:

Poplars.—Lombardy, Bolles Silver, White.

Willows.—White, Laurel-leaved.

Mulberry.—White.

Maple.—Weir's Cut-leaf, Water or Box Elder.

Birch.—White, Red.

Ailanthus.

Spruce.—Norway.

Pine.—Austrian, Scotch, White.

Arborvitæ.—Western.

Shrubs for screen:

Sumacs, Privet, Nine-bark, Elder, Alders, Dogwood, Witch Hazel, Red Bud, Shad Bush, Bush Honeysuckle.

Shrubs suitable for the base of the house:

Japanese Barberry, Thunbergs, Waterer's and Van Houttes' Spirea, Red-Twigged Dogwood (*C. alba*), Dwarf Deutzia, Hydrangea, Kerria, Lespedeza, St. John's Wort, Regel's Privet, Japanese Rose (*Rugosa*), Snowberry, Stephenandra, Mahonia, Rhododendron, azaleas, Eulalias (ornamental Grasses), and hardy perennials.

Shrubs suitable for general border plantings:

Blooming in early spring: Amelanchier, azaleas, daphne, calycanthus, forsythia, cereis, cornus mas, cydonia, lindera, lonicera fragrantissima, almond.

Blooming in late summer: Althea, baccharis, aralia spinosa, caryopteris, cephalanthus, clethra, hydrangea, hypericum, lespedeza, Sambucus canadensis, spirea Bumalda, tamarix, vitex agnus castus, rosa rugosa.

For winter berries: Rosa rugosa, berberis, corylus, crataegus, enonymus, ilex, cephalanthus, callicarpa, physocarpus, synphoricarpus, viburnum opulus, ligustrum, rhodotypos.

For winter bark color:—Cornus alba, stolonifera, lutea, Euonymus alata, kerria, eleagnus, tamarix.

Suitable hedges:

Japan barberry, privet-california, common and for untrimmed hedge, Regellianum. Flowering hedge.—Spirea van houttei, Althea, rosa rugosa, cydonia, deutzia gracilis, lilacs.

Protective hedge.—Barberry, rhamnus, crataegus, gleditsia.

Evergreen hedge.—American arborvita, hemlock, white pine (for a broad hedge), Norway spruce.

Suitable for windbreaks:

Evergreens.—Norway spruce, Douglas spruce, Scotch pine, Austrian pine, arborvita.

Deciduous.—Poplars, willows, box elder, larch, birch, ailanthus, mulberry, osage orange, and other tree species set out about ten feet apart to form a belt at least twenty feet wide.

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CHAPTER 17

WINDOW GARDENING

BY A. W. COWELL

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The prime requisites in raising plants in the house are proper soil, good drainage, equable temperature, the correct amount of sunlight and regular care in watering and re-potting. Contrary to superstition, no better geraniums can be grown in a tomato can than in a piece of fine pottery. So you may choose your own receptacle so long as it fits the plant it is to house—being neither too large nor too small.

Drainage.—Good drainage is brought about by having an opening in the bottom of the receptacle—at least half an inch in diameter, and for very large jars or tubs, three or more openings. Over these lay pieces of broken pottery to prevent the dirt from falling through. Good drainage allows any excess of moisture to escape and provides for free circulation of air through the soil. This prevents it from becoming soggy and sour.

Soil and Exposure.—Good soil is often difficult to secure. Many planters take chances and use what is handiest. This is a mistake. Even the blackest woods earth is not always most suitable to use. Soil which is clayish and bakes is not good; neither is light, sandy soil. A combination of the three types, however, is satisfactory, and a soil recommended by a practical florist is one made up as follows:

Skim off the sod thinly from a bit of pasture land and take the loam directly under the sod for the ground matter of your soil; mix together 32 quarts of this loam with 4 quarts of black woods earth and 4 quarts of sharp sand. For the plant-food, mix together 8 quarts of decomposed manure, 1 quart of air-slaked lime and 1 quart of ground bone (bone meal). Now mix and mix and *mix* these two piles together, sift through a sieve of a quarter-inch mesh, and you have a soil suitable for the most “persnickity” of plant tastes.

As to light, for flowering plants generally, a south or east window is best. Some foliage plants and ferns like the sunless windows or interior of a room. Their numbers are few, however, and this is unfortunate.

Method of Potting.—To pot up the plants, cover the drainage material in bottom of the flower pot with an inch or two of the soil prepared as above described. Then place the plant roots flatwise into the soil, holding the stem erect while soil is sprinkled in until the pot is nearly full, and press down firmly but not too hard. Now sprinkle a light covering of soil (*not*

firmed in) over top of the pot to prevent excessive evaporation and drench with water.

A plant which has made a vigorous growth may need more root room. It fills up the receptacle and becomes "pot bound," as the florist says. It should be "shifted up" to a pot the next size or two sizes larger. There is failure in pots larger than necessary. Reverse the plant with the palm of the left hand against the top of the pot and the stem passing through the



REMOVING THE PLANT FROM OLD POT.¹

fingers and with a slight tap the pot may be removed. The ball of roots should be put into the new quarters, setting the old surface about level with the top of the new pot. Chink in new soil around the ball of roots and then water the plant plenteously. In potting up plants from the summer garden—geraniums, snapdragon, ten weeks' stocks, petunias, scarlet sage—set them in a shaded corner for a few days and *syringe* the tops daily before placing in the sunny window.

Nothing is more unsightly than a lot of "leggy" old plants or puny weak ones. Grow few plants and have kinds which will thrive. Make cuttings and keep the plants vigorous and shapely. Cut back the old plants, remembering that flowers are on new wood, and that it is "easier" for an old plant to grow a lot of new shoots than to carry leaves on the tips of long, lanky branches. So cut the old plants back vigorously once in a while.

In selecting plants at the florist's for home window gardening, do not be interested in those of his hottest house; choose plants from a night temperature of about 50 degrees. Plants like equable temperatures as well as

¹ Courtesy of The Countryside Magazine, N. Y.

regularity of other conditions. Do not allow the room temperature to get above 70 degrees in daytime nor below 50 degrees at night.

Watering.—The watering of plants is largely a matter of judgment. It is offered as good advice that a plant should be watered when it needs it, and contrariwise *not* when it does not need it. Water copiously once in two days rather than a little each day, unless the earth has become dried out. This can be determined by tapping the flower pot with the finger nail; a clear, ringing sound will indicate dryness; a dull sound shows a damp condition and water *not* required. Watering at the roots is not sufficient, strange to say. Plants respond also to a wetting of the leaves. This can



A WELL-PROPORTIONED FERN.¹

be accomplished by turning them half over in a tub and syringing the tops. Do not allow the sun to play upon wet leaves; it may injure them severely.

Feeding Plants.—Pot-grown plants respond to “feeding up”—the application once in a while of liquid manure—which is merely stable manure and water allowed to stand a few days and strained. Apply the liquid once a month for two successive waterings. Bone meal worked in at the top of a pot is slow in its action, but beneficial. There are prepared plant-foods which are valuable and convenient, but more expensive than these two.

¹Courtesy of The Countryside Magazine, N. Y.

Ferns and Foliage Plants.—Plants should fit the purpose for which they are intended. If a green and growing plant for house decoration during the winter months, one that can be moved from place to place, is wanted, the aspidistra, dracaena, cocos and other palms, asparagus plumosus, rubber plant, aurocauria (Norfolk Island Pine), and with restrictions, the Boston, Scott's and crested ferns should be chosen. Maidenhair ferns do not generally succeed with house culture, but of them all *Adiantum gracillimum*, *cuneatum*, and *Capillus-Veneris* are best. For the table, small ferns in a fern dish are as good as anything except the pots of spring bulbs as they are brought in from the cellar. The fern dish should have a

porous earthen dish in which to grow the plants, regardless of the ornamental character of the dish in which it rests. Ferns, purchased as "table ferns," are but baby big ferns, and are good to use in a fern dish. As they become larger, they should be transplanted to larger pots or to a fern box and placed in a sunless window.



A LARGE BOSTON FERN.¹

that they may not be too wet. For plants there is a good variety: Abutilon, flowering begonias; fuchias, swainsonia, billbergia, Quenista, geraniums (especially "Christmas Pink"), cuphea, lobelia, oxalis (also for hanging basket), cyclamen (in shaded spot), Chinese, starry, and "Baby" primroses, stevia, Marguerites, candytuft, alyssum, ageratum, heliotrope, bouvardia, balsam ("touch-me-not"), cactus, and plants mentioned later which may be brought from the outdoor summer gardens. Among bulbs, amaryllis, calla and the so-called "Dutch bulbs" are probably the most satisfactory of all flowering plants for the house. A dozen Paper white narcissus may be grown in an eight-inch deep glass dessert-dish half full of sand, above which the bulbs rest, held firmly in place by

¹ Courtesy of House and Garden, Published by Robert J. McBride & Co., N. Y.

pebbles sprinkled in among them and covered with water. Freesias, hyacinths, tulips, daffodils, single narcissus, crocus, even the Easter Lily in any of the many named varieties listed in seedsmen's catalogues, may also be grown successfully by the amateur. These Dutch bulbs should be purchased in September, and excepting freesias, Paper white narcissus and Roman hyacinths, which may be started at once, planted and put away for about six weeks to form roots before any top growth is allowed. Set them in a cool place—buried in coal ashes in a corner of the cellar or out-of-doors in a box buried in cinders for one inch above the pots and protected from freezing too hard by a layer of straw, leaves and boards. Keep them moist and cool. They may be brought into flower a pot at a time and furnish pleasure from Thanksgiving to April—a gamut of color and delightful fragrance.

Plant Lice.—The most prevalent insect pest attacking house plants is the plant louse, a little green insect feeding upon the under side of leaves and tender shoots. Another form is black. Both forms are combated by tobacco concoctions obtainable ready-made at the seed store; also, the plants may be fumigated with burning tobacco, dusting the leaves with tobacco dust, and by spraying the leaves with soap in solution. The insect must be *wet* with the solution, so care must be exercised in spraying to reach the under side of the leaves. Another common pest is the brown scale which attaches itself firmly to branch or leaf and resists water and fumigation. It can be removed by brushing the leaves and by kerosene emulsion, which, however, may injure a tender plant.



BULBS GROWN IN WATER-TIGHT RECEPTACLE.¹

REFERENCE.

"Manual of Gardening." Bailey.

¹Courtesy of The Countryside Magazine, N. Y.

PART II
PLANT DISEASES, INSECT ENEMIES
AND THEIR CONTROL

(197)

CHAPTER 18

DISEASES OF GARDEN AND ORCHARD CROPS; AND THEIR REMEDIES

BY DR. MEL. T. COOK

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When any of the various parts of a plant are not doing their work properly the plant is said to be diseased. The disease frequently causes poor growth or poor fruit, or both; and in case of our cultivated plants, an unsatisfactory crop.

The most important causes of plant diseases are fungi, bacteria, slime moulds, parasitic flowering plants, insects, mites, nematodes, unsatisfactory soil, too much or too small amount of moisture, unfavorable temperature, gas fumes and smoke. Some plant diseases occur for which there are no satisfactory explanations.

Plant diseases may be detected by characteristic symptoms which readily distinguish the disease upon the healthy plants. The most common of these symptoms are: (a) a discoloration of the foliage and sometimes of the new growths; (b) wilting, frequently followed by yellowing and browning; (c) dropping of the foliage; (d) the formation of spots on foliage, stems or roots; (e) perforation of the foliage commonly called "shot hole;" (f) variegation of the foliage commonly called mosaic; (g) the "damping off" or dying which is especially common on seedling plants; (h) the blight or dying of leaves, twigs or stems; (i) the dwarfing of parts; (j) the increase in size of parts; (k) formation of galls, pustules or corky growths; (l) cankers on fruit, stems or roots; (m) abnormal fruits; (n) the formation of masses of small shoots called "witches' brooms;" (o) the curling of leaves; (p) the formation of leaf rosettes; (q) abnormal root growths commonly known as hairy root; (r) exudations of gums, resins, etc.; (s) the rotting of fruit, stems or other parts; and (t) sunburn of fruits and foliage.

Some diseases of the soil, such as "damping off," are very severe in seed-beds and in greenhouses, and can be controlled by sterilizing the soil. Diseases that occur in the soil in fields are frequently overcome by a rotation of crops, by improved drainage and sometimes by stimulating the plants with suitable fertilizer.

Many diseases are controlled by spraying, but in most cases spraying is used for the protection of plants against disease and not for curing them; therefore, it is a kind of insurance and must always be supplied in advance of the appearance of the disease. Spraying cannot be conducted in a satisfactory manner unless the grower is sufficiently familiar with the disease

to understand when, why and how to give the necessary treatments. In recent years it has been found possible to overcome some diseases by growing plants that are disease-resistant and, therefore, do not need treatments.

In this chapter only the most common and important plant diseases in the United States and Canada are considered. Brief descriptions and condensed directions for treatment are given.

Farmers should always report the presence of disease on crops to the agricultural experiment station of the state in which they reside, and ask advice as to treatment. The treatment of some diseases will vary somewhat, dependent upon the part of the country in which it occurs.

APPLE

Bitter Rot or Ripe Rot (*Glomerella rufomaculans* [Berk.], Spaul and von Schrenk).—This rot is not confined to ripe apples and is not always bitter. It attacks both fruit and twig and occurs in orchard and in storage. On the fruit it appears as a brown, sometimes black, circular spot which gradually enlarges. It may be soft and wet or dry and corky, depending on variety of the fruit and age of the infection. The spore pustules start from the center of the spot and gradually spread over the surface, usually forming rather definite circles. They are pinkish in color and watery and spread the disease from fruit to fruit. Large spots become depressed and wrinkled and the entire fruit eventually becomes rotten, then dry and shrunken, and is finally known as a "mummy."

The disease may be carried from year to year on these mummies and also on the stems. On the twigs and branches it causes rough spots known as cankers. These cankers are rough and vary in size with age. The fungous spores from these infect the growing crop.

Treatment.—Remove and burn the mummified fruit and twig cankers. Spray with lime-sulphur before the buds open. After the petals fall, spray with self-boiled lime-sulphur or Bordeaux mixture. (See spray table for pear.)

Black Rot (*Spharopsis malorum*, Peck).—The rotten spot on the fruit is usually blacker and drier than the bitter rot spot and can be readily distinguished by the numerous black dots or papillae from which masses of black spores emerge.

It also causes a stem canker in which the twigs become swollen, rough and black. On the trunk and larger branches it causes peculiar cankers. On young trees it causes a blight which is somewhat similar to the fire blight of the pear, but which can be readily distinguished by the presence of numerous small black dots. It also attacks the leaves, causing peculiar spots frequently spoken of as "frog eye."

Treatment.—Same as for bitter rot.

Brown Rot.—Usually not severe on the apple. (See Peach.)

Storage Rots.—The rots which occur in storage may be due to the

preceding fungi or to a number of others. Thorough spraying of the orchards, careful handling of the fruit, regulation of temperature and humidity will reduce these rots to a minimum.

Scab (*Venturia inaqualis* [Cke.], Wint.).—This is one of the most injurious diseases of the apple. It causes a dry, black spotting of the fruit which is well characterized by the name "scab." As the season

advances the seriously infected fruits become distorted and cracked. Affected fruits are especially susceptible to storage rots.

The disease also attacks the leaves and twigs, causing a more or less thick, velvet-like covering, varying in color from olive-green to black.

Treatment.—Spray with concentrated lime-sulphur (5 quarts in 50 gallons of water) or Bordeaux mixture when the pink shows, but just before the blossom opens.

Blotch (*Phyllosticta solitaria*, Ell. and Ev.).—This disease causes dark, irregular blotches on the fruit and, when severe, causes a cracking. In the older spots a number of small, black, fruiting dots are



APPLE SCAB.¹

Photograph by Prof. M. A. Blake.

formed. It also attacks the twigs, causing small tan-colored cankers. In the old cankers the bark becomes cracked and roughened.

Treatment.—Spray with lime-sulphur or Bordeaux mixture. (See table for apples, pears and quinces.)

Rust (*Gymnosporangium macropus*, Link.).—This disease attacks foliage, fruit and twig, causing a yellowish orange-colored spot which is not readily confused with other diseases. On the upper surface these spots show numerous small yellow pustules becoming black. On the

¹Courtesy of New Jersey Agricultural Station.

under surface, in the late stages, are produced small, fringed, cup-like structures containing great masses of spores. These spores will not re-infect the apple, but are carried by the wind to neighboring red cedar trees, where they cause the formation of the familiar cedar apples.

These large brown cedar apples of the cedar, occurring in the spring, produce gelatinous, horn-like projections, bearing masses of spores. These spores are borne by the wind to the apple tree, which is re-infected with the disease.

Treatment.—Remove the cedar apples, or still better, remove the cedar trees. Spraying the apple trees as for scab will reduce the disease to some extent.

Fire Blight.—See Pear.

Other Foliage Spots and Twig Cankers.—There are leaf spots and twig cankers due to other causes which cannot be enumerated in this brief discussion. These diseases are all more or less injurious, but can be controlled by the regular spraying methods and sanitation.

Mildew (*Spharotheca mali* [Duby], Burr.)—This fungus grows on the surface of the leaf, causing a grayish or whitish covering. Usually it is not severe and can be controlled by the regular spraying or by spraying with potassium sulphide.

Crown Gall and Hairy Root (*Bacterium tumefaciens*, Smith and Townsend).—These two diseases are due to the same organism. The crown galls or root galls occur at the crown or on the roots and sometimes on the stems. They are more or less spherical, with irregular, roughened surfaces. Some are hard and others soft, but they are all probably due to the same cause. They are most severe on red raspberries, are very injurious to peach



APPLE TREE WITH TYPICAL COLLAR BLIGHT.¹
Showing proper method of cutting back into healthy bark before treating with paint.

¹ Courtesy of Pennsylvania Agricultural Experiment Station, State College, Pa.

trees and more or less injurious to apple trees, dependent somewhat on the varieties. They also occur on pears, quinces, cherries, plums, grapes, roses and many other plants. The diseased tissues extend throughout a



YOUNG APPLE TREE FROM NURSERY.¹
Showing the disease known as Root Gall.

crops in orchards. Nursery stock known to be infected should be destroyed.

PEAR

Blight (*Bacillus amylovorus* [Burr], De Toni).—This very familiar disease causes the leaves and young twigs to die and blacken very much as though injured by fire. These dead leaves hang on the trees during the winter instead of falling in the autumn, as is the case with healthy leaves. The disease also attacks the branches, causing black, sunken cankers from

considerable part of the plant which makes cutting off of these malformations a very uncertain treatment.

The hairy root appears underground as a mass of fibrous roots and above ground as warty knots on trunk and branch, and is sometimes mistaken for cankers, due to other causes.

Treatment.—The organism which causes this disease lives in the soil for several years, and cannot be eradicated except by a long rotation of crops. It is unwise to set orchards, especially peach orchards, in old berry fields or other fields known to be infected or to use berries as inter-row

¹Courtesy of The Field, New York.

which a sticky, milky fluid oozes in the early spring, and from which the disease is spread, by means of insects, to the opening blossoms. If the weather conditions are favorable the blossoms and fruit spurs die and blacken and very frequently considerable quantities of the young fruit are destroyed. The disease also occurs on the apple, crab, hawthorn and other related trees.

Treatment.—Prune and burn the diseased twigs on young trees; clean out the cankers on old trees, dipping the knife from time to time in formaldehyde (1 part in 20 parts water). Paint these wounds with formaldehyde and then with white lead paint or coal tar. Do not over-fertilize or over-cultivate the orchard.

SPRAY TABLE FOR APPLES, PEARS AND QUINCES.

TIME.	MATERIAL.	PURPOSE.
1. Before the buds swell.	Concentrated commercial lime-sulphur, 1 part in 9 parts water or home-made concentrated lime-sulphur diluted to a specific gravity of 1.03.	For fungous diseases and for San José scale.
2. As soon as the flower buds show the pink color.	Concentrated commercial lime-sulphur, diluted to 5 quarts in 50 gallons of water or 1:40, or home-made concentrated lime-sulphur diluted to specific gravity of 1.007. (Bordeaux mixture can be used for this treatment.)	For scale and fungi.
3. Immediately after petals fall.	Same as 2.	Same as 2.
4. Ten days after blossoms fall.	Same as 2.	Same as 2.

Two additional sprayings are frequently necessary for fall and winter varieties.

Arsenical poisons for chewing insects and tobacco extracts for sucking insects may be added to treatments 2 and 3.

Rust (*Gymnosporangium juniperi-virginianae* and *G. blasdaleanum* [D. and H.], Kern).—Similar to apple rust.

Scab (*V. pyrina*, Aderh.).—Similar to apple scab.

Leaf Spot (*Septoria pyricola*, Desm.) appears as numerous small, well-defined, angular, ashy-colored spots with minute black dots. It is not often severe.

Leaf Spot (*Entomosporium maculatum*, Lev.) occurs on the leaf, causing small, circular spots with dull, red centers and dark borders. When severe it causes the leaves to become yellow or brown and fall. It also attacks the fruit, causing spots which are at first red, becoming dark and in severe cases causing the fruit to crack. It is carried over the winter on the fallen leaves.

Treatment.—This disease can be controlled by spraying with Bordeaux mixture, beginning when the leaves are about half or two-thirds full grown and repeating at intervals of three weeks until four treatments have been given.

Rots.—The black rot and brown rot also occur on the pear. (See Apple.)

Crown Gall.—See Apple.

QUINCE

Rust (*G. clavipes*, C. and P.).—This disease is very similar to the rusts on apples and pears, but is more severe on the fruit and twigs than on either of the preceding. It also has the cedar for its alternate host.

Blight.—See Pear.

Leaf Spot.—See Pear.

Rots.—See Apple.

Crown Gall.—See Apple.

PEACH

Brown Rot (*Sclerotinia fructigena* [Pers.], Schroet.).—This is one of the most destructive diseases of the peach. It attacks the fruit as



PEACHES ENTIRELY DESTROYED BY BROWN ROT.¹

Showing gray masses of spores of fungus.

it is approaching maturity, causing it to rot, become brown, soft and useless. The fungus produces an abundance of spores which form a dense brown, powdery mass over the fruit. It also attacks the blossoms, causing them to die, turn brown and fall soon after opening. It then spreads to the twigs, causing death of the young shoots and causing cankers on the older branches.

Treatment.—See spray table for peach.

Scab or Freckles (*Cladosporium carpophilum*, Thuem.).—This extremely common disease attacks the fruit, causing sooty, black specks or blotches

¹From Farmers' Bulletin 440, U. S. Dept. of Agriculture.

which, when severe, may prevent normal ripening and cause the fruit to be irregular in shape and to crack.

Treatment.—See spray table for peach.

Leaf Curl (*Exoascus deformans* [Berk.] Fekl.).—This very familiar and very injurious disease causes the leaves to curl, reduces their value to the tree and finally causes them to fall. With the appearance of the second crop of leaves, the growers frequently suppose the tree to have recovered. However, it has lost in vitality and vigor, which results in a reduction or complete loss of the crop.

Treatment.—Spray with lime-sulphur before the buds open.

Shot Holes (*Cercospora circumscissa*, Sacc., *Phyllosticta circumscissa*, Cke.).—These “shot hole” diseases are quite common, but readily controlled by the regular spraying treatments.

Another shot hole (*Bacterium pruni*, Smith) is very common in the Southern states and especially on Elbertas. It frequently causes the foliage to fall in midsummer. It also attacks the fruit, causing a spotting somewhat similar to the scab. It cannot be controlled by spraying.

Crown Gall.—See Apple.

Mildew (*Sphaerotheca pannosa* [Wallr.], Lev.).—Similar to the mildew of the apple. It is of little importance and can be controlled by the regular spray treatment. (See table for peach.)

Yellows.—The cause of this very destructive disease remains a mystery. In its earlier stages it causes a premature ripening of the fruit, accompanied by a red blotching over the surface and through the flesh which is usually insipid and frequently bitter. (Prematuring may also be caused by borers or winter injury.) In its later stages it causes the so-called “willowing” or formation of slender yellowish-green shoots on the trunk and larger branches. The leaves on these shoots are small, narrow and greenish-yellow. The foliage is frequently greenish-yellow, but when supplied with nitrogenous fertilizers will not show this character. In its earlier stages, one part of the tree may show the disease and the other parts appear perfectly healthy, but in fact the entire tree is diseased. It can be transmitted from tree to tree by contact and to young trees by budding. Buds from the apparently healthy parts of very slightly diseased trees will transmit the disease. Healthy nursery stock is of the greatest importance.

Treatment.—Dig and burn the trees as soon as the disease appears, using care to prevent the tree coming in contact with others. Young trees can be set in the places from which the old ones were removed; the disease does not persist in the soil. The greatest care should be used in the selection of bud wood, to insure its freedom from disease.

Little Peach.—The cause of this disease is also unknown, but it is of the same nature as yellows. The fruit of diseased trees is small, ripens late, is inferior in quality, frequently insipid and watery. The leaves are frequently lighter than normal leaves or yellowish-green and often rolled and drooping.

Treatment.—Same as for yellows.

Peach Rosette.—The cause of this disease of the peach in the Southern states is also unknown. It is very similar to yellows, but the leaves tend to cluster, giving the general appearance of green roses.

Treatment.—Same as for yellows.

SPRAY TABLE FOR PEACH.

TIME.	MATERIAL.	PURPOSE.
1. Same as first treatment for apple. (See page 943.)		
2. Just as the husks fall from the small fruit.	Self-boiled lime-sulphur.	For brown rot, scab and other diseases.
3. Three weeks after 2.	Same as 2.	Same as 2.
4. Three weeks after 3, for late varieties.	Same as 2.	Same as 2.
5. Same as 2 for very late varieties.		.

NOTE.—Arsenical poisons may be added to No. 2 for curculio. Tobacco extract's and soap can also be added for sucking insects.

PLUM

Black Knot (*Plowrightia morbosa* [Schw.], Sacc.).—This very common and well-known disease causes swollen growths on the branches which are at first olivaceous in color, but finally become deep black and very hard and brittle. It will spread over the greater part of a tree, interfere with its growth and finally cause its death.



BLACK KNOT ON THE CHERRY.¹

Photograph by Prof. J. P. Helyar.

Leaf Spot.—See Cherry. **Mildew.**—See Cherry. **Yellows.**—See Peach. **Brown Rot.**—See Peach. **Crown Gall.**—See Apple.

Treatment.—The diseased parts should be cut out and burned and the trees should be sprayed with lime-sulphur in the spring before the opening of the buds. (See table for plum.)

¹Courtesy of New Jersey Agricultural Experiment Station,

SPRAY TABLE FOR PLUM.

TIME.	MATERIAL.	PURPOSE.
1. Same as for apple and peach.		
2. Immediately after the petals fall.	Self-boiled lime-sulphur.	For brown rot.
3. When fruit is about the size of green peas.	Same as 2.	Same as 2.
4. Three weeks after 3.	Same as 2.	Same as 2.

NOTE.—Arsenical poisons for control of curculio may be added to No. 2. Tobacco extracts and soap may be added for control of plant lice.

CHERRY

Leaf Spot (*Cylindrosporium padi*, Karst.).—This disease, which is also called "shot hole," causes discolored circular spots usually with reddish or purple border, eventually becoming brown and breaking into a hole and often resulting in a defoliation of the tree. When severe it is very injurious to the growth and health of the tree.

Treatment.—Spray with lime-sulphur or with Bordeaux mixture.

Black Knot.—See Plum.

Crown Gall.—See Apple.

Brown Rot.—See Peach.

Powdery Mildew (*Podosphara oxycanthu* [D. C.], DeBy.).—Similar to *S. mali* of the apple.

SPRAY TABLE FOR SWEET CHERRIES.

1. Treatment same as first treatment for apple.
2. Treatment same as second treatment for peach, but given immediately after the petals fall.
3. Repeat treatment 2 when fruit is about the size of small pea.
4. Repeat treatment 2 after the fruit is picked.

CITRUS FRUITS

Brown Rot (*Pythiaecystis citrophthora*, Sm. and Sm.).—This disease of the California fruit is sometimes the cause of heavy losses. It is caused by a fungus which is white in mass. It occurs in the orchard and packing houses causing a rot with a peculiar rancid odor. Very slightly infected fruits rot during transportation. It is most abundant in wet weather or on low ground after irrigation.

Treatment.—It is spread by contact and can be controlled by using a heavy straw mulch or cover crop under the trees and by disinfecting the fruit in the packing house.

Black Rot (*Alternaria citri*, Pierce).—This disease of the navel orange causes a premature ripening. It usually enters the fruit through the navel, causing an internal rot accompanied by a reddish color. The diseased fruit should be burned or buried.

Stem End Rot and Melanose (*Phomosis citri*, Fawcett).—This disease is most common on mature packed fruit, causing a circular patch of soft

rot at the stem end which can be detected by a pressure of the finger even though there may be no discoloration. The presence of scale insects and warm, damp weather tend to increase the disease.

This organism also causes the disease known as melanose of the fruit, twig and leaf. This form of the disease appears as a raised brownish area forming dots, lines and crosses, varying from yellow to brown and black. The cutting out of the dead wood is an important factor in the control of this disease.

Other Rots (*Penicillium italicum*, Wehm., and *P. digitatum* [Fr., Sacc.].)—These rots are covered by the fungus and appear as blue moulds. They are the causes of heavy losses in transportation. The fungus enters the fruits through slight wounds and therefore the fruit should always be handled carefully.

Sooty Mould (*Meliola camelliae* [Catt.], Sacc.).—In this case the fungus covers the fruit with a black velvety coating which can usually be removed. It is not nearly so serious as some other diseases. It really grows on the exudations (honey dew) of plant lice and its control depends on their destruction.

Black Pit of the Lemon (*Bacterium citriputeale*, Sm.).—This disease appears as circular or oval, well-defined, reddish-brown, brown or black spots or pits on the fruit. They are caused by bacteria which gain entrance through wounds.

Anthracnose or Wither Tip (*Colletotrichum glæosporioides*, Penz.).—This disease attacks the young leaves, twig tips and fruits. It causes a yellowish spotting of the leaves, a withering and dying of the new shoots and canker-like spots on the fruit. It is one of the most common diseases of the citrus fruits.

Scab (*Cladosporium citri*, Mass.).—This very common disease attacks leaves, twigs and fruits, causing prominent warty or corky outgrowths. The leaves are frequently twisted and twigs are frequently cracked.

Canker.—This is a comparatively new disease in America and there is some difference of opinion as to the cause. It is very destructive and a very vigorous campaign is being made against its spread. It occurs on leaf, twig and fruit, causing dead, circular spots which are usually raised. They are light-colored when young, but become brown and corky and frequently marked with small cracks.

Other important diseases of the citrus fruits are the scaly bark or nail head rust (*Cladosporium herbarum* var. *citricolum*) of Florida, the citrus knot (*Sphæroopsis tumefaciens*, H. and T.) of the West Indies, and the gummosis, which is very widely distributed.

Treatment of Diseases of Citrus Fruits.—So much progress is being made in the study of these diseases at this time that it is inadvisable to attempt a discussion as to treatment. Those interested in these diseases should consult with the agricultural experiment station in the state in which the disease occurs.

FIG

Rust (*Kuehneola fici* [Cast.], Butler).—This very common disease causes numerous rusty red spots on the lower surface of the leaves. When severe the trees are almost defoliated. It can be controlled by frequent spraying with Bordeaux mixture.

Cankers (*Libertella ulcerata*, Masee).—This disease is sometimes severe where figs are grown under glass. It starts as small radiating cracks which develop into cankers, sometimes completely girdling the branch and causing the death of the parts beyond the point of attack.

Another canker (*Tubercularia fici*) causes a shrinking and drying out of the tissues surrounding the fruit scars, followed by a drooping of the dead parts.

Fruit Rots (*Glomerella rufomaculans* [Clint], Sacc.).—This disease is due to the same organism as the bitter rot of the apple. It causes sunken, rotten spots, usually covered with a whitish growth and later by numerous pustules of salmon-pink colored spores. If the fruit is attacked when young, it becomes dry and hangs on the tree.

Ripe fruit rots may be due to various fungous organisms.

Other important diseases of the fig are the yellow rot (*Fusarium roseum*, Lint), the leaf spot (*Cercospori fici*, H. and W.) and the limb blight (*Corticium latum*, Karsten).

PINEAPPLE

The pineapple is subject to several diseases, all of which should receive more attention. Growers who have reason to complain of these troubles should consult with the state agricultural experiment station.

MANGO

Bloom Blight (*Colletotrichum gloeosporioides*, Penz).—This most severe disease of the mango is due to the same organism that causes the wither top of the orange. It attacks the blossoms, causing them to turn black and fall. Unfortunately, the blooming is during the rainy season, which makes spraying impractical.

AVOCADO

Leaf Spot (*Colletotrichum gloeosporioides*).—This is due to the same organism as the wither top of the orange. It is frequently so severe as to cause a heavy loss of foliage. It also attacks the fruit, frequently causing a pronounced cracking.

OLIVE

Olive Knot (*Bacterium savastanoi*, Smith).—This disease originates as irregular, more or less hemispherical swellings on trunk, branches and leaves. They are firm and fleshy, but finally become woody and crack. Badly infected trees frequently die as a result of this disease.

BLACKBERRY, DEWBERRY AND RASPBERRY

Crown Gall.—See Apple.

Leaf Spot (*Septoria rubi*, West) occurs on the leaves of these bush fruits, causing small white or ash-colored spots with brown or reddish margins. Close examination shows very small black dots in each spot. It is frequently the cause of considerable damage.

Treatment.—Spray in the spring with Bordeaux mixture.

Anthracnose (*Glæosporium venetum*, Speg.).—This disease attacks the young canes of these fruits, causing small purplish spots which enlarge and become grayish or dirty white in the centers. When severe, it causes the canes to crack and die, the leaves to be dwarfed and the fruit to ripen prematurely. The disease also occurs on the leaves, causing them to develop unequally.

Treatment.—Cut and burn the diseased and dead canes soon after picking the fruit. Spray with Bordeaux mixture in the spring and also as soon as possible after the berry season.

Orange Rust (*Gymnoconia interstitialis* [Schlecht], Lagh.).—This disease is very abundant in the spring of the year, causing a dense coating of red rust (spores) on the under surface of the leaves. The fungus grows within and may spread throughout the entire plant.

Treatment.—Dig and burn the entire plant. Spraying with Bordeaux mixture will prevent the infection of healthy plants, but is not a practical treatment.

Double Blossom (*Fusarium rubi*, Wint.).—This disease is especially abundant on the Lucretia dewberry, the black diamond or Brazil blackberry and also occurs upon other varieties of blackberries and dewberries. The fungus lives within the buds, causing them to form witches' brooms of slender shoots with deformed or double flowers producing little or no fruit. The infection of the new buds which are forming for the next year occurs when the diseased flower buds are opening.

Treatment.—The disease can be greatly reduced by picking these deformed leaf buds soon after they open and before the opening of the flower buds. Select plants so far as possible from fields free from the disease.

Cane Blight (*Coniothyrium fuckelii*, Sacc.).—This disease of the raspberries attacks the canes, causing them to be lighter in color, with smoke-colored patches. The foliage of diseased canes wilts and dies very much as from drought. The disease penetrates wounds, frequently those made by pruning. It is readily distributed in nursery stock and will persist in the soil for several years.

Treatment.—Rotate the crops and use only healthy plants for setting.

Yellows.—This disease is confined to the raspberries. It resembles peach yellows and should be treated in the same manner.

STRAWBERRY

Leaf Spot (*Sphaerella fragariae* [Tul.], Sacc.).—This is the most prominent of the diseases of the strawberry. It causes small leaf spots with white or ashy centers and purple or red borders. These spots frequently unite, forming irregular blotches. It reduces the vigor of the plant and, therefore, the quality and quantity of the fruit.

Treatment.—The soil should be well drained and rotation of crops practiced. Cutting over the beds and burning of the tops is advantageous. Spraying with Bordeaux mixture will reduce the disease to the minimum, but there is doubt as to whether this treatment will prove profitable.

CRANBERRY

Scald or Blast (*Guignardia vaccinii*, Shear)—This fungus attacks the blossoms or the fruit soon after the falling of the blossoms, causing the berry to shrivel and turn black. This form of the disease is known as the "blast." The form known as "scald" causes small, soft, light-colored, watery spots which spread over the entire fruit, sometimes causing a zone effect. The disease also attacks the leaves, causing irregular, reddish-brown spots. The disease is likely to become worse from year to year and to prove very destructive.

Treatment.—Careful irrigation, raking and burning of the dead material and sanding the bogs are advantageous. Selection of resistant strains for planting, and spraying with Bordeaux mixture about five times during the season will control the disease.

Rot (*Acanthoshynchus vaccinii*, Shear).—This fungus causes a rot very similar to the scald and can be controlled by the same treatment.

Anthracnose (*Glomerella rufomaculans* [Berk.] Spaul. and von Schrenk; *vaccinii*, Shear).—This fungus is the same as the one causing the bitter rot of the apple. It causes a rot very similar to and almost indistinguishable from the scald and can be controlled by the same treatment.

GOOSEBERRY

Powdery Mildew (*Spharotheca mors-uvæ* [Schw.] Berk. and Curt.).—Very similar to the mildew on the apple and other fruits and should receive the same treatment.

CURRANT

Anthracnose (*Pseudopeziza ribes*, Kleb.).—This very common disease of the currant attacks the leaves, causing many small brown or black spots, followed by a yellowing of the entire leaf which falls prematurely. The disease also attacks the canes and the fruit, causing small black, sunken areas. It is carried from year to year on the canes.

Treatment.—Remove the old canes and spray with Bordeaux mixture in the spring just before the buds open, again after the leaf

buds open and then at intervals of three weeks until the fruit is two-thirds grown.

NOTE.—There are several other leaf diseases of the gooseberry and currant that may occasionally prove injurious or destructive and should be treated as the circumstances may demand.

GRAPE

Black Rot (*Guignardia bidwellii* [Ell.], V. and R.).—This very common disease of the grape attacks the fruit, causing a black rot followed by a shriveling and drying into a hard, wrinkled mummy. It occurs on the leaves and young shoots earlier than on the fruit and causes tan-colored spots with minute black dots in the centers.

Treatment.—Spray with Bordeaux mixture before the opening of the flower-buds, and again after the setting of the fruit. Additional spraying should depend on the weather; in dry seasons it may be necessary to spray every three weeks until the fruit is two-thirds grown.

Bird's Eye or Anthracnose (*Sphaceloma ampelinum*, DeBy.).—This disease is not nearly so severe as the black rot. It attacks the fruit, causing brown or black spots with sunken centers and red borders. On the canes it causes similar spots, but as they approach maturity the centers become ashy in color and the edge dark.

Treatment.—Badly diseased canes should be cut out and burned. Spray treatment same as for black rot.

Bitter Rot or Ripe Rot.—This is the same as on the apple but its attack is confined to the ripe fruit.

Treatment.—Spray with ammoniacal copper carbonate solution.

Downy Mildew (*Plasmopara viticola* [Berk. and Curt.], Berl. and De Toni.).—This fungus causes whitish and finally brownish areas in the leaf, followed by a very perceptible downy growth on the lower surface. It sometimes causes the death of the entire leaf, shoot or vine. It is especially severe on the European varieties. It sometimes attacks the fruit, causing the gray or brown rot.

Treatment.—Same as for black rot.

Powdery Mildew (*Uncinula necator* [Schw.], Burr.).—This fungus is very similar to the powdery mildew of the apples and other fruits. It attacks all parts of the plant above ground, and occurs on both upper and lower surfaces of the leaves, causing circular, whitish, powdery spots which frequently unite and cover the entire leaf. It also attacks the fruit, causing it to develop irregularly, fail to develop or to fall. It is especially common in vineyards where the vines are too closely set and on vines grown under glass.

Treatment.—Spray with potassium sulphide or when the temperature is above 75° F., sprinkle the vines with flowers of sulphur.

Necrosis (*Fusicoccum viticolum*, Reddick).—This disease causes a

dwarfing of the new shoots and leaves and when severe a shriveling up and dying.

Treatment.— Dig and burn all diseased vines, and spray with Bordeaux mixture.

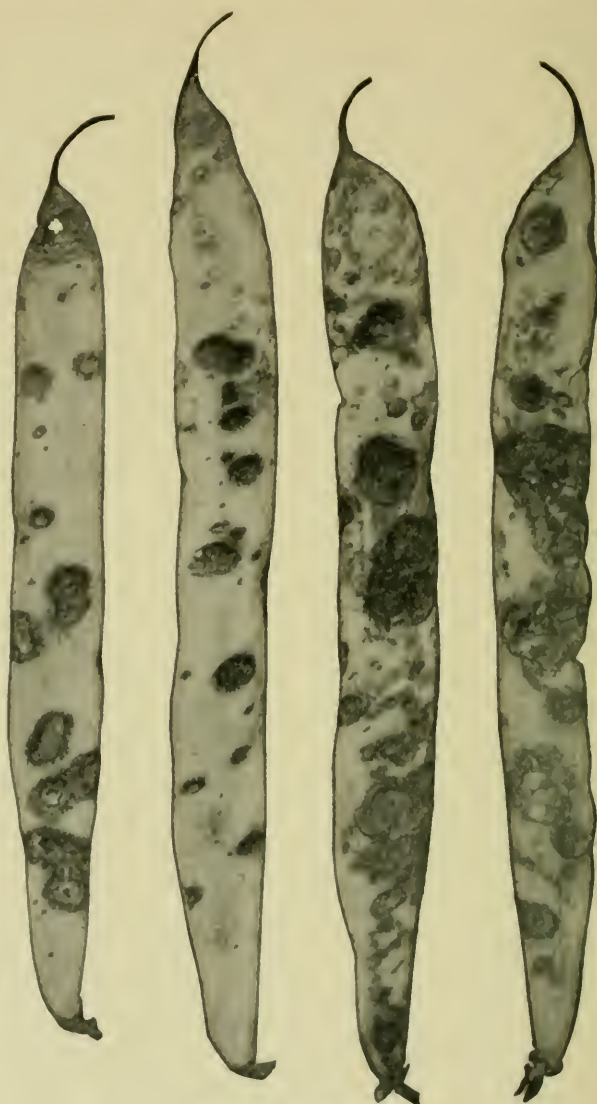
Crown Gall.— See Apple.

NOTE.— A number of other minor diseases will be controlled by the treatment prescribed for the rot.

ASPARAGUS

Rust (*Puccinia asparagi*, D. C.).— This fungus causes the tops of the plants to redden soon after blossoming. The leaves turn yellow and fall, and the stems show numerous small blisters containing masses of rust-colored powder (spores). Later in the season these pustules break and become black in color. The disease spreads rapidly and causes heavy losses.

Treatment.— Cut and burn diseased plants as soon as observed. Spray with Bordeaux mixture.



ANTHRACNOSE OF BEAN.¹

The brown spots occur on both the pods and plants. They are caused by spores coming in contact with the tender plant tissues, where they germinate and give rise to serious damage.

¹Cornell Agricultural Experiment Station Bulletin 255.

BEAN

Anthracnose (*Colletotrichum lindemuthianum* [Sacc. and Magn.], B. and C.).—This disease is most severe on the wax beans. It occurs on the pods, causing unsightly, dark-colored, sunken, canker-like spots. It also attacks the leaves and stems, producing similar spots and frequently causing the death of the plants. The fungus is carried in the seed and one diseased seed in a thousand is enough to infect a large number of growing plants.

Treatment.—Select clean seed.

Rust (*Uromyces appendiculatus* [Pers.], Link).—This fungus causes minute rusty spots or blisters on the under surface of the leaves and occasionally on the pods. These blisters break and set free great quantities of the reddish or rust-colored spores. It is not so severe as the anthracnose.

Treatment.—Practice clean cultivation and burn all old vines in the fall.

Blight (*Pseudomonas phaseoli*, Smith).—This disease attacks leaves, stems and pods, causing large watery areas, which later become dry, brown and papery. It is carried from year to year in the seed.

Treatment.—Use seed from healthy plants.

Downy Mildew (*Phytophthora phaseoli*, Thaxt.).—This disease is unlike the mildew on the fruits. It attacks the pods of lima beans, causing irregular areas of dense, woolly-white growth. It also occurs on other parts of the plant, causing dwarfing and irregular growths.

Treatment.—Spray with Bordeaux mixture.

Leaf Spot (*Phyllosticta sp.*).—This disease is most severe on the pole lima beans. It causes an irregular spotting of the leaves and to some extent of the pods. It is carried from season to season in the seed.

Treatment.—Spray with Bordeaux mixture.

PEA

Spot (*Ascochyta pisi*, Lib.).—This disease causes spots on stems, leaves and pods which are most conspicuous on the latter. On the pods they are circular, sunken with dark borders and pale centers, becoming pink when mature. The spots on the leaves are oval and usually show concentric circles. When severe on the stems it causes wilting and death of the plant.

Treatment.—Select clean seed and rotate crops.

BEET

Leaf Spot (*Cercospora beticola*, Sacc.).—This fungus causes the very common circular, brown, purple-bordered spots with ash-colored centers.

Treatment.—Spraying with Bordeaux mixture will control this disease.

Root Rot (*Rhizoctonia beta*, Kuhn).—This disease causes the outer leaves to turn black and fall. As the disease advances the roots crack and then rot from the crown downward.

Treatment.—Use lime and rotate crops.

Scab.—See Potato.

CABBAGE, CAULIFLOWER, TURNIP, ETC.

Black Rot (*Pseudomonas campestris*, Pammel).—This is a bacterial disease which attacks all of the above and many related plants. It starts at the edges of the leaves, causing a blackening of the veins, gradually working downward to the main stalk and then upward and outward until the entire plant is affected. The affected leaves become yellow, wilt and then dry. In advanced stages the disease is accompanied by other rot organisms which cause a pronounced odor.

Treatment.—When once in the soil it is extremely difficult to eradicate. Prevent infection by using clean seed, which as a precautionary measure should be soaked for fifteen minutes in formaldehyde (1 part formalin to 30 parts water).

Club Root or Finger and Toe Disease

(*Plasmodiophora brassica*, Wor.).—This very destructive and well-known disease attacks cabbage and related plants, causing unsightly knotted roots. The diseased plants are dwarfed and fail to develop heads.



ENLARGED ROOTS OF CABBAGE CAUSED BY NEMATODES¹

¹ From Farmers' Bulletin 488, U. S. Dept. of Agriculture.

Treatment.—Use nothing but absolutely clean soil in the seed-beds; use lime in the fields; rotate crops.

CANTALOUPE AND MELONS

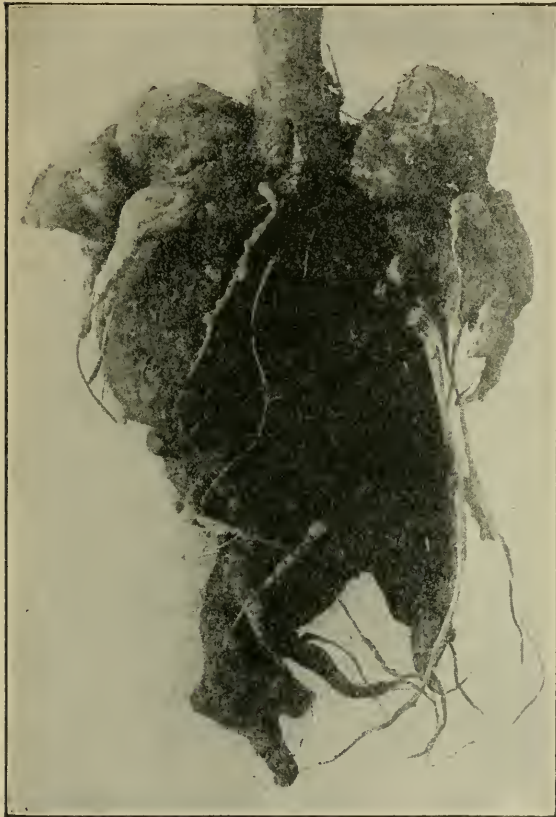
Leaf Blight (*Alternaria brassicae* [Berk.], Sacc. var. *nigrescens*, Pegl.).—This disease starts as small brown spots with concentric rings, which

enlarge, unite and frequently cause the destruction of the entire leaf. The melons ripen prematurely and are soft, wilted and insipid.

Treatment.—Rotate crops and spray with Bordeaux mixture.

Downy Mildew.—See Cucumber.

Anthracnose (*Colletotrichum lagenarium* [Pass.], Ell. and Halst.).—This disease attacks all parts of the vines of cucumber and squash, but is most injurious to watermelons, causing the buds and tendrils to die and turn black and the leaves to turn yellow. It is very noticeable on the fruit, causing sunken canker-like spots with pinkish centers. When the young fruit is attacked it is likely to have a bitter flavor.



ENLARGED ROOTS OF CAULIFLOWER CAUSED BY THE CLUB-ROOT ORGANISM.¹

Treatment.—Spray with Bordeaux mixture.

Wilt (*Bacillus tracheiphilus*, E. F. Smith).—This disease of melons and cucumbers, and sometimes of pumpkins and squash, may start with the central stem, causing the entire vine to wilt and die quickly, or it may start with a branch and work slowly back to the central stem.

Treatment.—Rotation of crops; avoid those that are susceptible.

¹ From Farmers' Bulletin 488, U. S. Dept. of Agriculture.

CUCUMBER

Downy Mildew (*Pseudoperonospora cubensis*, B. and C. Rost.).—This disease causes yellow, angular spots on the older leaves and eventually causes the entire leaf to turn pale and die. Considerable quantity of white growth appears on the under surface.

Treatment.—Spray with Bordeaux mixture.

Anthracnose.—See Melon.

Leaf Blight and Fruit Spot (*Cladosporium cucumerinum*, Ell. and Arth.).—This disease appears on the leaves as water spots and finally causes the entire leaf to wilt and rot. On the fruit it appears as minute gray, sunken, velvety spots which frequently unite and finally become black.

Treatment.—Prompt spraying with Bordeaux mixture.

Wilt.—See Melon.

CELERY

Leaf Spots (*Cerospora apii*, Fr., and *Septoria petroselini*, Desm., var. *apii*).—There are two leaf spot diseases which can be controlled by spraying with Bordeaux mixture. The first treatment should be while the plants are in the seed-bed and should be given whether the plants do or do not show the disease. Other sprayings should be at intervals of two weeks and with a high pressure sprayer. If necessary to spray late in the season, the last treatment should be with ammoniacal copper carbonate solution.

ONION

Smut (*Urocystis cepulae*, Frost.).—This very destructive disease attacks the young plants, causing dark opaque spots on the leaves. The leaves finally die and dry up and the spots burst and permit the escape of masses of spores. The mature bulbs show black masses of spores in the outer and sometimes in the inner leaves, and when badly infected dry and rot. Sets and young onions when well started are practically immune from the disease. The spores persist in the soil for many years.

Treatment.—Prevent the introduction by using clean sets. Use lime and long crop rotations for infested soil. In small plantings disinfect the soil with formaldehyde.

Downy Mildew or Blight (*Peronospora schleideni*, Ung.).—Diseased plants have a tendency to develop a violet tint by which they can be recognized at a distance. As the disease advances, they become covered with a mouldy coating and finally collapse. Slightly affected plants may recover under suitable weather conditions. The disease spreads rapidly in damp, warm weather and on wet land.

Treatment.—See that lands are well drained. Rotate crops. Spray with Bordeaux mixture.

CARROT

Soft Rot (*Bacillus carotovorus*, Jones).—This is a bacterial disease which causes a soft rotting of the roots. It also attacks turnips, radishes,

parsnips, onions, celery, beets and many other plants. The only satisfactory treatment lies in the rotation of crops.

PARSNIP

Blight (*Cercospora apii*, Fr.).—See Celery.

POTATO

Late Blight or Downy Mildew (*Phytophthora infestans* [Mont.], De By.).—This disease usually starts near the tip or margin of the leaf, but causes the infected area to die and blacken. In cool, wet, cloudy weather it spreads very rapidly and causes an offensive odor. The diseased tubers may show slightly depressed, dark-colored areas and a dirty brown color within. The disease is frequently the cause of heavy losses by rotting.

Treatment.—Spray with Bordeaux mixture, beginning when the plants are about six inches in height and repeat about every two or three weeks throughout the growing season.

Early Blight (*Alternaria solani* [E. and M.], J. and G.).—This disease appears earlier in the season than the late blight. It causes brown, brittle, irregular, more or less circular leaf spots with rather definite concentric circles. These spots frequently unite and the plant dies very much as though from natural causes.

Treatment.—Same as for late blight.

Wilt, Stem Rot and Dry Rot (*Fusarium oxysporum*, Schlecht.).—The plant assumes an unhealthy appearance, the leaves roll and curl and the plant falls and dries prematurely. The stems are partly or entirely black and dead near the base and frequently show a white or pink mould. When stems are cut across below the ground they show discolorations just below the surface. This field form of the disease is known as “wilt” or “stem rot.”

In storage the tubers undergo a “dry rot” beginning at the stem end, which causes them to shrivel and become light in weight. When cut across, these tubers show black discolorations just below the surface. The disease can be carried on the seed and will also persist in the soil.

Treatment.—Select seed potatoes which are free from surface cankers and are perfectly white when cut. When the soil becomes infected use rotation of crops for from three to five years.

Black Leg (*Bacillus phytophthorus*, Appel.).—This disease causes the plants to be dwarfed, erect, pale in color and to die early. The stems become brown or black near the ground and the disease works downward. It is carried in the seed.

Treatment.—Soak the seed in formaldehyde or corrosive sublimate as recommended for potato scab.

Scab (*Oospora scabies*, Thaxt.).—This well-known disease is readily recognized by the rough, pitted character of the tubers and is the cause of heavy losses. It can be carried on the seed and will persist in the soil for several years.

Treatment.—Soak the seed potatoes for two hours in formaldehyde (1 pound in 30 gallons of water) or in corrosive sublimate (4 ounces in 30 gallons of water) for one and one-half hours. When the land becomes infected, avoid the use of stable manure and lime, and rotate crops for three to five years.

Little Potato, Rosette, Stem Rot, Scurf (*Rhizoctonia* or *Corticium vagum*, B. and C., var. *solan*, Burt.).—This disease assumes different forms, varying with the climatic conditions, soils and varieties. In very severe cases many of the young plants fail to get through the ground. Many that do get through are dwarfed and show a peculiar crinkling of the foliage. The part of the stems below ground shows peculiar brownish or black cankers. In some cases the leaves tend to roll upward; many small tubers are formed just below the surface of the ground and just above a very pronounced canker, and aerial potatoes along the stem above ground. The fungus can be readily detected on the tubers; it appears as small black spots, which do not wash off, but can be readily removed by rubbing. However, the presence of these spots on the tubers does not necessarily mean a severe outbreak of the disease.



A POTATO AFFECTED WITH RUSSET SCAB.¹
Showing the russeting and cracking, associated with the fungus *Rhizoctonia*.

Treatment.—Soak seed potatoes in corrosive sublimate as recommended for scab.

Bacterial Wilt (*Bacillus solanaccarum*, Smith).—The plants wilt prematurely, become yellow, then black and dry. This disease attacks tomatoes, tobacco, peppers and eggplants.

Treatment.—Rotate crops, avoiding those that are susceptible.

Tipburn.—This disease is due entirely to hot, dry weather. It causes the leaves to dry at the tips and margins, roll up and break off.

NOTE.—There are a number of other diseases of the potato which cannot be included in this brief discussion.

TOMATO

Early Blight.—See Potato.

Leaf Blight (*Septoria lycopersici*, Speg.).—This disease appears as

¹From Farmers' Bulletin 544, U. S. Dept. of Agriculture.

numerous small spots over the surface of the leaves, beginning with the lower and older leaves, causing them to turn yellow and fall. It is one of the most severe diseases and the cause of heavy losses.

Treatment.—Spray with Bordeaux mixture.

Fusarium Wilt (*Fusarium lycopersici*, Sacc.).—This is a disease in which the fungus works on the inside of the plant, causing it to wilt and die. It cannot be controlled by spraying. Rotation of crops is advantageous.

Bacterial Wilt.—See Potato.

Blossom-End Rot or Point Rot.—The cause of this disease is disputed, but it is now generally believed to be due to drought, although it may also be due to other causes. It is a dry black rot starting at the blossom end of the fruit and is often very destructive. It is more serious in dry weather and in dry soils.

Treatment.—Practice thorough cultivation of the soil and remove diseased fruit.

Anthraxose (*Colletotrichum phomoides* [Sacc.], Chester).—This disease causes discolored, sunken spots which become centers of decay. It is likely to be very severe in wet weather.

Treatment.—Spray with Bordeaux mixture.

Fruit Rot (*Phoma destructiva*, Plowr.).—This disease causes a spotting of the leaves and a fruit rot. Can probably be controlled by spraying with Bordeaux mixture.

EGGPLANT

Attacked by several fruit rots and leaf spots which sometimes prove destructive. They can be controlled by the use of Bordeaux mixture.

PEPPER

Susceptible to several fruit and stem rots, leaf spots and wilts which can be controlled by rotation of crops and treatment with Bordeaux mixture.

LETTUCE

Mildew (*Bremia lactuceæ*, Regel).—This disease is frequently very destructive. It causes rather large, pale spots, which become yellowish above and fuzzy below.

Treatment.—Good cultural methods for outdoors. Ventilation for crops grown under glass.

Drop or Wilt (*Sclerotinia libertiana*, Fckl.).—This causes a very pronounced wilting and drooping, beginning with the lower leaves and gradually spreading throughout the entire plant.

Treatment.—Removal and destruction of the diseased plants and disinfection of soil at that point with Bordeaux mixture.

NOTE.—There are several other diseases of the lettuce more or less important.

SWEET POTATO

Soft Rot (*Rhizopus nigricans*, Ehrbg.).—This storage rot is caused by the bread mould fungus and can be readily recognized. It is accompanied by a sweetish odor and dense growth of white mould which becomes black. It spreads rapidly, but can be controlled by proper ventilation and regulation of temperature.

Black Rot (*Spharionema fimbriatum* [Ell. and Halst.], Sacc.).—This disease occurs in both field and storage house. It appears as dark-brown or black, irregular, dry patches on the potatoes, sometimes causing breaking or cracking near the center of the diseased area. On the young sprouts and stems it causes black patches and frequently kills the entire plant.

Treatment.—Do not use diseased plants for setting. Do not use stable manure. Grow seeds from slips. These slips should be cut from the old plants and set as early in July as possible.

Stem Rot (*Nectria ipomoea*, Halst.).—This disease attacks the stem near the surface of the ground and spreads in both directions, frequently causing the death of the plant. The interior of the stem shows a yellow discoloration.

Treatment.—Rotate the crops and use slip seed.

NOTE.—There are a number of other rots and diseases which will not be taken up in this discussion.

PEANUT

Peanuts are subject to several foliage and root diseases of more or less importance. Growers of this crop should consult with their state agricultural experiment station.

TOBACCO

Granville Tobacco Wilt (*B. solanacerarum*, Smith).—This is due to the same organism as the wilt of the potato, tomato, peppers and eggplants. (See Potato.)

Mosaic, Calico or Mottle Top.—The cause of this disease is still somewhat uncertain. The leaves of the diseased plants show dark and light areas and frequently irregular thickenings or twistings.

Treatment.—Remove the diseased plants. Be careful not to touch healthy plants while working with the diseased plants. The disease can be communicated by contact.

Leaf Spots.—There are a number of leaf spot diseases and also mildews which cause more or less trouble.

Root Rots (*Thielavia basicola*, Zopf.).—This disease is a rotting of the roots, accompanied by the production of numerous new roots. The affected plants are dwarfed and frequently killed.

Treatment.—Sterilize seed-bed. Rotate crops. Avoid liming and acid fertilizers.

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CHAPTER 19

INSECT PESTS AND THEIR CONTROL

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Insects are, without doubt, the greatest enemies of the farmer, for they destroy the crops of field and garden and render the fruit on the trees unfit for use; they injure the domestic animals by constant irritation, causing them to lose weight and even to die. Stored grains, tobacco and other farm products also suffer from their attacks.

After studying their life histories and habits, methods of control have been devised by which they can be combated with a reasonable amount of success. Many species can be held in absolute control by thorough and timely applications of the proper remedies, while others are only partially held in check.

In order to intelligently apply a treatment for the control of an insect, something of its habits must be known, especially in regard to its manner of feeding. Most of the important pests fall within two great groups, namely, biting or chewing insects and sucking insects, depending on whether the mouth parts are chisel or pincher-like in the first class, or beak-like and made for piercing and sucking in the second class. A number of these pests will fall in certain special groups which require a definite treatment, indicated by their manner of living or by the injury they do. Some of these special classes are internal feeders, as boring insects, subterranean insects and insects affecting stored products.

The external feeders, which have biting mouth parts, usually feed upon plants by gnawing out small pieces of the plant tissue which are swallowed. This group includes the larvæ or caterpillars of moths and butterflies, the larvæ and of adult beetles, grasshoppers and crickets, and the larvæ of some species of *Hymenoptera* or the wasp group. Such insects may usually be controlled by applying a poison to the plant, either as a fine spray or as a powder dusted or blown over its surface. The arsenicals have been found to be the best remedy for this group.

The sucking insects feed by piercing the skin or epidermis of plants with their sharp beaks and sucking the sap. This group of insects is represented by the true bugs or *Hemiptera*, to which order belong the squash bug, scale insects, plant lice and leaf hoppers. It is evident that a stomach poison on the surface of the plant would not affect insects of this class, so it is necessary to use what is known as a contact insecticide, which should be applied as a spray or wash directly to the insect's body. Such

remedies kill by their suffocating or corrosive action. The most common of these insecticides are nicotine solutions, kerosene or oil emulsions, lime-sulphur wash and fish-oil soap.

In the following pages will be found listed the principal insect pests under the classification of general crop insects, truck crop insects, and fruit insects. Only a very brief description of each insect can be given, and in most cases nothing of their life histories, in the limited space devoted to the subject. The treatments which have given the best results in each individual case are indicated briefly and reference is made to publications which give a more extended account of the insects. The abbreviations which are used in the references are as follows:

Bur. Ent. Bull.—U. S. Department of Agriculture, Bureau of Entomology Bulletin.
 Bur. Ent. Cir.—U. S. Department of Agriculture, Bureau of Entomology Circular.
 Farm. Bull.—U. S. Department of Agriculture, Farmers' Bulletin.
 Dept. Bull.—U. S. Department of Agriculture Bulletin.

GENERAL CROP INSECTS

Caterpillars (leaf-eating).—Many plants are attacked by caterpillars which feed upon the leaves. These worms are the larvæ of *Lepidopterous* insects, or moths and butterflies.

Treatment.—Spray with an arsenical, preferably arsenate of lead, or dust with powdered arsenate of lead or Paris green. If the spray gathers in drops and does not adhere well to the surface of the leaves, use a resin fish-oil soap sticker.

Cutworms.—Various species of the family *Noctuidæ*, usually feeding at night upon the roots, crowns or foliage of plants. The worms may be found in daytime lying curled up in ground about an inch below surface.

Treatment.—Broadcast poison bran mash about the garden in the spring just before the plants come up. Make other applications later if the cutworms are still found. Cultivate the ground thoroughly in late summer and early in the spring to prevent the growth of grasses and weeds, thus starving out worms if present.

Grasshoppers or Locusts.—A number of species feed on corn, wheat, sorghum and other field crops, also on many garden crops and at times on fruit trees.

Treatment.—Cultivate the fields and stony fence rows in the fall to break up the egg masses deposited one to two inches below the surface of the ground. Broadcast Criddle mixture or poison bran mash flavored with juice of orange or lemon in fields where grasshoppers are plentiful.

Leaf Beetles (*Chrysomelidæ*).—Crops of many kinds are injured by beetles which feed upon the leaves as adults and sometimes as larvæ.

Treatment.—Spray or dust the affected plants with arsenicals.

Plant Lice (*Aphididæ*).—Many species of plant lice are found attacking field, garden and orchard crops. They feed by sucking the juices of the host plant and cannot be controlled by a poison spray.

Treatment.—Use sprays of nicotine or tobacco extract, kerosene emulsion (5 to 10 per cent strength) or fish-oil soap just after the aphids appear and at such other times as may be necessary. Spray thoroughly, being sure to wet all plant lice. If spray does not adhere to the bodies of insects, add 2 or 3 pounds of laundry soap to 50 gallons of spray solution, or preferably an equal amount of resin fish-oil soap as a sticker. For underground forms practice rotation of crops or use soil fumigants.

White Grubs (*Lachnosterna spp.*).—White grubs or grubworms are the larvæ of the common brown beetles known as May beetles or June bugs, commonly seen around lights and on the screens in the spring and summer. Their natural breeding place is grass lands, but they are found in fields and gardens feeding upon the roots of many plants.

Treatment.—No successful treatment is known. Practice crop rotation when necessary. Fall plowing will be of some benefit. Do not plant crops liable to be injured, as strawberries, on recently broken sod land.

Wire Worms (*Elaterida*).—Slender, brown, hard, shining larvæ, $\frac{1}{2}$ inch to $1\frac{1}{2}$ inches long, body divided into several segments which show plainly three pairs of small legs near front end of body. Their natural breeding place is grass lands, but they feed on or in the roots of many garden and field crops. Two years or more are required for development.

Treatment.—No satisfactory treatment has been found. Rotation of crops, preventing ground from remaining long in grass, and late fall plowing followed by repeated harrowing for a month or two are the best means of preventing their increase. Seeds might be protected by the use of some substance as a repellent which would not injure germination.

The Army Worm (*Leucania unipuncta*, Haworth).—In general appearance it resembles cutworms. About $1\frac{1}{2}$ inches long, dark in color, with three yellowish stripes down the back. The adult insect is a dull brown moth, often seen about lights in the spring. The worm feeds naturally on wild grasses, but when it is abundant marches across fields, destroying many crops, including corn, wheat, oats and related crops, as well as many truck crops.

Treatment.—The march of the worms to uninfested fields may be checked by a deep dust furrow through which a log is dragged occasionally to crush the worms and to maintain a thick coat of dust on the sides. Scattering poison bran mash through infested fields will often prove very effective. Late fall plowing and cultivating will help in destroying overwintering worms.

The Fall Army Worm (*Laphygma frugiperda*, S. and A.).—In general appearance is similar to the common army worm, but distinguished therefrom by dark stripes along each side, separated by a stripe of grayish yellow. So called from the fact that the most destructive brood appears after August 1st. It has wide range of food plants, including many forage and truck crops. The worms are especially injurious to lawns.

Treatment.—Practice fall plowing to break up the pupæ cells in the

ground. Scatter poison bran mash when the caterpillars appear, or spray or dust with arsenicals.

Bur. Ent. Bull. 29.

TRUCK CROP INSECTS

The Asparagus Beetle (*Crioceris asparagi*, Linn.).—This beetle is about one-fourth of an inch long, with dark-colored body, red thorax and yellow wing covers marked and bordered with blue. The adults and grubs feed on the stems and tender shoots of asparagus.

Treatment.—Apply arsenical sprays. Air-slaked lime will kill the grubs.

Bur. Ent. Cir. 102.

Bean Aphis (*Aphis rumicis*, Linn.).—A small black plant louse with pale shanks. It attacks beans, dock, shepherd's purse, pigweed, "burning bush" and snowball bush.

Treatment.—Spray the plants thoroughly with nicotine solution.

Bur. Ent. Bull. 33, p. 109.

Bean Weevil, The Common (*Bruchus obtectus*, Say.).—A small gray or brown beetle with mottled wing covers, about one-eighth of an inch long. It lay its eggs on or in beans in the field, also breeds in stored beans. The grub eats its way into the bean and develops there, sometimes several to one bean.

Treatment.—Heat the infested seed or fumigate with carbon bisulphide.

Bur. Ent. Bull. 96; Year-Book, U. S. D. A., 1898, p. 239.

Other Bean Weevils.—Several other weevils affect the bean in March, in the same way as the common bean weevil.

Treatment.—See Bean Weevil, the Common.

The Beet Army Worm (*Laphygma exigua*, Hbn.).—Beets are sometimes attacked in the Western states by this insect at about the same time the fall army worm is making its attacks in other sections. Several



SPRAY OF ASPARAGUS, WITH COMMON ASPARAGUS BEETLE IN ITS DIFFERENT STAGES.¹

Asparagus tip at right, showing eggs and injury. Natural size.

¹Bur. Ent. Cir. 102.

other food plants are known, including a few garden crops and a number of weeds.

Treatment.—Spray or dust arsenicals upon the leaves. Poison bran mash may also be of value.

Bur. Ent. Bull. 43.

Beet Leaf Beetle, The Larger (*Monoxia puncticollis*, Say.).—This leaf beetle, known also locally as the alkali bug and the French bug, resembles somewhat the elm-leaf beetle. It causes considerable injury to the sugar-beet in Colorado and nearby states.

Treatment.—Dust or spray foliage with arsenicals.

The Beet Leaf Hopper (*Eutettix tenella*, Baker).—The beet in the Western states is often troubled with a condition known as "curly leaf," caused by the above-named leaf hopper, a light yellowish green species about one-eighth of an inch long.

Treatment.—Spray the beets thoroughly with a 40 per cent nicotine sulphate solution in water, diluted 1 part to 600; or spray with



BLISTER BEETLE
(*Epicauta marginata*).²
Enlarged.



BROAD-BEAN WEEVIL
(*Larid rufimana*).¹
Adult, or beetle, enlarged.

5 per cent kerosene emulsion. Many hoppers may be captured on a shield smeared with tanglefoot or covered with sticky fly paper if it is pushed up and down between the rows. A wire or rod should be fastened in front of the shield at the proper distance to stir out the hoppers.

Bur. Ent. Bull. 66, Pt. 4.

Blister Beetles (*Meloida*).—At times a number of crops are badly damaged by the insects known as blister beetles or "old-fashioned potato bugs." These beetles are rather large, long-legged and are variously colored, the usual colors being black, gray or striped with yellow and black.

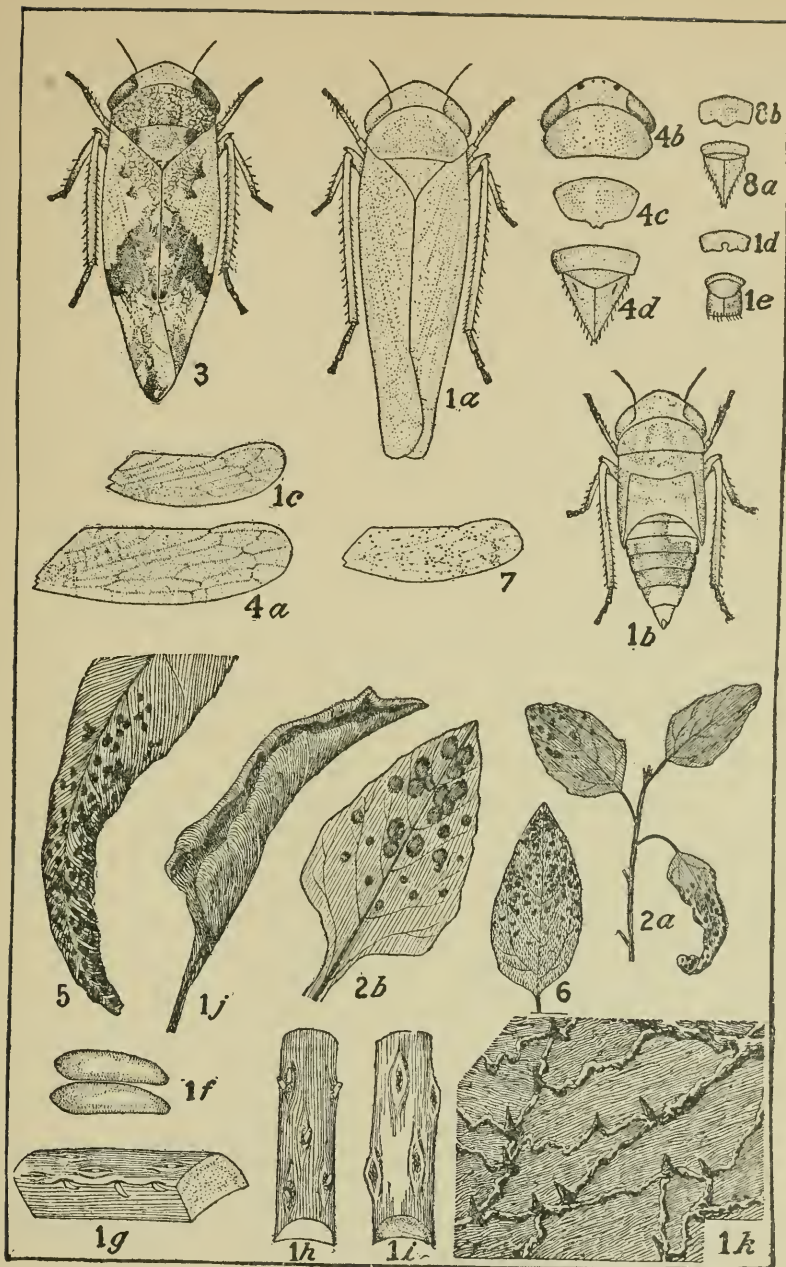
Treatment.—Apply arsenate of lead or other arsenicals to the affected plants as a spray or dust. Several treatments may be necessary if the beetles swarm on crops from other localities.

Bur. Ent. Bull. 43, pp. 21-27.

The Cabbage Looper (*Autographa brassicae*, Riley).—The looper is a light-green worm often referred to as a measuring worm because of its looping movement when crawling. It feeds on the leaves of cabbage.

¹Bur. Ent. Bull. 90, Pt. 5.

²Bur. Ent. Bull. 43.



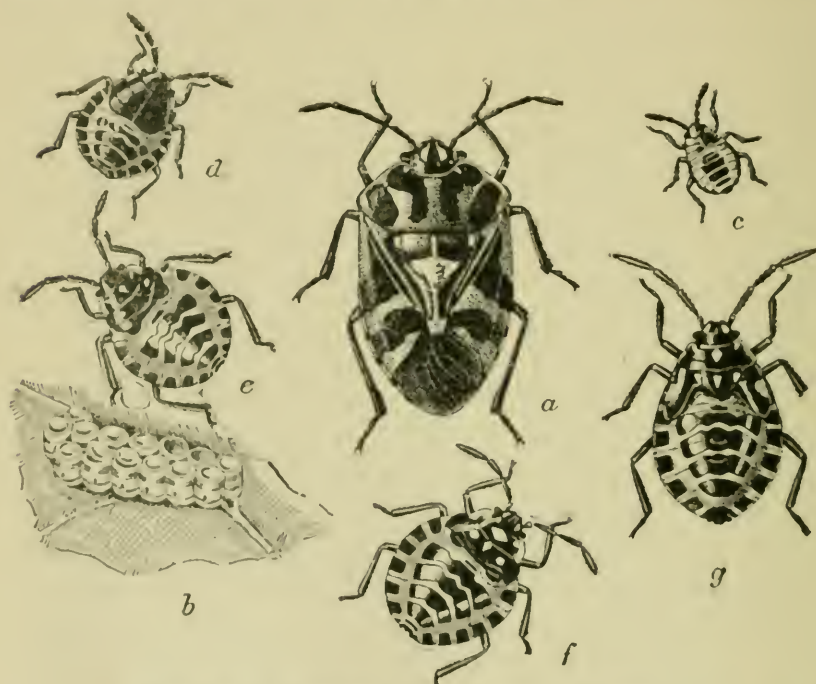
LEAF HOPPERS (*Eutettix*, *Spp.*) AND THEIR WORK.¹

Explanation of illustration on page 230.

¹Bur. Ent. Bull. 66, Pt. 4.

1—*Eutettix tenella*: a, adult; b, nymph; c, wing; d, e, genitalia; f, eggs, greatly enlarged; g, section of beet stem, showing fresh eggs in place; h, same, showing eggs ready to hatch; i, old egg-sears on beet stems; j, small leaf of sugar-beet, showing characteristic "curly-leaf" condition; k, enlarged section of back of an extreme case of "curly-leaf," showing "warted" condition of veins. 2—*Eutettix strobi*: a, work of nymphs on sugar-beets; b, leaf enlarged. 3—*Eutettix scitula*: adult. 4—*Eutettix clarivida*: a, wing; b, head and pronotum; c, d, genitalia. 5—*Eutettix nigridorsum*: work of nymphs on leaf of *Helianthus*. 6—*Eutettix straminea*: work of nymphs on leaf of another *Helianthus*. 7—*Eutettix insana*: wing. 8—*Eutettix stricta*: a, b, genitalia.

Treatment.—Apply arsenicals until the cabbage head is half grown. If spray is used, add resin fish-oil soap as a sticker.



HARLEQUIN CABBAGE BUG (*Murgantia histrionica*).¹

A—Adult. B—Egg mass. C—First stage of nymph. D—Second stage.
E—Third stage. F—Fourth stage. G—Fifth stage. All enlarged.

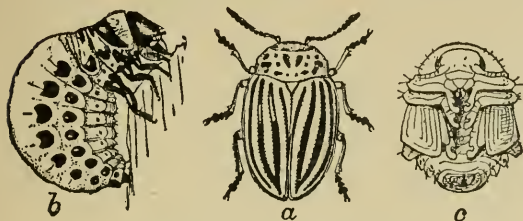
The Cabbage Maggot (*Pegomya brassicae*, Bouché).—Soft white maggots work in the roots of cabbage, turnip and cauliflower, eating away the root hairs and scarring the surface of the larger roots. This maggot is the larva of a two-winged fly which lays its eggs in the ground near the plants.

Treatment.—Fit a disk of tarred paper about four inches in diameter around the stem of each plant, letting it lie flat on the ground to keep the

¹ Bur. Ent. Cir. 103.

maggots from reaching the roots. Clean up all cabbage stumps in the fall and plow deeply. Rotate crops.

The Colorado Potato Beetle (*Leptinotarsa decemlineata*, Say).—With-



COLORADO POTATO BEETLE
(*Leptinotarsa decemlineata*).¹

A—Beetle. B—Larva. C—Pupa. Enlarged.

Bur. Ent. Cir. 87, Bull. 82, Pt. 1.

Flea Beetles.—Small dark-colored insects which as adults feed upon the foliage of many truck crops and weeds. The larvæ feed upon the roots. The name is derived from the active way in which the insect hops about. In this respect it resembles a flea.

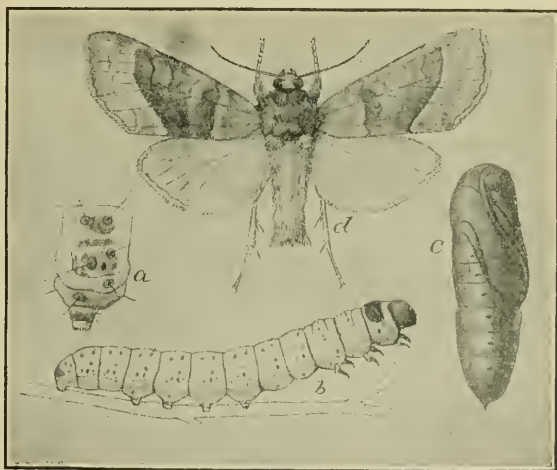
Treatment.—Clean up weeds about the garden that may form a breeding place for the pests. Apply arsenicals to plants as a spray, using Bordeaux mixture preferably, which acts as a repellent.

Harlequin Cabbage Bug (*Murgantia histrionica*, Hahn.).—This gaudily marked bug is easily recognized by its bright colors of red, yellow and blue. It feeds upon cabbage, cauliflower, mustard and other related plants.

Treatment.—Plant a trap crop of mustard or turnips in the spring and fall and when the bugs have become numerous spray with pure kerosene. Hand picking may be profitable in the spring. Methods of clean culture should be practiced, especially in the fall, tall cabbage stalks and weeds

out doubt the worst enemy of the potato is the robust yellow-striped beetle which, together with its larvæ or slugs, feeds upon the leaves. The insect is too well known to need description.

Treatment.—Apply arsenicals either as a dust or as a spray. Hand picking or “bugging” may be resorted to in a small garden patch.



HOP PLANT BORER (*Hydracia immanis*).²

A—Enlarged segment of larva. B—Larva. C—Pupa. D—Adult. Natural size.

¹Bur. Ent. Cir. 87.

²Bur. Ent. Bull. 7

being destroyed in order to starve out the bug. Destroy trash where it might hibernate.

Bur. Ent. Cir. 103.

The Hop Aphis (*Phorodon humuli*, Schr.).—This plant louse is found on the plum in spring, but flies to the hop plant in early summer, where it turns the leaves yellow, causing them to fall.



WINGLESS PROGENY OF WINGED HOP APHIDS FROM ALTERNATE HOST.¹

Treatment.—When aphids appear spray thoroughly with 40 per cent nicotine solution diluted 1 part to 800 parts water.

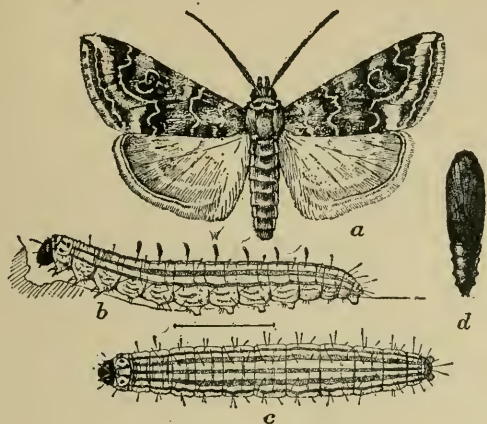
Bur. Ent. Bull. 111.

The Hop Plant Borer (*Hydraxia immanis*, Get.).—The hop plant is attacked in three places by this borer during the period of development of the insect. Early in the season it bores into the tender tips, causing them to droop; after a short time it falls to the ground and bores into the stem at the crown. Later it bores out of the stem and goes below the ground, feeding just above the old roots, where it nearly severs the plant.

Treatment.—In the spring search for the affected tips and crush the insects in the stem.

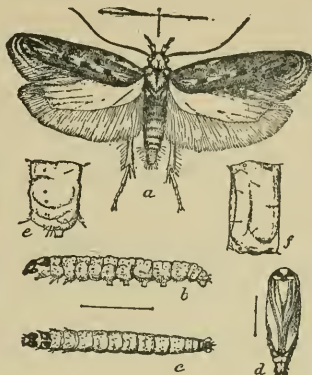
Bur. Ent. Bull. 7, p. 40.

¹Bur. Ent. Bull. 111.



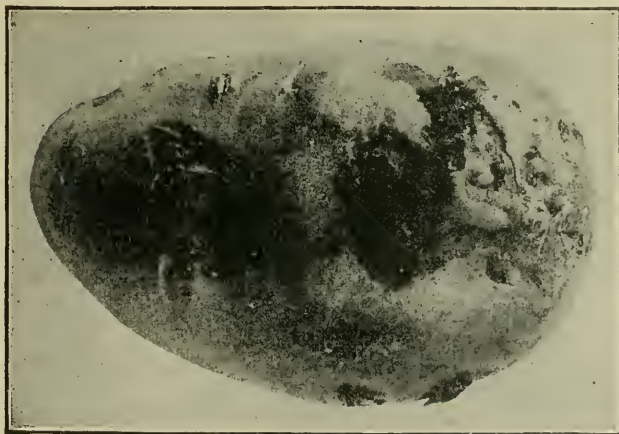
IMPORTED CABBAGE WEB WORM
(*Hellula undalis*).¹

A—Mature moth. B—Larva, lateral view.
C—Larva, dorsal view. D—Pupa. All three
times natural size.



POTATO TUBER MOTH
(*Phthorimæa operculella*).²

A—Moth. B—Larva, lateral
view. C—Larva, dorsal
view. D—Pupa. E, F—Seg-
ments of larva, enlarged. (Re-
drawn from Riley and Howard.)



WORK OF THE POTATO-TUBER MOTH.²
Exterior view of potato.

¹Bur. Ent. Bull. 19.

²Farm. Bull. 557.

The Imported Cabbage Web Worm (*Hellula undalis*, Fab.).—This worm feeds upon cabbage, turnips and other similar crops, spinning a web under which it retires when not feeding.

Treatment.—Same as for cabbage looper.

Ent. Bull. 23, p. 54.

The Imported Cabbage Worm (*Pontia rapa*, Linn.).—Of all the insects on cabbage, this is the worst pest. It is the larvæ of the white butterfly seen fluttering about over fields of cabbage during spring and summer.

Treatment.—Same as for cabbage looper.

Bur. Ent. Cir. 60.

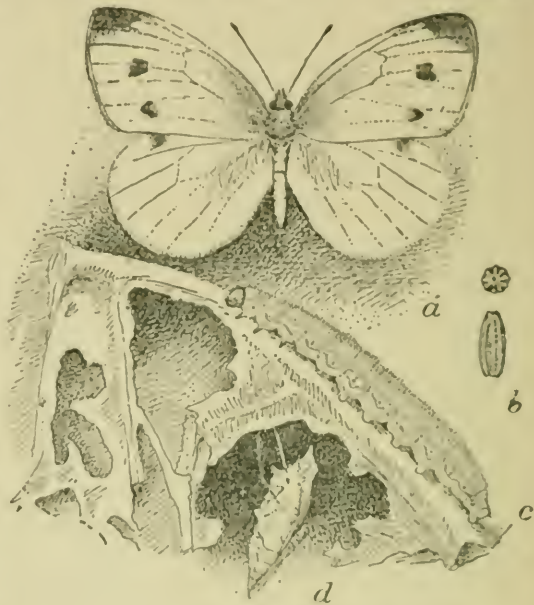
The Melon Aphis (*Aphis gossypii*, Glov.).—This plant louse feeds not only on melons but on cotton, strawberries and a number of other plants.

Treatment.—Before the leaves are badly curled spray them with nicotine solution, turning the vines over if necessary, so as to hit the under sides of the leaves. In small gardens fumigate under tub with carbon bisulphide, using about a teaspoonful to each cubic foot of space. Tobacco fumes may also be used.

Bur. Ent. Cir. 80.

The Potato Tuber Moth (*Phthorimæa operculata*, Zell.).—Potato growing is now menaced in California, Washington and southern Texas by this insect, which bores into the vines and tubers of potatoes. It also feeds upon tomato, eggplant and tobacco, and on the latter plant is known as the split worm.

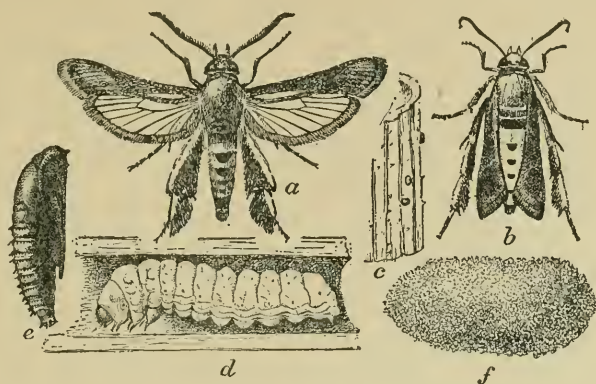
Treatment.—No satisfactory method of treatment is known, but the injury may be partly prevented by clean methods of cultivation, crop rotation and fumigation of infested tubers. The latter is by far the best remedy. For a full discussion of methods of control see Farm. Bull. 557.



IMPORTED CABBAGE WORM
(*Pontia rapa*).¹

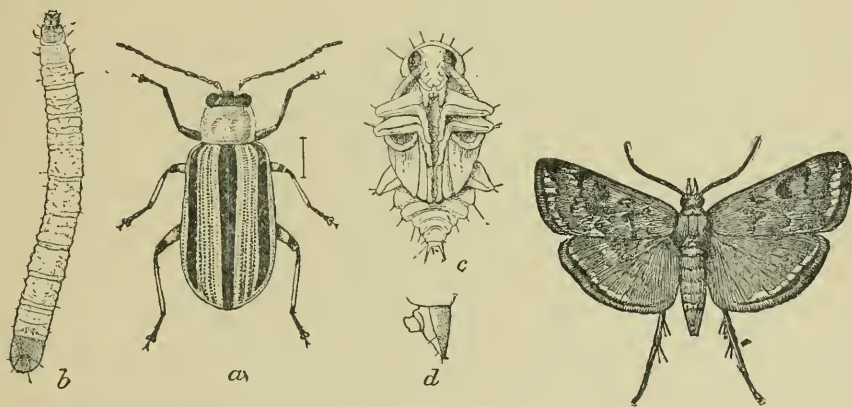
A—Female butterfly. B—Above, egg as seen from above; below, egg as seen from side. C—Larva in natural position on cabbage leaf. D—Suspended chrysalis. A, C, D—Are slightly enlarged. B—More enlarged.

¹Bur. Ent. Cir. 60.



SQUASH VINE BORER
(Melittia satyriniformis).¹

A—Male moth. B—Female moth with wings folded in natural position when at rest. C—Eggs shown on bit of squash stem. D—Full grown larva—in *situ* in vine. E—Pupa. F—Pupal cell. All $\frac{1}{3}$ larger than natural size.



STRIPED CUCUMBER BEETLE
(Diabrotica vittata).²

A—Beetle. B—Larva. C—Pupa. D—Anal proleg. A, B, C—Much enlarged. D—More enlarged.

SUGAR-BEET WEB WORM
(Loxostege sticticalis).³

Moth twice natural size.

¹ Bur. Ent. Cir. 38.

² Bur. Ent. Cir. 31.

³ Bur. Ent. Bull. 109, Part 2.

The Squash Bug (*Anasa tristis*, De G.).—This well-known insect is often a serious pest of squashes and pumpkins and can nearly always be found upon the vines during the summer.

Treatment.—Pick off and destroy the eggs in the spring. Trap the



CANTALOUPE LEAVES, SHOWING CURLING CAUSED BY MELON APHIDS; APHIDES ON LOWER SURFACE.¹

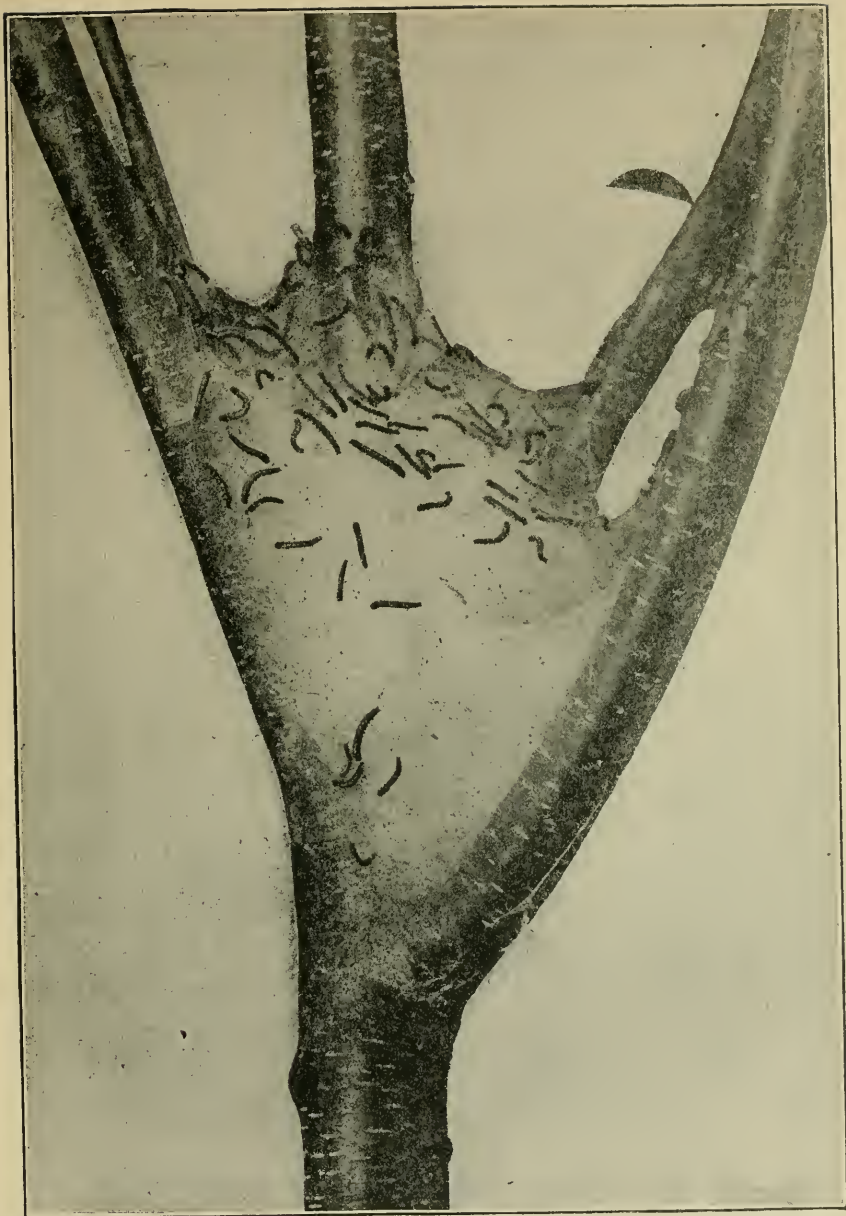
Slightly reduced.

bugs under boards placed near the vines and gather them up in the morning. Protect cucumbers and melons by planting early squashes among them, from which adults should be picked. Spray with kerosene emulsion.

Bur. Ent. Cir. 39.

Squash Vine Borer (*Melittia satyriniformis*, Hbn.).—In many localities

¹ Bur. Ent. Cir. 80.



NEST AND LARVÆ OF APPLE TREE TENT CATERPILLAR IN CROTCH OF
WILD CHERRY TREE.¹

¹ Farm. Bull. 662.

this is the most serious pest of squash vines. The larvæ bore into the vines, causing them to rot and break off easily.

Treatment.—Rake up and destroy vines as soon as possible in the fall. Plow deeply in the spring. Rotate crops; plant early squashes among other vines as a trap crop.

Bur. Ent. Cir. 38.

The Striped Cucumber Beetle (*Diabrotica vittata*, Fab.).—A black-and-yellow striped beetle two-fifths of an inch long, injuring cucumbers, squashes and melons by feeding on the young plants as they come up.

Treatment.—Cover the hills of young plants with nets to protect them from beetles. Dust

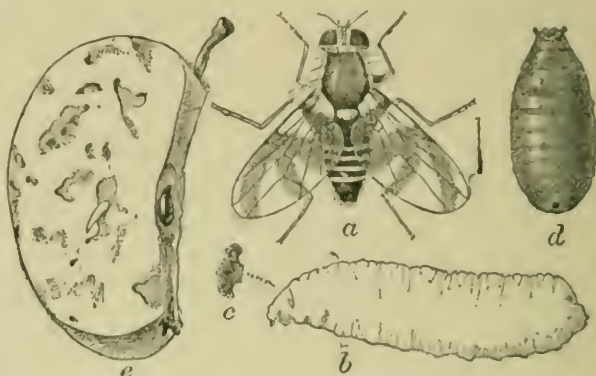
heavily with air-slaked lime and tobacco dust while the dew is on. Spray the plants with arsenate of lead 3 to 5 pounds to 50 gallons.

Bur. Ent. Cir. 31.

Sugar Beet Web Worm (*Loxostege sticticalis*, Linn.).—This insect defoliates beets and webs them together at times, causing notable injury. It also feeds on onions, cabbage, alfalfa, pigweed and careless weed.

Treatment.—Plow the infested land in late fall or winter. Spray or dust the plants with arsenicals.

Bur. Ent. Bull. 109, Pt. 6.



APPLE MAGGOT, OR RAILROAD WORM
(*Rhagoletis pomonella*).¹

A—Adult. B—Larva or maggot. C—Funnel of cephalic spiracle. D—Puparium. E—Portion of apple showing injury by maggots. A, B, C—Enlarged. D—Still more enlarged. E—Reduced.

FRUIT INSECTS

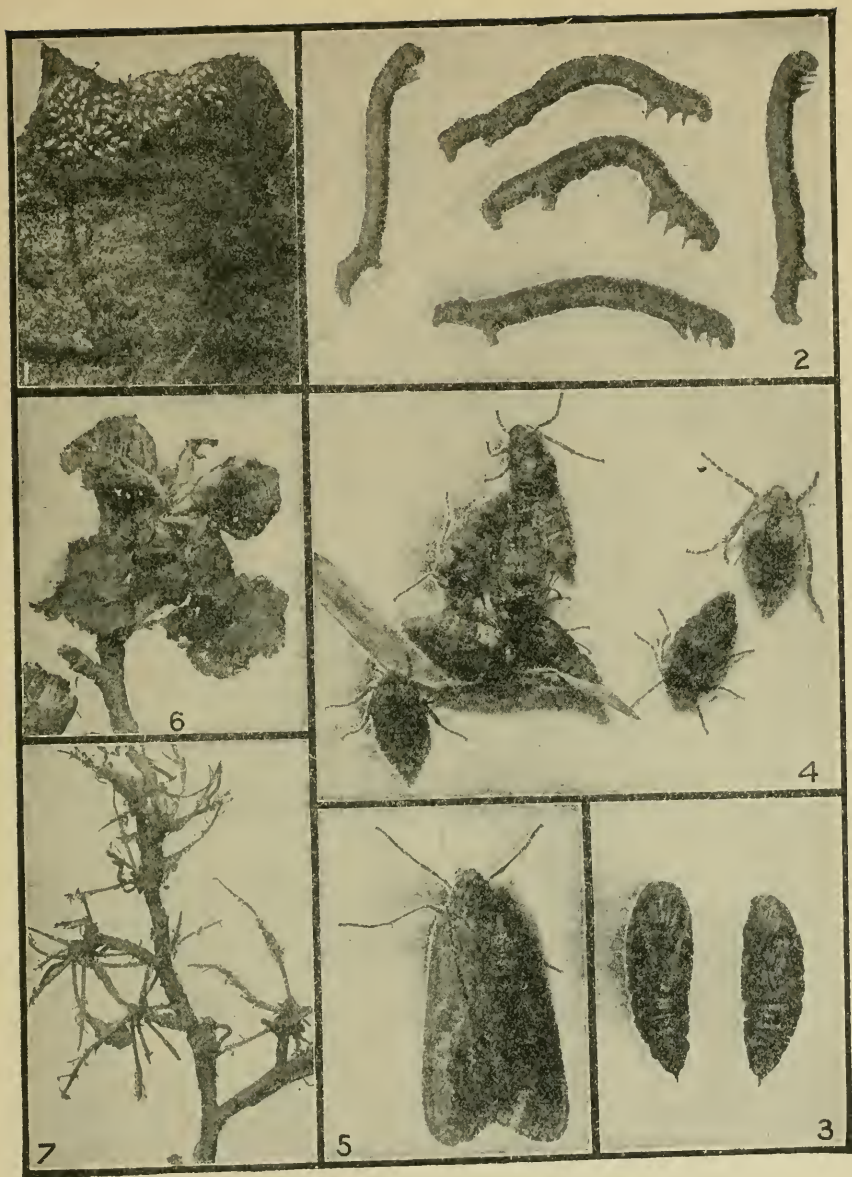
Apple Maggot, or Railroad Worm (*Rhagoletis pomonella*, Walsh.).—The larva of a two-winged fly. It infests summer and early fall apples and occasionally winter apples, tunneling through the flesh of fruit and causing it to fall.

Treatment.—Spray the trees during the first week in July with arsenate of lead, 4 pounds to 100 gallons. Pick up infested fruit every two or three days and feed it to hogs or bury it deeply.

Bur. Ent. Cir. 101.

Apple Tree Tent Caterpillar (*Malacosoma Americana*, Fab.).—The

¹Bur. Ent. Cir. 101.



STAGES AND WORK OF SPRING CANKER-WORM (*Paleacrita vernata*).¹

1—Egg mass on bark scale. 2—The larvæ or canker-worms. 3—Pupæ. 4—Female moths. 5—Male moth. 6—Work of canker-worms on apple leaves when small. 7—Later work of the larvæ, only the midribs of leaves being left. 1-5—Considerably enlarged. 6, 7—Reduced.

¹Bur. Ent. Bull. 68 Pt 2.

larva of moth. It feeds on the foliage of apple and a number of other trees. It makes large nests or web tents in which caterpillars stay when not feeding.

Treatment.—Spray the trees with arsenate of lead when the nests first appear. Make later application if necessary.

Farm. Bull. 662.

The Brown-Tail Moth (*Euproctis chrysorrhæa*, Linn.).—This well-known caterpillar was accidentally introduced into Massachusetts from Europe. It has now spread over a large part of New England and is still extending its territory. The moths appear early in July and the female deposits masses of eggs on the under side of leaves. The young caterpillars web terminal leaves together and spend the winter in those nests in partially grown condition. They resume feeding in the spring and soon reach their full development.

Treatment.—Cut out and burn all the winter nests before the buds start. Spray the trees with arsenate of lead, 4 pounds to 100 gallons. Band the trees with tanglefoot to prevent the ascent of caterpillars from other trees.

Farm. Bull. 264.

Canker-Worm, The

Spring (*Palcacrila vernata*, Peck), and **The Fall** (*Alsophila pomataria*, Harris).—The larvae of canker-worm moths are measuring worms about an inch long, dark-colored and variously striped. The adult males are winged, females wingless. They defoliate apple trees.

Treatment.—Cultivate orchards well in summer to destroy pupæ. Apply sprays of arsenate of lead 4 or 5 pounds to 100 gallons water, first before the blossoms open; second, just after petals fall. Apply barriers of tanglefoot or cotton batting to the trunks of trees to prevent the ascent of the moths to lay eggs.

Bur. Ent. Cir. 9; Bur. Ent. Bull. 68, Pt. 2.

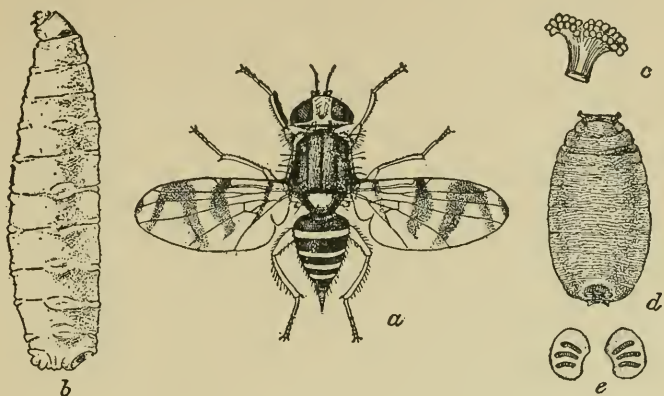
The Cherry Fruit Flies (*Rhagoletis cingulata*, Loew, and *R. fausta*, O. S.).—Two-winged flies deposit eggs in cherries. Maggots develop in the fruit on the tree, causing it to rot on one side. They enter ground to pupate.



BROWN-TAIL MOTH
(*Euproctis chrysorrhæa*.)¹

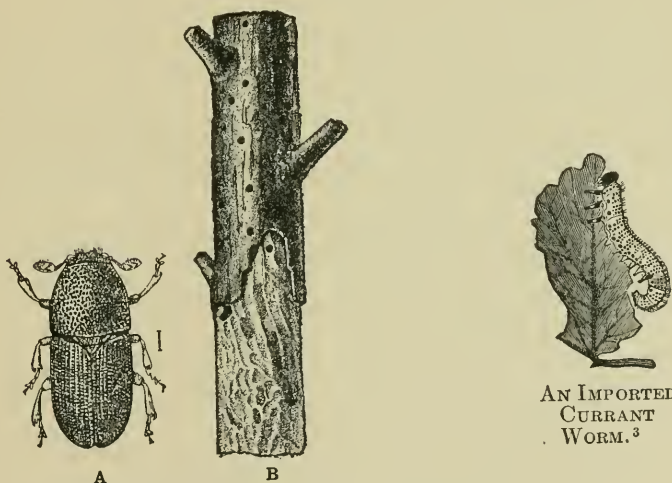
Female moth above, male moth below, larva or caterpillar at right, slightly enlarged.

¹ Farm. Bull. 264.



CHERRY FRUIT FLY
(*Rhagoletis cingulata*).¹

A—Fly. B—Maggot from side. C—Anterior spiracles of same. D—Puparium. E—Posterior spiracular plates of pupa. All enlarged.



FRUIT TREE BARK BEETLE
(*Scolytus rugulosus*).²

A—Adult beetle. B—Work in twig of apple. Natural size.

AN IMPORTED
CURRANT
WORM.³

¹Bur Ent. Bull. 44.

²Bur. Ent. Cir. 29.

³Courtesy of Connecticut Agricultural Experiment Station.

Treatment.—Apply arsenate of lead to the trees, either with or without sweetening, 4 or 5 pounds to 100 gallons, at the time the flies are emerging. Two applications usually necessary.

Bur. Ent. Bull. 44, pp. 70-75; Cornell Agricultural Exp. Sta. Bull. 325.

The Codling Moth, or Apple Worm (*Carpocapsa pomonella*, Linn.).—This is the insect the larva of which is responsible for most of the wormy apples, pears and quinces. The female moths lay their eggs upon the leaves and fruit. The larvæ upon hatching begin at once to hunt for the fruit, which they enter mostly through the calyx cup. In spraying it is very necessary to fill this cup with the poison, as it is here that the larvæ mostly take their first meal. The time when this first and most important spray should be made is just after the petals have fallen and before the calyx cup closes. In most parts of the country there are two broods of insects, but in the South there may be three and in places even four.

Treatment.—Spray with arsenate of lead, 4 pounds to 100 gallons, first just as the petals have fallen; second, three to four weeks after the petals have fallen; third, eight to nine weeks after petals have fallen.

Bur. Ent. Bull. 115, Pts. 1 and 2; Farm. Bull. 492.

Currant Worm, The Imported (*Pteronous ribesii*, Scop.).—This currant worm is the most destructive insect enemy of the currant, but is easily controlled.

Treatment.—At the time the worms begin to appear spray or dust with an arsenical.

Report of the Conn. State Entomologist, 1902, pp. 170-172.

The Flat-Headed Apple Tree Borer (*Chrysobothris femorata*, Fab.).—A larva about one inch long, slightly flattened. The front end much enlarged. It usually attacks trees partly dead or in poor condition, rarely sound trees. As a preventive measure, keep trees healthy by use of fertilizers and thorough cultivation.

Treatment.—Dig the borers from burrows with sharp instrument.

Bur. Ent. Cir. 32.

The Fruit Tree Bark Beetle (*Scolytus rugulosus*, Ratz.).—The small dark-brown beetle which bores shot holes in fruit trees of nearly all kinds, like the flat-headed borer, works only in dead or dying wood. As a preventive, keep the trees healthy; clean up all dead wood about orchards; cut out and burn all infested wood.

Treatment.—No satisfactory treatment is known.

Bur. Ent. Cir. 29, Revised.

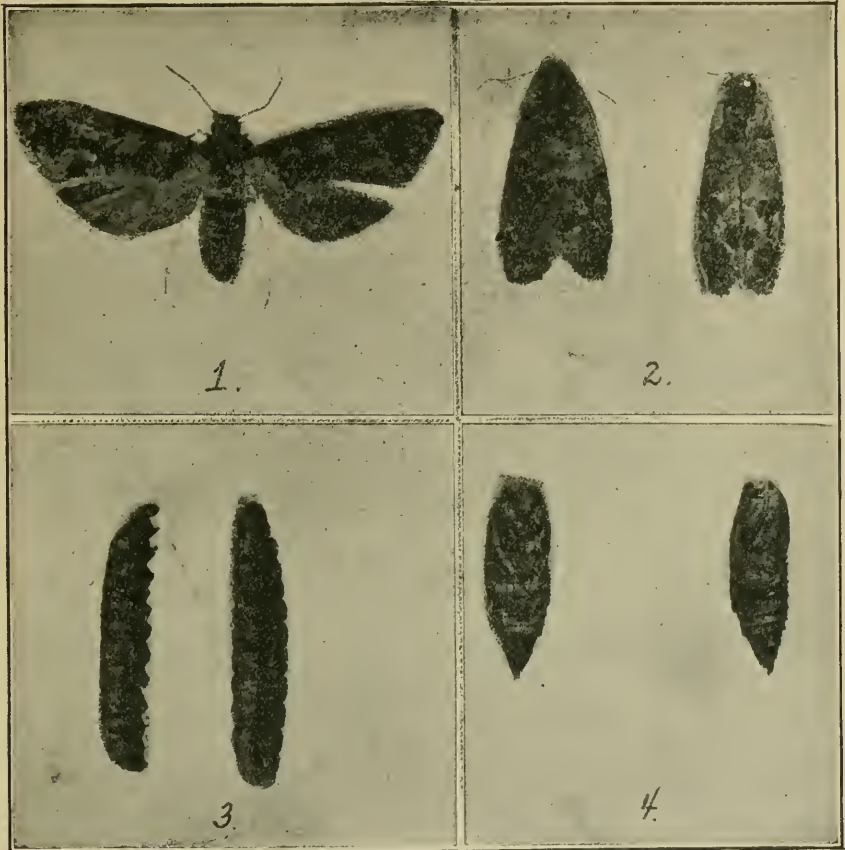
The Gipsy Moth (*Porthetria dispar*, Linn.).—The gipsy moth, like the brown-tail, is a serious enemy of forest and fruit trees. Egg masses are deposited in the fall on trunks of trees, on fences or wherever a roughened surface can be found. They hatch in the spring and the larvæ feed on the foliage of various trees.

Treatment.—Hunt out the egg masses in winter time and soak with

coal tar creosote. Spray the trees in the spring with arsenate of lead as soon as the eggs hatch, using 10 pounds to 100 gallons of water.

Bur. Ent. Bull. 87; Farm. Bull. 564.

The Grape Berry Moth (*Polychrosis viteana*, Clem.).—A larva about



GRAPE BERRY MOTH
(*Polychrosis viteana*).¹

1 and 2—Adult, or moth. 3—Full grown larvæ. 4—Pupæ.
All greatly enlarged.

one-fourth of an inch long, works in the berry of grape, webbing several together. It is the cause of most of the wormy grapes in the eastern sections of the country.

Treatment.—Spray with arsenate of lead, 6 pounds to 100 gallons.

¹Bur. Ent. Bull. 115.

First application shortly after fruit sets; second, about ten days later, and third, when the fruit is about half grown or when the second brood eggs are hatching.

Bur. Ent. Bull. 116, Pt. 2, Farm. Bull. 284.

Grape Leaf Hopper (*Typhlocyba comes*, Say.).—This active little



INJURY TO GRAPES BY LARVÆ OF SECOND BROOD OF GRAPE-BERRY MOTH.¹

Just previous to harvesting of fruit.

hopper is known in all parts of the country where grapes are grown. It is yellowish in color, marked with green stripes. The leaves of the grapes are injured by the puncture made by the hopper in feeding on the under side of the leaf, causing them to turn spotted and yellow and finally fall off.

Treatment.—Spray the vines thoroughly about the first week in July, when the maximum number of young hoppers are on the leaf, with a

¹Bur. Ent. Bull. 116, Pt. 2



GRAPE LEAF HOPPER
(*Typhlocyba comès*).¹
Adult, winter form.
Greatly enlarged.

solution of 40 per cent nicotine, diluted 1 part to 1000 parts water. Clean up trash and weeds in fence corners and practice clean culture generally. Dept. Bull. 19.

The Grape Vine Flea Beetle (*Haltica chalybea*, Ill.).—A blue metallic beetle about one-fourth of an inch long. It feeds on buds and tender shoots in early spring. The grubs feed later upon the leaves.

Treatment.—Spray with arsenate of lead to kill the adults and grubs on the leaves during May and June. The beetles may be captured in sheets or pans by jarring the vines.

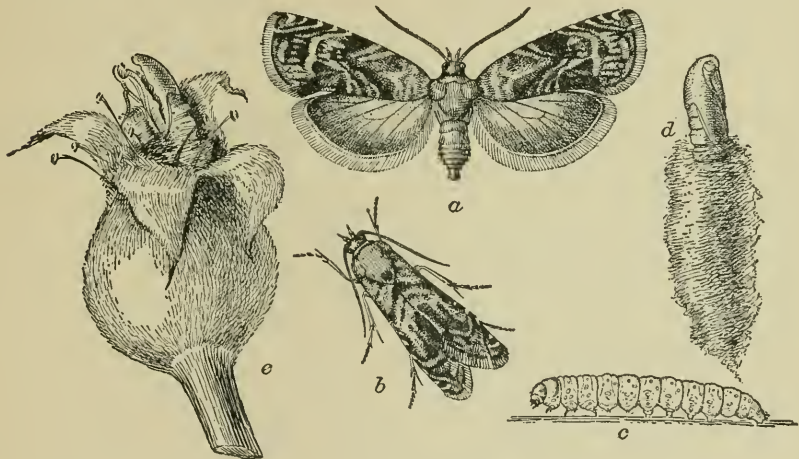
New York (Geneva) Exp. Sta. Bull. 331, pp. 494-514.

The Lesser Apple Worm (*Enarmonia prunivora*, Walsh).—This insect is closely related to the codling moth and has very much the same life history.

Treatment.—Spray as for the codling moth, but take especial pains to make the second spray very thorough, three to four weeks after petals have fallen.

Bur. Ent. Bull. 68, Pt. 5; Bur. Ent. Bull. 80, Pt. 3.

The Peach Tree Borer (*Sanninoidea exitiosa*, Say.).—The larvæ of this insect are found at the crown of peach, plum and cherry trees, boring



LESSER APPLE WORM
(*Enarmonia prunivora*).²

A—Adult, or moth. B—Same with wings folded. C—Larva. D—Pupa in cocoon ready for transformation to adult. E—Young apple, showing at calyx end empty pupa skin from which moth has emerged. Enlarged about three times.

¹Dept. Bull. 19.

²Bur. Ent. Bull. 68.

beneath the bark. The external indications of their presence are the mass of sap which is commonly seen at the base of the tree and the frass or wormwood that has been worked out through holes in the bark. Preventive means that have given some measure of success are various styles of protectors placed around the base of the trees, and coating washes applied to the trunk. The latter are not satisfactory.

Treatment.—Remove the ground from the crown of the tree in the spring and fall and dig out the borers with a sharp knife.

Georgia Agri. Exp. Sta. Bull. 73; N. J. Agri. Exp. Sta. Bull. 235.

Pear Leaf Blister Mite (*Eriophyes pyri*, Pagenstecher).—This small mite, only $\frac{1}{125}$ -inch in length, is the cause of the rough, blistered surface of pear and apples leaves. When the attack is severe the trees become so brown that they have the appearance at a distance of having been swept by fire.

Treatment.
—Spray in the spring or fall with concentrated commercial lime-sulphur testing 33° Baumé, diluted at the rate of 1-10 or 11.

Plant Lice (*Aphidida*).—

Many species of plant lice are found upon the various fruit trees grown in this country. They feed by sucking the sap from the leaves and stems and thus do considerable injury at times. Some species curl the leaves about them so that they are very difficult to reach with a spray unless the treatment is made before the attack becomes severe. The treatment for all aerial forms is practically the same.

Treatment.—Spray carefully with a 40 per cent nicotine sulphate solution diluted at the rate of 1 part to 800 parts of water, being sure to touch all insects with the spray. A kerosene emulsion spray is also good if used at the 8 or 10 per cent strength.

Plum Curculio (*Conotrachelus nenuphar*, Hubst.).—On apples this insect injures the fruit by deforming or scarring it by its feeding and egg-laying punctures.

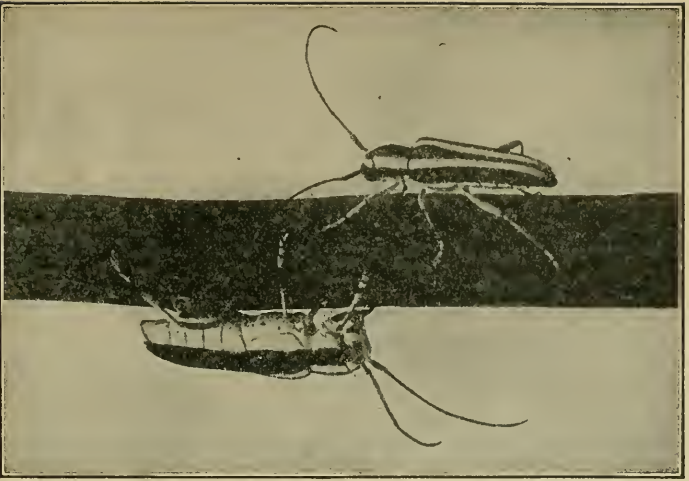
Treatment.—Spray as for codling moth, except that one additional



PEACH TREE BORER
(*Saminiodea exilis*).¹

A—Adult female. B—Adult male. C—Full grown larva. D—Female pupa. E—Male pupa. F—Pupa skin extruded partially from cocoon. All natural size.

¹ Bur. Ent. Cir. 17.

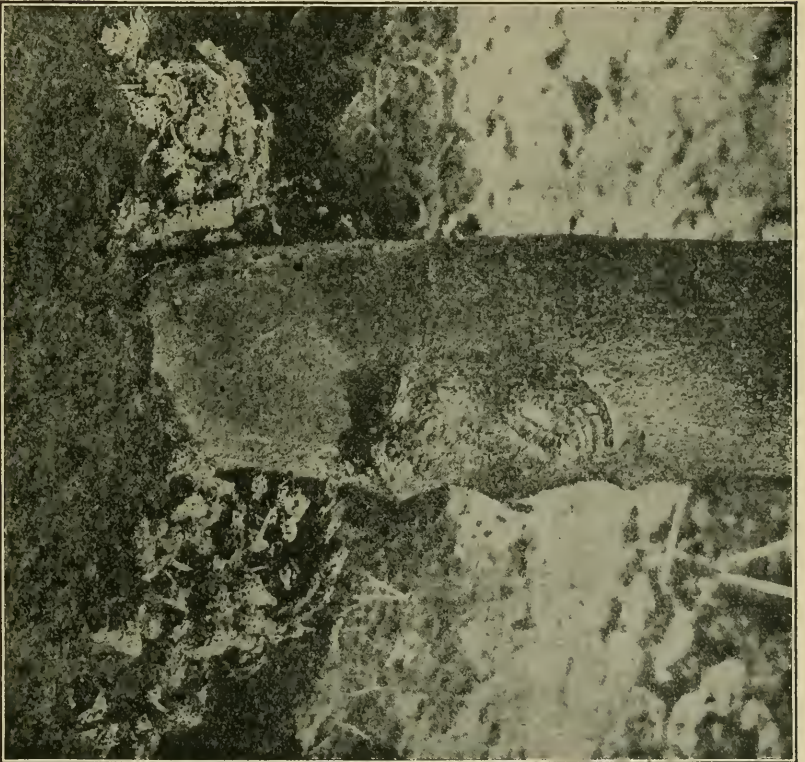


ADULT MALE AND FEMALE ROUNDHEADED
APPLE TREE BORER.¹

Male on left, female on right, slightly enlarged.

¹Farm. Bull. 675.

²Farm. Bull. 657.



CASTINGS OF ROUNDHEADED APPLE TREE BORER AT BASE OF YOUNG
APPLE TREE.²

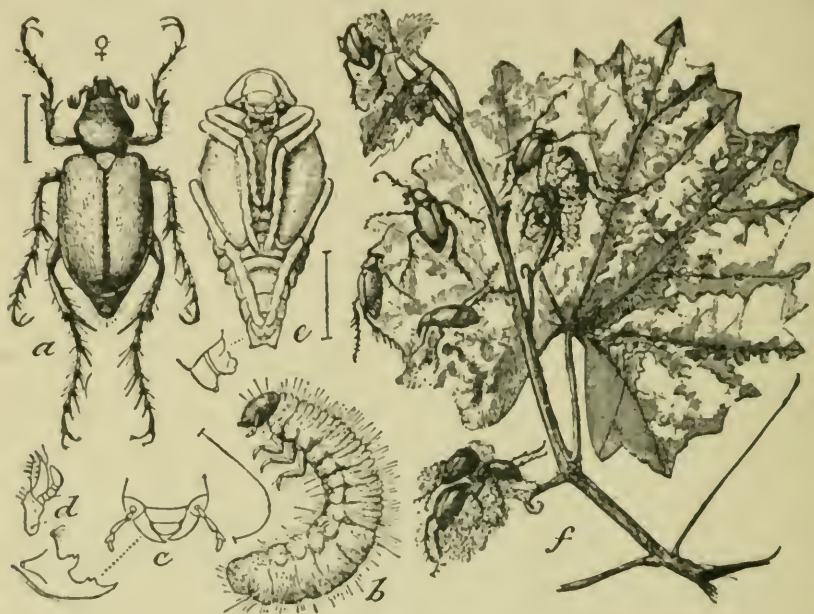
spray should be given before the blossoms open or at the time the cluster buds have opened out.

On plum, peach and cherry trees most of the injury is caused by the grubs inside the fruit.

Treatment.—For plums, spray with arsenate of lead, two pounds to 50 gallons; first, soon after petals fall; second, a week or ten days later.

For cherries, same as for plum.

For peaches, first, spray just as calyxes or shucks are shedding;



ROSE CHAFER

(*Macrodactylus subspinosus*).¹

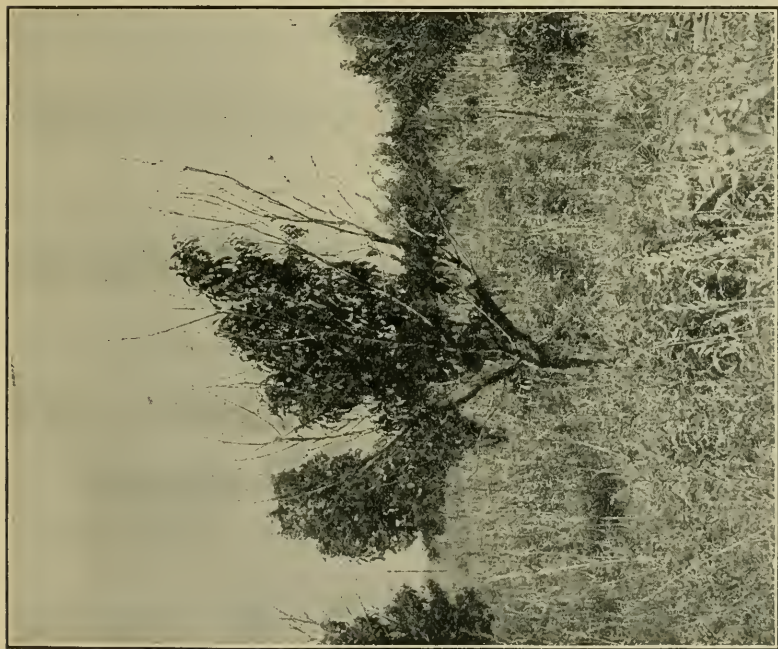
A—Adult, or beetle. B—Larva. C, D—Mouth parts of larva. E—Pupa. F—Injury to leaves and blossoms of grape, with beetles at work. A, B, E—Much enlarged. C, D—More enlarged. F—Slightly reduced.

second, spray three weeks later. When spraying peaches, self-boiled lime-sulphur is usually added to prevent fungous troubles.

Farm. Bull. 440, Farm. Bull. 492.

The Rose Chafer (*Macrodactylus subspinosus*, Fab.).—This beetle is recognized by his long legs and yellowish-gray color. Often in sandy regions the beetles swarm upon the grapes in great numbers, causing serious injury.

¹Bur. Ent. Bull. 97.



1

1—Peach tree with top killed by scale.



2

2—Peach twig moderately infected, showing male and female scale. Enlarged four times.

Treatment.—Spray with arsenate of lead at the rate of 8 or 10 pounds to 100 gallons of water, to which is added 1 or 2 gallons of cheap molasses. Bur. Ent. Bull. 97, Pt. 3.

Round-Headed Apple Tree Borer (*Saperda candida*, Fab.).—The adult of the round-headed borer is a handsome striped beetle. It lays its eggs on the bark at the base of apple trees and the young grubs eat through and enter the wood. Their presence can be detected by dark areas or discolored places on the bark and usually by the presence of small chips or frass worked out through the holes.

Treatment.—When the borer is located it should be removed with a sharp knife. Many washes and protectors have been tried to prevent injury from this insect. White lead has been strongly recommended for this purpose.

Bur. Ent. Cir. 32, Farm. Bull. 675.

The San José Scale (*Aspidiotus perniciosus*, Comst.).—This insect has a wide distribution throughout the country and is a serious enemy of fruit trees in many states. The scale is nearly circular in outline and about the size of the head of a pin. When it is plentiful upon trees it becomes encrusted on the trunk and branches, giving the tree a scurfy appearance. The insect under the protecting scale feeds by sucking the sap of the tree, so a contact insecticide is necessary for its control.

Treatment.—Spray the trees during the dormant season with concentrated lime-sulphur giving a Baumé test of 33°, diluted at the rate of 1 gallon to 8 or 9 of water. The so-called miscible oils (mineral oils which have been so treated that they may be readily mixed with water) are also used successfully.

Bur. Ent. Bull. 62.

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543. "Common White Grubs."

557. "Potato Tuber Moth."

564. "The Gipsy and Brown Tail Moth: Their Control."

650. "The San José Scale and Its Control."

658. "Cockroaches."

659. "The True Clothes Moth."

662. "The Apple Tree Tent Caterpillar."

668. "The Squash Vine Borer."

671. "Harvest Mites or Chiggers."

674. "Control of Citrus Thrips in California and Arizona."

675. "The Round-Headed Apple Tree Borer."

CHAPTER 20

INSECTICIDES AND FUNGICIDES

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The word insecticide has come to mean any chemical or other substance used to destroy insects that are hurtful or objectionable in any way to man. This definition excludes substances such as sticky fly-paper that may be employed to entrap pests and would, according to some entomologists, exclude also simple deterrents, such as oil of citronella, used to keep insects away by their offensive odors. In a general way, however, every substance employed to prevent the injuries of insects is an insecticide and in this view it does not matter whether or not they kill, deter or entrap.

The insecticides most used and valued by practical men either kill as poisons when eaten with food, or else destroy when brought in contact with the bodies of insects, in which case they are sometimes called contact insecticides.

A group of insecticides of which the effective ingredient is arsenic has proved especially popular and useful in suppressing insects which feed by gnawing away and devouring the leaves of plants.

Paris Green.—Of these the one best known and most used is Paris green, Schweinfurth green, or Imperial green, French green and Emerald green. It was first used in the arts, and because of its cheapness and poisonous properties was early tried on the Colorado potato beetle (about 1868) proving a very satisfactory means of suppressing the pest when used either as a dry powder or when stirred into water. It contains a little soluble arsenic however, and in water this is liable to burn leaves to which it is applied, hence care must be exercised not to use too much. Four to five ounces of the powder in a barrel of water is commonly regarded as enough; if more is used a pound or two of freshly-slaked lime may be added to neutralize its caustic effect.

Arsenate of Lead.—Paris green has two defects: Its burning action is often hard to guard against, and its weight causes it to settle quickly when used in water, rendering the spray produced uneven in strength. Stirrers connected with spray pumps obviate the latter trouble, but sometimes increase the labor of operating pumps. The addition of lime, as already suggested, lessens the burning action, though the lime may, if care is not exercised, increase the labor of applying.

Arsenate of lead has neither of these defects. It is practically insoluble in water, does not burn foliage, and it is so finely subdivided that it

remains suspended much better than Paris green. It has the additional advantage of adhering to leaves longer than Paris green, and thus fewer applications are required. A single spraying with this substance, if applied at the right time, is for some plants sufficient for a whole season. The arsenate of lead paste is commonly used with water in the proportion of $2\frac{1}{2}$ to 3 pounds in 50 gallons. As found in the market it contains about 50 per cent of water.

It requires more by weight to destroy insects than Paris green, but the cost per pound is less and hence the actual cost for materials amounts to about the same, whichever poison is used. Its advantages are so decided in other directions that it is now supplanting Paris green in popular favor. For the injuries of most gnawing insects working on foliage this insecticide may be safely recommended.

To meet the objections sometimes made to arsenate of lead paste, a powdered arsenate of lead has recently been offered to the public by manufacturers of insecticides. The paste when dried out is lumpy and is not in this condition easy to mix with water. In the powdered form it is not open to this objection and may, besides, be dusted over plants without the addition of water.

There are serious objections to the use of poisonous dusts, however, though in practice they have advantages that always commend them to workmen. The weight of the water to be carried when using liquid sprays increases the labor, of course, and this ought to be lessened if it can be done without diminishing the effectiveness of the applications, and also without increasing the danger to those making the applications. The inhaling of either dry Paris green or arsenate of lead is a serious matter, and if continued long is certain to lead to ill health. Liquid sprays go more directly and evenly to the plants and stay there. They may be made just as promptly effective as the dusts if used when the injury is beginning. They are not so likely to be inhaled.

Arsenite of Zinc.—This poison has somewhat recently been recommended as a substitute for Paris green and arsenate of lead, and appears to be about equally good and somewhat cheaper than either. It is a finely divided white powder as put on the market and remains in suspension about as well as arsenate of lead, having thus some advantage over Paris green. It contains a little water-soluble arsenic and has been claimed to be less injurious to foliage even than arsenate of lead, possessing at the same time about the same killing power. For use it is stirred first into a little water and allowed to soak for a time, then is stirred into the water in which it is to be used, about one pound of the powder being added to 50 gallons of water. It contains nearly the same quantity of arsenic as Paris green. Like arsenate of lead, it remains in suspension better if a little soap is dissolved in the water into which it has been stirred. It has of late been quoted by dealers at from 20 to 25 cents per pound.

London Purple.—This arsenite came into use for injurious insects

somewhat later than Paris green (about 1878), but is less used now than formerly because of its lack of uniformity in composition and its excessive burning of foliage. Its affective ingredient as an insecticide is arsenic in the form of lime arsenite and lime arsenate, of which it contains about 40 per cent, nearly half of which is soluble. It is the soluble arsenious and arsenic oxides that make this insecticide so injurious to the foliage and render necessary the addition of lime. The amount of pure arsenic present has been found to be about 29 per cent. For use it is customary to recommend about one-quarter pound each of London purple and fresh lime in from 50 to 75 gallons of water.

White Arsenic.—The use of this poison has been recommended from time to time for gnawing insects, but the time and labor required in boiling it with milk of lime (thus producing an arsenite of lime) in order to avoid its burning effect on foliage has prevented its general employment as an insecticide. It can be made to accomplish the same purpose as Paris green and arsenate of lead, without injury to foliage, by boiling for a half hour 1 pound of commercial arsenic and 2 pounds of fresh lime in 4 gallons of water, diluting with water finally to make 100 gallons.

Sulphur.—Flowers of sulphur has been used for many years as an insecticide, especially for mites infesting hothouse plants. When dusted on plants it does no harm to the leaves, but is not as effective as could be desired. When burned in hothouses it may do severe injury to plants. These defects have led to its neglect by entomologists. When sulphur is boiled with lime, however, it produces a lime sulphide, in which condition it becomes one of the best of insecticides for use in winter against scale insects.

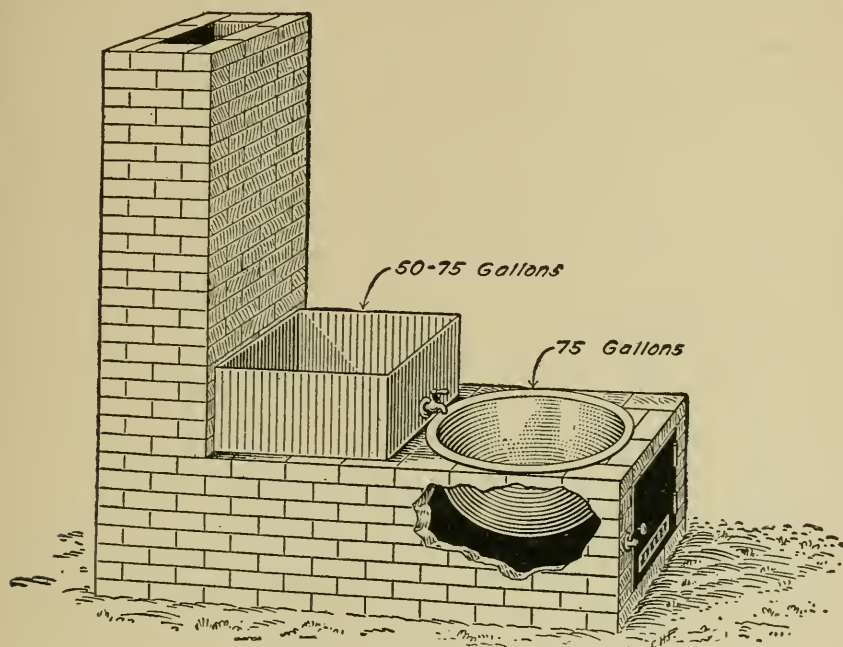
Lime-sulphur Wash.—In this condition thousands of barrels of the boiled sulphur and lime are sold to fruit growers every year, who use it largely as a remedy against San José scale. A concentrated solution is prepared by boiling in large iron kettles, tanks or other vessels, 50 pounds of fresh lime, 100 pounds of sulphur and 50 gallons of water. Part of the water is heated, then the lime is added and is followed by the sulphur, the whole being stirred continually while boiling, the time employed being from fifty minutes to an hour. Finally, after adding enough hot water to make 50 gallons, the solution is strained and set aside until ready to use. Home-made solutions may not test higher than 27 to 30° Baumé, but when carefully made go higher and may even reach 34 or 35° Baumé, the differences being apparently due to differences in the quality of limes used.

The manufacturers now follow about the same formula in producing their concentrated products, but because of having better facilities will perhaps average higher in concentration than the fruit grower, although analysis of samples bought in the market have sometimes shown that they did not test as high as good home-made lime-sulphur.

These concentrated solutions are of a deep reddish-yellow color and for use must be greatly diluted with water. It is customary in spraying

for San José scale to use one part of the solution to eight or ten of water and to apply during open weather in February or March, while the trees are still dormant. For summer use they must be diluted with from 30 to 50 parts of water to avoid injury to the foliage, but lose much of their value as insecticides when thus weakened. The concentrated solution is regarded as the most effective remedy for scale injury now in use.

It should be added that there has somewhat recently appeared a so-called "soluble sulphur" which is recommended for the same uses as



A LIME-SULPHUR COOKING OUTFIT.¹

lime-sulphur. It promises well, but has not been tested long enough and carefully enough to justify very positive statements as to its merits.

Tobacco Extracts.—For use against soft-bodied insects such as plant lice there is no more useful insecticide than extracts made from the midribs of tobacco leaves. These extracts contain as their effective ingredient nicotine and differ widely in the percentage of nicotine they contain. Home-made extracts or decoctions are made by placing a couple of pounds of the midribs in a wooden bucket full of boiling hot water, allowing it to stand over night. The percentage of nicotine under such treatment will probably not be more than 0.07 per cent, but it is a very useful wash for plants infested with aphides, does no harm at all to leaves, and where

¹From Farmers' Bulletin 650, U. S. Dept. of Agriculture.

tobacco is grown and the midribs can be easily secured is one of the very best insecticides for uses of this sort. The whole leaf makes a somewhat stronger extract (0.12 per cent) as determined by tests recently made at the Virginia Station. Soaking seems to extract as much of the nicotine as boiling. When plants are to be treated on a larger scale it becomes important to know just how much nicotine is present in a wash, and manufactured extracts, some of them containing 40 per cent of nicotine, are demanded. For the apple leaf louse, the lettuce louse, the rose aphid and other similar pests, these extracts are safe and effective. For thick-skinned insects they are not so satisfactory.

Tobacco is often used in other ways as a remedy for insect injuries, but is open to some objections when so employed. Florists have long used the midribs (often called "stems") for making a smudge for the destruction of plant lice. The tobacco is simply burned in a perforated iron vessel. The smoke leaves a strong smell of tobacco on flowers, which is sometimes objected to by buyers. The odor can be avoided by using the extract diluted with water and driven off as a vapor by dropping a hot iron into a pan containing it.

Pyrethrum.—Under the name Persian insect powder or simply insect powder this insecticide is to be obtained from most dealers in drugs. It is a brown powder made from the flowers of a rather handsome plant of the sunflower family (*Compositæ*). Its beauty leads florists to propagate it, though few who grow the plant know that it has any relation to the powder sold in drug stores. It comes to us from the East, and the powder commonly sold here is imported, though an effort has been made in the west coast states to manufacture the powder in this country.

The powder is thought to give off a volatile oil which penetrates the breathing tubes of insects and thus by some irritating or suffocating effect overpowers them. It is effective either dry, in water or when burned to produce a smudge, but must be fresh. It loses much of its effectiveness if kept in open packages. Though rather costly for use on field crops, it has a place in the household at times, and may sometimes be profitably resorted to for limited outbreaks of garden pests. Unlike most other insecticides, this one is not hurtful to man; at any rate, not more so than snuff.

White Hellebore.—This is another vegetable product, being the pulverized rootstocks of a plant (*Veratrum album*) of the lily family, occurring in Europe and northern Africa. It is used in this country for the rose slug, either dry or in water, in the latter case about two heaping tablespoonfuls being stirred into a wooden bucketful (2½ gallons) of water. It is a stomach poison and also a contact insecticide.

Old samples when not kept in airtight receptacles lose their virtue and tend to discredit this vegetable poison as a remedy for pests.

Coal Oil.—This oil has become well known as an insecticide in the form of an emulsion. It is a good contact insecticide, serving the same purpose as lime-sulphur wash in the destruction of scale insects, and having

the advantage of remaining effective when diluted. It can, therefore, be used on foliage in summer for both scale insects and plant lice, and being quicker in its action than tobacco extract, has advantages under some circumstances over the extract for the prompt destruction of soft-bodied insects. It is, however, more likely to do injury to plants, especially if the emulsion is badly prepared, and this, together with the work required in making it, leads practical men to neglect it whenever they can use something else.

The standard emulsion is made of one-half pound of whale oil or laundry soap dissolved in a gallon of boiling hot water, this to be added to two gallons of coal oil, and the whole churned for ten minutes by passing rapidly through a force pump. As thus made it can be diluted for use, one part to ten of water.

Crude Oils.—These are sometimes used for the same purposes as the refined oil, and to render them easily mixed with water are sometimes mixed with caustic potash, fish oil and crude carbohc acid, producing a so-called miscible or soluble oil, which can be diluted with water for use like the coal oil emulsion.

Soaps.—Many of the soaps sold in our market can be used at times as a means of lessening the injuries of insect pests. A good soapsuds frequently and freely used on plants infested with aphides or scale insects has a good effect, though not a very prompt one. Stronger solutions must be used with some caution to avoid injury to foliage. When trees are dormant very strong solutions (one or two pounds to a gallon of water) are sometimes used on the trunks for scale and other insects.

Whale oil soap or fish oil soap, as it is sometimes called, is to be preferred to most others because of its more even composition. It is particularly good for use in making coal oil emulsion.

Coal Tar.—In the early days of fruit growing in America this substance was much used on the trunks of trees to prevent the ascent in the spring of the wingless female canker worm moth. It proved to have an injurious effect on the trees after a time, and hardened on exposure, so that the insects could pass over the barrier. It was then used on bands of tin, and by frequent renewal proved a useful check on the insect. But with the introduction of arsenites and spraying machinery, it was given up for the more convenient treatment. It is still used as a barrier, poured along the ground, for chinch-bugs which are migrating from small grains to corn. Seed corn may be treated with it before planting to deter wire worms and the seed corn maggot from attacking the germinating seeds. The corn is first immersed in warm water for a minute or two, then a couple of teaspoonfuls of the tar are stirred quickly among the grain so as to bring a little in contact with each seed. It dries over night so as to be ready for planting the following day. The application does no harm to the germ, as has been determined by germination tests of treated seeds.

Borax.—This substance has often been recommended for roaches in

dwellings, and is sometimes found with an arsenite as an ingredient of proprietary roach pastes. Recent work done with a view to destroying the larvæ of house flies in manure indicates that this is one of the best of insecticides for the purpose, excelling for this use, coal oil, pyroligneous acid, formalin and Paris green. Sodium borate and crude calcium borate were both found effective in killing the larvæ, either when used dry or in solution. It was recommended as a result of the work done that about 0.62 pound of borax be used in 8 bushels of manure. Larger amounts of borax are believed to be injurious to plants when the manure is spread on land. The cost was estimated at one cent per horse per day.

Other Insecticides.—Numerous other insecticides have been recommended, and have had a limited use, but, excepting the fumigants considered later, they have not been generally adopted by practical men. Among them may be mentioned benzene, which is sometimes applied to fabrics to destroy clothes moth; carbolized plaster, sometimes recommended as a remedy for fleas about stables; fir-tree oil, lemon oil and oil of citronella, the latter often employed as a deterrent against the attacks of mosquitoes and also as a preventive of injury to seed corn in the soil. Quassia, the effective ingredient of which is quassiin, is obtained from the wood of the Jamaican *Picrasma excelsa*. It is an old insecticide that has been perhaps most used in solutions for the hop aphid in the West. The extract is made from the "chips" by either soaking or boiling.

Bisulphide of Carbon.—As sold by druggists and manufacturers, this is a brownish fluid which quickly disappears in the air when exposed in an open vessel. Its disagreeable odor is due to impurities, since the odor of pure bisulphide of carbon is not unpleasant. The fumes are not only poisonous, but are inflammable, so that some care must be exercised in handling the fluid. It has proved of special service as a remedy for grain weevil, bean weevil and other insects attacking stored seeds, and for the phylloxera of grapevines in Europe, for the woolly aphid, for ants, and even for the clothes moth. Its great value for such purposes comes not only from its effectiveness in destroying all insects, but also because it is not corrosive and is otherwise not injurious to seeds, fabrics and other objects fumigated. The offensive odor is soon gone if objects that have been exposed to the fumes are thoroughly aired. It cannot be used for fumigating plants infested with insects because of its destructive effect on the plants themselves.

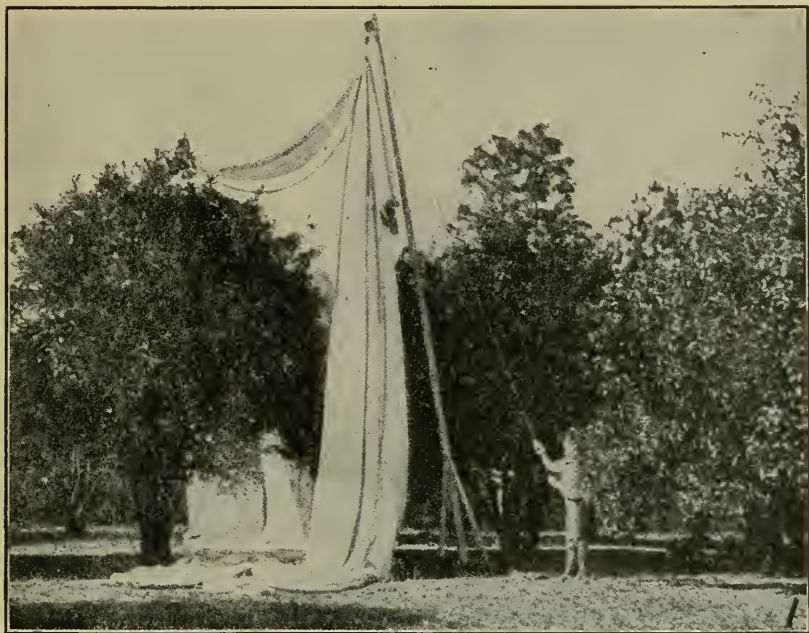
About one fluid ounce should be used on each bushel of seed, and may be poured over the seeds or simply placed in a saucer or other open vessel set on their surface. It is absolutely necessary that the seeds be enclosed in a tight box or bin to get satisfactory results, and the time of exposure should not be less than two hours.

Carbon Tetrachlorid.—The disagreeable odor of commercial bisulphide of carbon renders it objectionable to some people for use on fabrics infested with moth, and has led to the suggestion that carbon tetrachlorid, which

has a rather pleasant odor, be used in its stead. This also is a fluid, and is used in the same way as carbon bisulphide, namely, by pouring it into open dishes or crocks and allowing it to evaporate in a box, bin or room.

It is not nearly as effective in small quantities as either cyanide of potassium or carbon bisulphide, and the large quantities that must be used increase the cost of treatment.

Para-dichlorobenzene.—This is a recently proposed fumigant and is not yet in general use, because of its cost. It is not evil-smelling like



MAKING PREPARATIONS TO FUMIGATE WITH HYDROCYANIC GAS.¹

Front edge of sheet tent and top of derrick ready to be pulled over tree.

carbon bisulphide, and appears to be quite effective in destroying weevils in grain and clothes moth. Since it is not inflammable, it can be more safely used about dwellings, though its fumes have wonderful penetrating power and escape in some quantity even from tightly stoppered bottles. From a limited experience with it the writer is disposed to regard it very favorably for fumigating seeds and fabrics, though more extended tests may show it to have defects that are not now apparent.

Hydrocyanic Acid Gas.—This gas is made from cyanide of potassium (98 per cent), commercial sulphuric acid of good grade and water. The

¹Courtesy of U. S. Dept. of Agriculture.

gas produced is very poisonous, as are also the cyanide of potassium and sulphuric acid. When fumigating it is well to place a notice on the room or house warning people not to enter. After the fumigating is accomplished it is advisable to open up doors and windows and air out for ten minutes or more before entering.

The dose to be used depends upon the space to be fumigated and upon the character of the plants to be treated. Dormant trees can be exposed for



FUMIGATING WITH HYDROCYANIC GAS.¹
Sheet tent ready for introduction of chemicals.

a time to very strong fumes. Growing plants must be treated cautiously with very mild doses. Some of them are very sensitive to the gas and will be slightly burned with any dose calculated to be of value in destroying insects. The condition of the air as to moisture may influence the results, since dampness favors injury from the gas.

For nursery stock it is customary to employ for each 100 cubic feet enclosed, the following:

Cyanide of potassium.....	1 ounce
Sulphuric acid.....	1 25 fluid ounces
Water.....	3 fluid ounces

¹ Courtesy of U. S. Dept. of Agriculture.

The box or house should be as nearly gas-tight as possible, with a very tight-fitting door. The water and sulphuric acid are placed in a deep open crock, then the cyanide of potassium, broken up into pieces about as large as a hickory nut, is poured into the crock and the door shut as quickly as possible. The fumes must be left about the trees not less than forty minutes, and fifty minutes or an hour is better. Short exposures in badly constructed houses have sometimes resulted in the sending out of living San José scale on trees.

In the hothouse the gas must be used with very great care to avoid injury to plants. Plants of the grass family (*Graminæ*) endure more gas than most others tested by the writer. Corn, timothy, blue grass and the like are not very sensitive. The leguminous plants, such as clover, sweet pea and cowpea, are very likely to suffer some injury with any but very light doses, and on this account it is best to use the less hurtful tobacco extract when practicable. The extract will not, however, destroy the adults of all hothouse pests, and has no effect at all on the scale insects nor on the immature white fly.

FUNGICIDES

When all has been said the number of fungicides approved by the experience of practical and scientific men is very small. Many have been recommended, but comparatively few have stood all the tests as to effectiveness, convenience of application and cheapness. Some are cheap and only slightly effective; some are difficult to prepare; others are too costly for extensive use.

Copper Sulphate.—At the head of the list stands copper sulphate, a cheap, effective fungicide, commonly known as bluestone. This is the active and most essential ingredient of Bordeaux mixture. Concentrated solutions of it cannot be used alone on foliage because of their caustic action. In winter on dormant trees it is sometimes used for fungous troubles, about two pounds being dissolved in a barrel of water. A weaker solution—1 pound in 200 gallons of water—may be used on foliage in summer when fruit is well matured and it is not desirable to use sprays like Bordeaux mixture, which leave a residue. The bluestone may be quickly dissolved by pouring boiling hot water over it. When one is not hurried it may be dissolved by suspending in a loose sack in the water. It dissolves slowly if simply thrown in the water and allowed to settle.

To avoid to some extent the delays involved in dissolving bluestone it is well to buy a finely powdered grade now manufactured for the making of fungicidal preparations.

Bordeaux Mixture.—A standard formula for the preparation of this valuable mixture is the following:

Bluestone.....	4 pounds
Fresh lime.....	4 pounds
Water.....	50 gallons

Dissolve the bluestone in 25 gallons of water, slake the lime separately, and add water to make 25 gallons; then pour the two, bucket by bucket, into a third barrel so as to mix thoroughly. For peach and plum, which are more tender than apple and grape, the above formula may be changed to the following:

Bluestone.....	2.5 pounds
Fresh lime.....	2.5 pounds
Water.....	50 gallons

These are the best preparations known for mildews, rots, scabs, smuts and the like, and where one is dealing with a fungous trouble and is uncertain as to how to proceed, the chances are that he will accomplish as much



EFFICIENCY OF BORDEAUX MIXTURE ON POTATOES. ONE ROW NOT SPRAYED.¹

by using this preparation as with anything that could be recommended. It is the best general-purpose fungicide we have at present.

Copperas, or Iron Sulphate.—While this is less often used than bluestone, yet it has decided fungicide and antiseptic value, and because of its cheapness may sometimes be found serviceable. As now used it generally comes to the market as a waste product in the manufacture of steel wire, and may be bought for a cent or less per pound.

Formalin, or Formaldehyde.—This very valuable preservative and antiseptic has been much used of late as a remedy for potato scab and to some extent for wheat smut. It is sold as a fluid containing forty per cent of formalin. In this condition it is very acrid, and gives off fumes that affect the eyes and nostrils unpleasantly. Used on the hands, it quickly destroys the outer skin. It cannot, therefore, be employed except when

¹ Courtesy of New York Agricultural Experiment Station, Geneva, N. Y.

greatly diluted. But since it retains its active fungicide and bactericidal properties even when very greatly diluted, and is not so dangerous a poison in this condition as are corrosive sublimate and other antiseptic agents, it becomes very useful in the hands of those who wish to disinfect quarters in which have been lodged people, or animals, affected with communicable diseases. The wash or spray of the dilute formalin has always seemed to the writer much better for such uses than the fumes of formalin as generally produced.

On plants the action of even dilute sprays is very quickly destructive, and I doubt if it has a value for their treatment. But for seed wheat,



TREATING GRAIN WITH FORMALIN FOR SMUT.¹

likely to produce smutted heads and for potato scab it has proved very convenient and useful. A pint of the 40 per cent formalin may be poured into a barrel containing 30 gallons of water, stirred thoroughly, and the potatoes in a sack can be set in the barrel for disinfection. They should be left in the fluid for two hours and may then be removed and spread out on grass or on a clean plank floor to dry, when another sack may be placed in the barrel. The treated potatoes must not be put in barrels or sacks that have not been treated with the formalin. By having a number of barrels at hand, the work proceeds rapidly.

Oats and wheat liable to smut may be treated by sprinkling the seed with dilute formalin (1 pint in a barrel of water) until every seed is moist, not wet, then leaving for several hours in a heap, finally spreading out to dry.

¹Courtesy of H. L. Bolley and M. L. Wilson, North Dakota Agricultural Experiment Station.

Fumes of formalin produced either by heat or by the use of permanganate of potash have been recommended as a remedy for potato scab, but the writer's experience with the fumes has not been such as to warrant him in recommending them for this or for other purposes.

Bichloride of Mercury.—A very poisonous chemical, valuable in dilute solutions (1 part in 1000) as a disinfectant, and particularly good as a remedy for potato scab. The whitish, crystalline, very heavy material is very dangerous to have about, since it may attract the attention of children or animals. It should of course always be kept labeled as a poison. It dissolves slowly in cold water, and it is best, therefore, to make use of heat, afterward turning the dissolved poison into the larger quantity of water required, best kept in a barrel. Good results have been obtained in checking potato scab with this disinfectant, using 4 ounces in 30 gallons of water and soaking the seed potatoes one hour. They were placed in the fluid in gunny sacks and afterward spread out on a barn floor to dry.

It is very essential that poisoned potatoes be not left where stock will eat them, and the poisonous fluid must be disposed of after treating the seed, so that it will do no harm.

Lime-Sulphur Wash.—This preparation of sulphur and lime has already been mentioned under insecticides. It has undoubted fungicide value both in concentrated and dilute preparations. For foliage the latter must always be used. Even the sulphur alone thickly strewn over leaves is a fairly good remedy for mildew. A very small quantity of the sulphur dissolved in the presence of lime renders it more effective both as an insecticide and as a fungicide.

COMBINED INSECTICIDES AND FUNGICIDES

The cost of treatment for pests is greatly increased by the necessity for frequent spraying when insecticides and fungicides are used separately. They have been combined in some cases with no loss in the effectiveness of either, and one of the important problems of both entomologists and plant pathologists at the present time is the finding of ways and means of reducing the number of sprayings still further.

Some work in determining the compatibility of different mixtures has already been done, and it may be said that the following mix without loss and in some cases with a gain in effectiveness:

- Arsenate of lead (acid) and Bordeaux mixture.
- Arsenate of lead and tobacco.
- Arsenate of lead and acids.
- Arsenate of lead (neutral) and Bordeaux mixture.
- Arsenate of lead (neutral) and lime-sulphur.
- Arsenate of lead (neutral) and tobacco.
- Paris green and Bordeaux mixture.
- Arsenite of lime and Bordeaux mixture.
- Arsenite of lime and tobacco.
- Lime-sulphur and tobacco.
- Soaps and Bordeaux mixture.

Soaps and tobacco.
 Soaps and emulsions.
 Tobacco and lime-sulphur.
 Tobacco and soaps.
 Tobacco and emulsions.
 Tobacco and alkalies.

Some dangerous combinations are the following:

Arsenate of lead (acid) and soaps.
 Arsenate of lead (acid) and emulsions.
 Arsenate of lead (acid) and alkalies.
 Arsenate of lead (neutral) and acids.
 Arsenite of zinc and lime-sulphur.
 Arsenite of zinc and soaps.
 Arsenite of zinc and emulsions.
 Arsenite of zinc and alkalies.
 Arsenite of zinc and acids.
 Hydrocyanic acid gas and Bordeaux mixture.

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440. "Self Boiled Lime Sulphur Mixture as a Promising Fungicide."
492. "Fungous Enemies of the Fruit and Foliage of Apple Tree."
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603. "Arsenical Cattle Dips."

PART III

**TABLES OF WEIGHTS, MEASURES AND
AGRICULTURAL STATISTICS**

TABLE I.—PERCENTAGE COMPOSITION OF AGRICULTURAL PRODUCTS.

Crop.	Water.	Ash.	Protein.	Crude Fiber.	Nitrogen- Free Extract.	Ether Extract.
Corn, dent.....	10.6	1.5	10.3	2.2	70.4	5.0
Corn, flint.....	11.3	1.4	10.5	1.7	70.1	5.0
Corn, sweet.....	8.8	1.9	11.6	2.8	66.8	8.1
Corn meal.....	15.0	1.4	9.2	1.9	68.7	3.8
Corn cob.....	10.7	1.4	2.4	30.1	54.9	0.5
Corn and cob meal.....	15.1	1.5	8.5	6.6	64.8	3.5
Corn bran.....	9.1	1.3	9.0	12.7	62.2	5.8
Corn germ.....	10.7	4.0	9.8	4.1	64.0	7.4
Hominy chops.....	11.1	2.5	9.8	3.8	64.5	8.3
Germ meal.....	8.1	1.3	11.1	9.9	62.5	7.1
Dried starch and sugar feed.....	10.9	0.9	19.7	4.7	54.8	9.0
Starch feed, wet.....	65.4	0.3	6.1	3.1	22.0	3.1
Maize feed, Chicago.....	9.1	0.9	22.8	7.6	52.7	6.9
Grano-gluten.....	5.8	2.8	31.1	12.0	33.4	14.9
Cream gluten.....	8.1	0.7	36.1	1.3	39.0	14.8
Gluten meal.....	8.2	0.9	29.3	3.3	46.5	11.8
Gluten feed.....	7.8	1.1	24.0	5.3	51.2	10.6
Wheat, all analyses.....	10.5	1.8	11.9	1.8	71.9	2.1
Wheat, spring.....	10.4	1.9	12.5	1.8	71.2	2.2
Wheat, winter.....	10.5	1.8	11.8	1.8	72.0	2.1
Flour, high grade.....	12.2	0.6	14.9	0.3	70.0	2.0
Flour, low grade.....	12.0	2.0	18.0	0.9	63.3	3.9
Flour, dark feeding.....	9.7	4.3	19.9	3.8	56.2	6.2
Bran, all analyses.....	11.9	5.8	15.4	9.0	53.9	4.0
Bran, spring wheat.....	11.5	5.4	16.1	8.0	54.5	4.5
Bran, winter wheat.....	12.3	5.9	16.0	8.1	53.7	4.0
Middlings.....	12.1	3.3	15.6	4.6	60.4	4.0
Shorts.....	11.8	4.6	14.9	7.4	56.8	4.5
Wheat screenings.....	11.6	2.9	12.5	4.9	65.1	3.0
Rye.....	11.6	1.9	10.6	1.7	72.5	1.7
Rye flour.....	13.1	0.7	6.7	0.4	78.3	0.8
Rye bran.....	11.6	3.6	14.7	3.5	63.8	2.8
Rye shorts.....	9.3	5.9	18.0	5.1	59.9	2.8
Barley.....	10.9	2.4	12.4	2.7	69.8	1.8
Barley meal.....	11.9	2.6	10.5	6.5	66.3	2.2
Barley screenings.....	12.2	3.6	12.3	7.3	61.8	2.8
Brewers' grains, wet.....	75.7	1.0	5.4	3.8	12.5	1.6
Brewers' grains, dried.....	8.2	3.6	19.9	11.0	51.7	5.6
Malt sprouts.....	10.2	5.7	23.2	10.7	48.5	1.7
Oats.....	11.0	3.0	11.8	9.5	59.7	5.0
Oat meal.....	7.9	2.0	14.7	0.9	67.4	7.1
Oat feed.....	7.7	3.7	16.0	6.1	59.4	7.1
Oat dust.....	6.5	6.9	13.5	18.2	50.2	4.8
Oat hulls.....	7.3	6.7	3.3	29.7	52.1	1.0
Rice.....	12.4	0.4	7.4	0.2	79.2	0.4
Rice meal.....	10.2	8.1	12.0	5.4	51.2	13.1
Rice hulls.....	8.2	13.2	3.6	35.7	38.6	0.7
Rice bran.....	9.7	10.0	12.1	9.5	49.9	8.8
Rice polish.....	10.0	6.7	11.7	6.3	58.0	7.3
Buckwheat.....	12.6	2.0	10.0	8.7	64.5	2.2
Buckwheat flour.....	14.6	1.0	6.9	0.3	75.8	1.4
Buckwheat hulls.....	13.2	2.2	4.6	43.5	35.3	1.1
Buckwheat bran.....	10.5	3.0	12.4	31.9	38.8	3.3
Buckwheat shorts.....	11.1	5.1	27.1	8.3	40.8	7.6
Buckwheat middlings.....	13.2	4.8	28.9	4.1	41.9	7.1
Sorghum seed.....	12.8	2.1	9.1	2.6	69.8	3.6

TABLE I.—PERCENTAGE COMPOSITION OF AGRICULTURAL PRODUCTS (*Continued*).

Crop.	Water.	Ash.	Protein.	Crude Fiber.	Nitrogen- Free Extract.	Ether Extract.
Broom-corn seed.....	11.5	3.4	10.2	7.1	63.6	3.0
Kaffir seed.....	9.3	1.5	9.9	1.4	74.9	3.0
Millet seed.....	14.0	3.3	11.8	9.5	57.4	4.0
Hungarian grass seed.....	9.5	5.0	9.9	7.7	63.2	4.7
Flaxseed.....	9.2	4.3	22.6	7.1	23.2	33.7
Flaxseed, ground.....	8.1	4.7	21.6	7.3	27.9	30.4
Linseed meal, old process.....	9.2	5.7	32.9	8.9	35.4	7.9
Linseed meal, new process.....	10.1	5.8	33.2	9.5	38.4	3.0
Cotton seed.....	10.3	3.5	18.4	23.2	24.7	19.9
Cotton seed, roasted.....	6.1	5.5	16.8	20.4	23.5	27.7
Cottonseed meal.....	8.2	7.2	42.3	5.6	23.6	13.1
Cottonseed hulls.....	11.1	2.8	4.2	46.3	33.4	2.2
Cottonseed kernels (no hulls).....	6.2	4.7	31.2	3.7	17.6	36.6
Coconut cake.....	10.3	5.9	19.7	14.4	38.7	11.0
Palm nut meal.....	10.4	4.3	16.8	24.0	35.0	9.5
Sunflower seed.....	8.6	2.6	16.3	29.9	21.4	21.2
Sunflower seed cake.....	10.8	6.7	32.8	13.5	27.1	9.1
Peanut kernels (no hulls).....	7.5	2.4	27.9	7.0	15.6	39.6
Peanut meal.....	10.7	4.9	47.6	5.1	23.7	8.0
Rape seed cake.....	10.0	7.9	31.2	11.3	30.0	9.6
Pea meal.....	10.5	2.6	20.2	14.4	51.1	1.2
Soy bean.....	10.8	4.7	34.0	4.8	28.8	16.9
Cowpea.....	14.8	3.2	20.8	4.1	55.7	1.4
Horse bean.....	11.3	3.8	26.6	7.2	50.1	1.0
Corn fodder, field cured.....	42.2	2.7	4.5	14.3	34.7	1.6
Corn stover, field cured.....	40.5	3.4	3.8	19.7	31.5	1.1
Corn husks, field cured.....	50.9	1.8	2.5	15.8	28.3	0.7
Corn leaves, field cured.....	30.0	5.5	6.0	21.4	35.7	1.4
Corn fodder, green.....	79.3	1.2	1.8	5.0	12.2	0.5
Dent varieties, green.....	79.0	1.2	1.7	5.6	12.0	0.5
Dent, kernels glazed green.....	73.4	1.5	2.0	6.7	15.5	0.9
Flint varieties, green.....	79.8	1.1	2.0	4.3	12.1	0.7
Flint, kernels glazed green.....	77.1	1.1	2.7	4.3	14.6	0.8
Sweet varieties, green.....	79.1	1.3	1.9	4.4	12.8	0.5
Leaves and husks, green.....	66.2	2.9	2.1	8.7	19.0	1.1
Stripped stalks, green.....	76.1	0.7	0.5	7.3	14.9	0.5
HAY FROM GRASSES:						
Mixed grasses.....	15.3	5.5	7.4	27.2	42.1	2.5
Timothy, all analyses.....	13.2	4.4	5.9	29.0	45.0	2.5
Timothy, cut in full bloom.....	15.0	4.5	6.0	29.6	41.9	3.0
Timothy, cut soon after bloom.....	14.2	4.4	5.7	28.1	44.6	3.0
Timothy, cut when near ripe.....	14.1	3.9	5.0	31.1	43.7	2.2
Orchard grass.....	9.9	6.0	8.1	32.4	41.0	2.6
Redtop, cut at different stages.....	8.9	5.2	7.9	28.6	47.5	1.9
Redtop, cut in full bloom.....	8.7	4.9	8.0	29.9	46.4	2.1
Kentucky blue grass.....	21.2	6.3	7.8	23.0	37.8	3.9
Kentucky blue grass, cut when seed is in milk.....	24.4	7.0	6.3	24.5	34.2	3.6
Kentucky blue grass, cut when seed is ripe.....	27.8	6.4	5.8	23.8	33.2	3.0
Hungarian grass.....	7.7	6.0	7.5	27.7	49.0	2.1
Meadow fescue.....	20.0	6.8	7.0	25.9	38.4	2.7
Indian rye grass.....	8.5	6.9	7.5	30.5	45.0	1.7
Perennial rye grass.....	14.0	7.9	10.1	25.4	40.5	2.1
Rowen (mixed).....	16.6	6.8	11.6	22.5	39.4	3.1

TABLE I.—PERCENTAGE COMPOSITION OF AGRICULTURAL PRODUCTS (Continued).

Crop.	Water.	Ash.	Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.
HAY FROM GRASSES (Continued):						
Mixed grasses and clovers.....	12.9	5.5	10.1	27.6	41.3	2.6
Barley hay, cut in milk.....	15.0	4.2	8.8	24.7	44.9	2.4
Oat hay, cut in milk.....	15.0	5.2	9.3	29.2	39.0	2.3
Swamp hay.....	11.6	6.7	7.2	26.6	45.9	2.0
Salt marsh hay.....	10.4	7.7	5.5	30.0	44.1	2.4
Wild oat grass.....	14.3	3.8	5.0	25.0	48.8	3.3
Buttercups.....	9.3	5.6	9.9	30.6	41.1	3.5
White daisy.....	10.3	6.6	7.7	30.0	42.0	3.4
Johnson grass.....	10.2	6.1	7.2	28.5	45.9	2.1
FRESH GRASS:						
Pasture grass.....	80.0	2.0	3.5	4.0	9.7	0.09
Kentucky blue grass.....	65.1	2.8	4.1	9.1	17.6	1.3
Timothy, different stages.....	61.6	2.1	3.1	11.8	20.2	1.2
Orchard grass, in bloom.....	73.0	2.0	2.6	8.2	13.3	0.9
Redtop, in bloom.....	65.3	2.3	2.8	11.0	17.7	0.9
Oat fodder.....	62.2	2.5	3.4	11.2	19.3	1.4
Rye fodder.....	76.6	1.8	2.6	11.6	6.8	0.6
Sorghum fodder.....	79.4	1.1	1.3	6.1	11.6	0.5
Barley fodder.....	79.0	1.8	2.7	7.9	8.0	0.6
Hungarian grass.....	71.1	1.7	3.1	9.2	14.2	0.7
Meadow fescue, in bloom.....	69.9	1.8	2.4	10.8	14.3	0.8
Italian rye grass, coming in bloom.	73.2	2.5	3.1	6.8	13.3	1.3
Tall oat grass, in bloom.....	69.5	2.0	2.4	9.4	15.8	0.9
Japanese millet.....	75.0	1.5	2.1	7.8	13.1	0.5
Barnyard millet.....	75.0	1.9	2.4	7.0	13.1	0.6
HAY FROM LEGUMES:						
Red clover.....	15.3	6.2	12.3	24.8	38.1	3.3
Red clover in bloom.....	20.8	6.6	12.4	21.9	33.8	4.5
Red clover, mammoth.....	21.2	6.1	10.7	24.5	33.6	3.9
Alsike clover.....	9.7	8.3	12.8	25.6	40.7	2.9
White clover.....	9.7	8.3	15.7	24.1	39.3	2.9
Crimson clover.....	9.6	8.6	15.2	27.2	36.6	2.8
Japan clover.....	11.0	8.5	13.8	24.0	39.0	3.7
Alfalfa.....	8.4	7.4	14.3	25.0	42.7	2.2
Cowpea.....	10.7	7.5	16.6	20.1	42.2	2.2
Soy bean.....	11.3	7.2	15.4	22.3	38.6	5.2
Pea vine.....	15.0	6.7	13.7	24.7	37.6	2.3
Vetch.....	11.3	7.9	17.0	25.4	36.1	2.3
Serradella.....	9.2	7.2	15.2	21.6	44.2	2.6
Flat pea.....	8.4	7.9	22.9	26.2	31.4	3.2
Peanut vines (no nuts).....	7.6	10.8	10.7	23.6	42.7	4.6
Sainfoin.....	15.0	7.3	14.8	20.4	39.5	3.0
FRESH LEGUMES:						
Red clover, different stages.....	70.8	2.1	4.4	8.1	13.5	1.1
Alsike clover.....	74.8	2.0	3.9	7.4	11.0	0.9
Crimson clover.....	80.9	1.7	3.1	5.2	8.4	0.7
Alfalfa.....	71.8	2.7	4.8	7.4	12.3	1.0
Cowpea.....	83.6	1.7	2.4	4.8	7.1	0.4
Soy bean.....	75.1	2.6	4.0	6.7	10.6	1.0
Serradella.....	79.5	3.2	2.7	5.4	8.6	0.7
Horse bean.....	84.2	1.2	2.8	4.9	6.5	0.4
Flat pea.....	66.7	2.9	8.7	7.9	12.2	1.6

TABLE I.—PERCENTAGE COMPOSITION OF AGRICULTURAL PRODUCTS (Continued.)

Crop.	Water.	Ash.	Protein.	Crude Fiber.	Nitrogen- Free Extract.	Ether Extract.
STRAW:						
Wheat.....	9.6	4.2	3.4	38.1	40.4	1.3
Rye.....	7.1	3.2	3.0	38.9	46.6	1.2
Oat.....	9.2	5.1	4.0	37.0	42.4	2.3
Barley.....	14.2	5.7	3.5	36.0	39.0	1.5
Wheat chaff.....	14.3	9.2	4.5	36.0	34.6	1.4
Oat chaff.....	14.3	10.0	4.0	34.0	36.2	1.5
Buckwheat straw.....	9.9	5.5	5.2	43.0	35.1	1.3
Soy bean.....	10.1	5.8	4.6	40.4	37.4	1.7
Horse bean.....	9.2	8.7	8.8	37.6	34.3	1.4
SILAGE:						
Corn.....	79.1	1.4	1.7	6.0	11.0	0.8
Sorghum.....	76.1	1.1	0.8	6.4	15.3	0.3
Red clover.....	72.0	2.6	4.2	8.4	11.6	1.2
Soy bean.....	74.2	2.8	4.1	9.7	6.9	2.2
Apple pomace.....	85.0	0.6	1.2	3.3	8.8	1.1
Cowpea vine.....	79.3	2.9	2.7	6.0	7.6	1.5
Cow and soy bean vines mixed.....	69.8	4.5	3.8	9.5	11.1	1.3
Field pea vine.....	50.1	3.5	5.9	13.0	26.0	1.6
Barnyard millet and soy bean.....	79.0	2.8	2.8	7.2	7.2	1.0
Corn and soy bean.....	76.0	2.4	2.5	7.2	11.1	0.8
Rye.....	80.8	1.6	2.4	5.8	9.2	0.3
ROOTS AND TUBERS:						
Potato.....	78.9	1.0	2.1	0.6	17.3	0.1
Common beets.....	88.5	1.0	1.5	0.9	8.0	0.1
Sugar beets.....	86.5	0.9	1.8	0.9	9.8	0.1
Mangels.....	90.9	1.1	1.4	0.9	5.5	0.2
Turnip.....	90.5	0.8	1.1	1.2	6.2	0.2
Rutabaga.....	88.6	1.2	1.2	1.3	7.5	0.2
Carrot.....	88.6	1.0	1.1	1.3	7.6	0.4
Parsnip.....	88.3	0.7	1.6	1.0	10.2	0.2
Artichoke.....	79.5	1.0	2.6	0.8	15.9	0.2
Sweet potato.....	71.1	1.0	1.5	1.3	24.7	0.4
MISCELLANEOUS:						
Cabbage.....	90.5	1.4	2.4	1.5	3.9	0.4
Spurry.....	75.7	4.0	2.0	4.9	12.7	0.8
Sugar beet leaves.....	88.0	2.4	2.6	2.2	4.4	0.4
Pumpkin, field.....	90.9	0.5	1.3	1.7	5.2	0.4
Pumpkin, garden.....	80.8	0.9	1.8	1.8	7.9	0.8
Prickly comfrey.....	88.4	2.2	2.4	1.6	5.1	0.3
Rape.....	84.5	2.0	2.3	2.6	5.4	0.5
Acorns, fresh.....	55.3	1.0	2.5	4.4	34.8	1.9
Apples.....	80.8	0.4	0.7	1.2	16.6	0.4
Cow's milk.....	87.2	0.7	3.6	...	4.9	3.7
Cow's colostrum.....	74.6	1.6	17.6	...	2.7	3.6
Mare's milk.....	91.0	0.4	2.1	...	5.3	1.2
Ewe's milk.....	81.3	0.8	6.3	...	4.7	6.8
Goat's milk.....	86.9	0.9	3.7	...	4.4	4.1
Sow's milk.....	80.8	1.1	6.2	...	4.4	7.1
Skim milk, gravity.....	90.4	0.7	3.3	...	4.7	0.9
Skim milk, centrifugal.....	90.6	0.7	3.1	...	5.3	0.3
Buttermilk.....	90.1	0.7	4.0	...	4.0	1.1

TABLE I.—PERCENTAGE COMPOSITION OF AGRICULTURAL PRODUCTS (Continued).

Crop.	Water.	Ash.	Protein.	Crude Fiber.	Nitrogen- Free Extract.	Ether Extract.
<i>MISCELLANEOUS (Continued):</i>						
Whey.....	93.8	0.4	0.6	...	5.1	0.1
Dried blood.....	8.5	4.7	84.4	...	...	2.5
Meat scrap.....	10.7	4.1	71.2	...	0.3	13.7
Dried fish.....	10.8	29.2	48.4	...	...	11.6
Beet pulp.....	89.8	0.6	0.9	2.4	3.3	...
Beet molasses.....	20.8	10.6	9.1	...	59.5	...
Apple pomace.....	76.7	0.5	1.4	3.9	16.2	1.3
Distillery slops.....	93.7	0.2	1.7	0.6	2.8	0.9
Dried sediment from distillery slops.....	5.0	11.3	27.4	3.0	36.1	12.3

TABLE II.—FERTILITY IN FARM PRODUCE.

Produce.	Amount.	Nitrogen. pounds.	Phosphorus. pounds.	Potassium. pounds.
Corn, grain.....	100 bushels....	100	17	19
Corn, stover.....	3 tons.....	48	6	52
Corn crop.....		148	23	71
Oats, grain.....	100 bushels....	66	11	16
Oats, straw.....	2½ tons.....	31	5	52
Oat crop.....		97	16	68
Wheat, grain.....	50 bushels....	71	12	13
Wheat, straw.....	2½ tons.....	25	4	45
Wheat crop.....		96	16	58
Soy beans.....	25 bushels....	80	13	24
Soy bean straw.....	2¼ tons.....	79	8	49
Soy bean crop.....		159	21	73
Timothy hay.....	3 tons.....	72	9	71
Clover seed.....	4 bushels....	7	2	3
Clover hay.....	4 tons.....	160	20	120
Cowpea hay.....	3 tons.....	130	14	98
Alfalfa hay.....	8 tons.....	400	36	192
Cotton, lint.....	1000 pounds..	3	0.4	4
Cotton, seed.....	2000 pounds..	63	11	19
Cotton, stalks.....	4000 pounds..	102	18	59
Cotton crop.....		168	29.4	82
Potatoes.....	300 bushels....	63	13	90
Sugar beets.....	20 tons.....	100	18	157
Apples.....	600 bushels....	47	5	57
Leaves.....	1 tons.....	59	7	47
Wood growth.....	1 tree.....	6	2	5
Total crop.....		112	14	109
Fat cattle.....	1000 pounds..	25	7	1
Fat hogs.....	1000 pounds..	18	3	1
Milk.....	10,000 pounds.	57	7	12
Butter.....	400 pounds....	0.8	0.2	0.1
Rye, grain.....	1470 pounds..	28	12	9
Rye, straw.....	3500 pounds..	12	4	27
Rye crop.....	4970 pounds..	40	16	36
Beets, roots.....	36,800 pounds	88	22	158
Beets, tops.....	9200 pounds..	26	11	69
Beets, crop.....	46,000 pounds	114	33	227
Grass.....	4000 pounds..	53	13	58
Cotton cake, decorticated.....	1000 pounds..	66	31.2	15
Rape cake.....	1000 pounds..	48	24.6	13.2
Linseed cake.....	1000 pounds..	45	19.6	14.7
Cotton cake, undecorticated.....	1000 pounds..	39	22.9	20.1
Linseed.....	1000 pounds..	36	15.4	12.3
Palm kernel meal, English.....	1000 pounds..	25	12.2	5.5
Malt dust.....	1000 pounds..	38	17.2	19.5
Bran.....	1000 pounds..	22	32.3	14.8
Mangels.....	1000 pounds..	1.9	0.7	3.9
Swedes.....	1000 pounds..	2.4	0.6	2.0
Carrots.....	1000 pounds..	1.6	1.0	3.2
Turnips.....	1000 pounds..	1.8	0.6	2.9

TABLE III.—WEIGHT PER BUSHEL, SEEDING RATE PER ACRE, NUMBER OF SEEDS PER POUND AND DEPTH TO COVER FARM SEEDS.

Crop.	Weight per Bushel, pounds.	Rate of Seeding.	Number of Seeds per Pound.	Depth to Cover, inches.
GRASSES.				
Bermuda.....	36	5 pecks.....	180,000	$\frac{1}{4}$ - $\frac{1}{2}$
Canada blue.....	14-20	15 pounds.....	2,583,000	$\frac{1}{4}$ - $\frac{1}{2}$
Creeping bent.....	15-20	.....	8,000,000	$\frac{1}{4}$ - $\frac{1}{2}$
Crested dog's tail.....	26-30	.....	897,000	$\frac{1}{4}$ - $\frac{3}{4}$
Erect brome.....	14-15	4-6 pecks.....	162,000	$\frac{1}{2}$ -1
Fowl meadow.....	12-15	30 pounds.....	.....	$\frac{1}{4}$ - $\frac{1}{2}$
Hard fescue.....	10	.....	578,000	$\frac{1}{4}$
Italian rye.....	17-24	30 pounds.....	275,000	$\frac{1}{4}$ - $\frac{3}{4}$
Johnson.....	28	4-6 pecks.....	.....	$\frac{1}{2}$ -1 $\frac{1}{2}$
Kentucky blue.....	6-28	25 pounds.....	2,637,000	$\frac{1}{4}$ - $\frac{1}{2}$
Meadow fescue.....	12-28	12-15 pounds..	264,000	$\frac{1}{2}$
Meadow foxtail.....	6-14	40 pounds.....	769,000	$\frac{1}{2}$
Orchard.....	12-21	20 pounds.....	457,000	$\frac{1}{4}$
Perennial rye.....	18-30	30 pounds.....	280,000	$\frac{1}{4}$ - $\frac{1}{2}$
Redtop.....	12-40	12-15 pounds..	4,135,000	.....
Reed canary.....	14-48	20-25 pounds..	632,000	.....
Rough stalked meadow.....	12-28	26 pounds.....	2,706,000	$\frac{1}{4}$
Sheep's fescue.....	12-28	30 pounds.....	802,000	$\frac{1}{4}$
Smooth brome.....	12-14	15-20 pounds..	120,000	$\frac{1}{2}$ -1
Sweet vernal.....	6-15	30 pounds.....	837,000	$\frac{1}{2}$
Tall meadow fescue.....	14-25	12-20 pounds..	246,000	$\frac{1}{4}$
Tall meadow oat.....	7-14	30-40 pounds..	151,000	$\frac{1}{2}$ - $\frac{3}{4}$
Timothy.....	44-50	15 pounds.....	1,146,000	$\frac{1}{4}$
Velvet.....	6-7	20 pounds.....	1,268,000	$\frac{1}{4}$ - $\frac{1}{2}$
Yellow oat.....	12-14	30 pounds.....	1,540,000	$\frac{1}{4}$
LEGUMES.				
Alfalfa.....	60-63	15-25 pounds..	210,000	$\frac{1}{2}$ -1 $\frac{1}{2}$
Alsike clover.....	60-66	4-8 pounds....	692,000	$\frac{1}{2}$
Bird's foot trefoil.....	60	11 pounds.....	367,000	$\frac{1}{4}$ - $\frac{1}{2}$
Bur clover.....	60	15 pounds.....	.....	$\frac{1}{2}$ -1
Common vetch.....	60	60 pounds.....	.....	.....
Cowpeas.....	60	4-6 pecks.....	.....	1-2
Crimson clover.....	60	12-15 pounds..	129,000	$\frac{1}{2}$ -1 $\frac{1}{2}$
Field peas.....	52-68	2 $\frac{1}{2}$ -3 $\frac{1}{2}$ bushels	2,400-4,000	1 $\frac{1}{2}$ -3
Garden peas.....	60	3 bushels.....	800-2,400	1-3
Hairy vetch.....	60	40-60 pounds..	75,000	1 $\frac{1}{2}$ -2
Horse bean.....	56	4 bushels.....	.....	.....
Japan clover.....	25	15-25 pounds..	370,000	$\frac{1}{4}$ - $\frac{3}{4}$
Kidney beans.....	60	.....	3,200-4,000	1-2
Kidney vetch.....	60-64	18-22 pounds..	169,000	$\frac{1}{2}$ -1 $\frac{1}{2}$
Red clover.....	60-64	8-14 pounds..	304,000	$\frac{1}{2}$
Soy beans.....	60	2-3 pecks.....	2,000-7,000	1-2
Sweet clover.....	.....	2-4 pecks.....	.....	$\frac{1}{2}$ -1
Velvet beans.....	60	2-6 pecks.....	.....	.....
White clover.....	60-63	3-6 pounds....	739,000	$\frac{1}{4}$
White lupine.....	50-60	1 $\frac{1}{2}$ -2 bushels..	.....	1-2
Yellow trefoil.....	64-66	4-6 pounds....	305,000	$\frac{1}{4}$ - $\frac{1}{2}$
ANNUAL FORAGE CROPS.				
Barnyard millet, Japanese.....	35	1-2 pecks.....	212,000	.....
Broom corn millet.....	60	2-4 pecks.....	212,000	$\frac{1}{2}$ -1 $\frac{1}{2}$

TABLE III.—WEIGHT PER BUSHEL, SEEDING RATE PER ACRE, NUMBER OF SEEDS PER POUND AND DEPTH TO COVER FARM SEEDS (Continued.)

Crop.	Weight per Bushel, pounds.	Rate of Seeding.	Number of Seeds, per pound.	Depth to Cover, inches.		
ANNUAL FORAGE CROPS (Continued).						
Millet, common.....	50	2-3 pecks	212,000	$\frac{1}{4}$ - $\frac{1}{2}$		
Millet, Hungarian.....						
Millet, German.....						
Millet, Golden Wonder.....						
Rape.....	50-60	3-8 pounds	23,000-35,000	$\frac{1}{2}$ -1		
Sainfoin.....	26	40 pounds		$\frac{3}{4}$ -1		
Serradella.....	28-36	40-50 pounds		1-2		
Sorghum.....	56	1 $\frac{1}{2}$ -2 bushels		$\frac{1}{2}$ -1 $\frac{1}{2}$		
Sunflower.....	24-50	10-15 pounds		1 $\frac{1}{2}$ -2 $\frac{1}{2}$		
CEREALS.						
Barley.....	48	7-9 pecks	22,500	1-2 $\frac{1}{2}$		
Buckwheat.....	42-50	3-5 pecks		1-2		
Flax.....	56	2-8 pecks		$\frac{1}{2}$ -1		
Kaffir corn.....	50-60	3-12 quarts		1-2		
Milo.....	50-60	5 quarts		1-2		
Maize, shelled.....	56	5-16 quarts		1 $\frac{1}{2}$ -4		
Maize, on cob.....	70					
Rice.....	43-45	1-3 bushels		1 $\frac{1}{2}$ -3		
Rye.....	56	5-10 pecks		$\frac{3}{4}$ -2		
Spelt.....	40-60			1-3		
Wheat.....	60	5-8 pecks		1-3		
Oats.....	32	8-10 pecks		1-2 $\frac{1}{2}$		
VEGETABLES AND ROOTS.						
Artichokes.....		6-8 bushels		25,000	
Beets.....	50-60*	4-6 pounds	384,000		
Carrots.....	50*	3-4 pounds			$\frac{1}{4}$ - $\frac{3}{4}$	
Mangels.....	50-60*	5-8 pounds			$\frac{1}{2}$ -1	
Parsnip.....	45-50*	4-8 pounds			$\frac{1}{2}$ -1	
Potato.....	60	8-15 bushels			$\frac{5}{8}$ -4	
Turnip.....	55-60*	2-4 pounds			$\frac{1}{2}$ -1	
Rutabaga.....	50-60*	3-5 pounds			$\frac{1}{2}$ -1	
Sugar beets.....	50-60*	15-20 pounds			$\frac{1}{2}$ -1	
Sweet potato.....	50-55	1 $\frac{1}{2}$ -4 bushels			2-4	
FIBER.						
Broom corn.....	30-45	3 pecks			208,000	1-2
Cotton, Sea Island.....	44	1-3 bushels				1 $\frac{1}{2}$ -3
Cotton, upland.....	30					1-2
Hemp.....	44	3 $\frac{1}{2}$ -4 pecks		.....	

* Roots.

TABLE IV.—WATER REQUIREMENTS OF VARIOUS STANDARD CROPS.

Crop.	Location.	Experimenter.	Pounds Water per Pound Dry Matter.		
			Max-imum.	Min-imum.	Mean.*
Wheat.	Germany.	Sorauer.	708	...	708
	Germany.	Hellriegel.	390	328	339
	Germany.	Von Seelhorst.	333	...	333
	India.	Leather.	544	...	544
	Akron, Col.	Briggs and Shantz.	534	468	507
	England.	Lawes.	235	...	235
	Logan, Utah.	Widstoe.	489	427	458
	Davis, Cal.	Fortier and Beckett.	359	286	326
	Bozeman, Mont.	Fortier and Gieseker.	334	226	271
	Reno, Nev.	Fortier and Peterson.	395	309	360
Oats.	Germany.	Wollny.	...	...	665
	Germany.	Sorauer.	...	...	600
	Germany.	Hellriegel.	464	339	401
	India.	Leather.	...	...	469
	Wisconsin.	King.	526	502	514
	Akron, Col.	Briggs and Shantz.	639	598	614
Barley.	England.	Lawes.	262	258	260
	Germany.	Wollny.	...	...	774
	Germany.	Sorauer.	...	...	490
	Germany.	Hellriegel.	366	263	297
	Germany.	Von Seelhorst.	454	295	365
	India.	Leather.	...	...	468
	Wisconsin.	King.	401	375	388
Corn.	Akron, Col.	Briggs and Shantz.	544	527	539
	Germany.	Wollny.	...	...	233
	India.	Leather.	...	...	337
	Wisconsin.	King.	390	305	348
	Akron, Col.	Briggs and Shantz.	420	319	369
Rye.	Germany.	Hellriegel.	438	315	377
	Germany.	Von Seelhorst.	700	343	469
	Akron, Col.	Briggs and Shantz.	...	...	724
Peas.	England.	Lawes.	...	...	235
	Germany.	Wollny.	...	...	416
	Germany.	Hellriegel.	353	231	292
	India.	Leather.	...	...	563
	Wisconsin.	King.	...	...	477
Potatoes.	Akron, Col.	Briggs and Shantz.	...	...	800
	Germany.	Von Seelhorst.	294	268	281
	Wisconsin.	King.	...	...	423
	Akron, Col.	Briggs and Shantz.	...	...	448
Alfalfa, 1 year.	Davis, Cal.	Fortier and Beckett.	1265	1005	1102
Alfalfa, 2 years.			971	522	761
	State College, N. M.		889	757	823
	Akron, Col.	Briggs and Shantz.	...	...	1068
Clover, red.	England.	Lawes.	...	...	251
	Germany.	Hellriegel.	363	297	330
	Wisconsin.	King.	564	398	481
Sugar beets.	Logan, Utah.	Widstoe.	...	...	497
	Akron, Col.	Briggs and Shantz.	...	...	377
Rice.	India.	Leather.	...	...	811

* This column represents the average of all reliable and comparable tests.

TABLE V.—COST PER ACRE, PRODUCING CROPS.*

Crop.	Average Cost.
Barley, fall plowed.....	\$8.21
Clover, cut for seed.....	6.50
Corn, ears husked from standing stalks.....	10.44
Corn, cut, shocked and shredded.....	15.30
Corn, cut, shocked and hauled in from field.....	10.26
Corn, grown thickly and siloed.....	19.89
Flaxseed, threshed from windrow.....	7.50
Flaxseed, stacked from windrow.....	7.85
Flaxseed, bound, shocked, stacked, threshed.....	7.28
Fodder corn, cut and shocked in field.....	9.65
Fodder corn, cut, shocked and stacked.....	12.36
Hay, timothy and clover, first crop.....	5.59
Hay, timothy and clover, two cuttings.....	7.18
Hay, millet.....	7.10
Hay, wild grasses.....	4.04
Hay, timothy.....	3.39
Hemp.....	6.74
Mangels.....	32.68
Oats, fall plowed.....	8.86
Oats, on disked corn stubble.....	8.88
Potatoes, machine production.....	26.37
Potatoes, machine production, use of fertilizer.....	37.72
Timothy, cut for seed.....	4.43
Wheat, fall plowed.....	7.25

*Minnesota Experiment Station, Bulletin No. 117, page 29.

TABLE VI.—AVERAGE FARM PRICES FOR THE UNITED STATES.
FIVE-YEAR PERIODS, 1866-1915.*

Agricultural Region.	Total Annual Cost of Keeping One Horse. Average 5 Years, 1908-12.	Actual Cost per Hour of Work for One Horse. Average 9 Years, 1904-12.
Southeastern Minnesota.....	\$103.27	9.72 cents
Southwestern Minnesota.....	100.64	8.64 cents†
Northwestern Minnesota.....	84.67	8.05 cents

NOTE.—The cost figures shown in this table have been selected from the statistical data of the Division of Farm Management of the Minnesota Agricultural Experiment Station. These figures are not estimates, but actual records from a large number of Minnesota farms. The averages are based on records of about 450 horses in each region. The annual cost includes interest on investment, depreciation, harness depreciation, shoeing, feed, labor and miscellaneous expense. Feed is the largest item in the cost of farm horse power, representing on the average $\frac{3}{5}$ of the total cost. The cost of horse power per hour is computed by dividing the total annual cost by the actual number of hours worked.

* Taken from "Field Management and Crop Rotation," by Parker.

† Seven-year average.

TABLE VII.—WEIGHTS AND MEASURES.

AVOIRDUPOIS WEIGHT.

16 ounces (oz.).....	=1 pound (lb.).
100 pounds.....	=1 hundredweight (cwt.).
20 cwt.....	=1 ton (T.).
1 ton.....	=20 cwt. or 2000 lbs. or 32,000 oz.

DRY MEASURE.

2 pints (pt.).....	=1 quart (qt.).
8 qts.....	=1 peck (pk.).
4 pks.....	=1 bushel (bu.).
1 bu.....	=2150.42 cu. in.

LIQUID MEASURE.

4 gills (gi.).....	=1 pint (pt.).
2 pints.....	=1 quart (qt.).
4 quarts.....	=1 gallon (gal.).
31½ gallons.....	=1 barrel (bbl.).
U. S. gallon.....	=231 cu. in.
7½ gallons water.....	=1 cu. ft. approximately.

LINEAR MEASURE.

12 inches (in.).....	=1 foot (ft.).
3 feet (ft.).....	=1 yard (yd.).
5½ yds. or 16½ ft.....	=1 rod (rd.).
320 rds.....	=1 mile (mi.).
1 mile or 320 rds. or 1760 yds. or 5280 ft or 63,360 ins.	

SQUARE MEASURE.

144 square inches (sq. in.).....	=1 square foot (sq. ft.).
9 square feet (sq. ft.).....	=1 square yard (sq. yd.).
30¼ sq. yds.....	=1 square rod (sq. rd.).
160 sq. rds.....	=1 acre (a.).
640 acres.....	=1 square mile (sq. mi.).
1 sq. mi.....	=1 section.
36 sections.....	=1 township (twp.)
43,560 sq. ft.....	=1 acre.

SOLID OR CUBIC MEASURE.

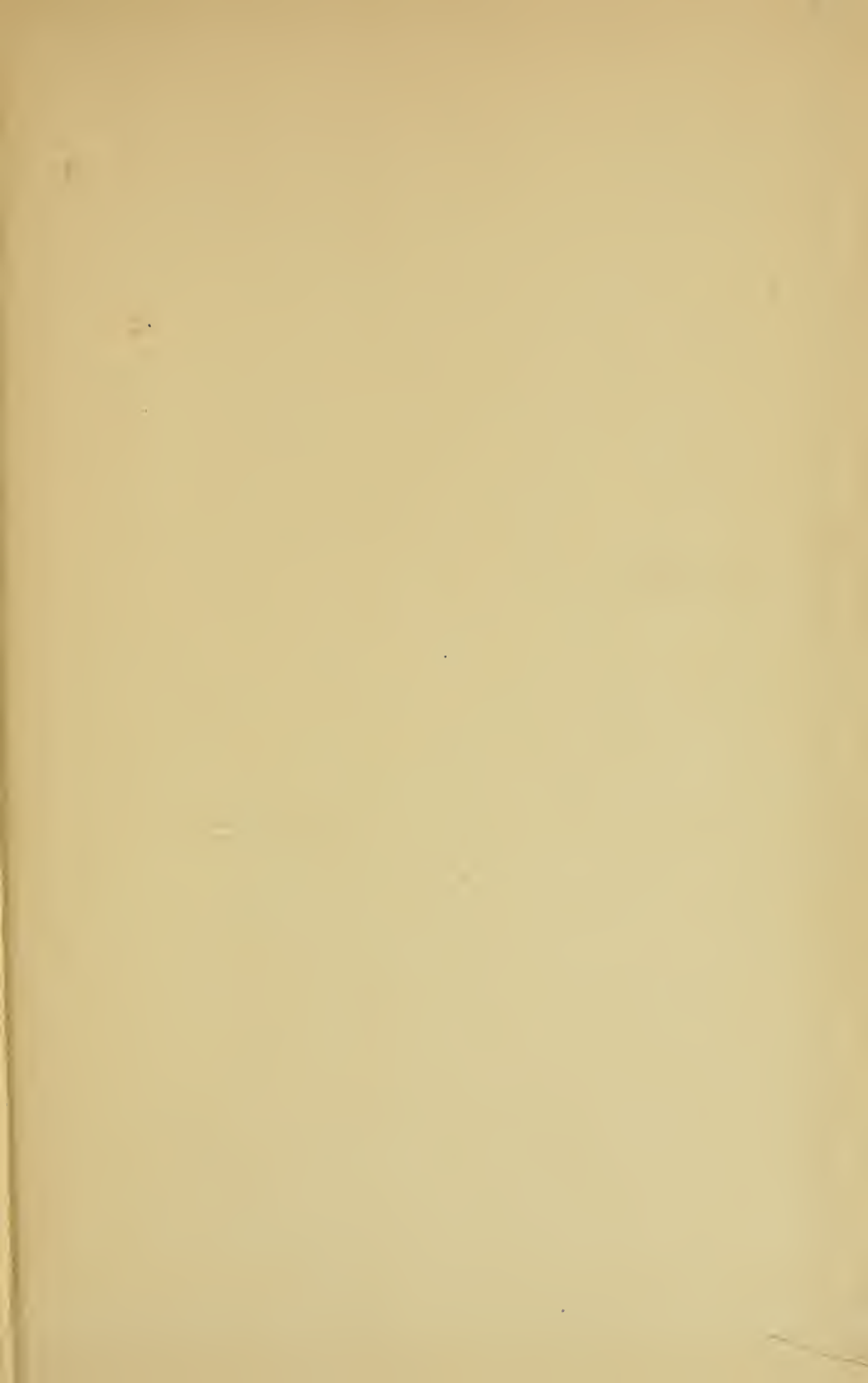
1728 cubic inches (cu. in.).....	=1 cubic foot (cu. ft.).
27 cu. ft.....	=1 cubic yard (cu. yd.).
1 cu. yd.....	=27 cu. ft. or 46,656 cu. in.
1 cu. yd.....	=1 load.
24¾ cu. ft.....	=1 perch.
128 cu. ft. or 8 ft. × 4 ft. × 4 ft.....	=1 cord.
1 ft. x 12 in. x 1 in.....	=1 board foot.

SURVEYOR'S LINEAR MEASURE.

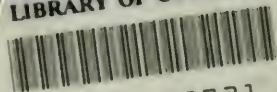
7.92 inches.....	=1 link.
100 links.....	=1 chain.
80 chains.....	=1 mile.
Gunter's chain is the unit and is 66 feet long.	

SURVEYOR'S SQUARE MEASURE.

10,000 sq. links.....	=1 square chain.
10 sq. chains.....	=1 acre.
10 chains square.....	=10 acres.



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