U. S. DEPARTMENT OF AGRICULTURE.

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ONION CULTURE.

BY

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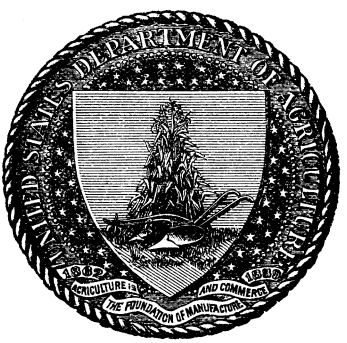

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U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., March 31, 1896.

SIR: I have the honor to transmit herewith, and to recommend for publication as a Farmers' Bulletin of this Department, an article on onion culture by R. L. Watts, instructor in horticulture at the University of Tennessee and horticulturist of the Tennessee Agricultural Experiment Station. This article is based upon the work of the various agricultural experiment stations and upon the experience of extensive and successful onion growers in all parts of the United States, and gives a concise summary of information regarding the methods of cul ture of this important crop.

Respectfully,

A. C. TRUE,
Director.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

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INTRODUCTION.

There are few vegetable crops of more importance to the rural population of the United States than the onion crop. The relatively large profits which it is possible for the skillful grower to obtain from a limited area have rendered the cultivation of this bulb especially popular with those possessing small tracts of land, while gardeners residing in localities whose soils and climate are preeminently adapted to onion culture have found it profitable to till large areas. Twenty-five to 100 acres in one field is not an unusual thing in such localities. Large yields overstock the market some years, resulting in very low prices; but the prices received during a series of years make onion culture, as a rule, a profitable enterprise where the soil and climatic conditions are favorable.

Notwithstanding the extensive production of onions in the United States, hundreds of thousands of bushels are annually shipped to our ports from Bermuda, France, Spain, and Cuba. This fact demonstrates that the home demand at all seasons of the year is not yet fully supplied by growers of our own country. The bulbs of foreign varieties are superior in quality to those originated in this country—such as the Yellow Danvers, Red Wethersfield, and Silver Skin. The imported bulbs are also placed on the market before the gardeners in the North can mature their crops, but the long season of California and certain parts of the South renders it possible for these sections to cultivate successfully the foreign varieties and mature the onions almost, if not quite, as early as the countries named.

SELECTION OF SOIL.

A judicious selection of soil is of the greatest importance. The profit or loss of the business depends largely upon whether the soil contains a combination of conditions especially conducive to the proper development of the plant, or such as will enfeeble it in every stage of growth. The mechanical condition of the soil should first be considered. Heavy clay lands should be avoided, because they are difficult to plow and cultivate, usually deficient in organic matter, and often improperly drained. It is impossible to prepare them for the seed or plants as early in the spring as is desirable; and the surface bakes and cracks

after the rain, unless stirred just at the proper time; besides, the plants will not bottom freely or ripen properly in heavy soils, and tend to produce scallions. Lands in which sand largely predominates should not be selected because of their incapacity to resist drought and to retain the fertilizers applied. Gravelly soils are objectionable for the same reasons. The gravel also, if very large, forms an impediment to the wheel hoe and hand weeder. Very stony soils can never be profitably used for onions.

Soils abounding in decomposed vegetable matter are generally most valuable for the cultivation of onions. It is on such soils that the largest plantations are found. An Ohio firm annually tills about 400 acres of black muck. A gardener in Santa Clara County, Cal., states that in his section great quantities of onions are grown on black adobe, some on deep sandy loam, and some on reclaimed tule land, which is much like pulverized bog or peat. This last-named soil has never been fertilized and continues to produce well, although it will probably need enriching in the course of time. Similar soils have been used largely in New York, Michigan, Connecticut, and other States. They are valuable because of their loose mechanical condition, abundance of plant food, and ability to retain an abundant supply of moisture.

Most farmers, however, who contemplate engaging in the production of onions own their land and do not desire to sell and locate where soil is, perhaps, more favorable to the growth of this crop. Under such circumstances if rich, deep, friable loam can be found on the farm, it should be selected for onions. A fair amount of sand is an advantage if the soil is sufficiently retentive to resist drought and to hold the fertilizers applied. Clayey soils, if not too tenacious, may be used with satisfactory results, provided the proper attention is given to cultivation.

Many soils which are not properly drained might prove valuable for onion culture if a few lines of tile were laid to carry off the surplus water. Hilly locations should not be selected, because of their tendency to wash, thus exposing some bulbs and burying others. Soils which have been heavily cropped for a series of years with very light applications of manures can not be profitably cultivated in onions without first restoring the supply of plant food which has become exhausted. Poor soil will not produce good onions, and it requires several years to bring such soil into condition for the successful culture of this crop.

Fields which have been overrun with weeds should be cultivated in hoed crops for a series of years to destroy the seeds which would otherwise germinate and greatly increase the cost of cultivating and weeding the onions.

The onion may, by liberal fertilizing, be grown on the same ground year after year with increasing yields. Continuous culture, however, should not be followed in localities where diseases and insects are prevalent. In such cases a strict rotation should be followed.

Soils which afford natural advantages for irrigation should not be overlooked. In seasons when the rainfall is not sufficient to supply necessary moisture for the growing crop irrigation will prove highly beneficial. The light soils of many creek and river bottoms, which are rich in organic matter, might be irrigated at a small cost by means of dams and ditches, or, in some cases, by pumps operated by windmills, water wheels, or engines.

PREPARATION OF THE SOIL BY PREVIOUS CROPPING.

Soils which are stiff and heavy, which contain too much sand, which abound in pernicious weeds, or are deficient in fertility may be greatly improved by the cultivation of one or more crops previous to planting onions. A favorite practice in some sections is to sow clover, and after the first crop is cut for hay the second growth is allowed to rot on the field and with a heavy dressing of stable manure is plowed under in the fall. The following spring the ground is planted in potatoes and the next year onions are grown. Such a course of treatment leaves the soil in excellent condition. The land is improved by the application of manure and the decomposition of the clover roots and tops, while the nitrogen supply is increased both by means of the clover, which gathers this element from the atmosphere, and by the manure. The effect of such treatment is to enrich the soil, make it loose and friable, and free it from many weed seeds. Crimson clover could be used to advantage in States where this legume thrives, since, when plowed under, it produces the same effect as red clover.

Cowpeas are used as a substitute for clover in the South. The peas may be sown in July or August, after a crop of early potatoes has been removed. The dead tops are plowed under later in the fall, with a liberal dressing of barnyard manure. If either cowpeas or clover is used, and followed the next year by some hoed crop which does not impoverish the soil to any considerable extent, the land is put in the best condition for raising onions. Carrots are said to be the most desirable crop to precede onions. Corn and potatoes, however, are not objectionable. Of course, more plant food should be applied than these crops remove, so that the soil will be constantly improved.

FERTILIZING.

The onion requires a liberal amount of plant food in the most available form. The quantity and quality of manures which would make potatoes, cabbages, tomatoes, or many other garden crops profitable will not give even a fair compensation in onion culture, unless favored by soils highly fertile in their natural state. Beginners fail more frequently perhaps from lack of appreciation of this fact than from any other cause. The most expensive item in onion culture is labor. A prominent grower estimates that it costs $100 per acre to start the seedlings, prepare the soil, transplant, cultivate, weed, and pull the crop

when the "new onion culture" (see p. 17) is adopted. The cost of labor is just as great for a crop of 500 bushels as for 1,000. Hence it is judicious for the onion grower to be liberal in the use of fertilizers. If the supply of fertilizer is limited it will pay better to manure one acre thoroughly than two sparingly.

Barnyard manure is indispensable in the production of superior bulbs unless the soil naturally contains a large amount of humus (decomposed vegetable matter). Muck soils, such as are referred to on a previous page, may be properly treated with concentrated commercial fertilizers alone, but nothing can be entirely substituted for barnyard manure on other soils with as satisfactory results. Hen manure is very highly esteemed by onion growers because of its high percentage of fertilizing constituents. Next to this manure, that from the pigsty is considered most valuable, although rotten barnyard manure of any kind gives good results. It is customary to deposit the manure in large piles where it can undergo fermentation, or to compost it with other materials. From 40 to 75 loads per acre should be applied if a large yield is expected. It should be spread evenly over the surface just before plowing in the fall or early spring, a manure spreader being valuable for this purpose.

Hen manure will produce the best results when applied as a top-dressing before planting. Poultry droppings should be dried and pulverized before broadcasting. Specially prepared composts should also be spread after plowing and thoroughly mixed with the surface soil by harrowing. A common practice near large cities is to secure night soil and compost it with barnyard manure, muck, or loam. This makes a valuable top-dressing. Care should be exercised that all the manures used are free from weed seeds.

We may learn something on the question of fertilizing by studying the composition of the onion. An analysis made by the Connecticut Experiment Station of White Globe onions showed that 2,000 pounds of mature bulbs contain 2.70 pounds of nitrogen, 0.92 pound of phosphoric acid, and 2.09 pounds of potash. The average legal weight per bushel in different parts of the Union is about 56 pounds. A yield of 800 bushels per acre is frequently reported. A crop of this size (44,800 pounds) therefore, would remove from an acre of soil 60.48 pounds of nitrogen, 20.61 pounds of phosphoric acid, and 46.82 pounds of potash.

This shows that the onion removes the three essential fertilizing constituents from the soil in large quantities, and these must be supplied to the soil if it does not already contain them. Soils which have been freely cropped with clover, cowpeas, or other leguminous plants are not likely to be deficient in nitrogen, although light dressings of the quick-acting nitrate of soda may often be profitable on such soils. Potash and phosphoric acid, however, must usually be applied more liberally. Sometimes one and sometimes the other of the three princi-

pal fertilizing constituents—nitrogen, phosphoric acid, and potash—is deficient in the soil. It is important for each grower to study the special requirements of his soil. A few experiments with concentrated fertilizers will settle many doubtful points. It is impossible to supply the needed fertilizers in the proper proportions without first acquiring a fair knowledge of the fertilizing constituents already in the soil.

Of the nitrogenous commercial fertilizers, nitrate of soda is the most largely used. It contains about 15 per cent of nitrogen. This salt is readily soluble and exceedingly quick in its action. It should never be applied in the fall or winter, because a large amount of the nitrogen would be washed out of the soil before the growing crop required it. From 200 to 400 pounds applied in four equal dressings is sufficient in most cases. The first application should be made just before seeding or planting and mixed with the surface soil by harrowing. The other dressings may be given at intervals during the growing season, carefully broadcasting the salt. Ammonium sulphate, dried blood, and wool refuse, which are also nitrogenous fertilizers, are occasionally substituted for sodium nitrate, and soot is sometimes used with advantage.

To supply the potash, wood ashes are frequently employed. They have the additional advantage of improving the mechanical condition of the soil, making it loose and friable. Either leached or unleached ashes may be used with satisfactory results, the latter being more valuable on account of their larger content of potash—5 to 10 per cent. From 6 to 8 tons of unleached or 10 to 14 of leached ashes is a liberal supply. Ashes should be drilled or harrowed in after plowing. If ashes are not available, or if the expense of transportation is excessive, the grower will find potash salts, such as kainit and muriate of potash, valuable fertilizers. They are applied in the fall, winter, or early spring. The soil will retain the potash until the plants require it, so that the loss by drainage is exceedingly small. Kainit contains 13 to 14 per cent of potash, and the muriate about 50 per cent. About 200 to 300 pounds per acre of the muriate or 800 to 1,000 pounds of kainit is a sufficient application. They should be sown broadcast after plowing, and harrowed in or distributed by means of a fertilizer drill. A few hundred pounds of bone meal or other phosphates will be beneficial, if phosphoric acid is needed.

The manures applied are never completely taken up by the growing crop. This makes it necessary to supply more than is actually needed. In the cases of the potash and phosphoric acid, for which the soil has a strong retentive power, the excess will remain to benefit succeeding crops.

Other manures may be used with profit in certain parts of the country. Specially prepared fertilizers are largely employed by many extensive and highly successful growers.

PLOWING, HARROWING, AND ROLLING.

Fall plowing is preferable in most parts of the country, but it should be deferred as late as possible. Any manure which has been previously applied should be short enough to allow the plow to turn it entirely under the surface. The character of the soil will determine the proper depth for plowing. If the land is rich, loose, and friable to the depth of 10 or more inches, there is little danger of plowing too deep. It is never desirable to turn up a stiff heavy subsoil in preparing ground for onions, for this invariably diminishes the yield, renders cultivation more difficult, and requires more frequent tilling. Fall plowing is especially desirable with new soils, pastures, and clover sods. It hastens the decay of vegetable matter, and the alternate freezing and thawing of winter and early spring thoroughly pulverize the soil. The ground also can usually be worked sooner in the spring, which is a great desideratum in sections where it is important to sow the seed or set the bulbs at the earliest possible date.

No labor necessary to put the soil in a thoroughly fine condition should be spared. A disk harrow is almost indispensable if clods and lumps are numerous. The roller and this implement may be used alternately with advantage. A disk harrow which contains a large number of small disks is excellent to follow one with larger disks, but the ordinary smoothing harrows will answer the purpose on many soils. After thorough harrowing a plank drag should be employed to level the surface and make it smooth for planting. With the many improved cultivating implements at the gardener's command it is not necessary to use the rake on plats larger than the kitchen garden.

THE SEED.

It is impossible to secure satisfactory results without seed of superior quality. Growers sometimes make the mistake of purchasing seed of uncertain vitality because it is cheap. The cost of seed is a small item compared with the other expenditures necessary for a profitable crop, and an attempt to reduce the cost of production by purchasing inferior seed is always injudicious.

Several methods are employed to determine the vitality of onion seed. Actual planting in the hotbed or greenhouse is frequently employed. Another plan is to place a few seeds on a woolen cloth or moist cotton and to note the number germinating.

Although these methods will answer the purpose, the most reliable results are obtained by the use of some of the devices commonly used in testing seeds, such as the Geneva tester. Of course any preliminary test can only approximate the truth. The cold, moist condition of the field may cause a much smaller percentage of germination than the test shows. Previous to purchasing, however, it is advisable to secure sample packages of the varieties desired from a half dozen or more reliable dealers and carefully test the seeds. The results will at least indicate the firm from which it is safest to purchase.

VARIETIES.

Varieties which are grown successfully in this country are divided into two classes, namely, American and foreign types, the latter frequently called Italian or Spanish sorts. As American varieties keep longer and are better adapted to most States than those of foreign origin, they are extensively cultivated.

Varieties should be selected which contain the greatest number of desirable characteristics or command the highest prices in the market for which the crop is to be grown. The best type for general purposes is a bulb of considerable size, as nearly globular in form as possible, hard and compact in structure, mild and sweet in flavor, with close, thin, and fine skin and small neck. It should also be bright and handsome in appearance, productive, and of superior keeping quality. Few, if any, varieties combine all the above-named qualities as fully as is desirable. None of the American sorts are as delicate in flavor as many well-known varieties of foreign onions, but the Italian and Spanish onions are inferior in keeping quality and rarely mature from seed sown in the open ground in the Northern States.

It is important for each grower to carefully study the many varieties in cultivation, investigate the market to be supplied, and then make an intelligent selection of those sorts which it is thought will yield the greatest return under existing conditions.

DESCRIPTION OF AMERICAN VARIETIES.

Danvers (Danvers Yellow, Round Yellow Danvers, Yellow Globe Danvers).—The most largely grown of the yellow onions, being produced in immense quantities for shipping purposes. It is very productive, giving much larger yields than varieties which form flat bulbs. Four hundred to 600 bushels per acre from seed sown in the field is a very common yield, while 800 to 1,000 bushels are sometimes harvested. The bulbs are very solid, large when given the proper attention, compact, and of excellent flavor. This variety commands higher prices than red onions in most markets.

Extra Early Red.—On account of its earliness in maturing, this variety is valuable in many sections. The bulbs are rather small, flat in shape, and good keepers. It is especially well adapted to cold, mucky soils, and is largely used in the production of sets.

Egyptian (Winter Onion, Perennial, or Tree Onion).—An unusually hardy variety in the colder States, remaining in the ground with safety all winter. It starts early in the spring and may be bunched and marketed several weeks before any other variety. The quality is inferior, but the bulbs may be readily sold when better varieties are wanting.

Red Globe and Yellow Globe (Southport).—These varieties closely resemble the White Globe, except in color.

Potato Onion (Yellow and White Multiplier).—The potato onion is

most largely grown in Southern localities. The yellow variety has been in cultivation for many years, while the white sort is of much more recent introduction. The bulbs are thick, compact, tender if eaten soon after pulling, and very mild and sweet in flavor. Fall planting is generally resorted to with this variety, the sets being placed in drills 4 or 5 inches deep. As the name "Multiplier" indicates, if a large bulb is planted, division occurs during the season of growth, resulting in the formation of from 3 to 10 or more bulbs from the parent. If sets are planted, they will make single large onions, but not multiply. The plants begin active growth very early in the spring, and may be bunched and marketed at a good profit, or may be allowed to mature. In the milder sections of the South the potato onion will grow during the entire winter. The mature bulbs should be stored in thin layers in a dry apartment to insure their keeping. This variety is rarely, if ever, affected by the onion maggot. From the fact that the small bulbs increase in size and the large ones multiply, it is necessary to plant both sizes in order to secure onions for market and also maintain the stock.

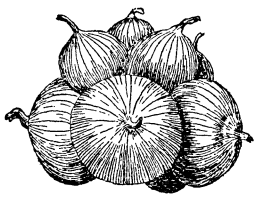

FIG. 1.—Potato onion sets.

Shallots.—Shallots are frequently mistaken for the potato onion. They differ from it in throwing up an occasional seed shoot and in the bulb always multiplying, which is not true with small potato onions. The bulbs are more oblong in shape than the potato onion. Shallots are small, may be kept the year round, and possess a mild, pleasant flavor.

Silver Skin (White Portugal, Philadelphia White).—A variety largely used in the production of the white sets sold by seedsmen. The bulbs are handsome, medium sized, and of excellent flavor. It commands higher prices than the red or yellow sorts, but is not so productive nor so easily wintered unless thoroughly cured. The smaller bulbs are popular for pickling.

Wethersfield (Wethersfield Red, Large Red Wethersfield).—The most extensively grown red sort. It rivals the Yellow Danvers in many portions of the country. Some markets prefer it to that variety. The bulbs are large, growing to 6 to 8 inches in diameter in especially favorable localities. It is very productive and a good keeper. The bulbs are somewhat flattened in form; in this respect being inferior to the Yellow Danvers. The skin is deep purplish-red, the flesh purplish-white, rather coarse and of stronger flavor than that of the yellow onions. (See fig. 3, p. 18.)

White Globe (Southport White Globe).—The perfect globe shape and smooth white skin make this one of the handsomest onions. It always commands good prices, but requires more care in cultivating, harvesting, and storing than the red and yellow sorts. The flesh is fine in grain, pure white, and of superior flavor. The bulbs are large and yield well when given careful attention. This sort should be grown in

every family garden in preference to any other large white American onion.

Yellow Strasburg (Yellow Dutch).—A productive variety, the bulbs being slightly darker in color than Yellow Danvers; of good size, quite flat, with a white and mild flesh. Yellow Danvers is preferred to the Strasburg by most growers.

DESCRIPTION OF FOREIGN VARIETIES.

Barletta.—The bulbs of this variety are pure white, measuring from 1 inch to 1½ inches in diameter, and about three-fourths of an inch in thickness. It is very early; said to mature a week or two earlier than the New Queen. The bulbs are smooth, uniform, and handsome in appearance, which makes them especially valuable for pickling. For this purpose no other variety is better adapted. The flesh possesses a mild, delicate flavor. To secure the best results the seed should be sown in loose, rich, friable soil.

Bermuda (Red Mammoth Tripoli, Bermuda Red).—The bulbs of this variety are large, fine grained, and of excellent flavor. The skin is thin and rich, and of a blood-red color. The flesh is white. It is largely imported into this country.

Early Pearl (Silver White Ætna, American Pearl).—An Italian variety which matures very early. The round, flattened bulbs are pure white, and possess a mild, pleasant flavor. It is excellent for sets or pickling, and is highly esteemed by some market gardeners.

Giant Rocca (Rocca of Naples).—This is a very large onion that is well adapted to the transplanting method of culture in the South. It requires a long season to mature the bulbs. Its flavor is mild and very pleasant. The bulbs are globular in shape, with a light, reddish-brown skin. It is very productive when transplanted or where the season is of sufficient duration.

Giant Red Rocca.—This variety differs very slightly from the preceding, except that it is darker in color.

Giant White Rocca (Silver Ball).—One of the most valuable sorts of the Italian type. The bulbs are very large, white, globular, compact, and the flesh is white, with a mild, pleasant flavor. An excellent variety for either home consumption or market when the transplanting method is adopted.

Giant Yellow Rocca (Spanish King).—Resembles the Giant Red in every particular except color, which is a bright yellow. This variety may be transplanted with very satisfactory results.

Mammoth Pompeii.—This is one of the largest of the foreign varieties, bulbs weighing over 4 pounds having been grown in this country. It does not appear to lose in quality when grown to such an enormous size. It should be grown by the transplanting method. The bulbs are red, with thin skins. The flavor, as is usual with the foreign sorts, is very mild and pleasant.

Marzajola (Italian May).—A small, early, flat onion. The bulbs are white and of superior quality.

Giant White Garganus.—Differs very slightly from the Mammoth Pompeii, except that it is white. A valuable sort for the South.

New Queen (Pearl, Early White Queen).—This variety is quite generally known in the South as the Pearl onion, but "New Queen" is the preferable name. It is one of the most valuable sorts for growing pickling onions from seed, although the Barletta is considered superior by many gardeners. The bulbs are pure white and can scarcely be excelled in flavor. Seeds may be sown in February where the season is sufficiently early, and mature bulbs will be produced by June. If sown in July or August another crop will be ready to harvest late in fall. The onions measure from 1 to 2 inches in diameter and generally command high prices.

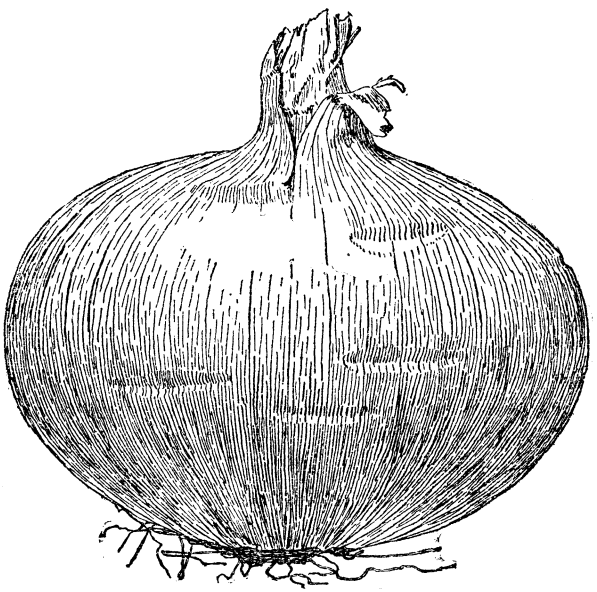

FIG. 2.—Prize-taker onion. (Diameter reduced about one-fourth.)

Prize-taker.—Burpee gives the history of this variety as follows: "In the winter of 1887 a shipment of the fine, large, straw-colored onions from Spain was received in San Francisco. As the price was too high to command ready sale on the markets, a large proportion was bought in the early spring by a California seed grower. Setting these large bulbs out for seed, the seed was first offered in 1888, under the name of Prize-taker." This variety is a favorite with all growers who follow the transplanting method. It gives more general satisfaction than any other variety in the production of bulbs from seed sown under glass, the young plants being transferred to the open ground. American-grown seed is greatly preferred. The Prize-taker is uniform and globular in form, and very large, some specimens weighing from 4 to 6 pounds having been grown in this country under special cultivation, while from 1 to 3 pounds are very common weights. It ripens well, and, if properly cured, may be kept through the winter, although it is considered a poor keeper. The bulbs are bright yellow, with a thin skin. The flesh is white, fine grained, mild, with a delicate flavor.

Red Victoria.—A large, handsome, globular-shaped onion. Skin very

dark red; flesh white or very light rose-colored; mild, pleasant. A heavy, rich loam is best adapted to this variety.

Silver King (Mammoth Silver King).—A very large, white Italian variety. Bulbs are flattened; flesh white, with a mild, sweet flavor.

White Italian Tripoli (El Paso, Large Mexican).—The Texas Experiment Station reports that out of 58 varieties grown in 1895 from seeds sown in the open ground this variety gave the largest yield. It is very large size, flat in form, with a white skin.

White Victoria.—The White Victoria is considered the most valuable of the White Italian onions for transplanting. The bulbs are very large, globular, and handsome. Wherever tested it is most highly esteemed. It produces heavy crops when the proper treatment is given.

GROWING ONIONS FROM SETS.

As regards methods of propagation, onions may be divided into two classes: (1) Those produced from sets, and (2) those produced from seed. In the first class belong the button, or top, onions, which are propagated by planting the little bulbs which form on the top of the stems in place of the seeds, and the potato onions already described, which are propagated from the sets produced by the division of the parent bulb.

The first method is employed by thousands of farmers and by many market gardeners who make a business of growing bunching onions. These sets, either red, white, or yellow, are usually purchased from seedsmen at prices varying greatly in different seasons. The size of the sets also regulates the price to a considerable extent. They can usually be bought for $3 or $4 per bushel, and it requires from 6 to 10 bushels to set an acre. If it is desired to mature the bulbs, the sets should be planted at the earliest date possible. Some growers prefer fall planting where the climate is not too severe. If this plan is adopted the sets should be planted early enough to allow them to become firmly rooted before the ground freezes.

Soil which is quite constant in the supply of moisture is best adapted to the production of mature bulbs from sets. Fertilizers should be used freely, and the soil thoroughly pulverized and rolled. The rows should be 12 or 13 inches apart, and the sets about 3 inches apart in the rows. The use of this method in growing mature bulbs in large quantities is not to be recommended. Better results can be obtained by sowing in the open ground or under glass and transplanting the seedlings.

In propagating from seed two methods are practiced: (1) Sowing the seed in the open field without transplanting, and (2) sowing the seed out of doors in the fall and transplanting to the permanent plantation the following spring, or sowing under glass in January, February, or March (depending upon the latitude) and transplanting to the field as early as the season will permit.

GROWING ONIONS FROM SEED SOWN IN THE FIELD.

The great bulk of onions produced in the United States is grown from seed sown in the open ground. If the soil is very fertile and especially well adapted to onion culture, very large yields may be secured by this method. An Ohio grower reports that he secured an average yield of over 800 bushels per acre in 1895, while some acres produced more than 1,000 bushels.

The American sort, such as Yellow Danvers, Red Wethersfield, White Globe, and many other varieties are almost exclusively grown by this method in the North. American onions, and also those of foreign origin, are produced from seed sown in the field in California and many of the Southern States. The summer season of California and of the South is of sufficient duration to allow the foreign varieties to mature, but it is important to select soils which rarely suffer from drought in these warmer localities or the bulbs will ripen before they have attained the proper size. Oemler, near Savannah, Ga., reports having raised the Giant Rocca at the rate of 1,050 bushels per acre.

Earliness in sowing is of the greatest importance, especially in the South, where the bulbs should attain the largest possible size before the advent of very hot weather. The soil should be harrowed and rendered fit for sowing the first day that it is dry enough to use implements.

The seed may be sown by hand or with a garden drill. If the soil is in the proper condition, about 4 pounds of seed should be used to the acre, which will require 12 to 14 seeds per foot.

Foreign-grown seed does not germinate so readily as American seed; hence a larger quantity should be used in order to secure a full stand. One-half to three-fourths of an inch is the proper depth to sow in most soils, although an inch is not too deep if the ground is sandy or very loose. Cultivating and weeding is more easily accomplished when deep sowing is practiced, but part of the soil must be drawn away from the bulbs when they begin to bottom, unless the ground is so light that it will not prevent the proper development of the onions.

The drills should be made from 12 to 14 inches apart. If a garden drill is used, which is always economy on large plantations, a trial should first be made on a clean floor to regulate the quantity of seed dropped. A marker attachment to the drill is valuable in marking straight rows. This is an important matter, for straight rows, with a uniform distance between them, greatly add to the attraction of the field and facilitates the use of the wheel hoe. A line may be stretched as a guide by which to drill the first row. If the spaces become irregular as the operation proceeds the rows should be straightened from time to time by means of the line.

TRANSPLANTING.

Transplanting consists simply in sowing the seed under glass early in the season (or in the open ground in the fall) and transferring the young

plants to the field. Market gardeners have known for many years that the onion may be readily transplanted, and have taken advantage of this fact in filling vacancies. Exhibition specimens have long been grown by this method both in England and America, and James J. H. Gregory reports having seen the plan followed in northern Mexico in 1882, but the inference is that the seed was there sown in the open ground in the early spring and then transferred to the permanent plantation. The practice was brought to general public notice early in 1890, through an article written by T. Greiner, of Lasalle, N. Y., and published in How the Garden Pays. W. J. Green, horticulturist of the Ohio Agricultural Experiment Station, working independently, arrived at the same conclusions at about the same date. Both writers strongly advocated the system which they had thoroughly tested, and under the name of The New Onion Culture it has become generally known and extensively practiced throughout the United States.[1]

Experiments have demonstrated that the transplanting system has many advantages, the most important of which is, perhaps, the increase in yield. This increase is due to several causes. The plants receive a good start under glass before they are set in the field, and thus have the full advantage of the cool spring weather, which is most favorable to rapid growth; when sown in the field a month or more is consumed before the plants are fairly started. This is a very important consideration in the South, where the hot, dry weather may arrive very soon. Transplanting, if properly performed, always secures a full stand, which is uncertain where the seed is sown in the open ground. Pulling the plants results in more or less root pruning, and this doubtless exerts some beneficial influence on the yield.

Experiments at many agricultural experiment stations show how material is the increased yield. At the Ohio station 10 selected transplanted Prize-taker bulbs weighed 8 pounds and 4 ounces; the same number of bulbs, not transplanted, 4 pounds and 4 ounces. Pompeii, transplanted, 7 pounds and 6 ounces; not transplanted, 4 pounds and 1 ounce. White Victoria, transplanted, 8 pounds and 6 ounces; not transplanted, 3 pounds and 7 ounces. Yellow Danvers, transplanted, 5 pounds; not transplanted, 2 pounds and 6 ounces. Transplanting gave a decided increase with each of the 14 varieties tried, amounting to 100 per cent in some cases.

At the Michigan station transplanted Prize-taker onions gave a yield of 548 bushels per acre, while bulbs not transplanted yielded only 216 bushels. Southport, transplanted, 296 bushels per acre; not transplanted, 172. Giant Rocca, transplanted, 556; not transplanted, 110. Experiments at the Rhode Island station gave a decided increase

[1]The method is described by T. Greiner in his books entitled "The New Onion Culture" and "Onions for Profit," and by W. J. Green in Ohio Station Bul., Vol. III, No. 9, 2d ser. (Experiment Station Record, vol. 3, p. 605).

with Yellow Danvers, Red Wethersfield, and White Portugal. Red Wethersfield onions transplanted at the Tennessee station yielded 823 bushels per acre, while those not transplanted produced at the rate of 206 bushels. North Dakota station reports experiments with several varieties, including Yellow Danvers, in which transplanted onions gave an increase from four to five times as great as those not transplanted. This enormous increase in North Dakota is due to the abundance of rain during the early spring.

Earliness in maturing is no less an advantage in many sections than the increased production. By transplanting, the large Spanish varieties, which are especially well adapted to this method, may be grown to perfection in the North, where the season is not long enough to raise large bulbs from seed sown in the open ground. It is not at all difficult in New York, for example, to mature Prize-taker onions by August, at which time the bulbs usually command good prices. This point is equally important for Southern growers. In sections of the South where the conditions are favorable the bulbs can be easily matured by June, at which time small quantities bring remunerative prices, both on the home and on Northern markets.

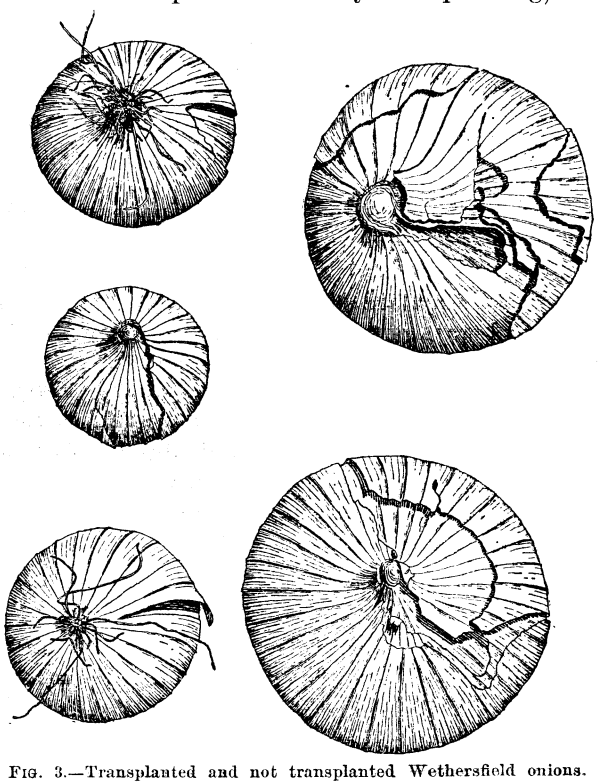

FIG. 3.—Transplanted and not transplanted Wethersfield onions. (Diameter reduced about one-third.)

When the transplanting method is followed the bulbs are always uniform in size. This is a great advantage, resulting in better prices and entirely eliminating the small-sized picklers.

The seed should be sown at least six weeks previous to the date on which the soil will probably be dry enough to prepare for setting the plants. Either hotbeds or greenhouses may be employed in growing the plants. The latter is more convenient, but just as good plants may be raised in hotbeds. If a greenhouse is used the ventilating appa-

ratus should be so arranged that the plants can be hardened just as thoroughly as when grown in hotbeds. Cold frames will answer the purpose in many parts of the South. The soil for growing the plants should be rich, loose, sandy loam, entirely free from stones, etc. If necessary, run it through a sieve. One and one-fourth ounces of seed are sufficient to sow under a 3 by 6 foot sash, placing the seed in drills 1 inch deep and 3 inches apart. To secure a full stand drop about 20 seeds to every inch of row, and when the plants are well started thin them out to 10 or 12 for each inch. If 10 rows are sown, 12 plants per inch will secure 9,500 plants under each sash. It will require 174,240 plants to set 1 acre, making the rows 12 inches apart and allowing 3 inches between the bulbs. It is necessary, therefore, to use eighteen 3 by 6 foot sash to raise enough plants for an acre. The soil must be kept in a moist condition while growing the young plants, but an excess of water should be avoided, otherwise the plants make a spindling growth or perhaps "slough" off. Ventilate freely on warm, bright days. Aim to secure strong, sturdy plants at the time of transplanting. Weak, spindling plants never produce satisfactory results.

The ground having been prepared according to directions already given, the rows are marked at the desired distances, 12 inches being sufficient space if a careful workman pushes the wheel hoe. Various devices may be used in laying off the rows. If a very small plantation is to be set, the garden line will be satisfactory. For marking large plantations there is no better device than the roller marker. It consists of a simple wooden roller 3 or 4 feet long and about a foot in diameter. Pieces of one-fourth or one-half inch rope are nailed around the roller at the distance apart desired for the rows. Cross marks can be made at the same time by pieces of rope nailed lengthwise of the roller. These cross marks may be 1 foot apart. When the land is marked by this device the workmen can set one plant at each cross mark and three between them, thus avoiding loss which may result from irregular planting where the rows are not checked.

For the most rapid and economical setting of the plants it is perhaps best to employ quick, active boys, separating them into squads of three. After rolling have one boy make the holes with a dibble, let another drop a plant into each hole after the roots and tops have been trimmed back about one-third or one-half their length, while the third boy sets them at about the depth they stood in the seed bed. R. H. Price, of the Texas Experiment Station, reports that he uses the hand turning plow with good results in transplanting. The method is as follows: Run a straight furrow with a small hand turning plow, lay the plants along the straight side of the furrow, turn the plow around and throw the dirt back to the roots, pressing it down with the feet or with a small roller. This method may doubtless be profitably used in some sections for special purposes, but hand setting is believed

to be more accurate and cheaper when very large, superior bulbs are desired.

In California some extensive growers sow the seed of the large Spanish varieties in the open ground in the fall and transplant the following spring. This plan would probably be well suited to the South, but it has not been sufficiently tested to determine its exact value.

The cost of growing the plants and setting them in the field are the objectionable features of this system. Nevertheless, many extensive growers follow the method and recommend it. A prominent onion producer of New York states that he can care for and transplant an acre of Prize-taker onions as cheaply as he can sow and care for the same area of Yellow Danvers. In this method one-third less seed is required and the expense of hand weeding is reduced to a minimum. The saving in these two particulars will nearly, if not quite, cover the cost of raising and setting out plants, while the additional profits accruing render it much the better method for gardeners.

The main bulk of American onions, however, will probably always be grown from seed sown in the open ground. It would require a considerable investment of capital to procure the necessary frames and sash, or greenhouses, to grow enough plants for some of the extensive onion farms of the country, but for garden culture of most American varieties, and the general culture of the large foreign varieties, the transplanting system is of decided value.

CULTIVATING AND WEEDING.

Cultivation is practiced for three purposes, namely: (1) To prevent the growth of weeds, or to destroy those which have already appeared; (2) to form a loose surface mulch, which prevents rapid evaporation and also allows the free development of the bulb; (3) to admit plenty of air, thus promoting the chemical and other changes that prepare the plant foods for assimilation. The operation should begin as soon as possible. If the onions have been transplanted, use the wheel hoe at once to loosen the soil which has been packed by the workmen. When the seed has been drilled in, the hoe should be operated as soon as the location of the rows can be determined. The wheel-roller attachment to many drills leaves a mark sufficiently plain in most soils to make the use of the wheel hoe safe before the onion plants have appeared. A few radish or turnip seed are sometimes drilled in with the onion seed; the plants from these make the rows very plain, and thus permit the early use of the cultivator.

The soil should be stirred frequently. Until the bulbs are well grown, cultivating can hardly be overdone. It is always desirable to stir the soil as soon as practicable after a rain to prevent the formation of a crust on the surface.

There are two classes of attachments to wheel hoes, namely, those cutting horizontally and those cutting vertically. The former are best

for cultivating the plants when small, because they throw the soil away from rather than to the plants. When the bulbs begin to bottom, vertical cutting attachments may be used, being careful not to run deep enough to injure the roots. A wheel hoe, with double hoe which straddles the rows, may be used with excellent results as long as the plants are not large enough to be injured. For large plants the single hoe must be employed. The turn-plow attachment can be used to throw away the soil from the bulbs when they are bottoming.

Hand weeding is the most expensive item in growing onions from seed sown in the field. The work can be done best by careful boys. They should have their knees well padded with cloth, covered with leather. They straddle the rows (on their knees), weeding with some simple tool, with which the soil containing the small weeds may be thrown away from the rows. At the second weeding the plants should be thinned out to about one to the inch.

When the transplanting system is followed only two weedings are usually required, and these may be done with long-handled hoes or other tools, the operator in a standing position. Large weeds should be removed by hand if they appear late in the season, when the onion tops form a mat and will not allow the use of wheel hoes.

IRRIGATION.

The irrigation of onion plantations has been practiced for many years in some of the Western and Southwestern States, where the rainfall is not sufficient to supply the necessary amount of moisture. Several Eastern growers have recognized the advantage of having a supply of water in droughty seasons, and have made provisions for irrigating whenever the crop requires it. Almost every section suffers more or less from drought, and if there are natural advantages for the securing of an additional supply of water it will pay to construct the necessary dams and ditches and perhaps to erect windmills or use engines to pump the water. If the soil is very fertile and naturally well adapted to growing onions, and the markets or shipping facilities are favorable, there will be no risk in making a considerable expenditure preparatory to irrigating.

There are three methods of applying the water, namely, by flooding, furrow irrigation, and subirrigation. The first method is practiced in Oregon, Colorado, California, Mexico, and other Western States. The plan consists in planting the onions in beds which are banked on all sides to confine the water which floods them to the desired depth. A prominent grower of Oregon recommends the use of beds 10 to 20 feet wide and 10 rods long. He says: "The beds, sidewise, should be perfectly level; and it is better to have them level lengthwise as well, though they may have a slight incline. If the beds are level lengthwise the ground can be wet to any desired depth. Water may be turned on until it stands 1 inch in depth all over the

bed—which would be equivalent to a rainfall of perhaps 1½ or 2 inches—or it may be turned on to a depth of 6 inches, according to the requirements of the case. If the bed has an incline, the lower end should be left open, allowing the water to pass off, else that end will receive a great deal more water and the ground will probably become packed."

In furrow irrigation the onions should be planted on ground which slopes just enough to allow the water to run in the small furrows which are made between the rows. These furrows may be made by the plow attachment of the hand wheel hoe. Small furrows may be run between all the rows, or larger ones at distances of from 4 to 10 feet, depending upon the porosity of the soil. If the latter plan is followed, which is perhaps the most satisfactory, it will be necessary to omit a row where each furrow is to be made.

Large ditches and flood dams are sometimes extensively used. In this case the main ditch, which conducts the water from a stream, is provided with a flood dam. Lateral ditches of smaller size are run at right angles, or nearly so, to the main ditch, each provided with a gate where it joins the main channel. These lateral ditches may be 20 to 40 feet apart. If the soil is loose and porous, 40 feet is not too much space to allow between them. By means of the flood gate at the stream from which the water is obtained, the current or a portion of it is turned into the main ditch. The flood gates of the lateral ditches are opened consecutively until they are filled and the entire plantation thoroughly soaked.

Subirrigation by means of 2-inch tile has many advantages. The tile are laid from 5 to 10 feet apart and 10 to 12 inches under the surface. The water supply is derived from a higher level and conducted to the tiles by means of hose or a combination of hose and iron pipe. The water readily finds its way out of the joints of the tile and permeates the soil in every direction. This system is especially applicable to small plantations.

Whatever system is adopted, care must be exercised that too much water is not applied; otherwise scallions are formed and the bulbs become spongy and succulent. Cultivation should follow each irrigation just as soon as the soil is dry enough.

HARVESTING.

Onions should be promptly harvested at maturity. Harvesting should begin when most of the necks have turned yellow and are considerably withered. Although there is generally still quite a number of green tops when the main crop is ready for harvesting, the bulbs of these will thoroughly ripen if pulled along with the others. It is not safe to postpone the harvesting on account of a few green tops. If left too long in the ground, the bulbs are liable to reroot, especially if there are frequent showers, and the quality of the bulbs is injured. Prompt-

ness in harvesting is not quite so important if the transplanting system is followed, as in this case the crop usually matures at a dry season.

The pulling of the crop is not an expensive operation if the bulbs are large and do not set too deep in the ground. Boys may be most economically employed in this work. The plants are simply pulled by the hand and deposited in windrows containing the onions from three or four rows. The crop is left in these windrows until fully cured, which will require from a week to ten or more days. On bright days the curing will be hastened by stirring with a wooden rake. The bulbs must be raked very gently to prevent bruising, which causes them to decay rapidly, special precautions being necessary in this respect with foreign varieties. If there is danger of a rainy season the crop may be cured in open sheds or on a barn floor. The bulbs of white varieties must be handled with greater care than those of the red and yellow sorts. If the rays of the sun are very hot the onions should be gathered in piles, each containing enough onions to make about a barrel, and then protected by thin layers of straw. This will prevent the sun from turning exposed portions of the onions green. After the crop is cured the bulbs are sorted, topped if desired, and properly stored. All weeds and refuse should be removed from the plantation, and, if possible, a fall crop grown on the land. Celery is highly profitable to follow onions where the soil is favorable to the growth of this vegetable. Cowpeas or turnips may be sown, or a crop of pickling onions raised.

WINTER STORING.

The winter storing of onions is always attended with more or less loss. If not thoroughly cured when stored many of the bulbs will sprout, and others will decay if they have sustained even slight bruises in harvesting. There will be more or less shrinkage, and a large percentage of the onions will be lost if the proper care is not given to ventilating and maintaining the desired temperature. For these and other reasons most growers prefer to dispose of the crop as soon as possible, and are willing to accept low prices rather than run the risk of loss by storage. This plan is doubtless the most judicious for those of limited experience or knowledge in the wintering of onions. But the prices received in the spring are generally so far in advance of fall prices that every grower should understand the conditions necessary to keep onions through the winter months. Very frequently the bulbs command $1 or even $2 more per barrel in the early spring than they do soon after harvest.

It is absolutely essential for successful winter storing that the bulbs should be well matured, thoroughly cured, not bruised, and in a perfectly dormant state. Most growers prefer topping the onions before storing. Sheep shears can be used to advantage in this work, leaving about an inch of the onion top extending above the bulb. The sorting may also be done by hand or by means of a screen, the rods or slats of

which diverge, letting the bulbs fall into three hoppers, separating the onions into three grades.

Onions may be wintered by two different processes, namely, by freezing the bulbs and keeping them in this state all winter, or by storing them in a dry apartment where the temperature can be maintained just above the freezing point. The freezing process is very satisfactory in the North, where the weather is cold during the entire winter. It consists in simply storing the bulbs in the barn, pit, or outbuilding, allowing them to freeze, then covering with hay, straw, or bags, and letting them remain undisturbed in this frozen state all winter. The covering should remain on the bulbs until they gradually thaw out with the rising temperature of the spring. A layer of hay must be thrown on the floor or bottom of the bins before putting in the onions. The temperature of the bins should not run above 32° or below 15° until spring. Too severe freezing or successive freezing and thawing will njure the bulbs.

Arlie, in his book entitled How to Grow Onions, gives the following plan for the freezing process, which could scarcely be improved upon:

> The building in which they are to be stored should be so arranged that it has a free circulation of air underneath the floor. Arrange bins in the building from 4 to 6 feet in width and 1 foot deep, leaving a space of a foot or so next the outer wall. The first bin should be raised 6 inches from the floor, and the bottom of the bin should be composed of 3-inch slats having 2-inch space between them. Now place good dry straw in the bottom of the bin, sufficient to make 2 inches when weighted down, and fill in with onions until nearly even with the top. Cover with straw sufficient to exclude all light from the onions. Continue next layer of bins on top of this in same manner, leaving sufficient space between the bins to admit a free circulation of air. Have windows so constructed that the sun can not shine into the room at any time. After good freezing weather has fairly set in, select some night when it is cold enough to freeze the onions solid and throw open the doors and windows. After this the temperature in the room should be kept below 32°, and only ventilate when the outside temperature is lower than in the building. In this manner the onions may be kept until warm weather. Let them thaw out with the covering on, and do not handle them until all frost is out of them.

Small quantities may be stored in pits, with satisfactory results. Select a well-drained location on which to place the onions in piles. Cover them with hay to the depth of about 12 inches, then add a layer of earth, and roof the mound with boards. It is essential that the bulbs be thoroughly protected from water, which causes decay. When the cold-storage process is followed the onions are stored on floors or in bins, barrels, boxes, or crates. The temperature must never quite reach the freezing point, but should not rise more than 2 or 3 degrees above it. Free ventilation is essential on bright days when the cold is not too severe, and the atmosphere is dry. Cellars will sometimes answer the purpose, but they usually contain too much moisture. Barns and well-constructed outbuildings are frequently frost proof, and will preserve the bulbs in perfect condition. Extensive growers, however, find it necessary to construct special buildings. An Ohio firm state that

they annually cultivate about 400 acres in onions, and that a large part of the crop is cured in sheds if the weather is not dry enough to cure the bulbs in the field. The onions are then stored in frost-proof buildings, with ventilators which may be opened at will, or closed to exclude the outside air when it is too hot or too cold. The temperature of the buildings is kept as low as possible without freezing the onions. Barrels, slatted boxes, and crates are used in storing. Gregory, in his work on onion culture, describes a house made on the above plan as follows:

The stone foundation is a foot thick and reaches just far enough above the surface to insert in it, every 8 feet, 6-inch tiles for ground ventilators. These are placed all around the wall excepting where the large double doors are at each end. These ventilators are crowded full of old fertilizer sacks, and covered at their outside openings with two or three shovelfuls of manure or snow in the coldest weather, but are kept open when the weather is moderate. The buildings are 40 by 78 feet inside. The sills are placed on top of the wall, which brings them within 7 or 8 inches of the ground. The floor is cemented; on this are loosely laid 3-inch by 2-inch slats crossways of the floor about 3 feet apart, and upon these oak scantlings are loosely laid, 3-inch by 4-inch, which run lengthwise of the building. * * * In erecting, the toughest kind of building paper is put on the outside of 10-inch studding, and the house is then boarded on the outside with choice ship-lap siding. The same kind of paper is next nailed inside on the studding, and strips 2 inches thick having been nailed on this studding, a second course of paper is nailed on, and the building is then sealed on the inside with choice matched boards, using a close-fitting strip for the corners after the ceiling is on. Overhead, across the rafters, is nailed a layer of the paper, then a tight floor, and the under side is ceiled on another course of paper. There are three large ventilating stacks in the middle of the building, with double-door ventilators. There are also four ventilators on each side of the building, running up through the floor, with double doors, which are closed in severe weather. * * * Their general experience with the keeping properties of these buildings has been very satisfactory. Before shipping the onions are all repacked.

THE PRODUCTION OF ONION SEED.

It should be the aim of every grower of onion seed to produce only seed of the highest quality. The characteristics of the ideal bulb, already described on page 11, should be carefully considered by the producer of seed. The bulbs from which the seed is to be grown should be selected with care, rejecting those which do not approach as near as possible to the grower's ideal. Culls or unsalable onions are too frequently used for this purpose, and although the seed therefrom in good seasons may be heavy and may germinate readily, they will not produce a satisfactory crop. By careful selection and judicious cultivation through a series of years, it is possible to greatly raise the standard of excellence. By this method the flat-formed bulbs, which are not so productive nor salable, may be ultimately changed to those of a perfect globular form. For selection of soil, methods of preparing the ground, cultivating, fertilizing, and storing the bulbs from which the seed is to be grown, the directions already given are applicable. After the soil has been properly prepared, cover the onions in trenches 4 or 5 inches deep,

allowing about 6 inches between the bulbs. The rows, if to be worked by a hand wheel hoe, should be from 14 to 18 inches apart; if a horse is to be used in cultivating, about 2½ feet apart. It is important to plant the onions as early as the spring weather will permit. Where the winters are not too severe, fall planting is preferable.

After the seed stalks are well started, the soil should be drawn about them to give the plants necessary support. This should be done three or four times during the season, finally leaving a ridge 7 or 8 inches high. Some growers prefer supporting the plants by means of twine stretched on either side of the rows.

After the last cultivation, the plants should be disturbed as little as possible until the time for harvesting. Promptness in harvesting is very important, for if delayed too long the seed receptacles crack open and part of the crop will be lost in handling. When the tops assume a yellowish appearance, remove them with 5 or 6 inches of the stem, and if overripe, deposit in tight vessels or in baskets with papers spread over the bottoms and sides to prevent loss. The entire crop does not mature at the same date, hence it is necessary to examine the plants three or four times in order to remove the seed at the proper stage of ripening. The tops should be stored in a well-ventilated room with a tight floor until dry enough for thrashing. Frequent turning of the tops will hasten their drying and shake out more than half the seed. The remaining seed may be removed by flailing. Cleaning is done by repeated winnowing, and by washing in buckets or tubs to separate the light seed and chaff that the winnowing fails to remove. The seed must be thoroughly dried and stored in a location free from excessive moisture.

BUNCHING ONIONS, SETS, AND PICKLERS.

Several methods are employed in the production of bunching onions. In the South, the Potato onion is largely used, the bulbs being planted in the fall. They are set in trenches 4 or 5 inches deep and placed 3 to 6 inches apart in the row. The bulbs increase and divide during the growing season, and may be pulled and bunched very early in the spring. Small sets of white or yellow varieties are extensively used by some market gardeners in the production of bunching onions. Either fall or spring planting may be practiced. The sets should be planted 1½ or 2 inches apart, allowing a foot between the rows. Seed is also largely used in raising bunch onions. The earliest crop can be secured by sowing in September or October, or sufficiently early for the seedling to become firmly established before the advent of cold weather. Fall sowing is best adapted to the warmer sections of the country. Seven or eight pounds per acre should be sown, making the drills 10 or 12 inches apart. The Barletta variety may be sown for early use.

The soil should be only moderately fertile for growing sets, but free from little stones and weed seeds. Seed is drilled in at the rate of from 50 to 60 pounds per acre. It is desirable to defer sowing in the

spring until most of the weed seeds which may be present in the soil have germinated. The aim of the grower should be to secure a crop of very small bulbs as nearly uniform in size as possible. The price received is largely regulated by the size of the sets. Of course, a bushel of the smallest sets will plant a greater area than the same quantity of the larger ones, hence they command a higher price. When mature, the sets are lifted by a trowel and deposited with the surrounding soil in a sieve with meshes small enough to hold the smallest bulbs. A crib or dry, well-ventilated apartment may be used to cure the onions, spreading them in thin layers. It is extremely important to dry the sets thoroughly, so that they will remain in an entirely dormant condition until sold or planted. Before the final storing a fanning mill is used to remove the loose skins or other light refuse. White sets command the highest price.

In the production of pickling onions about 25 or 30 pounds of seed per acre should be sown. No variety is better adapted to this purpose than the Barletta. The bulbs when harvested should be as uniform in size as possible. Onions measuring from three-fourths of an inch to 1½ inches in diameter are the proper size for this purpose.

TWO IMPORTANT ENEMIES OF THE ONION.

The onion maggot (*Phorbia ceparum*).—This is the most destructive insect enemy to this vegetable, both in Europe and America. The eggs are deposited on the plants near the ground, requiring about a week to hatch. After the eggs hatch, the larvæ therefrom burrow in the bulbs, where they remain for about two weeks, then emerge, pupate in the ground, and the adult insects deposit their eggs for another generation. The larvæ cause the plants to turn yellow in color, wither, and finally die before the bulbs have matured.

Various preventive measures and remedies have been suggested, as the application of unleached wood ashes and charcoal spread over the beds, the use of gas lime between the rows, the sowing of potash salts, rolling the beds before sowing, growing the bulbs in trenches, drawing the earth about them as they grow, and several other measures have been recommended. Planting in a new location each year is perhaps the most effective preventive.[1]

Onion smut (*Urocystis cepulæ*).—This disease attacks the young plants, causing the formation of dark spots or lines on the leaves. As the

[1]Carbolic-acid emulsion has been found to be an effective remedy by the New York Cornell Experiment Station. The emulsion is made by dissolving 1 pound of hard soap or 1 quart of soft soap in a gallon of boiling water, to which 1 pint of crude carbolic acid is added, the whole being stirred into an emulsion. One pint of this is added to 30 quarts of water and poured around the bases of the plants, about 4 ounces per plant at each application, beginning when the plants are set out and repeated every week or ten days until the last of May. To bring about the best results, some of the earth should be removed from about the plants before pouring on the emulsion.

onion seedling develops, these spots crack open, exposing a black, powdery mass, which contains the spores of the fungus. The disease, if very severe, causes the tops to wither and die, and then often spreads to the bulbs. Onion smut is more or less prevalent in different parts of the country, the loss therefrom being very serious some years. As a preventive all the refuse upon the onion field should be burned immediately after the crop has been harvested, thus destroying most of the spores, from which the disease rapidly spreads the following season. Adherence to a strict system of crop rotation is the most practical preventive against the disease. Transplanting is also quite effective.

Experiments at the Connecticut Agricultural Experiment Station have demonstrated that treatment with a mixture of equal parts of sulphur and lime or of sulphid of potassium and lime, increased the yield on land badly infected with smut in a ratio of about five to one. The mixture is sown in drills with the seed.

SUMMARY.

(1) The onion crop is one of great importance to the rural population of the United States, and is produced on an extensive scale, but the fact that hundreds of thousands of bushels are annually shipped to our ports from Bermuda, France, Spain, and Cuba, indicates that the home demand at all seasons of the year is not yet fully supplied by growers in this country. It is true that the bulbs of the foreign varieties appear to be superior in quality to those commonly grown in this country, but there are large sections in California and in certain parts of the South where the soil and climate are well adapted to the growth of these foreign varieties.

(2) The onion requires a light, friable, well-drained, fertile soil, well stocked with organic matter. Onions are extensively and successfully grown on reclaimed marsh soils.

(3) Soils which are deficient in organic matter, and which have been reduced by exhaustive cropping should be renovated by cultivation in other crops on which barnyard manure, green manures, and other fertilizers are liberally used. The onion requires liberal fertilizing, and since the cost of labor is about as great for a crop of 500 bushels as it is for 1,000 bushels, it is good economy for the onion grower to be liberal in the use of fertilizers. Soils which have been freely cropped with cowpeas or other leguminous plants are not likely to be deficient in nitrogen, although slight dressings of the quick-acting nitrate of soda may often prove profitable, while potash and phosphoric acid must be applied more liberally. When nitrogen is needed, applications of 200 to 400 pounds per acre of nitrate of soda in four equal dressings is recommended. Potash may be supplied in the form of wood ashes at rates of from 6 to 8 tons of unleached ashes, or 10 to 14 tons of leached ashes per acre. Potash may also be supplied in kainit, 800 to 1,000 pounds per acre, and muriate of potash, 200 to 300 pounds per acre.

A few hundred pounds of bone meal or other phosphates may be used if phosphoric acid is required.

(4) Late fall plowing is generally advisable, care being taken to completely cover all manure applied and to thoroughly pulverize the soil, but not to bring any of the subsoil to the surface.

(5) Seed should be selected with great care and a preliminary test of its germinating power made.

(6) Varieties successfully grown are divided into two classes: (1) American varieties, the most prominent of which are Danvers, Extra Early Red, Egyptian, Red Globe, Yellow Globe, Potato Onion, Shallots, Silver Skin, Wethersfield, White Globe, and Yellow Strasburg; (2) foreign varieties, of which the following are the more important kinds grown in this country: Barletta, Bermuda, Early Pearl, Giant Rocca, Giant Red Rocca, Giant White Rocca, Giant Yellow Rocca, Mammoth Pompeii, Marzajola, Giant White Garganus, New Queen, Prize-taker, Red Victoria, Silver King, White Italian Tripoli, and White Victoria. The American varieties keep longer and are better adapted to most parts of the United States, but foreign varieties possess certain desirable qualities which give them a high market value.

(7) Onions are propagated from (1) sets, (2) from seed sown in the open ground without transplanting, and from seed sown out of doors in the fall and transplanted the following spring, or from seed sown under glass in January, February, or March, the young plants being set out as early as the season will permit. The first method is extensively employed by market gardeners who make a business of growing bunching onions. It is not recommended for growing mature bulbs in large quantities. For this purpose, sowing the seed in the open ground or under glass and transplanting the seedlings is recommended. When set at distances of 3 inches in rows 12 inches apart an acre requires 174,240 plants.

(8) Cultivation should commence early, and should be frequent to keep the soil well stirred and to prevent the growth of weeds. Hand weeding is necessary in the early stages of growth, but certain forms of the wheel hoe may be used with advantage for the larger part of the necessary cultivation.

(9) Where a water supply is reasonably accessible, provision should be made for irrigation whenever the crop requires it.

(10) As soon as the bulbs attain full size and the tops turn brown they should be pulled, thrown into windrows, and allowed to cure for ten or more days, or if there is danger from rain the curing should be done in open sheds or on the barn floor. Excess of either sunshine or rain is likely to injure the bulbs. The most common processes of wintering the onions are: (1) Freezing the bulbs and keeping them in this state all the winter, and (2) storing them in dry apartments where the temperature can be maintained just above the freezing point.

(11) In growing onions for seed a strict system of selection with a

view to the development of an ideal type should be followed. In general, the same methods followed in ordinary culture are applicable in this case. For bunching onions, bulbs of the potato onion or some of the white or yellow varieties, planted generally in the fall in trenches 4 or 5 inches deep, at distances of 3 to 6 feet, are used. The bulbs are pulled and bunched early in the spring. Sowing the seed in September or October is also largely practiced in raising bunch onions. For sets the seed is drilled in the spring in moderately fertile soil, free from stones and weed seeds, at the rate of 50 to 60 pounds per acre, the object being to secure a crop of very small bulbs of uniform size. These bulbs should be thoroughly dried to render them dormant before storing. The Barletta variety, seeded at rates of from 25 to 30 pounds of seed per acre, is recommended for the production of pickling onions, which should be from three-fourths to 1½ inches in diameter.

(12) The principal enemies of the onion are the onion maggot (*Phorbia ceparum*) and onion smut (*Urocystis cepulæ*). For the first the most effective remedy is a change of location of the onion field each year. Carbolic-acid emulsion applied around the roots has also given good results. The latter is held in check to some extent by rotation of crops and by transplanting. A mixture of equal parts of sulphur and lime or sulphid of potassium and lime sown in the drills with the seed has given good results as a remedy for the disease.

FARMERS' BULLETINS.

These bulletins are sent free of charge to any address upon application to the Secretary of Agriculture, Washington, D. C. Only the following are available for distribution:

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No. 19. Important Insecticides: Directions for Their Preparation and Use. Pp. 20.
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