

THE ONION, in one or more of its several forms, has been in use throughout all time of which we have authentic history. It is of Old World origin, but was brought to North America by the early discoverers and colonists. The onion is grown universally in home gardens and is one of our important market-garden and truck crops. It is adapted for growing on a wide range of soil types and under varying climatic conditions, but requires a rich soil and plenty of moisture.

Onions are an intensive crop, their production involving considerable hand labor, but yielding a relatively high return per acre. Prices received by the growers vary considerably from one year to another, but the production of onions in the United States is fairly well stabilized and adjusted to market demands.

Recently there has been developed in several of the Western States a specialized industry in the production of the Valencia onion. The Bermuda-onion industry of southern Texas and California has been expanded and extended to several other sections.

The production and shipment of large numbers of early seedling onion plants by southern plant growers has to a certain degree replaced the use of onion sets for planting in home gardens and for a portion of the northern early market crop.

ONION CULTURE

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CONTENTS

	Page		Page
Introduction.....	1	Commercial varieties.....	21
Climatic requirements.....	2	Production of Bermuda onions.....	22
Soils adapted to onion culture.....	3	Soils and climate adapted to the Bermuda onion.....	22
Cultural methods.....	4	Cultural methods.....	23
Preparation of new land.....	4	Harvesting and marketing.....	23
Crop rotation.....	4	Yield of Bermuda onions and prices ob- tained.....	23
Preparation of the soil.....	5	Green onions for bunching.....	24
Fertilizers.....	6	Cultural methods.....	24
Planting.....	8	Marketing.....	24
Cultivation.....	11	Diseases of the onion.....	25
Irrigation.....	13	Onion insects and their control.....	25
Harvesting and curing.....	14	Present status of the onion industry.....	26
Storage.....	17		
Marketing.....	20		

INTRODUCTION

THE ONION is one of the important market-garden and truck crops in the United States and is very generally grown in home gardens. It thrives best on alluvial and drained muck soils under a temperate climate, but may be grown under a very wide range of soil and climatic conditions. Onions are grown to perfection on the alluvial soils of the Nile River Valley in Egypt, under the sea breezes of the South Sea Islands, on the delta lands along the sea-coast, on sandy uplands, in the arid regions under irrigation, and on reclaimed swamp lands. There is perhaps no extensive area in the United States or its possessions where the onion, in one or more of its forms, can not be successfully grown, at least for home and local use.

The onion is of Old World origin and has been used as a food plant from the earliest historic times. It was an important article of diet in Egypt at the time of the building of the pyramids, and Moses, in his account of the exodus of the Children of Israel from Egypt, mentions it as one of the articles of food for which the Israelites longed during their sojourn in the wilderness.

Onions were brought to North America by the early discoverers and became one of the common crops of colonial gardens. Commercial onion culture in its present form has developed mainly during the last 40 or 50 years. Formerly the production of onions for sale was confined principally to the New England States, but the industry soon spread to other sections, and when the vast muck areas of the Great Lakes and other regions were drained and brought under cultivation the onion soon became one of the most important crops on these soils.

At present the principal commercial onion-growing centers are located in New England, especially in the Connecticut River Valley, in northern New Jersey, southeastern New York, the entire Great Lakes region, and as far west as Minnesota. The production of Creole onions centers around New Orleans, La., and the greater part of the Bermuda-onion crop is grown in southwestern Texas and in California. Within the last few years the production of the mild Valencia onion has developed in several of the Western States, including New Mexico, California, Arizona, Utah, Nevada, Washington, and Oregon. In addition there are many local areas in the United States where onions are being grown in considerable quantities for the market.

The production of several crops closely related to the onion, such as chives, shallot, leek, and garlic, has been developed around local centers, especially in connection with market gardening near the large cities. Garlic might be mentioned as an exception, because it is produced mainly in a few localities where soil and climate are especially suitable for its growth.

The present acreage and production of onions in the United States are about equal to market demands. During years of short crops and low yields there is a shortage of onions with consequent high prices, but during years of heavy crops the supply, as a rule, exceeds the demand, and frequently prices are too low for profitable returns to the grower.

CLIMATIC REQUIREMENTS

For best results a temperate climate without great extremes of heat and cold should be selected. Onion culture is rarely profitable in regions where the climate does not change or has no definite seasons of heat and cold or moisture and drought. The onion does best under rather cool conditions, with plenty of moisture during its early stages, but requires a reasonable degree of heat, together with dryness of both soil and atmosphere, for its proper ripening. Where the onion industry has become established in the extreme southern part of the United States, the growing season is during the late autumn and winter, the crop maturing during the spring and early summer. If the crop matures at a time when there is considerable rainfall, it will be impossible to cure the bulbs without artificial means and they will be lacking in keeping qualities.

Certain types and varieties of onions, including the top onions and the multipliers or potato onions, are extremely hardy and may remain in the open ground throughout the winters of our Northern States, especially if given slight protection. These types are, however, not adapted to growing for market, except as green onions, "peelers," or "bunchers," to be sold during the early springtime. In certain sections of the South Atlantic coast region large areas of the top and multiplier onions are grown for this purpose. There is also a marked difference in the temperature requirements of the standard commercial sorts, some being adapted to growing far northward, while others, like the Bermuda, Egyptian, and Spanish types, do best in restricted southern localities.

The period required for the production of a crop of onions will depend upon the season, the methods employed in growing, and the

variety. If grown from seed, a period of from 130 to 150 days will be required. If from sets, the crop often may be matured in 100 days. If grown in the extreme northern part of the United States, where the seasons are short, the crop will mature more rapidly than to the southward. In the case of the Bermuda onion, as grown in Texas, the growing season extends from October to the following March or April.

Onions require an abundance of moisture during the early stages of their growth, but should be ripened under comparatively dry conditions. In most sections the seed is sown at a time of the year when frequent spring rains occur. Their period of greatest growth is during the early part of the summer, and the crop is ripened late in the summer when drying conditions may be expected. In irrigated regions the application of water is almost entirely under the control of the grower. During the active period of growth the water is applied about once a week, the soil being thoroughly soaked and the surplus water drawn off.

The amount of rainfall or irrigation required for the production of a crop of onions will depend largely upon the character of the soil and its drainage. Many of the peat or muck soils in which the soil water remains near the surface will require very little rainfall; in fact, the best crops of onions are produced on these soils during seasons of comparatively light but evenly distributed rainfall. Sandy and loose soils generally will require a greater amount of water, especially during the early part of the season.

SOILS ADAPTED TO ONION CULTURE

The essential requirements of a soil upon which to grow onions profitably are a high state of fertility, good mechanical condition in order that the crop may be easily worked, sufficient drainage, and freedom from weeds. If a soil has the proper mechanical properties—that is, if it contains sufficient sand and humus to be easily worked, is retentive of moisture and fertilizers, and is capable of drainage—all other requirements can be met. At least three types of soil are being extensively planted to onions in this country, the one common essential being proper mechanical condition.

Clay and alluvial loam soils abound in the river valley and delta regions near the coast. These soils are generally very fertile, but may require the addition of humus or stable manure in order to lighten them. The greatest difficulty encountered in growing onions upon land of this character is the tendency of the soil to run together and bake after hard rains. This is especially injurious after the seed has been sown and before the small plants have attained sufficient size to permit of stirring the soil about them. Where these soils contain considerable sand they are ideal for onion culture. It is upon this class of soil that the greater part of the Bermuda, Spanish, and Egyptian onions are grown.

Sandy soils, especially where underlain by a well-drained clay subsoil, are often well adapted to onions. Soils of this character generally require heavy applications of fertilizers before they will produce a paying crop, but the quality of the product is excellent. Onions grown on sandy loams are generally solid, heavy, and of excellent keeping quality. Where sandy soils are lacking in humus

this may often be applied by means of crops of legumes grown upon the land and plowed under.

Throughout the north-central part of the United States there are vast tracts of peat or muck soils that are capable of producing onions. Before planting to onions, however, these soils must be cleared, drained, and brought to a suitable state of cultivation. In many cases this process will require two or three years' time, but sometimes the soil can be broken during the early winter, allowed to lie exposed to the action of frost, then worked down and planted to onions the following spring. Some of the largest onion farms are located on muck lands. The store of plant food in muck soil is usually large, but often it is not in available condition, and heavy applications of manure and commercial fertilizers, especially superphosphate and potash, are essential to profitable crops.

CULTURAL METHODS

The onion belongs to that class of crops which gives best results under very intensive culture, and the greatest yields are secured where a moderate acreage is planted and the work conducted in a most thorough manner. There is nothing technical about the growing of onions, but close attention and frequent cultivation are essential. Once the weeds get a start, the cost of production will be greatly increased, or the crop may be lost altogether.

PREPARATION OF NEW LAND

As a general rule new land is not adapted to onion growing until it has been worked one or two years with other crops. Onions should follow some row crop that has been kept free from weeds the previous season. Corn, beans, and potatoes are suitable crops with which to precede onions. Muck and sandy soils may in some cases be brought to a suitable condition for onions the first season, but the fitting will have to be very thoroughly performed. The land should be plowed in the autumn, then replowed in the spring, after which numerous harrowings and doubtless some hand work will be required to get the soil in suitable shape.

If necessary to manure the land heavily before planting to onions, it will be desirable to plant to some farm crop one season, then apply the manure during the autumn in order to give it time to become incorporated with the soil. Owing to the value of good onion land it would not be advisable to devote it to general farm crops for any extended period, although corn is frequently planted and oats or rye are sometimes used in the North. Cowpeas may be of great service in bringing new land into shape for planting to onions.

CROP ROTATION

Onions should not be planted on the same piece of land year after year, but some system of crop rotation should be maintained. Care should be taken, however, to use crops in the rotation that will not be exhaustive of the high fertility necessary in the onion land. During the years when the land is not devoted to onions it can be planted to some truck crop that will give a return that will justify the appli-

cation of large quantities of fertilizers, or, better, to a leguminous crop to be turned under as green manure. Continuous cropping with onions will cause the land to become infested with both disease and insect enemies that will sooner or later injure the crop to such an extent as to render it unprofitable.

PREPARATION OF THE SOIL

Assuming that the land intended for planting to onions is capable of being brought to a good mechanical condition, is fertile, well drained, and reasonably free from weed seeds, the first step in the production of the crop will be to plow moderately deep, then harrow, disk, roll, and drag until the soil is smooth and mellow to a depth of 5 to 7 inches. The method of preparing the soil will depend somewhat upon its character, the manner of planting to be followed, and the requirements for irrigation. There are few truck or other crops that require so careful fitting of the soil as do onions, and it is essential that the fertilizers be well mixed with the soil.

On soils that are naturally well drained and where surface water can not accumulate, the plowing may be done in large blocks, but where the opposite conditions are found or irrigation is practiced it may be necessary to plow the land in narrow beds. In the case of insufficient drainage it will be desirable to throw the soil into beds, leaving double furrows between the beds to carry off surplus water. Where the flooding system of irrigation is practiced the beds must be leveled and a system of ditches and ridges provided for distributing and controlling the water. Where it is merely desired to secure surface drainage the beds may be from 75 to 150 feet in width, but for irrigation purposes the beds are generally but 12 or 15 feet in width. If spring plowing is practiced the soil should be harrowed closely behind the plow in order to prevent drying out.

For cutting and pulverizing the soil there is perhaps no tool as serviceable as the disk harrow. There is a type of disk having four gangs, in two sets, one combination in front of the other and so arranged that the soil is first turned to the center and then turned outward again by means of the rear combination. This tool turns the soil twice and leaves it in a level condition. For smoothing and leveling the soil behind the plow a harrow of the type shown in Figure 1 is very desirable; this tool not only levels but turns and crushes the soil at the same time.

On land that has been plowed during the autumn and requires replowing in the spring, a device of the type shown in Figure 2 will answer and will do the work more rapidly than the plow. This tool is especially adapted to bedding up land that has been previously plowed.

For imparting the final smoothing touch to the soil before planting there is a device consisting of a large number of small disks set in a wooden frame (fig. 3) which does about the same work as a steel rake, but in a rapid manner. A drag or float made from several pieces of scantling nailed together may be used for this purpose, or if the soil is very loose a roller should be run over it. The final leveling should be performed with a tool that will fill and obliterate all tracks or other depressions in the soil, leaving a smooth, even seed bed for either seed sowing or transplanting.

FERTILIZERS

As the onion is an intensive crop and should yield great quantities of marketable bulbs for the area planted, the grower is justified in fertilizing heavily. It would be difficult indeed to make the soil too rich for onions, provided the manures are thoroughly incorporated with the soil. A heavy application of fresh raw manure just before planting would have an injurious effect, but where the manure is well rotted and uniformly applied there is nothing to be feared.

ANIMAL MANURES

There is perhaps no fertilizer so well adapted to the production of onions as plenty of disease-free, well-composted stable manure, and the quantity and frequency of application will depend upon the nature of the land under cultivation. The Bermuda-onion growers of southwestern Texas apply as high as 20 tons of sheep and goat manure to an acre every three years. In addition to the manure

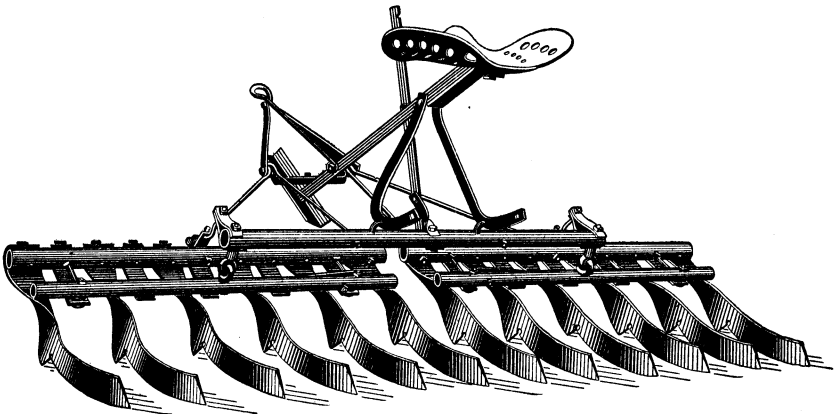


FIGURE 1.—Harrow for smoothing and leveling the soil behind the plow

there is used 1,000 to 2,000 pounds of cottonseed meal or commercial fertilizer, and sometimes a top-dressing of nitrate of soda. This sheep and goat manure, from animals that are fed largely on cottonseed meal, is saved in the corrals in a climate where there is very little rain, and contains the essential fertilizing ingredients in very high percentages. The manure is first piled where a little water can be thrown over it and it is composted for several months before spreading on the land. The best results from this manure are not realized until the second or even the third year after its application.

All stable manure used on onion land should be well composted before use and then spread upon the land several months before planting to onions. In the Northern States the manure may be applied during the autumn and well disked into the soil. The land can then be allowed to lie in the rough state and exposed to the action of frost during the winter, or it can be smoothed and seeded to rye, in which case it will be necessary to replot early in spring. In the Bermuda district the manure should be applied during the

spring and the land kept frequently stirred during the summer, with occasional irrigations in order to incorporate the manure and destroy weeds; the planting is not done until the autumn. Another practice in the Bermuda district is to apply fresh manure broadcast at the rate of 10 to 12 tons to the acre during the spring, then plant to corn and cultivate through the early summer, and add a top-dressing of well-rotted manure after plowing the land for onions in the autumn. This top-dressing should be well worked into the soil by means of disk harrows. Large quantities of fresh manure applied on onion land just before planting will have a tendency to produce an overgrowth of tops at the expense of the bulbs. This is especially true on irrigated lands and soils that are naturally moist.

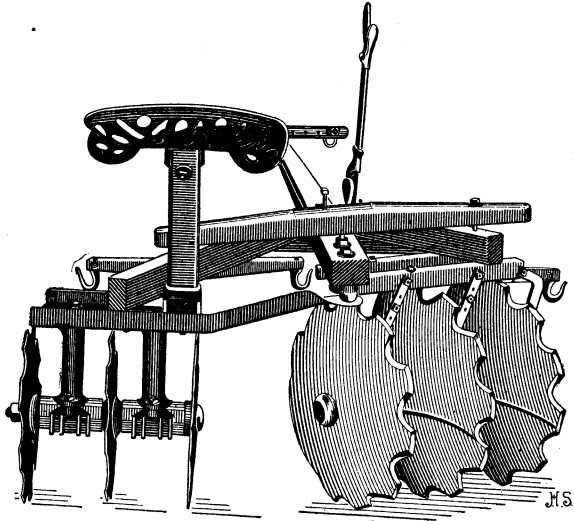


FIGURE 2.—Disk plow used for refitting land

COMMERCIAL FERTILIZERS

A fertilizer that is suited to the growing of potatoes will serve quite well for onions, but the potash should perhaps be supplied in the form of muriate rather than of sulphate. A fertilizer adapted to the growing of onions should contain 4 to 5 per cent of nitrogen, 8 to 10 per cent of phosphoric acid, and 8 to 10 per cent of potash.

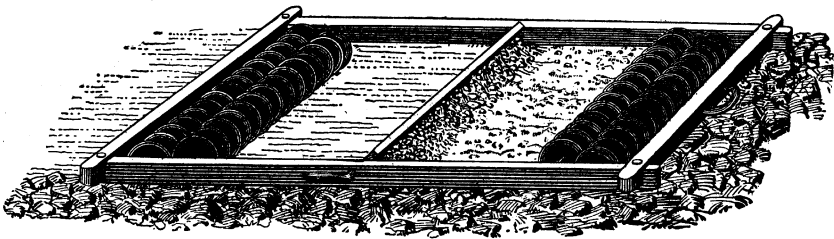


FIGURE 3.—Device used for smoothing soil before seeding

A fertilizer of this character will cost \$40 to \$45 a ton and can be profitably applied at the rate of 1,000 pounds to the acre on most soils. Where very intensive cultivation is practiced it may be profitable to apply as much as a ton to the acre in addition to stable manure.

Commercial fertilizers should be applied shortly before sowing the seed and should be uniformly distributed and thoroughly worked into the soil. There are fertilizer distributors that scatter the fertilizer broadcast, but where an amount not exceeding 1,000 pounds of fertilizer to the acre is being used the work of distribution may be performed by means of a common grain drill having a fertilizer attachment. On a small scale the work is generally performed by hand.

Many growers follow the practice of applying only a part of the fertilizer at planting time, reserving the balance to be put on as a top-dressing at some time during the period of cultivation. This plan is especially desirable where onions are grown during the winter, as the application of highly nitrogenous fertilizers in the autumn is liable to promote a soft growth that will be injured by cold. If the fertilizer is not put on until cold weather is over, the crop may be forced without danger of injury. For this purpose only those fertilizers of a very available form will answer. Nitrate of soda is frequently used as a top-dressing during the height of the growing period.

PLANTING

Most of the onions grown in the United States are started from seed. Propagation from seed is conducted by three more or less distinct methods: (1) By sowing the seed in the rows where the crop is to grow and mature; (2) by sowing the seed in specially prepared beds and transplanting the seedlings to the open ground; and (3) by first growing sets from seed and then, after keeping them through the winter, planting them in the field to produce the crop of mature bulbs. Of these three methods the one first mentioned of seeding in the rows where the crop is to mature is the one most used on a very large scale.

SEEDING IN ROWS

In the northern onion-growing districts the seed is sown as early in the spring as the soil can be brought to the proper condition. While it is desirable to plant quite early, it never pays to sow the seed before the land is in the best possible condition. When the soil has been brought to a smooth, even surface and is fine and mellow, the seed is sown by means of a common seed drill, of which there are several makes on the market. The hand drills which sow one row at a time are extensively employed, but many of the larger growers employ a gang of drills hitched together and plant from five to seven rows at once. In heavy or moist soils the depth to cover the seed should not be more than one-half to three-fourths inch, while on loose and sandy soils the seed may be covered about an inch.

Where hand cultivation is practiced throughout, the usual distance between rows is 12 to 16 inches. Where horse culture is employed the distance between rows varies between 24 and 36 inches. The quantity of seed required to plant an acre will depend both upon the distance between rows and the purpose for which the onions are being grown. For the growing of standard market onions in rows 14 inches apart, about $4\frac{1}{2}$ pounds of first-class seed will be required. With the rows 3 feet apart, but $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds will be necessary. Where it is

desired to produce small onions for pickling purposes, the amount of seed may be as great as 25 pounds to an acre. Good seed is essential, and if there is any doubt regarding the vitality of the seed it should be tested before planting by counting and planting 400 or 500 seeds in a window box and then determining the germination by counting the seedlings after 10 days' or 2 weeks' time. First-class seed is seldom sold at a low price and good seed at \$1.50 or even \$2.50 a pound may be cheaper in the end than poor seed at 50 cents. Old and inferior seeds are not only low in percentage of germination, but lack the vitality necessary to produce strong, healthy plants. There are dealers who make a specialty of securing and furnishing extra-quality onion seed, and while their prices are often somewhat above the general market the seed furnished by them is preferable to ordinary seed.

Experienced growers are able by using extreme care in regulating the drills to distribute onion seed in rows where the crop is to mature so that little thinning will be necessary. Thinning is generally left until the time of the first hand weeding, when all thick bunches along the rows are thinned to a uniform stand of 8 or 10 plants to the foot. It is always well, however, to allow for considerable loss of plants, and unless the plants are so thick as to actually crowd, thinning will not be necessary.

TRANSPLANTING METHOD OF GROWING ONIONS

The transplanting process is merely a modification of the regular seeding method. The objects gained by transplanting are an earlier crop, a uniform stand, and bulbs of more regular size. Practically the entire crop of Bermuda-type onions grown in the United States is handled in this manner. Where a small area is to be grown, the transplanting process is the ideal method, but for large acreages where labor is difficult to obtain this would not be practical. After transplanting, the seedlings will require rain or watering, and for this reason the transplanting process is practically limited to areas where some form of irrigation is available.

In growing onions by the transplanting method the seed is sown in greenhouses, hotbeds, coldframes, or specially prepared beds at the rate of $3\frac{1}{2}$ or 4 pounds for each acre to be planted. Onion seedlings are now being grown in great quantities by southern plant growers and are shipped to northern onion growers. When the seedlings are grown under cover, they are given the necessary attention regarding watering and ventilation and kept growing quite rapidly until near the time for setting them in the open ground. As planting time approaches, the seedlings are "hardened" or prepared for transplanting by increased ventilation and exposure and by withholding water. When ready to transplant, the seedlings should be somewhat smaller than a lead pencil and rather stocky. The plants are lifted from the seed bed and the roots and tops both trimmed somewhat, as shown in Figure 4. They are then packed neatly in shallow boxes for removal to the field where they are to be planted.

Various methods are employed for handling the plants in setting. As a rule, a line is used and the land marked to indicate the location of rows. Several methods are employed for marking the distance

between plants in the rows. A marking device much used by the Bermuda-onion growers in Texas consists of a sectional roller with the sections the same distance apart as the distance between the rows and each section provided with conical pins to form the holes in which the plants are set. The objection to the sectional roller marker is that it can not easily be drawn in a straight line and straight rows are essential to good cultivation.

After marking the land, the plants are dropped ahead of the planters, or they may be kept in the trays and simply removed as

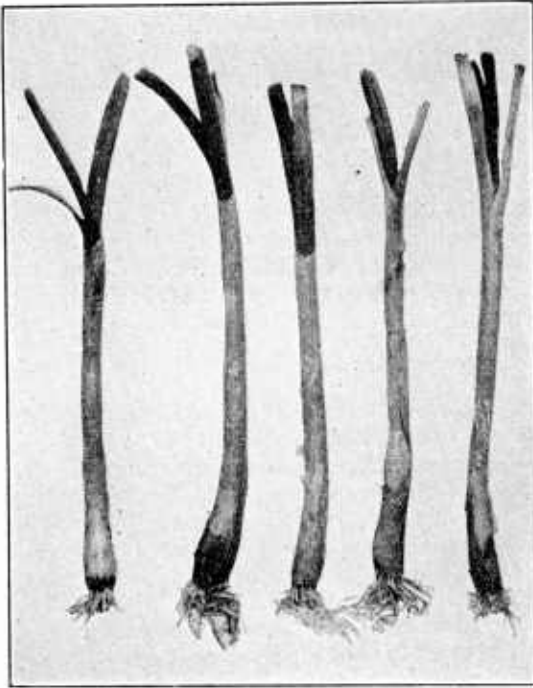


FIGURE 4.—Seedling onion plants trimmed ready for transplanting

planted. The transplanting process consists mainly in pushing the root end of the seedling into the soil with one finger and then firming the soil about the plant. This work is very laborious and can only be performed economically by very cheap labor. A small plow, such as is generally included with the attachments of the wheel hoe (fig. 5), is often employed for opening a furrow in which to set the small onion plants. As the plants are set the soil is either drawn about them by hand, or the plow may again be used for this purpose. In the Bermuda-onion district the work of transplanting is as a rule done by contract.

In transplanting, all inferior plants should be rejected, thus insuring a more nearly perfect stand and development.

PROPAGATION BY SETS

The use of sets is still another modification of the regular seedling method, in which the seed is planted one year to form the sets from which to grow a crop of mature onions the following year. Like the transplanting process the use of sets is limited in its application. Onions grown from sets will ripen earlier than those from seed sown in the field, but the use of sets for commercial onion growing is not so practical as transplanting seedlings, because of the high cost of sets. In planting onion sets a furrow about 2 inches deep is opened, the sets being dropped about 3 inches apart and firmly covered. The quantity of sets required to plant an acre will depend upon their individual size and planting distances, but it is generally between 15 and 22 bushels.

CULTIVATION

The cultural requirements of the onion are frequent shallow stirring of the soil and freedom from weeds. The feeding roots of the onion run close to the surface of the soil and should not be disturbed by deep cultivation. Sometimes a heavy rain immediately after seeding will so pack the surface that the seedlings can not break through. Under such circumstances it will be necessary to slightly break the surface by means of a steel rake or a rakelike attachment on a cultivator. As soon as the plants are up and the rows can be followed the cultivator should be started to loosen the soil, which is always more or less compacted during seeding.

HAND CULTIVATION

Where the rows are 14 inches or less apart, the work of caring for the crop must all be done by hand. For this purpose the wheel-

hoe tools of various types are essential. These implements are provided with several kinds of hoes, cutters, and sweeps designed to work the soil away from the plants, to shave the surface and destroy weeds, and to stir the soil and work it back around the plants. Onions grown on muck and alluvial soils will require from 8 to 14 workings with the wheel-hoe implements; on sandy soils it will not be necessary to cultivate so frequently.

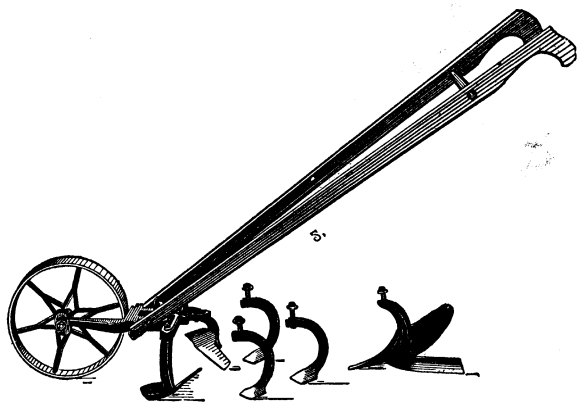


FIGURE 5.—Wheel hoe adapted to working onions

Several types of wheel hoe are in use, but those having a single wheel and passing between the rows are most desirable. Those of the type shown in Figure 5 are good. Many growers have designed special implements to suit the requirements of their soils; two of these are shown in Figure 6, the one designed to cut the soil away from the row and the other to stir and work the soil back to the row. Some of the growers in the onion fields near Chicago have adopted a hoe stock consisting of a pair of light plow handles, an iron stock, and the front wheel of a bicycle. To the stock of this device may be attached almost any form of sweep or cutter, and the implement is exceptionally easy to propel. The wide distance between the handles places the implement well under the control of the operator. Figure 7 gives an idea of the general appearance of this implement.

HORSE CULTIVATION

In sections where onions are grown on a soil that is not well adapted to hand culture the rows are placed 30 to 36 inches apart

and the cultivation is performed by means of horse-drawn tools. This is particularly true where onions are grown on the black waxy soils of Texas and other soils of the prairie type. As with hand



FIGURE 6.—Special wheel hoes for cultivating onions

culture, frequent shallow stirring of the soil is essential, the work generally being performed with one of the harrow-tooth cultivators. Those of the type shown in Figure 8 are well adapted to this work.



FIGURE 7.—High wheel type of hoe. (Patented)

An implement known as a weeder can be used for breaking the surface before the seedlings appear; also for general cultivation by removing a tooth at the point where the rows are located.

HAND WEEDING

It is well-nigh impossible to produce a crop of onions without some hand weeding. During favorable seasons the strictly handwork may be reduced to but one or two weedings, but a greater number will be necessary during rainy seasons. Each hand weeding will cost from \$5 to \$12 an acre, according

to wages paid and the number of weeds present. The work of hand weeding may be facilitated by the use of some of the small hand tools designed for the purpose. Among these tools might be mentioned the onion hoe (fig. 9), the hand weeder (fig. 10), and the thinning or weeding hook (fig. 11). Girls and boys are expert at hand weeding, the practice being to work them in gangs of 10 to 20 with an overseer behind them to see that the work is properly done. In some localities the wages paid for this class of work are \$1.50 to \$2.50 a day.

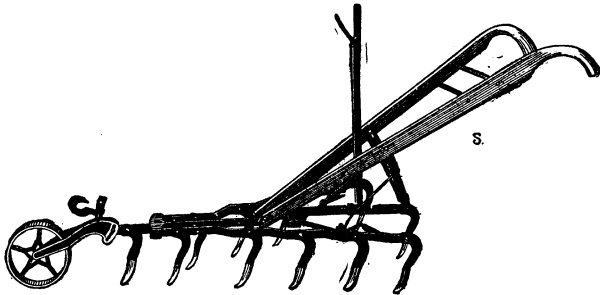


FIGURE 8.—Small-tooth horse cultivator

IRRIGATION

Outside of the areas where irrigation methods are depended upon for the production of general crops it is not customary to use artificial watering in the growing of onions. In a few cases the land has been equipped with overhead sprinkling systems which are employed to moisten the soil after the seed is planted and also during extremely dry weather. On peat and muck soils the young seedlings are frequently lost by the dry muck blowing with the high winds of early spring. In this way a part of the field may have the soil blown off to such an extent that the plants will be left without soil about them, while other portions of the field will be covered by 1 or 2 inches of loose muck. The use of a small quantity of water sprayed over the field will sometimes prevent this shifting of the soil during a windstorm but will not prevent the accumulation of muck blown on to the plants from adjacent nonirrigated areas. Sandy soils are also subject to the action of winds to a greater or less extent, and losses may be prevented by the timely application of water over the surface. In a few instances subirrigation is employed in the growing of onions.

Throughout the Bermuda district of the Southwestern States surface irrigation is almost universally employed. The Bermuda onions are planted mostly in comparatively level beds with dividing ridges and are flooded once each week or 10 days during the growing period. About a week before the plants are set the soil is flooded

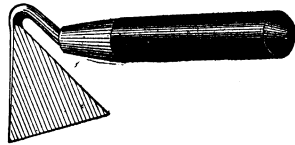


FIGURE 9.—Onion hoe

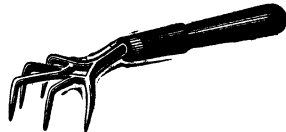


FIGURE 10.—Hand weeder



FIGURE 11.—Thinning or weeding hook

and then worked over with disk and smoothing harrows just ahead of the planters. Within a day or two after planting the land is again flooded and the surface water drawn off; this process is repeated, with alternate cultivations, as often as required. Toward the end of the growing season the water is withheld to allow the bulbs to ripen. As a rule about 10 waterings in all are required, at a cost of about \$2.50 an acre for each watering, or \$25 per acre altogether. Figures 12 and 13 give a good idea of the methods of applying the water in the Bermuda-onion growing district.

In the principal Bermuda-onion growing districts the water for irrigation purposes is obtained only after the expenditure of thousands of dollars for pipe lines and pumping machinery. The cost

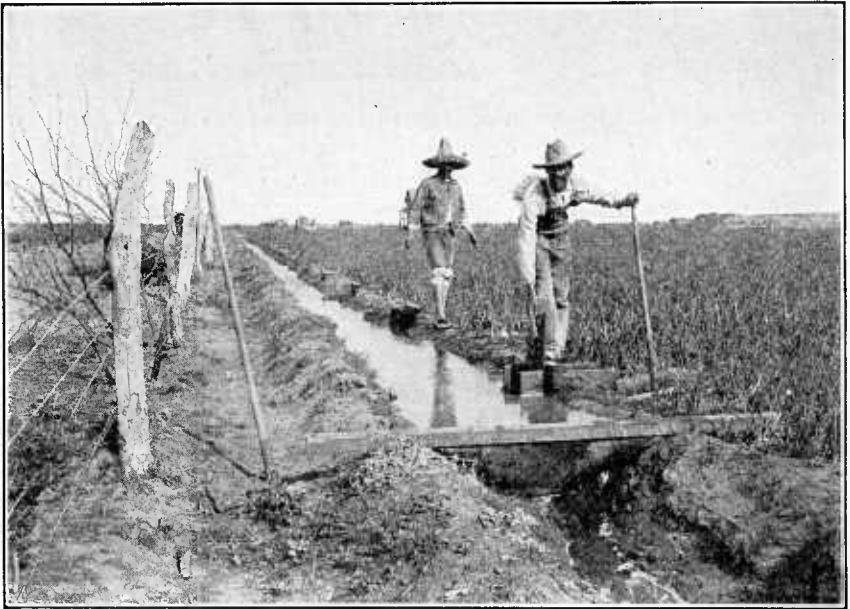


FIGURE 12.—Irrigation ditches in Bermuda-onion field in Texas

of watering as given above does not include any share of the original cost for installation or water charges, but covers only the labor.

HARVESTING AND CURING

In the northern onion districts the crop ripens and is harvested during the latter part of the summer and early autumn. As a rule the work of harvesting onions begins late in July and is practically completed and the crop housed before October. In the Southern States, where the crop is grown during the winter, the harvesting and marketing period is during the spring and is practically ended before the northern product comes upon the market.

In the North the bulbs are allowed to become as ripe as possible before removing them from the soil. Growers prefer that the tops

ripen down and shrivel and that the outer skin of the bulbs be dry before they are pulled. Figure 14 shows a field of onions in prime condition for gathering. To the southward, where the onions are not cured so thoroughly, they are often pulled about the time that the tops begin to break and fall. The ripening process often may be hastened by rolling a very light roller or a barrel over the tops to break them down. This process is frequently spoken of as "barreling."

Where the bulbs are practically upon the surface they may be pulled by hand and thrown in windrows consisting of 8 or 10 onion rows. If the onion bulbs are considerably covered with soil it will be necessary to employ a 1-horse plow or a cultivator with a sweep attached for lifting them. In any case it will be necessary to gather

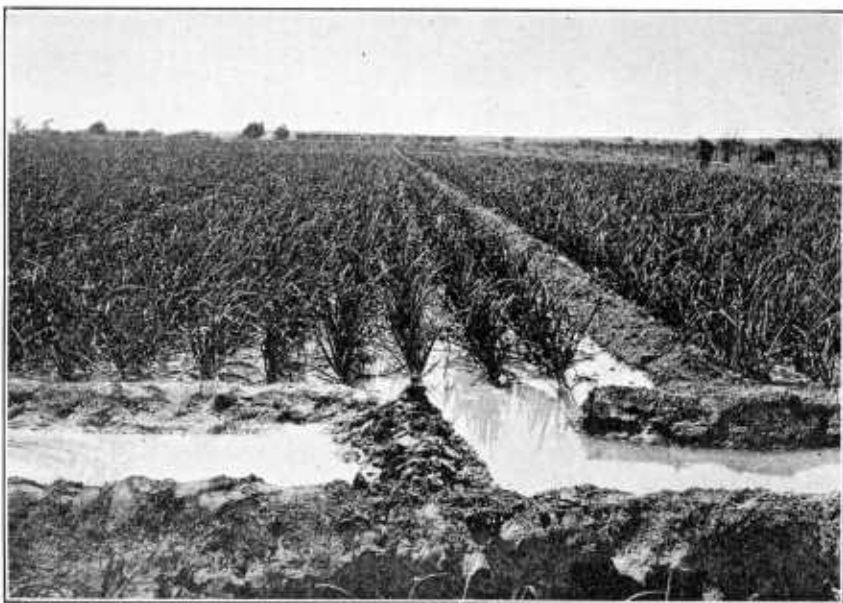


FIGURE 13.—Irrigation of Bermuda onions in Texas

them from the soil by hand. After lying in the windrows for several days and being stirred occasionally with wooden rakes, the tops are removed either by twisting or cutting with ordinary sheep shears. In cases where very bright color is important, as with fancy White Globe onions, and this would be injured by exposure to the sun and rain, the bulbs are cured in long, narrow, low ricks formed by placing several rows of onions laid with the bulbs to the center and the tops to the outside to protect the bulbs. As the tops are removed the bulbs are generally placed in crates for drying. Onion-topping machines frequently are employed, the bulbs being hauled from the field to a central location and run through the topper. These machines remove the tops, grade the bulbs, and deliver them into the crates or bags. If crates are not employed for curing, the bulbs are allowed to lie in the windrows for some time, and are then either

put into sacks or hauled to slat cribs, where the curing process is completed. Too long exposure to hot sunshine will injure the bulbs. Figure 15 shows a field of onions drying in windrows, with crates ready for their removal from the field.

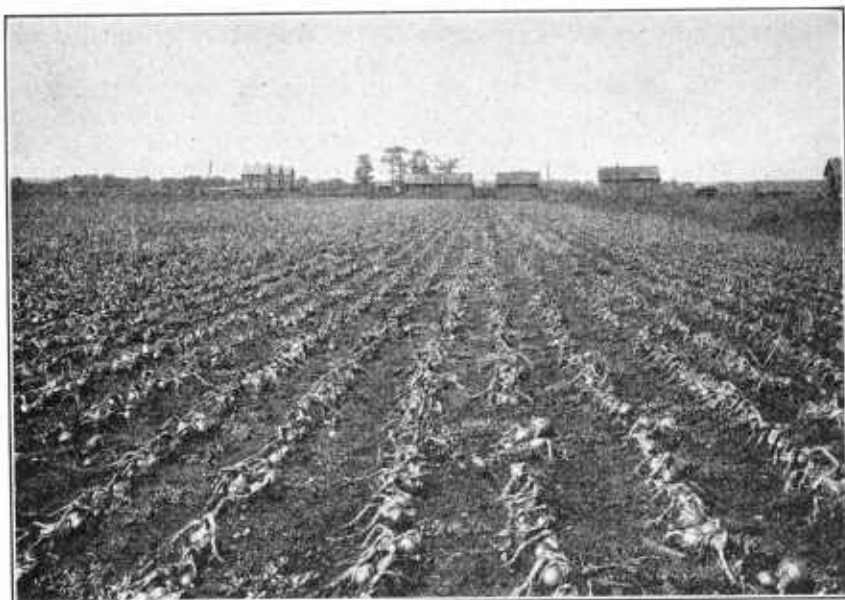


FIGURE 14.—Field of onions in condition for gathering

After gathering into crates, the crates are either stacked in the field, hauled to a central stacking yard where they are covered with boards or canvas, or hauled to open sheds and there piled one upon the other with numerous air spaces until the onions are thoroughly cured.



FIGURE 15.—Onions drying in windrows, showing crates used for curing and storing

Where the bulbs are extremely dry at the time of their removal from the soil, they may be allowed to lie in the windrows for a few days only, and then sorted and cleaned in the field ready for packing and marketing. Where onions are put into sacks and afterwards

allowed to remain in the field, the sacks should be supported on poles laid on the ground, as shown in Figure 16.

In the Bermuda-onion districts, where only a short curing process is given to the crop, it is the practice to pack and load into the cars as soon as possible after pulling and topping. When the shipping is at its height, it is not uncommon for onions that are pulled from the soil in the morning to be in the cars and on their way to market by evening; however, a portion of the crop is given a more thorough curing process, and the entire crop would be benefited by at least two days of curing before shipment.



FIGURE 16.—Method of curing onions in sacks standing in the field

STORAGE

In order that onions should keep well when stored they must be well ripened and thoroughly cured. "Thick necks" or those that are immature, or soft, should never be placed in storage but should be sold as soon as gathered for whatever price they will bring. Good storage onions will rattle almost like blocks of wood when poured from one crate to another. In order that the bulbs may remain bright and of attractive appearance they should not be allowed to lie exposed to the weather, but should be hauled and stored in open sheds just as soon as they may safely be placed in 1-bushel crates.

After the bulbs have remained in drying sheds or cribs for four or five weeks they will be ready for screening and removal to the storhouse. In handling onions it is the rule to pass them over a screen each time they are moved, as in this way the loose skins are removed and any soft or decaying bulbs may be sorted out. When bags are

used for drying in the field, the onions are screened in the manner shown in Figure 17, and the bags refilled for hauling to the storage house.

The essentials for the successful storage of onions are suitable containers, plenty of ventilation, a comparatively low temperature, dryness, and safety from actual freezing. Any building wherein the above conditions may be secured will answer, but houses of the type shown in Figure 18, which are built especially for the purpose, are most satisfactory.

The construction of the storage house should be double throughout, with plenty of felt or paper lining. Both top and bottom ventilation should be provided, and the ventilator openings should have doors that may be closed to control the temperature. The floors are con-



FIGURE 17.—Grading onions in the field by means of a screen

structed of narrow planks with half-inch spaces between the planks for the passage of air. Bottom ventilation is frequently secured by means of drainpipes built into the foundation at the surface of the ground. These pipes are carried some distance toward the center of the house and discharge the cool air at a point where it is most needed.

The temperature of the storage house should be carried as low as possible without actual freezing. During extremely cold weather the ventilator openings and doors should be kept closed to keep out cold air, and after the onions have become thoroughly chilled the house should be kept closed in order to hold the temperature down and prevent the entrance of moisture during warm or rainy periods.

Damp, foggy weather is injurious to onions, especially if it follows a period of cold, and will cause the bulbs to become covered with moisture if the outside air is admitted. A little artificial heat from a stove or radiator may be required during excessively cold weather, but so long as the temperature in the house does not fall below 32° F. there will be no danger of injury. A temperature of 36° to 38° will give good results.

The best method of storing onions is in standard-size slat crates 20 inches long, 16 inches wide, and 14 inches deep, outside measurements. The material for the sides and bottom is about three-eighths inch thick and 2½ inches wide, four pieces being used to form a side. The corners are reinforced on the inside by means of 3-cornered pieces of oak, to which the slats are nailed. These

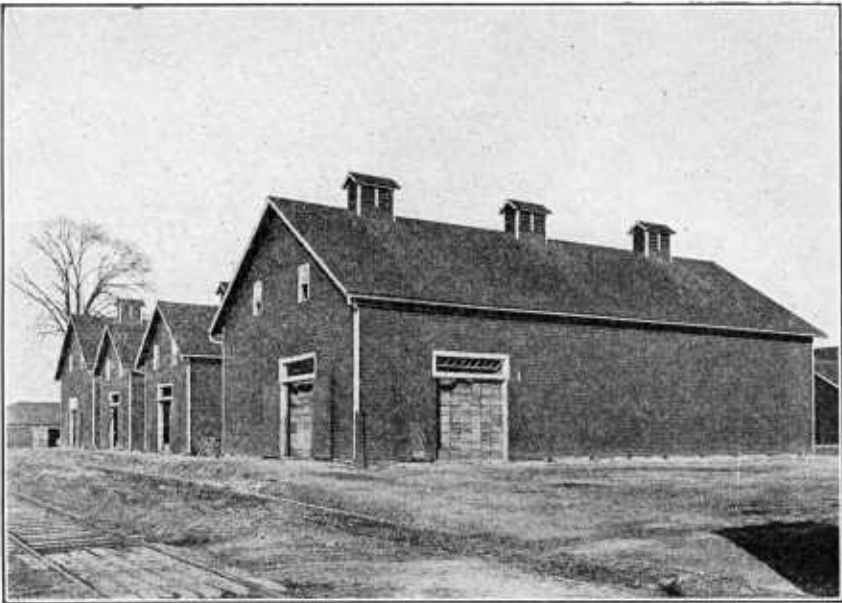


FIGURE 18.—Onion storehouses

dimensions provide crates that are interchangeable, the width of five being equal to the length of four. The crates will also nest together when empty, with one inside of two turned together. The full crates are stacked in the storehouse with 1 by 3 inch strips between them to allow for the circulation of air, as shown in Figure 19.

Onions are sometimes stored in slat bins holding 100 to 300 bushels each. Bags are also used to some extent, but neither bags nor bins are as satisfactory as the crates, on account of the difficulty in providing the necessary ventilation and change of air through the onions. Bulbs stored in bags or bins must be more thoroughly cured than those stored in crates. There are single large storehouses in use that will accommodate 50,000 to 60,000 bushels of onions when stored in crates.

MARKETING¹

Large quantities of onions are sold and shipped direct from the fields where they are grown. A part of the crop is held in temporary storage until late autumn or early winter. During recent years the winter storage of onions has become of great importance, and the finest stock is held for late-winter deliveries. The Bermuda crop from the southwestern part of the country comes on the market during April and May, so that most of the storage onions are disposed of before that time.

In marketing onions the first essential is to properly grade and clean the bulbs, in order that they may present an attractive appearance when offered for sale. Ordinarily the bulbs are separated



FIGURE 19.—Inside of storage house, showing method of stacking crates

into three grades—primes, seconds, and picklers. The primes include all of those $1\frac{1}{4}$ inches in diameter and larger, and the seconds consist of those from three-quarters of an inch to $1\frac{1}{4}$ inches in diameter, while all those that will pass through a $\frac{3}{4}$ -inch screen are sold for pickling purposes. The grading is generally done in the field during the cleaning process, but as onions shrink considerably while in storage it is necessary to regrade before placing upon the market. The type of screen used for grading onions is shown in Figure 20. For cleaning the pickling onions an ordinary fanning mill is employed, special screens being provided for the purpose.

¹ For detailed information on the marketing of onions, see the following: United States Department of Agriculture Bulletin No. 1283, *The Marketing and Distribution of American-Grown Bermuda Onions*, and No. 1325, *Marketing Onions*. No. 1325 is out of print, but may be consulted in libraries.

Onions are placed upon the market in 1-bushel crates, bags, barrels, 1-bushel hampers and baskets, and in bulk. The folding crate, shown in the foreground of Figure 20, is undoubtedly the most attractive package in use for marketing onions. The bags employed are of special open-mesh weave and hold 100 pounds. Onions are sometimes shipped loosely in cars and shoveled into barrels or bags at their destination.

The legal weight of dry onions is generally considered 56 pounds to the standard bushel, although this varies somewhat in different States.

COMMERCIAL VARIETIES

For trade purposes onions are divided into two classes as "strong" onions and "mild" onions. The strong onions include the greater

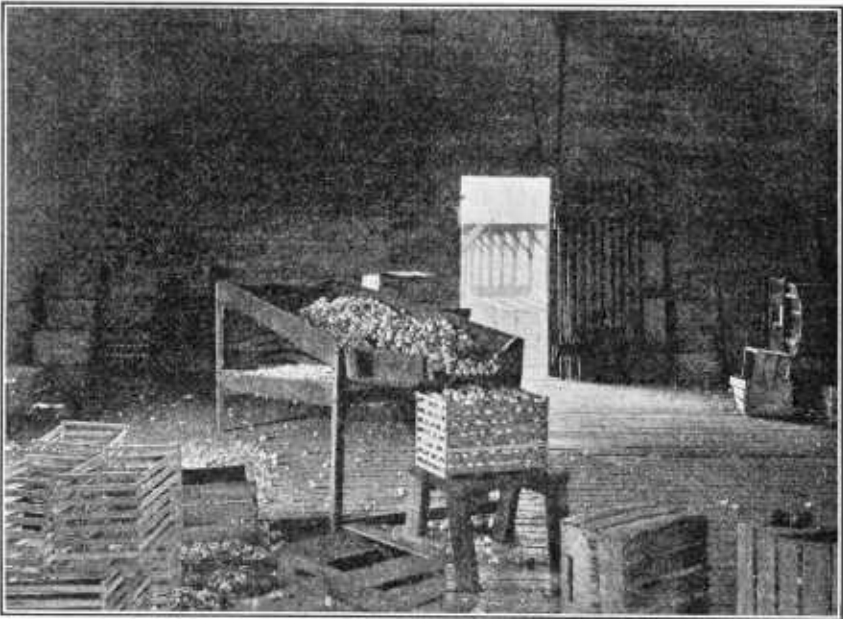


FIGURE 20.—Screen used for grading and cleaning onions, showing folding crates sometimes used for marketing

part of those grown in the northeastern United States and constitute the main storage and winter-marketing crop. This group includes such varieties as Yellow Danvers, Yellow Globe Danvers, Southport Yellow Globe, Ohio Globe, Japanese or Ebenezer, Australian Brown, and Red Weathersfield. The mild-flavored group includes the Red Bermuda, White Bermuda, Crystal Wax, Valencia, Sweet Spanish, and others.

In the selection of varieties for any particular locality the soil and climatic conditions and market requirements should both be considered. Those adapted to the muck soils are the yellow and red sorts. For alluvial and prairie soils the red and brown varieties are to be preferred, while all kinds do well on the sandy loams and light soils. A cleaner, better grade of white onions can generally be pro-

duced on light or sandy soils than on muck or clay loams. Those of the Bermuda, Spanish, and Egyptian types flourish on the deep, rich alluvial soils of the river bottoms and delta regions.

Certain of our markets show a decided preference for onions belonging to a particular type. The red and brown varieties find ready sale on the markets of the Middle West, while onions of the yellow and white varieties are preferred in the eastern cities. Onions will withstand long-distance shipment, those of the mild type being generally more subject to injury than the strong sorts. Some of the white varieties also have a thin skin and are easily injured. It should be the aim of every grower to employ varieties that will withstand handling and at the same time find ready sale on the market.

The top or tree onion, which reproduces by means of small bulbs formed on the top of the seed stalk, is extensively used in the production of early-spring bunching onions.

The multiplier or potato onion reproduces by a division of the bulbs. In growing this variety it is necessary to plant large bulbs to produce sets for the next year's planting and small bulbs or sets for the crop of large onions. The bulbs of this variety may remain in the soil year after year and are desirable for use early in spring.

Garlic is closely allied to the onion, but will remain in the ground from one year to another in a mild climate if undisturbed. Garlic is planted by setting the small bulbs, or cloves, in either the autumn or early spring. The culture is practically the same as for the onion.

The leek also belongs to the same class as does the onion, but requires somewhat different treatment. The seed is usually sown in beds and the plants transplanted about 4 inches apart in the row. The plants of the leek are given about the same cultivation as onions, except that after they have attained almost full size the soil is drawn around them to a height of 6 or 8 inches to blanch the fleshy stem. The leek does not form a true bulb like the onion, but the stem is uniformly thick throughout. Leeks are marketed in bunches, like young onions, and they may be stored in cellars for winter use.

PRODUCTION OF BERMUDA ONIONS

Bermuda onions are now an important commercial crop in Texas and California, with small plantings in a number of the Southern States. The Bermuda onion fields of Texas are located around Laredo and other points in or near the Rio Grande Valley.

SOILS AND CLIMATE ADAPTED TO THE BERMUDA ONION

Soils of a silty or alluvial nature are suited to the production of Bermuda onions, and those containing considerable sand are most desirable. As already noted in referring to fertilizers for onions, the Bermuda requires a very rich soil for the best results, and this can only be obtained by first selecting a good soil and then manuring heavily. The Bermuda onion as grown in this country is a winter crop; therefore, mild climatic conditions are required. While the plants would withstand considerable freezing, their growth is seriously checked by cold weather, and the crop will not mature in time for the early market if grown to the northward.

CULTURAL METHODS

The cultural methods employed in the growing of Bermuda onions are essentially the same as those for ordinary onions. As the greater portion of the crop is grown in a region which has no regular rainfall, irrigation methods are employed almost universally. The greater part of the crop is grown by the transplanting process and a great amount of hand labor is required. The seeds are sown in specially prepared outdoor beds from the middle of September to the middle of October, and the seedlings are transplanted to the field November 20 to January 10, or even later. From 3½ to 4½ pounds of seed are required for each acre to be planted; this will allow for discarding all the weaker plants. The plants are allowed to remain in the seed bed until they are from three-sixteenths to one-fourth inch in diameter before they are transplanted. As the seedlings are lifted the greater portion of both the small roots and the tops is trimmed off in order that they may be transplanted more readily. (Fig. 4.)

HARVESTING AND MARKETING

Bermuda onions are harvested as early as possible, generally before the tops have become fully ripened. For removing the bulbs from the ground a 1-horse plow, a potato digger, or a cultivator with a cutter wing attached is employed. The bulbs are then separated from the soil by hand, the tops cut off with shears, and the onions thrown in windrows or piles to dry in practically the same manner as for the regular-crop onions in the North. After the bulbs have become thoroughly dry on the surface they are either placed directly in the crates for shipment or are carried to a packing shed to be graded and packed for market.

During the early days of the Bermuda-onion industry the crop was shipped largely in bags, but it was soon found that the bulbs were too perishable for this method of handling. At present the greater portion of the crop is sent to market in folding slat crates that are about 20 inches long, 12 inches wide, and 12 inches high.

These crates hold approximately 50 pounds of onions and weigh 56 or 57 pounds when filled. The cost of these crates is about \$20 a hundred, but they add enough to the attractiveness and carrying qualities of the onions to make their use profitable.

YIELD OF BERMUDA ONIONS AND PRICES OBTAINED

Phenomenal yields of 34,000 and 35,000 pounds of Bermuda onions are frequently made on an acre of land, but this is far above the general average, which is in the neighborhood of 10,000 or 12,000 pounds to the acre. Many fields, especially when planted for the first time, do not yield as much as 10,000 pounds to the acre. On land that has been heavily manured and planted to onions for several years the yield averages about 16,000 pounds.

The best Bermuda-onion farms are valued at \$300 to \$500 an acre. In order to prove profitable, the growing of Bermuda onions should be conducted on a comparatively large scale. The necessary land and irrigation facilities will require the initial outlay of from \$10,000 to \$30,000, and the running expenses are quite heavy. Labor can be

secured at a low price, but is correspondingly inefficient and often not to be had in sufficient quantities. Furthermore, the markets are now pretty well supplied with Bermuda onions, and persons who desire to engage in their production are advised to investigate every phase of the industry before embarking too heavily in it. The expansion of the Bermuda-onion industry is limited by the facts that a large supply of bulbs can be grown on a comparatively small area, that the distance to market is great, that the product is perishable, and that the markets will consume only a limited quantity at the prices at which the crop can be sold with profit.

GREEN ONIONS FOR BUNCHING

Another phase of onion culture that is of considerable importance in certain localities is the production of young bunching onions for the early spring trade. In several sections along the South Atlantic coast the growing of this class of onions is quite an enterprise. Many persons who are engaged in other lines of work follow the practice of growing a small area of bunching onions as a side issue.

The varieties known as multipliers and top onions are generally employed for this purpose; however, bunching onions are sometimes grown from ordinary sets, from inferior and damaged large onions, and from seed.

CULTURAL METHODS

For growing bunching onions the bulbs or sets are planted during the autumn either in beds or in rows 12 or 14 inches apart with the bulbs quite close in the rows. The bulbs will start growing within a short time and make more or less growth during the winter. As soon as the weather becomes warm during the first months of spring the onions make a rapid growth and are ready for marketing about the time peach trees begin to bloom.

The land upon which these onions are grown should be rich and mellow, but very little actual cultivation will be required. Where the winters are severe it may be necessary to provide slight protection, either a little straw, loose manure, leaves, pine straw, or corn fodder that has been run through a shredder. If the onion beds are protected on the windward sides by means of a windbreak consisting of a grove of pine trees, a fence of boards, pine boughs, or corn fodder, the crop will be ready for marketing a little earlier than if left exposed. Multiplier onions not gathered for marketing are allowed to remain to form the bulbs for planting the following season.

MARKETING

In marketing this class of onions the young scallions are pulled, the roots trimmed, and the outside peeled off, leaving the stem white and clean. They are then tied in small bunches by means of soft white string, the tops trimmed slightly, and the bunches packed in crates or baskets for shipment or for sale on the local market. This phase of the onion industry is limited to small plantings and is well suited to the general market garden.

During the spring and early summer large quantities of ordinary young onions are pulled when the bulb is about the size of a 50-cent

piece, the roots and tops are trimmed, and they are then bunched and sold for stewing purposes. So far as known, this class of onions is not shipped to any great extent, but is sold mainly on local markets.

DISEASES OF THE ONION

The onion crop of the United States is by no means free from disease. For information regarding such diseases and measures of control, the reader is referred to Farmers' Bulletin 1060, Onion Diseases and Their Control, published by the United States Department of Agriculture, Washington, D. C.

ONION INSECTS AND THEIR CONTROL

In the United States the onion crop has only two serious insect pests. Of these, the onion thrips (*Thrips tabaci* Lind), because of its distribution over the entire country, is probably the most injurious. It is nearly always present on onions, and under favorable conditions it may increase to such an extent as to become very destructive. The onion thrips is a very small louselike insect, pale brown in color, and usually is first noticed because of the minute whitish spots which it leaves on the tips of the foliage after rasping away part of the leaf surface in feeding. The eggs are laid just beneath the surface of the leaf, and the insects, in both the mature and immature forms, feed on the surface from the sheath to the tip. In serious infestations the tops of the onions become grayish white, afterwards turning brown and dying. At such times the leaves, if examined, may be seen to be covered with thrips.

The onion thrips is particularly injurious in the South, and in the Texas Bermuda-onion district it is a constant menace to the crop. It is particularly likely to injure plantings which follow or are adjacent to such early crops as cabbage, from which the thrips migrate in great numbers at harvest time. A vigorous, strongly growing onion crop may grow away from thrips injury, but if for any reason growth becomes badly checked, damage is almost sure to result.

Recent experiments² have shown that the thrips can be controlled and the yield materially increased by the use of naphthalene dust. Crude naphthalene is crushed with a heavy roller on a cement floor and sifted through a 50-mesh screen. Forty pounds of the naphthalene is mixed with 60 pounds of hydrated lime. To be most effective the dust should be allowed to stand in a tight container for at least 24 hours.

The dust is applied at the rate of 200 pounds to the acre. The first application should be made when the injury first becomes apparent and repeated at intervals of about a week. The dust is applied with a rotary hand duster or with a power duster attached to a garden tractor. The dust is directed into the crown of the plants. The applications should be made in the morning while the air is still and the plants are wet with dew. From 3 to 5 applications, depending on the severity of the infestation, are required.

² Cornell University Extension Bulletin 206, Diseases and Insects Affecting Vegetable Crops.

Thrips may be fairly well controlled by spraying with nicotine at the rate of three-fourths of a pint of a 40-percent solution to 50 gallons of water in which 4 pounds of soap has been dissolved. Use a high-pressure sprayer and hold the nozzle close to the plants, as thrips often feed and remain protected in the leaf sheaths and creases. Clean up weed patches near the onion fields and rake together and burn the onion tops as soon as the crop is harvested. The grower should examine his onion plantings from time to time in order to detect the early stages of the infestation. It is easier to keep an infestation down by early treatments than to control a heavy infestation.

In the northern part of the United States the onion maggot (*Hylemyia antiqua* Meig.) often becomes very destructive, especially to small seedling onions. This pest is a white, footless maggot, the larva or young of a fly much resembling the common house fly, and is about three-eighths of an inch in length when full grown. The eggs are laid by the fly early in the spring, and are placed, in the case of seedling onions, on the ground near the plant, or in the sheaths of the leaves near the ground. On hatching, the young maggot burrows into the plant and bores through the stem and bulb, easily killing small seedlings. After killing one plant it proceeds to the next, thus causing many skips in the row. When larger plants are attacked, several larvae may be found in the bulb.

A remedy that has been used successfully in some sections consists of treating the soil about the plants with a bordeaux-oil emulsion. The emulsion is best applied to the onion rows by means of a sprayer, the material being directed to the base of the plants. Enough of the material should be applied to moisten the soil at the base of the plants. The bordeaux-oil emulsion may be prepared by adding 1½ gallons of oil emulsion, suitable for use against orchard scale insects, to 48½ gallons of 4-4-50 bordeaux mixture. Apply five times at weekly intervals, beginning when the young plants are about an inch high. An effective treatment requires about 115 gallons of the spray per acre.

Cutworms are sometimes troublesome, but are easily controlled by the bran mash and arsenic bait, scattered thinly wherever the young seedlings have been found to be cut off.³

PRESENT STATUS OF THE ONION INDUSTRY

Because of variations in the cost of labor, tools, fertilizers, seed, and other materials and the many factors involved in the production of an onion crop it is impossible to give definite cost and profit figures. The average yield of onions is around 290 bushels to the acre, but yields of 400 to 600 bushels are not uncommon. The price of onions is extremely variable one year with another, but on the whole the crop has proved profitable to the growers when taken on an average for a period of years.

In some sections onions are grown in rows 3 feet apart and given horse cultivation, thus reducing the yield to about 150 bushels on an acre and cutting down production costs in proportion. This method of growing onions is especially adapted for use on low-priced land and where hand labor is scarce.

³ For further information write to the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Washington, D. C.

Both the supply and demand for onions are increasing and at present bear about an equal relation to each other. Some years the supply falls a little short and the prices go somewhat higher, with the result that larger quantities are imported. The following season the plantings are generally heavier, the market may be a little slow, and the result will be low prices and a great many people will discontinue the growing of onions or reduce their acreage.

Prices of onions, especially the Texas-grown Bermuda onions, are greatly influenced by importations of Egyptian onions which appear on our markets about the same time of the year that the Bermuda onions are being marketed. The ease with which both the Egyptian and the Spanish onions can be delivered to our eastern markets as compared with the long freight haul from southwestern Texas or Pacific Coast States renders the position of the American grower of Bermuda and other mild onions more or less hazardous. Despite this condition, however, both the Bermuda and the Spanish onion industries have become well established in the United States. The American grower of Bermuda onions is still dependent upon the Canary Islands for his seed supply.

Recently the production of the large Sweet Spanish or Valencia type onion has become well established in a number of the Western States, and with the present tariff rate in effect on imported Spanish and other onions American growers are in position, under normal crop conditions, to fully supply the principal markets of the United States. American growers of the Sweet Spanish or Valencia type onions are no longer dependent upon imported seed, as an adequate supply is now being produced by the California and other western seed growers.

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