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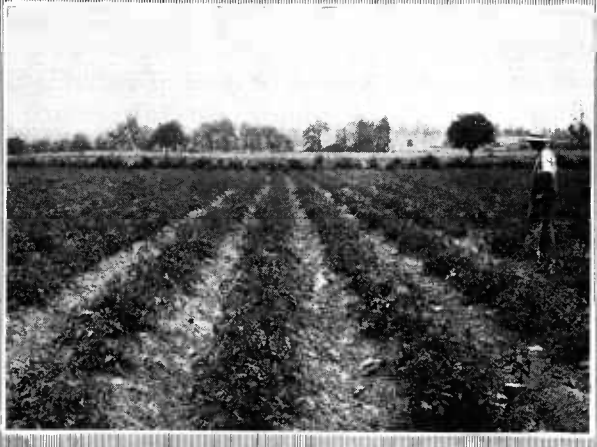
TOMATOES *for* CANNING *and* MANUFACTURING



THE TOMATO is among the first in value of the vegetable canning crops. A large portion of the crop is canned or made into soups, purées, and other products.

In the United States from 250,000 to 300,000 acres are devoted to the crop annually for canning and manufacturing purposes. The yield is about 1,000,000 to 1,250,000 tons.

The industry is widely scattered over the United States, but Maryland, New Jersey, Virginia, Indiana, and California produce a large part of the crop.

The practice of a farming system that will keep the soil well supplied with available plant food is essential to success.

Good soil, good disease-free seed of suitable varieties, strong well-grown plants, careful setting, good cultivation, and control of diseases are essential to good yields and satisfactory returns.

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TOMATOES FOR CANNING AND MANUFACTURING

By JAMES H. BEATTIE, *senior horticulturist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry*

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IMPORTANCE OF THE CROP

THE TOMATO is one of the few vegetables of American origin that have attained great commercial importance. Introduced into the United States about 1800, it was for a long time looked upon largely as an ornamental plant. Owing to its relation to the nightshade family, it was regarded with suspicion and was said to be poisonous, and it was not until after this strong prejudice had been broken down that its cultivation began to attract attention and its use became general.

About the middle of the last century canned tomatoes were introduced as an article of trade, and the tomato-canning industry soon attained considerable importance. In 1887 the total pack of canned tomatoes in the United States was about 3,000,000 cases, each case containing two dozen No. 3 cans, each holding approximately 1 quart.

Tomato production has grown until the tomato now occupies third place among the vegetable crops in value, being exceeded only by potatoes and sweetpotatoes. In recent years the area devoted to the tomato crop has amounted to about 400,000 acres, approximately two-thirds of which has been grown for canning and manufacturing purposes. The value of the crop has reached a total of over $50,000,000, of which about $20,000,000 represents tomatoes grown for canning and manufacture.

The popularity of the tomato, as well as of the canned products made from it, is due to its pleasing acid taste, which is retained to a very large extent in the manufactured goods, and to its cheapness.

DISTRIBUTION OF THE TOMATO-CANNING INDUSTRY

The tomato is a crop requiring a moderately warm climate and a long growing season for its best development. In the Northern States, where the frost-free season is too short for maturing the crop out of doors, it can be grown by starting the plants indoors, thus prolonging the growing season by several weeks. By following this practice it is possible to grow tomatoes in a commercial way in regions where the industry could not otherwise flourish. In climates where its growth is not interrupted by frost the tomato is a perennial plant, but in the portions of the United States where the tomato-canning industry has attained its greatest importance the tomato is treated as an annual.

Climatic conditions, nearness to market, labor supply, soils, and other factors have all had an influence in the development of the in-

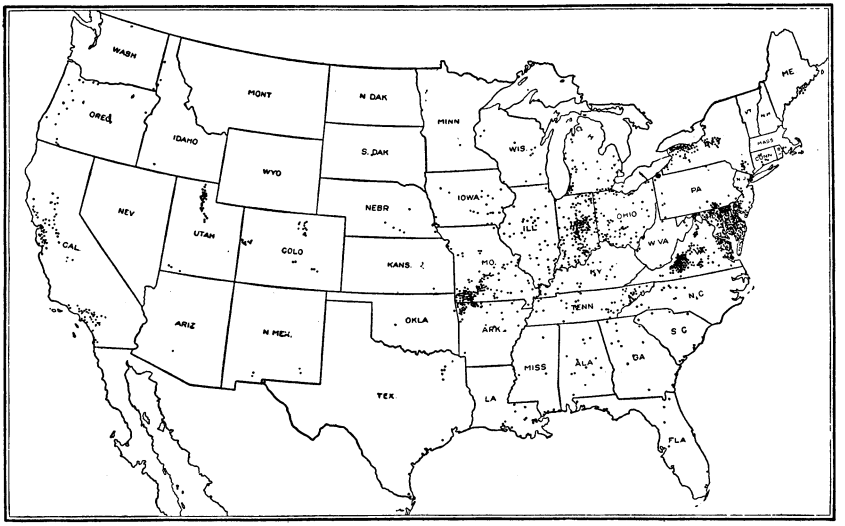

FIGURE 1.—Map of the United States, showing the distribution of the tomato-canning industry. Each dot represents one canning, soup, purée, or other tomato-product factory

dustry in Maryland, California, Indiana, Missouri, Delaware, New Jersey, New York, Utah, Illinois, Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia, where the major portion of the tomatoes grown for canning and manufacturing are produced.

The geographical distribution of the industry is indicated in Figure 1, each dot on the map indicating a factory devoted to the canning or the manufacture of tomatoes into soups and other products.

While many of these factories may be operating under serious economic disadvantages, the map shows that tomatoes for canning and manufacturing are being grown and packed over a considerable portion of the United States.

While the high temperatures and hot sun of the lower South are not well suited to the growing of tomatoes for canning and the northern limit of their growth is established by the short growing season of the northern portion of the United States, it does not follow that

the present distribution of the industry is in all cases economically sound. Within the climatic range to which the tomato is adapted it is not particularly exacting as to soil requirements. Any good soil suitable for general farm crops can readily be adapted to the growing of tomatoes for canning. The plant requires from 80 to 110 days from seed to come into bearing, but about one-third of this period can be spent in the greenhouse, the hotbed, or some other protected place, and the fruiting period of the plant can in this way be considerably lengthened. The plant bears until killed by frost unless injured by drought, insects, or diseases; hence, the longer the producing season the higher the yields. During the producing period the plant does best when the day temperature is from 80° to 90° F. and the night temperature about 60°. The crop requires about the same amount of moisture as other farm crops grown in the sections to which tomatoes are adapted.

From a consideration of these factors it is apparent that large areas lying in a broad belt between the extremely hot lower South and the short growing season areas of the North are, as far as the climatic requirements of the plant are concerned, well adapted to the growing of tomatoes for manufacturing purposes. The very fact that the tomato can be so easily produced under a wide variety of conditions has in the past led to the development of the industry in sections where there have been and are few economic reasons for its continuance. In sections where the soil is very light, requiring large quantities of organic material and commercial fertilizers and where the crop is easily injured by drought, and where, as a rule, under such conditions the yields are low, growers are at a serious disadvantage. When the crop is grown for canning only and where nearness to market is not essential, it would be better to center the industry in sections where the soil and climatic conditions are favorable for large yields over a long period.

METHODS FOLLOWED BY CANNERS TO OBTAIN A SUPPLY

Canners secure their supply of tomatoes either by contracting with growers for a definite acreage, by growing them themselves, or by buying them in the open market.

It is difficult, however, for the canners to safeguard a sufficient supply without some form of contract with growers. In some cases a plan has been devised whereby the growers are guaranteed a fixed minimum price for their tomatoes, this price being sufficient to return them the cost of growing the crop, and the final settlement is made on the basis of the price received for the canned goods. Some such plan as this may obviate many of the difficulties experienced in the past. Canners and growers should realize that their interests are in common and that each is indispensable to the other. The canner must have tomatoes if he is to operate his factory, and he in turn gives the grower a ready market for his crop.

Some of the large canning companies now produce a large percentage of the tomatoes they require on land either owned or leased by them. Such companies maintain a farm department, with the necessary equipment to plant, care for, and handle the crop. This plan has many points in its favor, but is hardly practicable for any

but the small canner handling the product of his own farm or for the very large concern able to command sufficient resources to produce the crop along the most advanced lines. Where a sufficient supply can be obtained from the farmers, most firms prefer to devote their whole energies to the manufacturing end, leaving the growing of the crop to the farmers.

Few canners depend on buying their entire supply on the open market, preferring as a rule to contract for at least 90 per cent of their requirements. Some large manufacturing firms follow the practice of buying the surplus stocks of tomatoes on certain markets available to them when the price drops to a specified point. Part of the surplus is thus taken off the market, and this acts as a safety valve, the growers being guaranteed against the entire loss of this part of their crop.

Whether the farmers have a direct financial interest in the cannery end of the business or not, there should be sufficiently close relations between the farmers and the canners to permit the employment of every agency to increase the yields and make the industry a profitable one to both, for unless the business gives the growers and canners reasonable returns, they can not be expected to continue the production and the packing of this crop.

Within the last few years the growing and canning of tomatoes have not been uniformly profitable to growers and canners. The average yield for the past few years in the Tri-State territory has been less than 4 tons per acre and in Indiana less than 5 tons per acre. Some growers in these States have uniformly obtained much higher yields, 10 to 12 tons per acre being quite common. Growers who expect to make a success of tomato growing must obtain good yields, and the purpose of this bulletin is to point out some of the practices that have proved successful in increasing the yields of tomatoes.

CROP ROTATION

A crop rotation that will keep the soil in good physical condition and well supplied with organic matter is particularly desirable on farms where tomatoes are grown year after year. The rotation should not include such crops as potatoes, peppers, or eggplants, as these are related to the tomato and liable to spread the diseases affecting the tomato. A rotation that includes at least one crop of clover or cowpeas is extremely desirable. It is too often the practice to relegate the tomato crop to the poorest part of the farm, using the good ground for other crops. The crop should be placed on good ground if success is to be expected. For details as to the rotation best suited to local conditions, the county agent should be consulted.

The particular method to be followed must be determined by the conditions found on each farm, but the purpose should be to keep the ground occupied at all times with some crop that is adding vegetable matter to the soil, preferably one that is adding plant food in the form of nitrogen. It should be remembered that even the non-nitrogen-gathering green-manure crops add to the fertility of the soil by making available much of the insoluble plant food found in most soils, as well as by adding organic matter.

SOILS FOR TOMATOES

Tomatoes can be grown on a wide range of soil types. They are successfully produced in commercial quantities on soils varying from mucks to clays and from clays to comparatively light sands. Light soils, however, are open to the objection that they suffer severely from drought and are hard to keep supplied with organic matter and available plant food. On the other hand, such soils are easier to work, are usually earlier, and the cost of preparing the ground and planting and caring for the crop is less than for heavier soils.

The tomato is very sensitive to poorly drained soil, and such ground should never be used for the growing of this crop. The land should be in a high state of fertility and in good physical condition as a result of proper treatment during previous seasons and should not have been in tomatoes, potatoes, peppers, or eggplants for at least three years. Crops that are closely related to the tomato may serve as host plants for various diseases which may later attack the tomato crop.

PREPARATION OF THE SOIL

Where fall plowing can be done without sacrificing well-established cover crops, it is in many cases desirable. On heavy soils, where it is possible to practice it without injury to the soil through leaching and washing, fall plowing is a good custom, as it promotes more thorough decay of roots and other organic matter in the soil and, owing to the alternate freezing and thawing, puts the soil in better physical condition. Plow as deeply as the soil will permit, and gradually increase the depth of plowing by half an inch each season until the soil is plowed at least 8 inches deep. It is not desirable to increase the depth of plowing suddenly so that large quantities of subsoil are brought to the surface, but through gradually deepening the plowing the surface soil can be increased in depth without affecting the present crop. The final result will greatly improve conditions for the growing of tomatoes and other crops. In case a cover crop or sod is to be plowed under, disking is recommended before plowing, as this will hasten the decay of the material being turned under. The preparation of the land after plowing should be more thorough than is ordinarily given for general farm crops. Before setting the plants the topsoil should be well pulverized to a depth of 3 or 4 inches.

MANURE

Many growers prefer to apply stable manure to the crop preceding tomatoes rather than to the tomato crop itself. Unless the soil is exceedingly rich in available plant food, however, there is no objection to the application of moderate quantities of well-rotted stable manure directly to the tomato crop. If the manure is short, it may be applied broadcast as a top-dressing and worked into the soil before planting. The application of 10 to 12 tons per acre is desirable, but owing to the increasing scarcity of stable manure growers of canning tomatoes as a rule can not depend upon this material for the maintenance of their soil. They should, through proper farm

practices, keep the soil well supplied with organic matter obtained by growing and turning under such crops as crimson clover, cowpeas, soybeans, rye, vetch, and winter oats.

COMMERCIAL FERTILIZERS

Judicious use of commercial fertilizers will, in most cases, pay good returns; but, as pointed out in previous paragraphs, it is far better to use soil that is in good physical condition and well supplied with plant food through years of proper treatment than it is to depend upon heavy applications of commercial fertilizer to improve the crop. However, moderate applications of commercial fertilizer to the tomato crop usually give a profitable increase in yield. Experimental work in Maryland, Missouri, New York, Pennsylvania, and elsewhere shows clearly that greatly increased yields result from the use of phosphorus. In Maryland, and to some extent elsewhere, potash also gives good returns. Unless the grower knows that his soil needs only one of these elements, it is best to use a complete fertilizer. On account of the bad effect of large amounts of nitrogen on the setting of the fruit, this element should be used cautiously. While only general recommendations can be given here, a fertilizer containing 3 to 5 per cent nitrogen, 8 to 12 per cent phosphorus, and 3 to 5 per cent potash, and used at rates varying from 400 to 800 pounds per acre, depending on the fertility of the soil, will usually give good returns. Not more than 400 pounds per acre should be used under the rows, and this very thoroughly mixed with the soil before setting the plants. The remainder of the application, if any, should be broadcast before the plants are set.

As a rule the lighter soils demand heavier applications of fertilizer than the heavier ones.

When moderate applications of manure are made, 400 pounds of a fertilizer with 4 per cent nitrogen, 12 per cent phosphoric acid, and 4 per cent potash per acre in rows under the plants will be sufficient.

VARIETIES AND SEED

Poor yields of tomatoes are often due to the use of poor seed and unsuitable varieties and in some cases to the use of mixed seed. Next to poor soils the greatest menace to the industry is poor seed, especially the promiscuous cannery-run seed which is saved from catsup and tomato-pulp manufacture. Cannery-run seed is often a mixture of varieties, frequently carries disease organisms affecting the fruits as well as the young plants, and is never saved from selected stock. Its use can not be too severely condemned. Two ounces of good seed will produce an abundance of plants to set an acre. Even though good seed may be expensive, its use is advisable.

Satisfactory tomato seed suited to the growers' conditions can be purchased from dealers who have made a specialty of its production. It is also possible to secure excellent results by associations of growers saving their own seed. If it is advisable for an association of growers to unite their efforts and save enough seed for the use of the entire membership of the association, this work can readily be done by one or two growers who have satisfactory facilities for producing the seed. The selection of seed from a high-yield field

will help, but such selection will never develop a very high strain, since the plant itself is the unit that must be considered.

Considerable progress has been made within the last few years in the development of strains of tomatoes resistant to wilt. Among these should be mentioned Marvana, an early sort; Marglobe, Marvel, and Marvelosa, second-early varieties; and Norton and Columbia, late kinds. Marglobe is the most extensively grown of these disease-resistant sorts. For early nonresistant varieties the Bonny Best is largely used. For late nonresistant tomatoes the Greater Baltimore, Stone, and Indiana Baltimore are satisfactory.

GROWING THE PLANTS

A number of disease-producing parasites invade the seed coats of tomato seed, and others are borne on the surface of the seed. To eliminate these seed-borne organisms as far as possible, the seed should be treated with a fungicide before it is sown. This costs but little, and it is a wise precautionary measure. The treatment may be done (1) by soaking the seed for 5 minutes in a mercuric-chloride solution of 1 part by weight to 3,000 parts of water, followed by washing 10 to 15 minutes in running water, or (2) with one of the organic mercury compounds.

Much attention should also be given to the soil and other materials used in plant beds. It is best where possible to use soil that has not grown tomatoes or related plants within several years. The use of manure containing old tomato or related plant remains may result in the inoculation of the seed bed with the blight fungi. If manure is used in the plant bed, or if collar rot or blight is known to be in the soil, it is well to dust 1 ounce of powdered copper carbonate on each square yard of soil in the plant bed. A formaldehyde solution, 1 pound of commercial formaldehyde (formalin) to 30 gallons of water, used at the rate of 1 gallon to each square foot of bed surface, is extensively employed for the treatment of tomato seed beds. Soil treated with formaldehyde should not be used until the odor of the formaldehyde disappears. Steam sterilization is another effective method for controlling seed-bed diseases and killing weed seeds.

Strong, well-developed plants are essential to the production of profitable crops of tomatoes. The method to be followed in obtaining these plants must be determined to a large degree by the geographical location of the grower, by the equipment available, by the time in the season the plants are needed, and by the desired size of the plants themselves. As already pointed out, the growing season can be lengthened several weeks by growing the plants indoors, as it is possible with proper facilities to have them well advanced when set in the field. In some sections the canners grow the plants, charging their growers the cost of the plants. In other cases several farmers unite to grow enough plants for the needs of all, dividing the cost among them. Perhaps the most general practice is for the individual tomato growers to start their own plants, making use of whatever facilities they may have. Whatever the method followed in obtaining the plants, the aim should be to secure plants that are free from disease and that can be moved from the plant bed to the

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field with a minimum amount of shock. It is obvious that the grower who is so situated that it is possible for him to grow his plants can, with proper precautions, produce stronger and healthier ones than would be possible with plants grown at a distance. Such plants can be moved from the plant bed to the field without much shock to them, a result which is sure to follow when they are shipped long distances.

THE OPEN SEED-BED METHOD

The method of growing tomato plants in the open on a specially prepared piece of land is very largely followed in Delaware, Maryland, New Jersey, Virginia, and other sections where canning tomatoes or plants for sale to canners are grown. The common practice of using the same area year after year for the seed bed is open to the objection that such ground is liable to become infested with diseases, such as collar rot. When it is necessary to use an old seed bed, it should be sterilized with steam, hot water, or formaldehyde. Such a practice is an effective insurance against certain diseases and is well worth the necessary effort. Directions for sterilizing seed beds may be found in Farmers' Bulletin 1629, United States Department of Agriculture.

Unless it is possible to sterilize the seed bed thoroughly each year, it is better practice to select a fresh area for the plant bed. A common practice is to burn large quantities of brush on the area, thus destroying many weed seeds and adding considerable quantities of potash to the soil.

The seed bed is, as a rule, prepared in the early spring, and as soon as the ground is warm the seed is sown in drills from 12 to 14 inches apart with from five to six seeds to the inch. The seed should be covered about one-half inch deep, provided the soil is of a light texture, and not over one-fourth inch deep if the soil is of a heavy or clayey nature. On heavy soil it is well to cover the seed with a half inch of leaf mold or compost to prevent baking of the soil. A hand seed drill so regulated that it will give uniform distribution is the best device for distributing and covering the seeds. Under favorable conditions an ounce of seed will produce enough plants to set an acre, but it is usually best to use 2 ounces. After the plants are up, they should be thinned to stand about 1 inch apart in the rows.

This method of growing tomato plants, while very largely followed, is open to several very serious objections. In the first place, the plants can not be produced sufficiently early in the season for the best results. While the method gives great numbers of plants at low cost, it should not as a rule be followed. One of the greatest handicaps to the tomato industry to-day is the use of poor plants, and the open seed-bed method of growing plants as a rule does not give the best plants. It is far better to employ a method that will give better plants, even though the cost is higher.

THE HOTBED-COLDFRAME METHOD

A method frequently followed, and one that usually gives good results, is to sow the tomato seed in hotbeds heated either by manure, coils of steam or hot-water pipes, or a flue, some six weeks before the time to set the plants in the field. The seed is sown in drills, as in

the case of the outdoor seed bed, although it may be sown more thickly in the row than would be permissible were the plants to grow in this position until taken to the field. About 10 days to 2 weeks after sowing the seed the plants should be ready for transplanting to coldframes fitted with sash or with muslin covers, to protect them from occasional frosts. These coldframes have from 3 to 4 inches of thoroughly fine and well-rotted potting soil, in which the plants are set, spacing them about 3 inches apart each way. They are allowed to grow in this position until time to move them to the field. During their growth in the coldframe the sash or cover is gradually removed, keeping the temperature as low as practicable consistent with safety to the plants. This practice tends to give strong, stocky plants that will not suffer much shock when shifted to the field. During the later stage of growth the covers are removed entirely. (Fig. 2.)

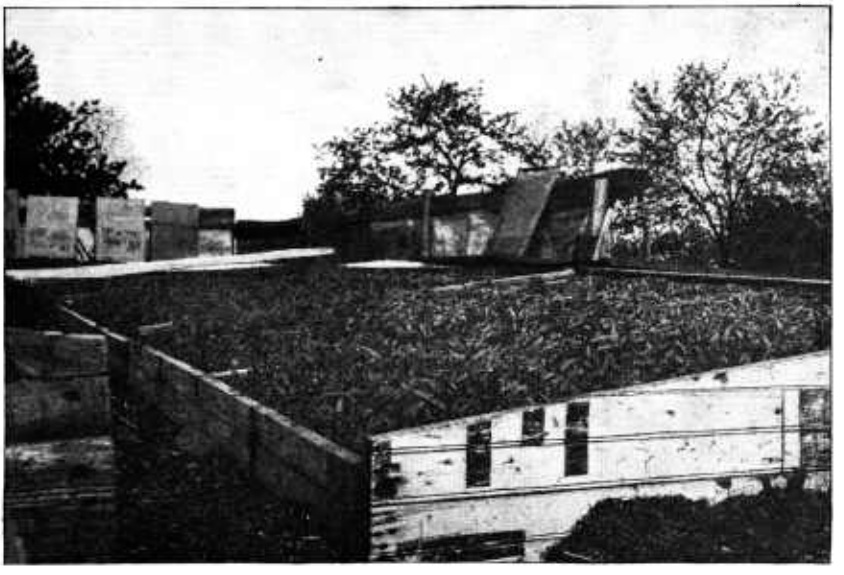

FIGURE 2.—Coldframe occupied by a crop of strong, well-hardened tomato plants. The covers are held in readiness for a sudden cold night

When the time comes to set them in the field, the root system of the plants will have spread through most of the top layers of soil, and the usual practice is to cut the plants apart with a spade or a trowel, allowing each plant to retain its square of soil with as little disturbance of the root system as possible. The plants are set in shallow boxes, or flats, and transported to the field, and when set in position with care need suffer little disturbance.

A modification of this method is to transplant seedlings to flats, or shallow boxes, instead of to the coldframe direct, setting these flats in the coldframe, so that when planting time comes these boxes can be moved to the field and the plants cut apart and set directly into the open ground. When such boxes are available this plan is an excellent one to follow and with proper care gives strong, healthy plants. (Fig. 3.) The seeds are also sown thinly in the hotbed or the coldframe and the plants moved directly to the field without transplanting.

GREENHOUSE-GROWN PLANTS

Another method that gives good results is to sow the seed in flats in the greenhouse, covering it with leaf mold and sand. (Fig. 4.)

FIGURE 3.—Transplanting tomato seedlings to flats, where they are allowed to grow until it is time to set them in the field

FIGURE 4.—Sowing tomato seed in flats in the greenhouse. The seed is covered with sand or leaf mold. As a rule the seedlings are ready to transplant in 10 days

When the plants are ready for transplanting they are shifted to 2-inch paper bands or pots (fig. 5), these being set in flats or directly on the greenhouse benches and kept under suitable temperature and moisture conditions. At the end of about two weeks they may be

again transplanted to 3-inch or 4-inch bands or pots and then shifted to an outdoor coldframe and handled as in the case of plants grown according to the second method previously described. The additional expense of the second transplanting is such that it is usually avoided by starting the plants at a time when they may be moved to the field after one transplanting. However, where the cost of labor is not too high it will pay to grow transplanted plants, as the results from the

FIGURE 5.—Transplanting tomato seedlings to paper pots, which may be set in flats for convenience in handling or set in sand on the greenhouse bench

use of such plants are usually better. Plants of the type shown in Figure 6 can be produced by following the method just described.

Whatever the method followed in producing the plants, too much attention can not be paid to the control of conditions under which the plants are grown, as this almost wholly determines the success or failure of the effort. The soil used for the seed beds should always be sterilized. The flats should be filled with thoroughly prepared potting soil made up of 1 part well-rotted manure and 2 parts well-rotted sod. This material should be prepared the season before by composting sod and manure. Some two or three weeks before it is time to sow the seed this compost should be placed either in the hotbed or brought into the greenhouse, so that it will reach a temperature of 60° to 70° F. before the time to sow the seed. If the seed is to be sown in the hotbed, the soil may be placed in sacks or boxes, put in steam boxes, as described in Farmers' Bulletin 1629, and thoroughly sterilized. It will be necessary to allow the soil to dry out before placing it in the hotbed ready for the seed. When the seed is to be sown in the hotbed, however, it is best to sterilize it in position by the methods described in the Farmers' Bulletin mentioned. A steam cabinet may be used when the seed is to be sown in flats in the greenhouse. Such a cabinet is inexpensive and can be made of lumber, concrete, or brick. The one shown in Figure 7 is constructed of concrete and is so planned that the flats filled with soil can be stacked on a truck and rolled into the cabinet. It is

suggested that sterilization equipment be constructed at the cannery, where steam is available. A processing kettle commonly used for sterlizing canned goods can also be used for sterilizing soil.

FIGURE 6.—A well-rooted, strong, and hardy tomato plant produced by two transplantings. Such plants increase the chances of success

Tomato seed germinates best at a temperature of about 70° F., and care should be taken that the soil is not kept too wet, as moisture is likely to induce damping-off and other diseases.

Many other methods aside from those described are employed in growing tomato plants; whatever the method used, the aim should be to obtain strong, healthy plants sufficiently early in the season so that the plants can be placed outdoors as soon as conditions permit. Stocky, well-grown, well-hardened plants are well worth the necessary effort required to produce them. Reject all plants that have any appearance of disease, such as mottling of the leaves, curling of the leaves, or discoloration of the stem.

SETTING THE PLANTS IN THE FIELD

Tomato plants should not be set in the field until danger of frost is past, the actual date depending upon the particular section of the country in which they are grown. It should be the aim of the grower to move the plants to the field with as little shock to them as possible. For this reason, just as much as possible of the root system should be saved. Tomato plants grown in such a way that they can be transferred to the field without disturbing the root system have a very great advantage over those whose root systems must be more or less injured in removing them from the seed bed to the field.

Planting distances for cannery tomatoes vary, but experimental work in Missouri indicates that there is little difference in the yield

from different spacings. In general, large-growing varieties like the Greater Baltimore need more space. Planting in checkrows 4 by 4 feet is perhaps the most usual practice, but some make the rows wider and set the plants closer in the rows, such as 5-foot rows with the plants 3 feet apart. This greatly facilitates spraying and harvesting and gives about the same number of plants per acre. Spacing the plants 4 feet apart each way will require about 2,700 plants per acre. The 5 by 3 foot spacing will require about 2,900 plants per acre.

If set in dry weather the plants should be watered in, and it is a distinct advantage to set them at a sufficient depth so that but a few inches of the tops will be exposed. Hand planting is necessary

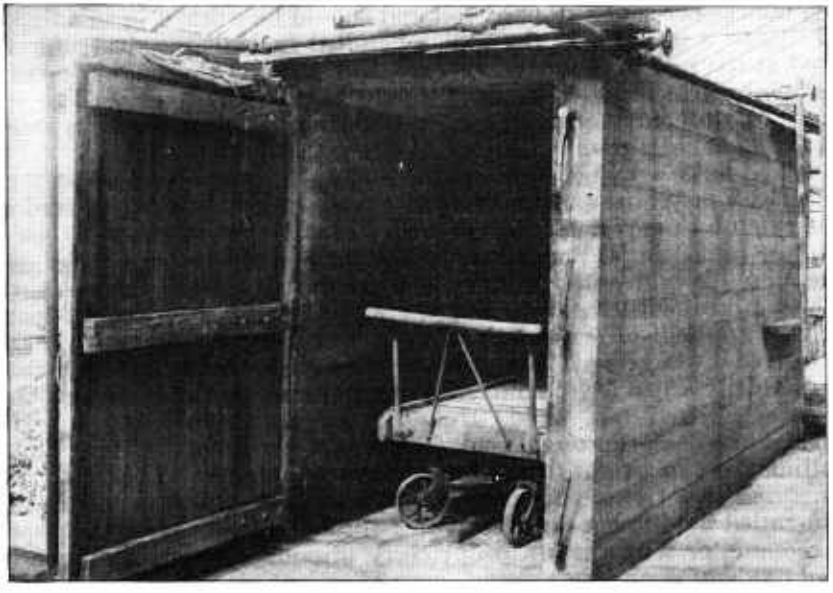

FIGURE 7.—A concrete cabinet used for sterilizing soil for the growing of tomato plants

where the plants have large quantities of earth adhering, such as is secured by blocking, growing in pots, paper bands, etc. The use of transplanting machines is advantageous where plants that have not been transplanted are used. The use of water in machine setting is advisable.

CULTIVATION

Clean, level cultivation is essential to success in growing tomatoes. The field must be kept free from weeds, and it is especially desirable that horse nettle, a plant common in some sections of the country and related to the tomato, which harbors certain tomato diseases, be kept out of the field. A good soil mulch should be maintained at all times. The tomato is not a very deep-rooted plant, and frequent shallow cultivations are much better than infrequent deep ones. Cultivation should not be carried on when the vines are wet, as this

tends to spread the spores of the leaf-blight fungus. It should continue until the vines cover the ground, but should be discontinued before the vines are injured thereby. The hoe should be used to keep stray weeds out of the field after that time.

DISEASES[1]

Some of the more serious field diseases of tomatoes are caused by fungi or bacteria that are carried on the seed or live over in seed-bed soils. When the seed-bed soil can not be steam sterilized the losses from damping-off and other seedling diseases can be greatly reduced by the use of a 6 per cent formaldehyde dust just before planting. In coldframes or hotbeds the dust should be applied at the rate of 1½ ounces per square foot of soil and should be worked in to a depth of 2½ to 3 inches. If the soil is handled in bulk the dust may be used at the rate of 8 ounces per bushel of soil and thoroughly mixed. After the dust is added the seed should be planted at once. The soil must be watered thoroughly after planting, as insufficient watering at this time may result in injury to the seed.

When large seed beds are used in the open, a 6 per cent dust may be placed in the row at the time of planting, the dust being used at the rate of 1 ounce to 30 feet of row. It is better, however, to use a 4½ per cent dust, at the rate of 1 ounce to 25 feet of row, since plants are more likely to suffer injury when the dust is used in the row than when mixed with the soil, and the 4½ per cent dust can be more evenly applied. Formaldehyde dust may be purchased or can be prepared by adding 1 pint of commercial formalin (40 per cent formaldehyde) to 5¾ pounds of a carrier composed of either ground charcoal, sifted leaf mold, ground peat, or screened muck. The formaldehyde is thoroughly mixed with the carrier by stirring or by rolling them in a tight drum containing a few stones. The dust must be stored in a tight container. Damping-off may also be effectively controlled by dusting the seed with red oxide of copper, with copper carbonate, or with certain proprietary organic mercury compounds. Red oxide of copper has proved very effective. It is used at the rate of 1 level tablespoonful to 3½ ounces of seed. Copper carbonate is used at the rate of 1 heaping tablespoonful to 8 ounces of seed, and the mercury dusts should be used as recommended by the manufacturer. Seed may also be effectively treated by being soaked in a solution composed of 2 ounces of copper sulphate dissolved in 1 gallon of water. The seed is tied loosely in a cheesecloth bag and soaked from one to two hours, after which it may be dried or planted immediately.

SEPTORIA LEAF SPOT

Septoria leaf spot is characterized by small, dark, circular spots with gray centers often showing small dark flecks which are the fruiting bodies of the fungus. It affects only the leaves and stems, beginning with the older leaves, and frequently defoliates the plant with the exception of a few leaves at the growing tips. Poorly ripened and sun-scalded fruit usually results from such defoliation.

[1] Revised by S. P. Doolittle, senior pathologist, Division of Fruit and Vegetable Crops and Diseases.

The fungus causing leaf spot overwinters on the remains of the previous crop, and diseased vines should be plowed under deeply in the fall. Crop rotation is also important in controlling the disease. As the fungus has a narrow temperature range it does little damage until the weather is warm, and its injury is not serious until early summer. Spraying with bordeaux mixture and resin fish-oil soap is effective if begun before the disease gains headway and repeated at 10-day intervals. Care must be taken to coat both the upper and lower leaf surfaces with the spray. A 4–4–50 bordeaux mixture should be used, with 3 to 4 pounds of resin fish-oil soap added to each 50 gallons. Dissolve 4 pounds of copper sulphate in 25 gallons of water and slake 4 pounds of lime in a small quantity of water and dilute to 25 gallons. Pour the two solutions together while stirring, and add the soap, which has been previously dissolved by adding a small amount of hot water at a time and stirring well until the sticky mixture is dissolved. The soap causes the spray to spread and to stick better to the surface of the leaves.

EARLY BLIGHT

Early blight is also caused by a fungus which attacks leaves, stems, and fruit. On the leaves it produces spots that are larger and less numerous than those of Septoria leaf spot. The stems of seedling plants are also attacked near the soil line, and the dark sunken spots known as collar rot produced. Although the leaf and stem symptoms are much the same in both cases, there are actually two forms of early blight. One form, known as nailhead rust, causes small reddish-brown spots on the surface of the fruit, which are only skin deep. This form is especially prevalent in the South. A second form causes large, firm, dark spots that generally occur immediately about the stem and may extend deeply into the fruit. This form is common throughout the Northern and Middle Atlantic States and also occurs in the South. The early blight fungus may live for some time on dead weeds and crop remains in the field, and it is also parasitic on weeds such as the horse nettle and jimson weed. The disease is best controlled by treating the seed with red oxide of copper or using one of the other seed treatments described on page 14, and disinfecting the seed bed by means of steam or formaldehyde dust combined with regular sprayings with bordeaux mixture, as suggested for the control of Septoria leaf spot. Fall plowing and crop rotation are also of considerable value as a means of control.

WILT DISEASES

FUSARIUM WILT

The wilt diseases of tomatoes are especially prevalent in the more southerly portions of the United States, particularly fusarium wilt. This disease is caused by a fungus which, when once introduced, will live for long periods in the soil. Plants affected with fusarium wilt show a gradual yellowing and wilting of the foliage which begins with the older leaves and often causes the eventual death of the plant. One of the chief characteristics of the disease consists of a brown discoloration of the woody tissues of the stem just below the green outer bark. When it is possible to do so the seed beds should

be located on wilt-free soil and the crop grown on land where wilt has not previously occurred. When such land is not available, however, the disease can usually be controlled by the use of wilt-resistant varieties of tomatoes. The United States Department of Agriculture has developed a number of wilt-resistant varieties, the most generally used of which are the Marglobe, Pritchard, and Break o' Day. The Marglobe is widely used, both as a market and canning tomato. The Pritchard is a somewhat earlier market tomato of excellent quality and is sometimes used for early canning. Break o' Day is an early trucking variety which gives best results when grown under cool conditions. All of these varieties are also resistant to nailhead rust.

VERTICILLIUM WILT

Another form of wilt disease known as Verticillium wilt produces symptoms somewhat similar to those of fusarium wilt, but it is confined chiefly to the Northern States and the Pacific coast, and is less common than fusarium wilt. This disease is also caused by a fungus which lives for long periods in the soil, but the tomato varieties listed as resistant to fusarium wilt are not resistant to the Verticillium wilt. Crop rotation is the best means of control.

BACTERIAL WILT

Bacterial wilt, or brown-rot, is a third form of wilt which sometimes affects tomatoes and is characterized by a browning of the interior of diseased stems and the presence of a creamy bacterial discharge from the cut vessels. A rather rapid and complete wilting of the plant frequently follows. The symptoms differ from those of fusarium wilt in that the discoloration of the stem extends deeply into the pith or central portion and there is little yellowing of the foliage. The disease is occasionally serious in the South and is best controlled by treating the seed by the copper-sulphate-soak method given on page 14, combined with disinfection of the seed bed with formaldehyde dust and rotation of the crop. Since brown rot also affects potatoes and peppers, it is best not to follow these crops with tomatoes, especially where the disease is known to occur.

MOSAIC

Mosaic produces a green and yellow mottling of the foliage and a noticeable stunting of the plant. Mosaic leaves are somewhat curled and may be distorted into the abnormally narrow forms known as "fern leaf." The cause of mosaic is unknown, but an infective principle or virus is present in the juices of affected plants, and the disease is transmitted by plant lice and also by pruning and handling diseased plants. It does not appear to be generally carried in the seed but occurs in certain perennial weeds, such as the groundcherry, whence it may be carried to the tomato by insects that have previously fed on the weed hosts. When mosaic once appears in the field, it is difficult to control, and every care should be taken to prevent infection of the young tomato plants. Weeds should be kept down at the edges of the field, particularly in the vicinity of seed beds. Plants should never be started in greenhouses where there are older tomato plants affected with mosaic, as

the disease is almost sure to be transmitted to some of the younger plants and pass unnoticed until after they have been set in the field. The virus causing tomato mosaic also affects tobacco and may be present in manufactured tobacco, particularly that used for chewing. It has been shown that plant infection may occur from workers who chew tobacco, and its use should be avoided when working with young plants.

BLOSSOM-END ROT

Blossom-end rot is a nonparasitic disease which causes a decay of the blossom end of the fruit. The disease usually makes its appearance during or after periods of drought when the plant requires water because of the rapid development of fruit. Loss from the disease can be materially reduced, but not entirely prevented, by avoiding the use of heavy applications of nitrogen, especially manures, and by supplying sufficient superphosphate. The disease is likely to develop on plants that have grown for a long period under favorable temperature and soil moisture conditions and then later are exposed to high temperatures and drought.

PICKING AND HANDLING TOMATOES

Tomatoes grown for manufacturing purposes are usually hauled directly from the field to the factory. Although they are to be used immediately, extreme care should be taken in picking and handling the crop. "U. S. grades" for canning tomatoes have been established by the Bureau of Agricultural Economics of the United States Department of Agriculture, and their use has greatly helped growers and canners in handling the crop. One of the greatest difficulties in the past in the production of high-quality canned tomatoes has been in getting the raw product to the cannery in first-class condition. The industry has been seriously penalized by carelessness in this respect.

Tomatoes should be picked when in prime condition for the purpose for which they are to be used. This means that they should be thoroughly ripe, but not overripe. All tomatoes injured or partly decayed should be discarded. It should be the aim of the grower to pick his tomatoes and get them to the cannery in the shortest possible time. It should also be the aim of the cannery to handle the product just as quickly as possible after it reaches the factory. In the past there has been a tendency among growers to pick at too infrequent intervals and among the canners to allow the tomatoes to stand around the factory too long in the hot sun before being used. It is especially desirable that they be protected from the hot sun after picking.

Tomatoes should not be picked when the vines are wet, as there is great danger that leaf spot and early blight, two very serious diseases, will be spread by the hands and clothing of the pickers.

Successful tomato growing depends on good farm practices, good seed, good plants, proper fertilizer, careful planting, clean cultivation, and disease control through crop rotation and spraying and through the use of disease-resistant varieties. Growers who pay due attention to these factors produce crops that give them satisfactory returns.

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