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DEPARTMENT OF HORTICULTURE

GROWING TOMATOES IN KANSAS[1]

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INTRODUCTION

The tomato is one of the most popular of the vegetables. It is grown in many home gardens and by so many gardeners and truck growers that it is one of the most important commercial garden crops. It is also grown as a forcing crop in greenhouses, but the varieties and methods of culture used there differ widely from those used in field or garden. As a commercial crop in Kansas the tomato ranks third among the vegetables, being outranked only by white potatoes and sweet potatoes. The early crop is more profitable than the later, though in some parts of the state there is a good demand for a very late crop. Earliness can be secured only through careful selection of varieties, proper methods of starting the seed, careful attention in growing the seedlings (fig.1), and proper soil management and cultural practices.

SOILS AND FERTILIZERS

Soil Adaptations.—The tomato adapts itself to a variety of soils. Good yields are secured on all classes of soil, from a heavy muck to a light sandy loam. Since a sandy soil warms up more quickly in the spring and dries out sooner following a rain, such soil is usually preferred where earliness is desirable. A heavy clay soil on the other hand warms up slowly in the spring, stays wet after a rain, and is difficult to plow or cultivate. It also dries hard and frequently cracks during a hot, dry period, but holds moisture rather well if properly managed.

In general a sandy soil is to be preferred, where yield can be sacrificed for earliness of maturity; a clay soil for a later but heavier crop; and a muck soil

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for a very heavy crop. The majority of growers seem to prefer a sandy soil with a clay subsoil. The sand warms readily in the spring, while the clay holds moisture for later use.

Manure as a Fertilizer.—The best fertilizer for tomatoes is barnyard manure. In a sandy soil manure not only increases fertility but, which is equally important, increases the water-holding capacity of the soil, thereby minimizing the effect of dry weather. Manure tends to loosen a clay soil. which makes it easier to plow and ready to work sooner after a rain.

FIG. 1.—Well-grown tomato seedlings.

Manure is best applied in the fall. It then has a chance to act on the soil, affecting it physically as well as chemically, and gives time for proper bacterial development and action. Fresh manure from the horse barn should never be applied in the late spring, for its heating effect is harmful.

The Use of Lime.—Some soils are greatly benefited by the use of lime. Lime corrects an acid condition, if one exists in the soil, and may have some effect on making available certain other plant nutrients. It may improve the physical condition of the soil somewhat, making it easier to work.

Commercial Fertilizers.—Commercial or chemical fertilizers are usually beneficial if properly used. The kinds and amounts of fertilizers that may be used profitably depend on the soil and the purpose for which the crop or to be used. On soils that are naturally rich, usually little or no fertilizer need be applied, while on poor and sandy soils large applications may be profitable. This is true especially for an early crop.

Most surveys and experiments conducted in Kansas indicate that the soils which have been handled properly in the past usually contain sufficient nitrogen for tomatoes. In these tests it has been found that phosphorus increased the income per acre where tomatoes have been grown for canning. The best results have been obtained by applying 600 pounds of superphosphate per acre—one-half at planting time, the other half three weeks later. The first half (about 2 ounces per plant) can be put in the holes in which the plants are set; the second half can be scattered around the plant and immediately worked into the ground. No tests have been conducted under irrigation, but it is probable that when water is added a greater amount of fertilizer might be profitably used.

In these tests sodium nitrate at the rate of 300 pounds per acre increased yields to some extent, though whether it is always profitable is yet to be determined.

Potash, wherever tried, did not seem to be profitable. It increased yields only slightly, and in some cases had no measurable effect on the crop,

SOME KANSAS VARIETIES

There are many varieties of tomatoes grown in Kansas. In tests conducted at the Agricultural Experiment Station many of the popular varieties have not produced the best yields. (Table I.) There are so many strains of the same variety that seed obtained from different sources does not always develop exactly the same type of fruit. Many Kansas growers are saving their own seed, thus developing their own improved strains. This is an excellent practice if properly done.

The following descriptions of some of the more popular varieties of tomatoes grown in Kansas are taken from "Vegetable Crops," by H. C. Thompson.

Earliana.—An early variety producing only moderately vigorous vines, with foliage rather susceptible to disease. Fruit red, often poorly colored at the stem end, inclined to crack, often rough although strains of smooth-surfaced fruits are available. Earliana is losing in popularity, but is still grown because it averages earlier than any other red variety. It is not a good shipping tomato.

Bonny Best.—Averages a few days later than Earliana. Vines vigorous, prolific, foliage somewhat susceptible to disease. Fruit red, solid, medium in size, smooth, small core, and usually uniform in size and color. This variety is similar to Chalk's Jewell. Typical strains of the original variety produce a small plant with fruit a trifle smaller, more symmetrical and not so flat, which ripens a little earlier.

Chalk's Early Jewell.—Vines vigorous; fruit medium to large in size, red and usually well-colored all over, smooth and regular. Ripens later than Earliana and averages a little later than Bonny Best.

John Baer.—A comparatively new variety, similar to Chalk's Early Jewell and probably a selection of it.

June Pink.—An early variety, a few days later than Earliana, but the earliest of the well-known pink-skin sorts. It is not so prolific as the Earliana.

Stone.—This is one of the most popular of the late varieties used for canning. It is also a popular market variety in some regions. The plants are strong and vigorous and produce a heavy yield of fruit where the growing season is long. The fruit is bright red in color, of good size, and smooth.

Louisiana Red.—This variety has been the most successful at the Kansas Agricultural Experiment Station. The plants are strong and vigorous and produce a heavy yield of fruit. The fruit is bright red, of good size, and

smooth. It is very similar to the Stone and may be a selection from it or from a cross of Stone with John Baer. Louisiana Red was introduced from the Louisiana Agricultural Experiment Station and is very resistant to the tomato wilt.

TABLE I.—RESULTS OF VARIETY TESTS

Eleven years, 1921 to 1931

VARIETY.	Not pruned, not mulched.	Pruned, not mulched.	Pruned and mulched.	Not pruned, mulched.
Average Date of First Harvest				
Bloomsdale	July 14	July 14	July 14	July 15
Bonny Best	July 18	July 17	July 16	July 18
Chalk's Early Jewell	July 30	July 1	June 30	July 1
Earliana	July 21	July 19	July 19	July 22
Globe	July 21	July 16	July 17	July 20
Greater Baltimore	July 17	July 12	July 14	July 16
John Baer	July 22	July 18	July 19	July 22
Landreth	July 16	July 11	July 13	July 16
Louisiana Red	July 21	July 22	July 21	July 22
Marglobe	July 14	July 14	July 14	July 16
Marvana	July 10	July 2	July 3	July 6
Ponderosa	July 21	July 21	July 21	July 21
Average Yield of Marketable Fruit Per Plant				
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
Bloomsdale	2.3	1.9	2.1	2.8
Bonny Best	5.8	3.0	3.8	6.0
Break O'Day	2 3	2.1	2.4	4.6
Chalk's Early Jewell	5 7	4 3	4.8	6.8
Globe	2.3	2.0	2.2	2.2
Greater Baltimore	3 0	2 6	2.9	3.1
John Baer	5.7	4.7	3.8	6.2
Landreth	5.4	4.8	5.8	6.2
Louisiana Red	5 1	4.8	5.8	6.2
Marglobe	4.9	4.8	5.5	5.6
Marvana	3 0	2.9	2.9	3.0
Ponderosa	4.1	2 8	2.8	4 0
Percentage of Marketable Fruit				
Chalk's Early Jewell	75	79	85	80
Bloomsdale	71	83	87	84
Globe	70	84	84	82
Greater Baltimore	63	89	90	81
Landreth	49	84	83	79
Louisiana Red	61	73	73	72
Marglobe	43	67	68	55
Marvana	58	78	73	69
Earliana	69	74	81	55
Bonny Best	70	89	83	69
John Baer	62	72	80	69
Ponderosa	61	82	81	68

YIELDS IN EXPERIMENTAL WORK

Cultural tests of many varieties have been made by the Agricultural Experiment Station and in part are reported in Table I. These data are the results of 11 years of experiments. The plants were all started in the college greenhouses and given care as recommended in this circular. Two of the varieties, Bloomsdale and Break O'Day, have been grown only four gears.

Each variety was grown in a separate row 180 feet long. Each row was

divided into four equal parts, the first section being mulched with about 4 inches of old, loose straw about the time the plants began to vine. No pruning was done. In almost every case the production per plant with this treatment was better than any other methods of culture used. (Table I). The second section was mulched in the same way, and in addition the plants were pruned to a single stem and trellised as shown in figure 2. The production of tomatoes was somewhat less than in the first section where no pruning was practiced, but some earliness was secured. By this method of culture it might be possible to double the number of plants grown to the acre and the acre production might be greatly increased over the first method. The cost of pruning and trellising, however, would have to be added to the cost of production. The practice of staking and pruning as done in the commercial tomato sections of northeastern Kansas indicates that this method of production is desirable. The decreased yield in this section, compared to the first section seems to be due to the increased amount of sun scald to the fruit after it has set. This injury reduced the number of marketable fruits. (Table I.)

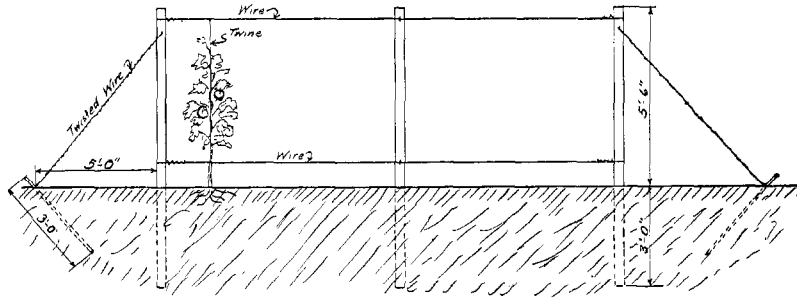

FIG. 2.—Diagrammatic sketch representing a portion of trellis used on sections where the vines were pruned.

Sections three and four of these rows were given clean cultivation throughout the entire growing season, section three being trellised, section four not pruned or trellised. The yield per plant (Table I) was so much less than from the mulched sections that where straw is available it seems that it should be applied. If one fears that this straw may raise the crude fiber or undecayed organic matter of the soil to a harmful point, it, together with the dead tomato vines, may be raked into rows in the fall and burned. This burning would destroy many insect eggs and larvæ as well as spores of disease-producing organisms, hence would be good sanitary practice.

GROWING TOMATOES

Choosing Varieties.— In choosing varieties the following points should be considered: (1) Purpose for which grown; (2) length of growing season; (3) susceptibility to disease; and (4) yield.

Purpose for Which Grown.— When grown for home use the preferences of the family alone are to be considered. When grown for market one must consider the buyers' preferences and keeping quality of the variety. For canning purposes, yield, color, smoothness, and solidity of fruit must be considered.

Length of Growing Season.—Some varieties of tomatoes which are recommended in other states do not do well in Kansas because of the number of

FIG. 3.—(A) A flat of tomato seedlings ready for transplanting. (B) Transplanting (pricking off) tomato seedlings into a second flat. (C) Transplanting tomato seedlings into 3-inch pots.

growing days which these varieties require. Some of them require from 150 to 200 frost-free days to mature a full crop. For Kansas the average number of frost-free days is approximately 150. Some varieties recommended in northern states will do well in Kansas, but complete their production so early that yield is lost toward the close of the season. The early crop may be so small and the type of fruit so undesirable that the variety is not to be recommended where other varieties will mature.

Susceptibility to Disease.—Just as length of growing season is important in the selection of varieties, so, too, is resistance to disease. While Septoria leaf spot (Table II and page 13) is an important disease some seasons, there are no commercially-grown varieties especially resistant to it. This is a serious handicap in variety selection.

Tomato wilt (page 12) is a very serious disease of the tomato in Kansas. Varieties have been developed that are resistant to it, and where the disease is present these varieties should be chosen.

Yield.—Yield is important. The cost of production of a large crop, with the exception of harvesting, is practically the same as the cost when a small crop is produced. The returns from the crop are usually in direct proportion to the yield.

Growing the Plants.—Stocky, vigorous plants of the right age and properly hardened off are necessary for an early or a full tomato crop. Spindling, weak, old, young, or tender plants take so long to recuperate or gain the proper size that they often are costly and never cheap. If the grower is not equipped to grow plants properly, he had better buy them from someone who is.

Seed Selection.—The first step in growing good plants is securing good seed. These are often difficult to obtain, for one must be familiar with the variety to anticipate the performance of the seed. Seed of some varieties are small and dark gray in color. Of other varieties they are large and light gray in color. The best and safest plan is to buy seed from a dealer who is known to be reliable. One ounce of seed will usually produce 2,000 plants.

Planting Seed.—Tomato seed are best started in boxes or "flats." (Fig. 3, A.) The flats are boxes 4 inches deep and 12 inches wide by 18 inches long. This size is easy to handle when full of soil. They are usually made of 3/8-inch cypress wood so as to be light and durable. The seed usually are sown in the greenhouse about 10 weeks before the plants are to be set outdoors. In sowing the seed scatter it generously over the soil, taking care that no two seed touch each other.

At a temperature of 65° Fahrenheit the seed should be sprouted in four days to a week. The seedlings should be transplanted into other flats a week after sprouting. (Fig. 3, B.) In these flats the seedlings are set two inches apart in the rows with the rows two inches apart. Grown this way at a temperature of about 60° F., they will be ready to be hardened off in the cold frames in six to eight weeks. They should be in the cold frames a week to 10 days before being set in the field.

Potting Seedlings.—Some growers start their seed much earlier than recommended here. They transplant from the seed flat into 3-inch pots. (Fig. 3, C.) Later they may transplant from the 3-inch pots (fig. 4) into 6-inch pots. This materially increases the cost but, of course, results in earlier-maturing vines and an earlier crop. Transplanting from pots—either clay or paper—disturbs the root system but little, thus allowing the plant to become established more quickly.

Soil.—The soil in the seed flats need not be rich. Some organic matter will help the seed germinate, as it holds moisture better, but much is not necessary.

Sand loosens the soil, making it easy for the seedlings to break through the ground and also helps prevent baking. In watering flats of seed or seedlings. a good method is to set the flat in a pan of water. This prevents washing out of the shallow-planted seed and does not break down the seedlings. It also keeps the foliage dry. reducing losses from leaf diseases.

The soil into which the seedlings are transplanted should be a llttle more fertile than the soil in the seed flat and at each succeeding transplanting the soil may be somewhat richer in plant food. Soil used in starting tomato plants should be sifted.

Hardening Off.—When the plants are ready for transplanting and the weather is unfavorable for putting them out, there are two methods of procedure. One is to pot or repot them. This is often expensive or inconvenient and may not be practical. The other is to withhold water and keep the plants at a lower temperature. This second practice holds the plants back

FIG. 4.—Tomato plants transplanted into 3-inch pots.

without injuring them seriously. It also makes them hardier and better able to withstand the outdoor weather. Such treatment is sometimes given them in the greenhouse to save the labor of moving them into cold frames. If done carefully and gradually this method is effective. The drying and moving to the cold frames to make the plants better able to withstand cool, outdoor conditions are known as "hardening off" the plants.

Planting Out.—When the weather is right for transplanting to the field, no time should be lost in doing so. The safe time is after all frost danger is over, for the tomato, being a warm-weather plant, is very susceptible to frost damage.

Preparation of the Soil.—Soil for the tomato should be in excellent condition. Where practical the soil should be manured and plowed in the fall. In the spring it should be harrowed and cross harrowed to keep it mellow and to conserve the moisture. The harrowing will also keep down early needs and make cultivation and weeding cheaper and easier later in the year.

Transplanting. — When the plants are set out, the work should be done quickly but carefully. This is in order that the roots will be disturbed or dried as little as possible. This can be done by first locating the places where the plants are to be set. If no pruning is to be practiced it is usual to set the plants 4 by 4 feet. The planting distance in exceptionally rich soil may be

4 by 5 feet or even 5 by 5 feet. Under irrigation even greater space may be allowed between plants.

If the plants are to be pruned and staked, one of several methods of planting may be followed. One method is to set the plants 2 feet apart in rows 3 feet apart. Another is to plant in double rows. The plants are set 24 inches apart in double rows, the rows being 18 inches apart. Between these double rows is left a 4-foot space. The trellising is arranged to fit the method of planting. (Fig. 2.)

Whether the plants are from beds, flats, or pots, the setting is the same. Make an opening in the soil about 4 inches deep and large enough for the entire ball of earth to fit easily. If the plant is spindling, trench the lower part of the stem in the furrow or opening. (Fig. 3, B.) After the plant has been set, fill the opening with water and replace the soil. Do not pack the soil around the roots as the water will do this quite satisfactorily. Of 18,000 plants set by this method in the station garden at Manhattan during six years, only 60 plants failed to become established. If no water is used when transplanting, firming the soil around the roots by packing is necessary.

Methods of Culture.—Cultivation should be frequent as long as it is possible to get at the soil without disturbing the plants. After the plants have vined out disturbing them may knock off some of the green fruit and may prevent setting of later fruit. Cultivation stimulates plant growth, keeps down weeds, and conserves soil moisture. Shallow cultivation will accomplish the same results as deep cultivation and is less liable to damage the roots.

Mulching.—The number of cultivations may be reduced by the use of a straw mulch. The mulch is applied after a very thorough cultivation, when the plants are about 12 to 15 inches high. Old or new straw may be used. The loose mulch should be about 4 inches deep. Mulching reduces labor of cultivation and weeding and makes it easier to go through the field for picking fruit after a rain or irrigation. The increases in yields (Table I) are due to fewer tomatoes' being lost by insect injury and fruit rots, a steadier production through dry periods, and a longer period of production in seasons of continued drought.

Pruning and Trellising.—Pruning and trellising are sometimes successfully practiced in Kansas. The advantages claimed for pruning and staking or trellising are: (1) Larger fruit, (2) less disease injury, (3) earlier ripening of the fruit, (4) larger yields, (5) cleaner fruit, (6) greater convenience in harvesting, and (7) greater convenience in spraying the vines and fruit. The disadvantages that may be encountered are: (1) More labor and expense, (2) less total yield, (3) greater loss from blossom-end rot, (4) more sun scald of the fruit, and (5) more cracking. Many of these advantages or disadvantages appear in comparison of the results of the experiments in the Agricultural Experiment Station gardens and can be seen in the figures given in Table I.

A comparison indicates that in Kansas convenience of harvesting and spraying is the only advantage gained by this method of culture. In experiments conducted at this station the plants pruned and trellised showed greater injury from mosaic, more loss of fruit from sun scald and blossom-end rot, and increased cost of production. There is a possibllity that by staking and pruning one may so increase the number of plants per acre that the decreased yield per plant may be overcome and the yield per acre increased. The cost of the plants is negligible, and that of trellising would not be materially increased by this procedure. In general, under Kansas conditions, pruning and trellising are not advisable, though growers are successfully using this method.

Staking.—In some parts of the state the commercial tomato growers follow a different method of training the tomato vines from that practiced in the

station garden. Instead of the trellis described in this circular (fig. 2), each plant has a single stake. The plants are trained to a single stem and are tied to the stake with a string or, in some cases, with a piece of rag. The tying material should not be tied in such a way as to restrict the growth of the plant or to cut into the stem. The plants are usually trimmed once every week or 10 days. Some growers pinch out the top of the plant when it reaches the top of the stake. This pinching out of the top of a tomato plant is said to hasten maturity of the fruit.

The stakes are usually 1 by 1 inch, though 1¼ by 1¼-inch material may be used. Willow saplings may be used when available. The stakes are usually 5 to 6 feet long and are driven into the ground 12 to 18 inches.

Irrigation. — Irrigation of tomatoes is undoubtedly of value. It is probably not so valuable or so necessary as with faster-growing crops, but where it has been tried it has been thought worth while. There are two systems of irrigation, the over-head system and the furrow or ditch system. The over-head is most commonly used for vegetable crops and, especially in sandy soils, is more economical and efficient where pressure is available, but may increase the losses due to leaf diseases. The first cost is rather high, but the increased returns of a single season may pay for the cost of installation. Automatic turning devices for distributing the water evenly are not always satisfactory.

Harvesting. — The stage of maturity at which tomatoes should be picked depends on the market. The tomatoes from Texas and Mexico, which are offered on the city markets in the northern states, are picked while quite green. Those offered to the cannery are usually canned the day they arrive and are usually grown close by, so they are allowed to become ripe before picking.

Time of Picking. — There are great differences in the flavor of tomatoes due to the stage of maturity of the fruits at the time of harvesting. These differences are due to the sugar-acid ratio. In brief, it has been found that fruit picked green and ripened without ventilation contains a greater amount of acid in proportion to sugar than does fruit that is picked when ripe. Wrapping the fruit before it ripens reduces the ventilation and unfavorably affects the flavor. The best quality is found in fruits which are permitted to become completely ripe on the vine.

Tomatoes should be picked while they are still solid, but after they become well colored. The fruit is injured by handling, and care must be taken not to injure it.

Cost of Production. — The cost of producing tomatoes, as with any crop, varies greatly on different farms. These differences are due to variations in the value placed on land, to cost of labor, amount of taxes or rents, methods of culture, yields, and the purpose for which the crop is grown. As a rule the cost of growing tomatoes for the cannery is less than the cost of growing for the general market. An extra early crop is the most expensive. If the crop is to be packed and shipped the cost of containers and packing must be added.

Cost and Returns. — A survey of twelve Kansas tomato growers' records revealed that the cost varied from $100 to $175 per acre and that the yield varied from 3 to 10 tons per acre. The selling price varied from 30 cents a pound for the first of the extra early crop to 25 cents a bushel during the period of the heaviest production. The canning crop has averaged $14 per ton in some years, but this is higher than the average for a period of years.

GRADES OF TOMATOES

The United States Bureau of Markets suggests three grades of tomatoes, U. S. Grades No. 1, No. 2, and No. 3. The specifications of these grades are:

U. S. No. 1 shall consist of tomatoes of similar varietal characteristics and which are mature but not overripe or soft; well formed, fairly smooth; free from damage by sun scald, catfaces, growth cracks, freezing, diseases, insects, hail, scars, or other means.

In order to allow for variations incident to proper grading and handling, not more than 10 per cent, by count, of any lot may be below the requirements of this grade, but not to exceed one-half of this tolerance shall be allowed for any one defect.

U. S. No. 2 shall consist of tomatoes which are mature but not overripe or soft, which are free from serious damage caused by sun scald, catfaces, growth cracks, freezing, disease, insects, hail, scars, or mechanical or other means, and from any defect or injury that has penetrated through the fleshy outer wall of the tomato.

In order to allow for variations incident to proper grading and handling, not more than 10 per cent, by count, may be below the requirements of this grade, but not to exceed one-half of this tolerance shall be allowed for any one defect.

U. S. No. 3 shall consist of tomatoes which do not meet the requirements of either of the foregoing grades.

The following marking requirements for size and definitions of terms are also given:

The minimum size, numerical count, or description of pack of the tomatoes in any package shall be plainly labeled, stenciled, or otherwise marked on the package.

"Minimum size" means the greatest diameter of the smallest fruit measured at right angles to a line running from the stem to the blossom end. It shall be stated in terms of whole and quarter inches as 2 inches minimum, 21/4 inches minimum, 21/2 inches minimum, and so on, in accordance with the facts. In order to allow for variations incident to proper sizing, not more than 10 per cent, by count, of the tomatoes in any package may be below the minimum size specified.

"Similar varietal characteristics" means that the tomatoes shall be alike as to the firmness of flesh and shade of color; that is, that soft-fleshed midseason and late varieties, or bright red varieties mixed with varieties having a purplish tinge, may not be mixed.

"Mature" means that the contents of the seed cavities have begun to develop a jelly of gluelike consistency and the seeds are fully developed.

"Well formed" means the normal, typical shape for the variety.

"Fairly smooth" means not noticeably ridged, angular, indented, or otherwise misshapen.

"Free from damage" means that the tomatoes shall not be injured to an extent readily apparent upon examination.

"Catfaces" means irregular, dark, leathery scars usually found at the blossom end, but sometimes on the sides. If shallow and no greater in total area than a dime, they shall be allowed in U. S. No. 1.

"Growth cracks" are ruptures or cracks radiating from the stem end. If well healed over and not longer than half an inch they shall be allowed in U. S. No. 1.

"Serious damage" means surface blemishes covering more than 15 per cent of the surface in the aggregate or any deformity so serious as to cause a loss of over 20 per cent in the ordinary process of preparation for use.

INJURIOUS INSECTS AND THEIR CONTROL

Kansas tomatoes are not troubled with a great variety of insects. Growers have, however, suffered a great annual loss from the depredations of the few insects which are present.

Hornworms. — Tomato hornworms are large, green worms which can strip a large plant quickly. They are sometimes called tomato worms and in parts of the state are known as tobacco worms. Spraying the plants with arsenate of lead will control this pest. Any worms found on the plants should be picked off and destroyed at once.

Fruit Worms. — Tomato fruit worms eat into the ripening fruit, making it unfit for use. They are the same insect which attacks cotton and corn and are known as bollworms of cotton and corn-earworms. Spraying the plants and fruit with arsenate of lead will partially control these pests. A straw mulch makes it more difficult for the worms to attack the fruit and thus reduces the damage done to the crop.

Aphids. — Aphids suck the juices of the plant. They reduce the vigor and vitality, and hence reduce the yield and increase susceptibility to disease. Certain diseases also are transmitted directly by them. Spraying or dusting the plants with nicotine sulphate will control this pest.

Spraying. — In order to be effective, spraying must be thorough. Arsenate of lead is a stomach poison which, in order to kill the insect, must be eaten by it. If the stem and the leaves are not completely covered the insect can eat large quantities of the plant and do considerable damage before being affected by the poison. It must, therefore, be reapplied after a heavy rain, and the new growths must be sprayed regularly. Arsenate of lead should be applied at the rate of 1 1/2 pounds to 50 gallons of water. This is at the rate of 1 1/2 tablespoonfuls to 1 gallon of water. Since the poison tends to settle, the spray must be agitated every few minutes.

Nicotine sulphate is a contact insecticide which, to kill the insect, must come in contact with it. It is applied at the rate of 1 part to 1,000 parts of water. This is 1 pint to 125 gallons, 1 teaspoonful to 1 gallon of water, or approximately 1 ounce to 8 gallons of water.

SERIOUS TOMATO DISEASES

Tomatoes in Kansas are subject to a few serious diseases, causing an estimated loss of approximately $50,000 annually, exclusive of the damage done to home gardens. By far the largest percentage of this loss is caused by Fusarium wilt. The Septoria leaf-spot disease ranks second in importance. Other diseases present each year are damping-off, anthracnose, blossom-end rot, root knot, scab, mosaic, and blossom-drop. (Table II). Considerable loss often results from fruit rots due to bacteria and from those rots caused by soil fungi which attack the fruit where it come in contact with the soil.

Fusarium Wilt. — By far the most important of the tomato diseases in Kansas is the Fusarium wilt disease caused by *Fusarium lycopersici* Sacco. This soil-inhabiting fungus attacks the roots in the hotbed, soon after the plants are set in the field, or at any time during the growing season when climatic conditions are favorable. Such factors as high temperatures and medium soil moisture favor severe outbreaks of wilt. The organism causes a decay of the roots and grows up inside the stem, causing browning and death of the conducting tissue. As a result of the attack, the leaves turn yellow at the base of the plant and the plant wilts and dies. Diseased plants produce but little fruit, which is poor in quality.

It has been found that some varieties are resistant to this disease. Varieties found resistant in Kansas are as follows: Louisiana Red, Louisiana Pink, Marvel, Kanora, Marglobe, Norton, Marvana, Norduke, Pritchard, and Break O'Day. Varieties which haVe proved susceptible when grown in Kansas are John Baer, Earliana, Jewell, Bonny Best, Grand Rapids, Tennessee Beauty, Greater Baltimore, Dwarf Champion, Bolgiano Capitol, Bolgiano Red, Texas Belle, and Comet.

Those who have experienced losses from this disease should not attempt to grow any varieties of the susceptible group, but should obtain seed of one of the more resistant group.

Rotations of several years' duration will help in keeping tomato wilt in check, but Will not eradicate from the soil the organism causing wilt. Tomatoes should not be grown more often than once in four years on any piece of ground where wilt has been present unless resistant varieties are used.[2]

Septoria Blight or Leaf Spot.— The most important disease attacking the leaves of Kansas-grown field tomatoes is the leaf-spot disease due to *Septoria lycopersici* Speg. This organism attacks the foliage and stems. It rarely occurs on the fruit, but does its most severe damage by killing the leaves. Leaf spot causes very small circular spots, at first dark brown, later becoming grayish-white in the center. These spots vary in size but generally are not larger than that of a pin head. The spots may coalesce, forming irregular dead areas on the leaf.

Infection starts on the lower leaves and progresses upward. In severe cases, almost complete defoliation results, exposing the fruit to the sun and causing sun scald and premature ripening.

Within the grayish-white center of the spots on the upper surface of the leaf occur small, black, pimple-like bodies, the spore cases of the fungus. These are just visible to the naked eye. Within these spore cases are produced millions of spores, or reproducing bodies of the fungus, which are discharged in periods of wet weather during the growing season. It is these very minute spores that spread the organism from plant to plant. The spores may also be carried by wind, splashing rain, insects, and pickers.

The fungus lives over winter on old tomato trash left in the field and on other plant refuse. The sources of infection in the spring are the germinating flats or hotbeds, and previous year's tomato plants. Clean soil, either new or sterilized, should be used for growing the seedlings, which should be sprayed with a weak Bordeaux mixture, 2-2-50, when well established in the frames. Plants should be well hardened off before transplanting. It has been found that plants properly hardened off before setting in the field are less subject to attack from the leaf-spot organism.

Fall plowing covers the old plant refuse in the field. The organism on this refuse cannot survive the winter when buried, and this is a very effective means of destroying an important source of infection. Weeds, such as horse nettle, ground cherry, Jimson weed, and nightshade, should be destroyed, since the organism causing leaf spot of tomato may live on these weeds.

Spraying with Bordeaux mixture, 4-5-50, in the field will control leaf spot if done thoroughly and frequently. The profits from spraying do not always justify the expense. If the application is not thorough, covering both sides of the leaf, control is not satisfactory. The number of applications will depend on seasonal conditions.

2. For more detailed information of this disease the reader is referred to Technical Bulletin 20 or Circular 140 of the Kansas Agricultural Experiment Station.

TABLE II.—TOMATO DISEASES OF MINOR IMPORTANCE IN KANSAS

DISEASE.	Symptoms.	Conditions favoring development.	Control measures.
Septoria leaf spot	Small circular spots on leaves. Dark brown, later gray, centers. Leaves die, causing defoliation.	Cloudy, wet weather	Bordeaux mixture, 4-5-50, at weekly intervals.
Damping-off	Plants decay at surface of soil	High humidity; too much water; soil with low calcium content.	Use sterilized soil in hotbeds and flats. Provide adequate ventilation. Do not overwater, especially on cloudy days. Add lime if soil is acid.
Anthracnose or ripe rot	On ripe or nearly ripe fruits. Small circular shrunken dark brown to black areas.	Wet seasons, periods of cloudy, wet weather.	Bordeaux mixture, 4-5-50, when fruits begin to ripen, or copper acetate, 4 pounds to 46 gallons of water. This does not spot the fruit.
Blossom-end rot	Dark brown to black, sunken areas on blossom end of fruit.	Low soil moisture and high temperature.	Keep plants in good growing condition. Irrigate if necessary during extreme drought. The use of hard-wood ashes or potash fertilizers helps.
Root knot	Small galls on roots. In severe infestations roots become a mass of galls. Leaves turn yellow, plants dwarfed.	Light soils, high temperatures	Rotation of crops. Use nematode-resistant crops on tomato soil for three years. Barley, corn, rye, or sorghum recommended. Do not use vegetable crops, since most are susceptible. In greenhouse, steam sterilization of soil.
Scab or bird's-eye spot	Small black slightly raised dots on fruit. Scabby spots, due to coalescence of these small spots, later appear.		Seed treatment in bichloride of mercury 1-3,000 for five minutes followed by washing in running water for 10 to 15 minutes.

For more extensive information on any of these diseases write to the Agricultural Experiment Station, Manhattan, Kansas.