

Tomato Growing in Michigan

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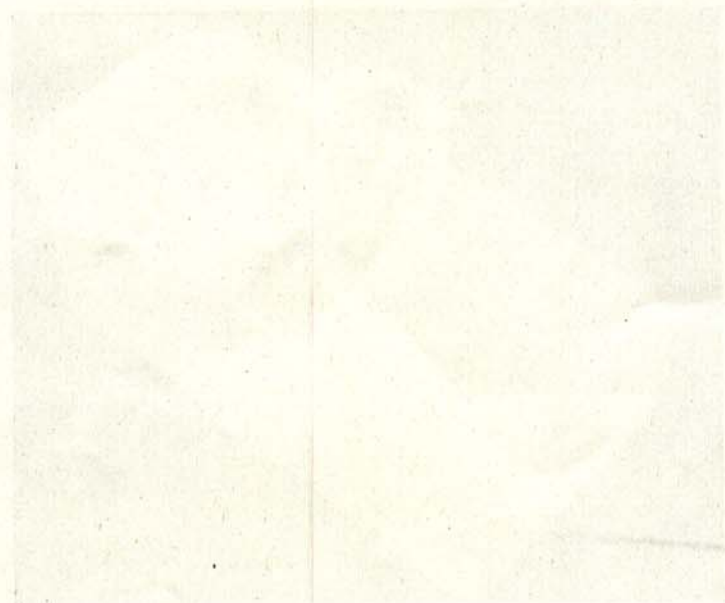
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TOMATO GROWING IN MICHIGAN*

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The tomato is one of the most popular as well as important vegetable crops of Michigan. The demand for the fruit is increasing as nutrition studies show its value in the diet. It is an excellent source of certain vitamins and has been termed "the poor man's orange". Few products have as wide a range of uses as does the tomato. It is used raw and cooked and is made into salads, soups, tomato juice, catsup, sauce, pickles, conserves, and many other products. The crop is grown on a commercial scale by nearly every market gardener in the State and as a canning crop in certain localities. Several hundred acres are annually devoted to growing tomatoes for seed purposes.



Fig. 1. The selection of suitable soils, adequate fertilization, and the prevention of disease and insect injury aid materially in securing good stands of tomato plants.

No home garden is complete without a few plants to supply the owner's table with fresh fruit during the ripening season. The crop is also grown extensively under glass during the winter months in the vicinity of Grand Rapids and other cities, so that it is possible to purchase Michigan grown tomatoes almost any day of the year.

*Revised by H. L. Seaton in 1936. The original manuscript was prepared by C. W. Waid in 1918 as Special Bulletin 89, was revised by E. P. Lewis in 1924 as Special Bulletin No. 131, and rewritten by H. L. Seaton in 1932.

Early tomatoes usually bring the largest returns and commercial growers strive to get as large a portion of their crop as possible on the market in time to secure the premiums paid for the first home-grown fruit. The growing season in all parts of Michigan is relatively short for tomatoes and the returns from the crop grown for the canning factory and in home gardens are in a large measure dependent upon early yields. Cultural methods now used vary greatly. Early fruit can be produced only when care is exercised in growing the crop. Hence, it is the purpose of this bulletin to set forth from the standpoint of the commercial grower the fundamentals of successful early tomato production which are also applicable to the growing of the crop for the canning factory and in home gardens.

Statistics of Production

The statistics of production of tomatoes for market and for manufacture from the Crop Report for Michigan are given in Table I. The acreage devoted to the market crop has increased annually since 1928 and in 1935 was more than ten times as great as in 1928. A recent survey has shown that the receipts of tomatoes from other states during the Michigan season amounted to only 5 per cent in 1929, 1 per cent in 1930, and 1931, and none in 1932 and 1933. Whether or not the large acreage increases during 1933, 1934, and 1935 are justified is questionable. Growers need be reminded that in 1933 and 1934 drought conditions prevailed in the states to the south and even in Michigan the yields were materially reduced. The 1935 season was abnormally cool and wet, maturity was delayed and severe losses occurred from foliage diseases. These climatic conditions were largely responsible for the maintenance of favorable prices. However, if the acreage of market tomatoes is further increased and normal weather conditions prevail the returns may be greatly influenced.

As with the market crop the acreage devoted to the canning crop has increased annually since 1929. In 1935 the acreage was more than twice the acreage in 1928. This increase is not of the magnitude of the market crop, and should not be taken as an indication of an unfavorable condition. In 1927 the canning crop was badly infested with bacterial canker and many canning factories did not contract acreage in 1928. Since 1928 the acreage has increased along with the demand for tomato products; also several eastern companies have located factories in this section. The grower of the cannery crop is usually not affected by market conditions as the price is established before planting.

The principal producing counties of market tomatoes are Berrien, Wayne, Monroe, Macomb, Jackson and Van Buren. The canning acreage is located in Berrien, Van Buren, Oceana, Jackson, Bay, Kent, Lenawee, Newaygo and Wayne counties.

Climatic Requirements

The tomato is a warm season plant and requires a relatively long growing season to produce profitable yields. In sections of the state having less than 110 days frost-free period, the crop is not likely to be profitable. The plant is tender and will not stand freezing, and the growth is often decidedly checked and the plants may be permanently

Table I. Acreage, yield, production, and value of tomatoes grown in Michigan.
MARKET CROP

Year	Acreage harvested	Yield per acre	Total production (000 omitted)	Average seasonal farm price	Total value (000 omitted)	Average value per acre
	acres	bushels	bushels	dollars	dollars	dollars
1923.....	1,170	143	167	1.31	219	187.33
1924.....	580	214	124	1.64	203	350.96
1925.....	860	214	184	1.35	248	288.90
1926.....	290	175	51	1.33	68	232.75
1927.....	290	196	57	.91	52	178.36
1928.....	290	209	61	.98	60	204.82
1929.....	700	170	119	1.26	150	214.20
1930.....	1,040	130	135	1.10	148	143.00
1931.....	1,700	160	272	.95	258	152.00
1932.....	1,900	175	332	.55	183	96.25
1933.....	2,180	185	403	1.20	484	222.00
1934.....	2,600	150	390	.90	351	135.00
1935.....	3,000	140	420	.75	315	105.00
Average 1923-1935....	1,276	174	209	1.09	211	193.12

TOMATOES FOR MANUFACTURE

Year	Acreage harvested	Yield per acre	Total production	Average seasonal farm price	Total value (000 omitted)	Average value per acre
	acres	tons	tons	dollars	dollars	dollars
1923.....	2,200	3.5	7,750	9.50	73	33.25
1924.....	2,300	5.7	13,100	10.29	135	58.65
1925.....	2,000	6.8	13,600	11.91	162	80.99
1926.....	1,800	5.0	9,000	11.80	106	59.00
1927.....	1,800	5.5	9,900	12.13	120	66.72
1928.....	1,660	5.8	9,600	11.00	106	63.80
1929.....	1,990	4.5	9,000	12.00	108	54.00
1930.....	2,600	5.4	14,000	12.00	168	64.60
1931.....	2,000	7.0	14,000	9.80	137	68.60
1932.....	1,900	5.8	11,000	7.90	77	40.60
1933.....	2,500	7.4	18,500	7.90	146	58.46
1934.....	3,150	5.5	17,300	8.50	147	46.75
1935.....	3,750	4.7	17,600	8.58	151	40.27
Average 1923-1935....	2,281	5.6	12,638	10.18	143	56.61

injured by low temperatures above the freezing point. For this reason, the plants should not be set in the field until weather conditions are favorable for continued growth. High humidity with high temperatures favor the development of foliage diseases, while hot drying winds and low soil moisture content may result in the dropping of the blossoms.

Soils for Tomatoes

The tomato is suited to a great variety of soils, producing good returns on types ranging from heavy clay to light sand. Under extensive methods of culture, as in the case of tomatoes grown for the canning factory, where low production cost is essential and earliness is not so important, a clay loam is very desirable. However, where earliness of ripening is essential, a warm, fertile, sandy loam is preferable. Invariably, the earliest fruits in the market garden sections of Michigan are

produced on fertile, light sandy soils which have good drainage and plenty of organic matter. These factors permit early planting, rapid growth, and early ripening of fruit. Where total yield is important, the heavier types of soil are to be preferred, because of their higher fertility and of their greater moisture-retaining power late in the season.

Fertilizers and Manure

The amount and kind of fertilizer required to produce the most profitable yields of tomatoes depends largely on the type of soil and the purpose for which the crop is grown. The tomato is a fairly heavy feeder of certain mineral elements and requires a relative large amount of these nutrients for its proper development, but the plant is sensitive to an unbalanced nutrient condition; thus, if the supply of nitrogen is over abundant and the supply of available phosphorus is low, the plant will grow vigorously but fail to set fruit until late in the season.

Manure has given good returns on many of the sands and sandy loam soils. However, on the more fertile loams and clay loams, manure may cause an excessive vine growth which will produce few early tomatoes. For this reason, heavy applications of manure should not be made on soils of medium to high fertility. A good system of soil management followed by many growers is to use the manure for the crop that precedes tomatoes in the rotation, since manure will usually give larger returns from melons, cucumbers, or sweet corn than from tomatoes. Where the soil is low in organic matter a light application of manure will be valuable, but, under no consideration, should the application exceed 20 tons per acre. The manure should be applied and turned under in the fall. If applied during the winter or early spring, it should be plowed under several weeks in advance of the field setting of plants.

Results of numerous fertilizer experiments show that phosphorus is of great importance in the nutrition of the tomato. This element not only increases the yield but has a marked effect on the earliness of the crop. Since practically all Michigan soils are low in phosphorus, fertilizers high in this element are recommended for tomatoes.

Some growers fertilize heavily with nitrate of soda or sulphate of ammonia early in the season. This treatment results in a rapid vigorous growth of the plants which, under most conditions, is deceiving to the observer because, at the time the plants should be setting the first clusters of early fruit, they are in such a vegetative condition that most of the blossoms drops. Nitrogenous materials that are readily available should not be used alone early in the season when large yields of early fruit are desired.

For the early market crop and those grown in the home garden, from 1,000 to 1,500 pounds of a commercial fertilizer per acre is recommended. From 300 to 400 pounds should be mixed well with the soil in the row or in the hills before the plants are set and the remainder should be applied broadcast and worked into the soil when it is being prepared for field setting. For the canning crop, an application of 500 pounds of fertilizer broadcast and worked into the soil before field setting is likely to give the most economical returns.

Recent fertilizer placement experiments at a number of experiment stations have shown some rather striking results of the effects of placement or early and total yields. In general, applications of 400 to 600

pounds per acre applied in bands $2\frac{1}{2}$ inches from the plant and at a depth of $2\frac{1}{2}$ inches have resulted in earlier and heavier yields than where much larger amounts were applied broadcast. However, this is still in the experimental stage and no definite recommendation can be made at this time. Furthermore, satisfactory equipment for such placements is as yet not available.

For the sands and light sandy loams where no manure has been used, or where no clover or alfalfa has been grown within the last two years, a 4-16-4 or a 4-16-8 mixture is recommended. Where the soil has been manured or a green manure crop has been grown within the last two years a 2-12-6 or 4-16-4 mixture will be better adapted.

For the heavy sandy loams, silt loams, and clay loams that have not been manured or a crop of clover or alfalfa has not been grown within the last two years, a 4-16-8 mixture should be used. Where clover or alfalfa has been grown or manure used within the last two years, an 0-14-6, 2-12-6, or 4-16-8 mixture should give satisfactory returns.

When grown on acid soil tomatoes are seldom benefited by liming the soil and a few cases are recorded where the yield has been reduced by liming. Recent tests have shown that lime when used in the rotation of tomatoes and leguminous crops has indirectly increased the tomato yields by increasing the growth of the legume crop.

Plant Growing*

The character of the plants transplanted has a marked influence upon the early and total yield. Plants that are stocky, vigorous, of the proper age, and well hardened are able to get a quicker start and make a more rapid growth than plants of a weak, succulent, spindly nature.

There are many methods followed in growing the plants but they are all essentially alike. The seed is sown in specially prepared seed-beds in greenhouses or hot beds several weeks in advance of field setting. The time of sowing the seed depends on the time the plants may be safely set in the field and the plant growing facilities available. Where the hot bed is used to start the seedlings, it should be made in late February or early March and the seed sown in this bed eight to ten weeks before the frost free date for the locality. This will ordinarily be between March 10 and 25 and if the seedlings are to be started in the greenhouse the seed should be sown at this time. Many growers sow the seed too far in advance of field setting because they think that a slow growth is desirable, but experimental work carried on at this and other stations, indicates that this may be overdone, as plants kept in the greenhouse or hotbed too long before field setting are likely to become too leggy or woody to be desirable. In either case, the plants do not begin to grow quickly when they are set out.

The seed may be sown in shallow wooden flats in rows two inches apart planting 10 to 12 seeds to the inch, or it may be sown directly in the soil of the hotbed or greenhouse bench in wide rows four to six inches apart. Better care can be given the young seedlings when they are grown in flats. When the plants are not to be transplanted before setting in the field, the rows should be at least six inches apart

*See Michigan State College Extension Bulletins No. 20, "Hotbed and Cold Frames" and No. 130, "Small Sash House for Vegetable Plants" for more detailed information on plant growing and structures used.

and the seed sown thinly so that the plants will be one and one-half to two inches apart in the row. However, this method does not give the most desirable type of plants and where it is followed the seeding should be delayed until about six weeks before the plants may be moved to the field. The seed should be covered from one-fourth to three-eighths of an inch. One or one and one-half ounces of seed will ordinarily produce enough plants to set one acre.

Care should be exercised in watering the seedlings in order to prevent damping off and spindling plants. The plants should be given water only when they show a need for it and then it should be applied in sufficient quantity to soak the soil for several inches. Watering should be done only early in the morning of bright clear days in order that the plants and the surface of the soil may become dry by night. Ample ventilation should be given at all times when it is possible to do so.

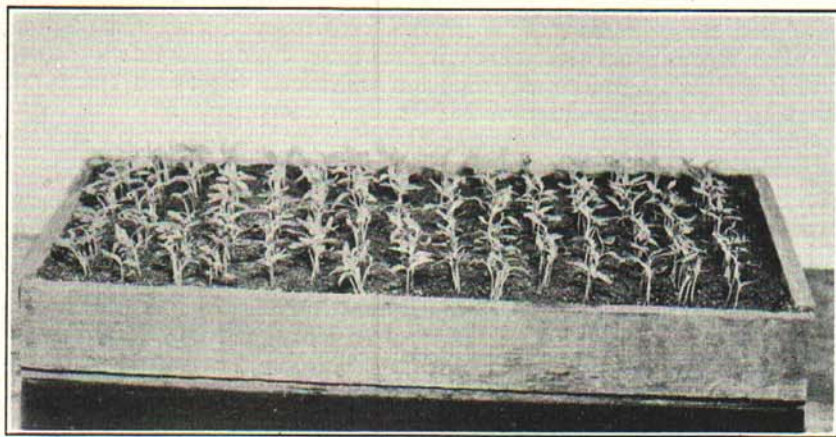


Fig. 2. A flat of tomato seedlings sown in rows. The seeds were not sown too thickly and each seedling may develop normally.

The seedlings should be transplanted after they are two to three inches high and show their third true leaf. If started in March, this will be from the middle to the last of April. The seedlings may be transplanted into clay pots, flats, veneer bands, or directly into the soil of the cold frame or greenhouse bench. When clay pots and veneer bands are used, the entire root system is not disturbed when the plant is set. Where pots are used, the four inch size is preferable and the 4 x 4 x 4 inch veneer bands used for starting early melon plants give satisfactory tomato plants. Some growers transplant into flats, setting the plants two by two or three by three inches apart. The greater distance is preferred where good stocky plants are desired. The flats may be taken to the field and the plants set with little disturbance to the root system.

A method that is commonly followed and which does not require the added expense of pots, bands, or flats is known as blocking. In preparing the cold frame a layer of well rotted manure one and one-

half or two inches deep is placed in the bed and this is covered with two to two and one-half inches of compost or garden loam soil. The plants are transplanted four by four or four and one-half by four and one-half inches apart. Ten days to two weeks before the plants are to be set in the field, the soil is cut into blocks each containing a plant. This work may be done with a large knife or a wide bladed hoe that has had the shank straightened out. The root pruning given in this manner retards the growth and causes the roots to branch. The new roots formed near the edges of the block help to hold the soil together when the plants are moved to the field. This system may also be followed where the plants are grown in flats.

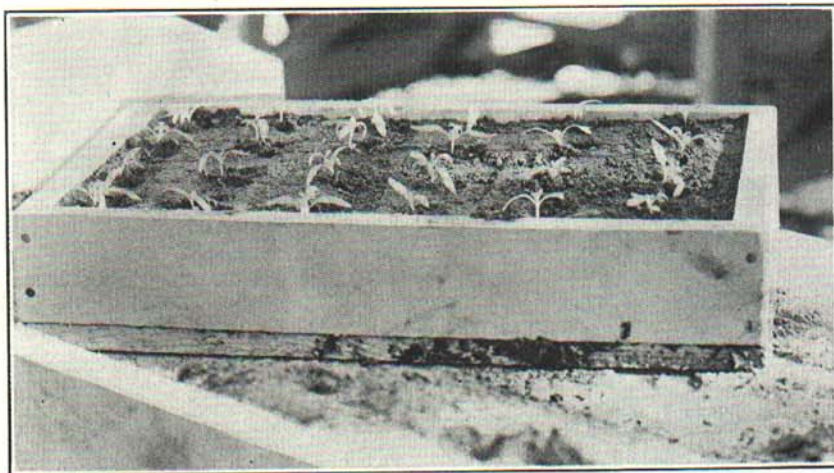


Fig. 3. Tomato seedlings transplanted in flat. The plants are spaced 3 x 3 inches.

Some growers transplant a second time before the plants are set in the field, but if proper spacing is given the plants at the time they are first transplanted this is of no advantage and merely increases the cost of producing the plants.

Tomato plants should be well hardened before they are taken to the field. This is usually accomplished by gradually subjecting them to out-door conditions either by removing the sash from the frames to lower the temperature or by withholding water except at times when the plants begin to wilt, or by a combination of the two methods. Any method that checks the growth results in hardening; and, as the temperature at that season of the year is difficult to regulate, limiting the water supply is a more certain method. Tomato plants cannot be hardened sufficiently to enable them to withstand freezing temperatures. Tests carried on at this experiment station indicate that plants may be hardened too severely. In these tests, plants seeded the same date and grown in the greenhouse without hardening gave larger early yields than those which were moved to the cold frames the middle of April in order to check their growth. However, the forced plants were long

and tender and required extra labor and care when set which was not required by the other plants.

Southern Grown Plants

During recent years large areas in the southern states have been devoted to the production of plants for sale to tomato growers. As it is possible to grow these plants with cheap labor in open beds in the



Fig. 4. The influence of transplanting on tomato plants. All of the plants are the same age and were grown under identical conditions. The two plants to the upper left were not transplanted; the two to the upper right were transplanted once when small; those to the lower left once when large and the ones to the lower right twice, once when small and again when large. Notice the difference in root and top development.

field, they are offered to growers in the northern states at prices much lower than plants produced locally in greenhouses and frames. In many cases, the results have been satisfactory, in others disappointing. These plants should be used with care. The spread of serious diseases, particularly, bacterial canker, Fusarium wilt, mosaic; Septoria leaf spot and nematodes, is a danger to be guarded against. Often it is impossible to distinguish these disorders in the young plants, as they do not become noticeable until several weeks after field planting.

Considerable supervision is necessary to insure proper choice of disease-free soil, proper growing, spraying, packing, transporting, handling and delivery of such plants. Where such supervision is possible, plants of satisfactory quality can usually be obtained. Such supervision can be given only by the larger canning companies, and an in-



Fig. 5. Blocked, flat grown tomato plants ready for field setting, seeded the same day but grown under different conditions. The plant on the left, was grown in the greenhouse and forced. The center plant and the one on the right were moved to the cold frame April 15. The two plants on the left were spaced 3 x 3 inches and the one on the right 1½ x 1½ inches. The center plant is the most desirable type for field setting.

dividual grower ordering direct from the southern plant grower has no assurance as to the kind of plants he will receive.

As these plants are grown under higher temperatures than usually prevail in Michigan at the planting season, they are often poorly hardened and considerable losses occur in transit. Shipped plants frequently arrive in a wilted condition. They may be planted immediately if the soil is moist, otherwise they should be planted thickly in trenches (heeled in), watered and held until they regain their turgidity or until the growers are ready to plant. The leaves should not be wet as they are liable to be attacked by soft rot in their crowded position.

Setting in the Field

The tomato plant is tender and should not be set in the field until danger of frost is past. Early planting is important as the fruit marketed early in the season brings the highest prices and plants set early will give the largest total yields, as they will continue to bear until frost. In general, if the plants are well grown, it is desirable to set them as soon as danger of frost is over. Ordinarily, this will be the last week of May or the first part of June.

The plants should be handled so that as much soil as it possible remains on the roots. They should not be allowed to become dry or wilted from the time they are removed from the cold frame until they are set. It is advisable to prepare the soil and the plants in the morning and set them during the late afternoon. Where earliness is a factor, the plants are set by hand as it is possible to set the plants with a block of soil on the roots. Where small plants are used, they are sometimes set with a transplanting machine.

The spacing given the plants in the field is determined by the fertility of the soil and the system of training. Untrained plants are set three and one-half by four or four by four feet and where the soil is very fertile four by five or four by six feet is desirable. Where the plants are to be staked and pruned the rows are three and one-half or four and the plants two to two and one-half feet in the row.

Cultivation and Irrigation

Frequent shallow cultivations should be given as often as is necessary to control weeds. Deep cultivations are nearly always injurious as many of the roots are destroyed by cultivations that are more than two inches deep. Experiments in New York carried on over a period of six years have shown that cultivation merely for the purpose of maintaining a soil mulch was of little value. When the vines cover the ground, cultivation should cease as more harm than good will be done. Large weeds that appear after the last cultivation may be pulled by hand or removed with a hoe.

Many Michigan growers have found that irrigation is decidedly beneficial for tomatoes grown for the market and in home gardens. Some cases have been recorded where the increased returns from one or two crops have more than paid for the cost of installation. In sections where short periods of drought occur, the yield and quality of the fruit may be greatly improved by irrigation. Blossom end rot may be completely controlled by proper irrigation and blossom drop caused

by hot drying winds and low soil moisture content may be greatly reduced. The overhead sprinkling system is used chiefly for this purpose.

Pruning and Training

The practice of staking and pruning of tomato plants on a commercial scale is not as widespread a practice as it formerly was. Training the plants to a stake and pinching out all of the lateral shoots that appear in the leaf axils was believed to increase earliness and give larger, cleaner fruit. The yield per plant is reduced but with the closer spacing of the plants the yield per acre of pruned and unpruned plants is about the same. The root system is decreased in proportion to the top growth allowed to remain and in a dry season this may be detrimental, as more blossom end rot is likely to develop. The main advantage of pruning and training is that, where foliage diseases are



Fig. 6. Tomato plants that were staked and pruned to a single stem.

prevalent, less damage on the staked plants occurs. The main disadvantage of pruning and training is the increased cost of production as at least twice as many plants are needed to set an acre and the labor required to stake, prune, and tie the plants every week or 10 days more than offsets the returns from the practice.

Varieties

There are many standard varieties of tomatoes. A large number of these are good and, under Michigan conditions of soil and climate, will produce satisfactory crops. However, as the differences which distinguish varieties are very slight in many instances, it is believed that a very few of the better varieties will entirely meet the needs of the Michigan grower.

It is unfortunate that inferior strains of many varieties are on the market. It will be necessary for the grower to become acquainted

with the better sources of seed supply in order that he may obtain the best strains of the recommended varieties. A brief description of a few of the best varieties for Michigan is given.

Earliana is the first early home and market garden variety. It requires from 55 to 65 days from the time medium sized plants are set in the field until the first commercial harvest. The plants are small and somewhat sprawling. The leaves are small and the fruit is usually exposed. The plants set a large number of fruits on the first clusters. The immature fruits are pale green with a deep green color at the stem end. The mature fruits range from five to six ounces. The shape is nearly round to slightly oblate. The color is scarlet with yellowish

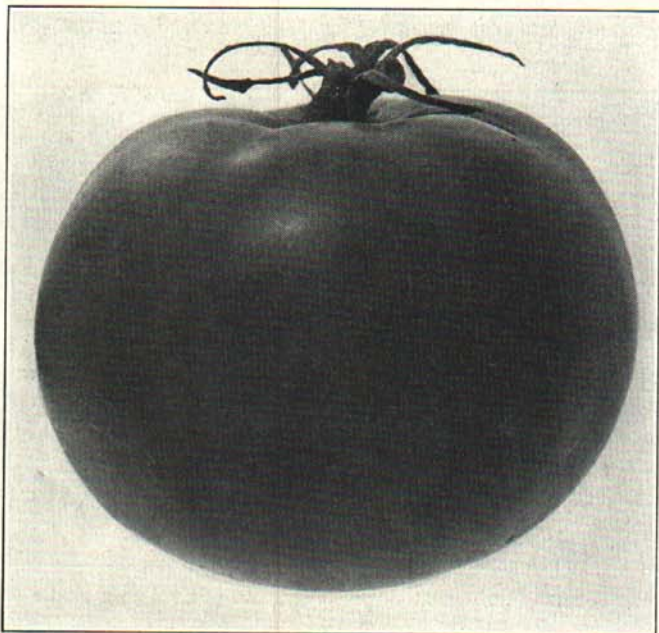


Fig. 7. Natural size, typical fruit of the John Baer, a variety well adapted to Michigan conditions.

red at stem end and the skin is yellow. The outer cell wall is thin and the cells are numerous. The flesh is medium firm, and the core is small.

This variety ripens its fruit five to ten days earlier than most varieties. The fruits are likely to be irregular in shape and of poor market quality if the best strains of the variety are not used. The fruit has poor shipping qualities and the variety should be planted only for local market trade.

Bonny Best, John Baer, and Chalks Early Jewel are similar varieties and are considered as the same variety by many authorities. These varieties ripen from five to ten days later than Earliana, usually requiring 60 to 75 days from the time medium sized plants are set until

the first harvest of commercial importance. The plants are medium in size, are semi-erect and spreading; leaves medium in size and number, covering the fruit partially. The fruit is borne in clusters of four to five and is pale green with dark green area at stem end in the immature stage. Mature fruits are medium in size, ranging from five to six ounces; nearly round to slightly oblate in shape (See Fig. 1). The color is deep scarlet when full ripe and the skin is yellow. The outer cell walls are medium thick and there are usually six to seven cells with a fleshy central mass. The flesh is medium firm and the core is small.

These two varieties are very popular in all sections suitable for tomato growing in Michigan. The fruits of these varieties have better shipping qualities than Earliana and the plants do not produce as large a percentage of culls as does that variety. The John Baer is used extensively in Michigan as a canning tomato. These varieties are well suited for growing for the market, canning factory, or home use.

Early Detroit is a pink midseason variety that is grown in localities where a pink tomato is preferred on the markets. It requires from 70 to 80 days after medium sized plants are set in the field until the first commercial harvest, with the peak harvest at 100 to 110 days. The plants are medium in size with semi-erect habit of growth; growth is medium to dense and fruit is well shaded. The plants normally set two to three fruits per cluster. Mature fruits are medium large, five and one-half to six and one-half ounces in weight, and nearly round to slightly angular. (See Fig. 8.) The cavity is shallow but many fruits produce shallow basins. The color is at first a uniform pale scarlet-red which changes to brilliant scarlet-red when full ripe. The skin is colorless, which gives the fruit its pinkish cast. Outer walls are thick with six to seven cells regular in shape; there is characteristically a medium sized fleshy central mass.

This variety is too late for an early market variety in many sections of Michigan. It is well suited for markets requiring a pink tomato as the fruits are somewhat above average size and fairly attractive. It may be used in home gardens where a pink fleshed tomato is desired.

Marglobe is a wilt-resistant variety developed by the United States Department of Agriculture. It is a mid-season variety requiring from 70 to 80 days from the time medium sized plants are set in the field to the first commercial harvest. Strains that will mature earlier are being developed and may shorten this period. The peak harvest is from 100 to 110 days after setting. The plants are large with semi-erect branches and have dense foliage which usually hides the fruit. The plants normally set from three to four fruits per cluster. The mature fruit is spherical in shape, being deeper than Bonny Best or Earliana (See Fig. 9.) The size of the fruit is large, weighing six to seven ounces, but may be smaller when grown on poor soils or in a dry season. The color is scarlet when usually harvested but becomes a deep scarlet when full ripe. Skin is yellow. The outer walls are thick and the interior of the fruit is fleshy with few seeds and deep scarlet in color.

Marglobe is recommended for the southern part of the State where Fusarium wilt has been prevalent the past few years. It is well suited for market and is ideal for home gardens and canning.

Pritchard is a relatively new variety developed by the late Fred J. Pritchard of the United States Department of Agriculture, which has been rather generally accepted in the commercial tomato producing sections of Michigan. It is the result of a cross between Marglobe and Cooper Special, a variety which sets an abundance of nearly globular fruit which mature early. In season it is similar to Bonny Best, requiring 65 to 70 days from the transplanting of medium sized plants to the first commercial harvest. It is characterized by having a heavy bearing period of about four pickings, on account of determinate type of growth. The spread of the vines is markedly less than Marglobe, but on rich soil the foliage is usually sufficiently dense to shade the fruit. The fruit is slightly flattened, globular shape, scarlet in color, medium in size, with thick outer and inner walls which give the fruit considerable firmness, an important quality for a canning and shipping tomato. The internal color is uniform scarlet-red, similar to but deeper than that of Marglobe. As this variety sets a large number of fruits, rich or liberally fertilized soil is required to develop the fruit to fancy size. Pritchard, like Marglobe, is resistant to Fusarium wilt and it is reputed to be less susceptible to stem end cracking than Marglobe.

Greater Baltimore or **Indiana Baltimore** is grown extensively throughout the Middlewest as a canning variety. Its season is late, generally requiring from 73 to 83 days from transplanting medium sized plants to first commercial harvest. The plants are large with medium dense foliage. The mature fruits are medium large (6 to 7 ounces). When viewed from either end, fruit is oblong in outline, and when viewed from side, the fruit is distinctively flattened. The cavity is deep and most fruits have broad relatively deep basins and large, coarse styler scars. Outside color is grenadine red, inner color scarlet. Walls medium thick with 7 to 9 cells in fruit. Because of its late maturity, Greater Baltimore can not be recommended for Michigan conditions, except in the most southern counties.

Break-O'-Day, a new variety, has been highly advertised. It is wilt-resistant and is claimed to have the quality of Marglobe combined with the earliness of Earliana. In tests at the Experiment Station this variety has not been out-standing. The season is similar to that of Bonny Best and the fruits develop a yellowish red color about the stem end as compared with the deep scarlet of other varieties. The **Grothen's New Globe** or **Red Break-O'-Day** is a strain of this variety which develops a much better color than the parent.

Penn State and **Rutgers** are two new varieties released in 1935. They were grown at East Lansing in 1935, but as the weather conditions were abnormal, neither can be recommended or condemned on the single year's test. The Penn State, released by the Pennsylvania Experiment Station, was developed from a cross between Penn State Earliana and Cooper Special. In season and fruit it is similar to Earliana with slightly better quality in the fruit. The determinate type of growth results in small plants, which should be planted much closer than standard varieties. It yields heavily early in the season but total yields are not as large as other varieties. In 1935, Septoria leaf spot reduced the foliage materially and the fruits were small and

ripened poorly. The Rutgers is a late variety released by the New Jersey Experiment Station from a cross between Marglobe and J. T. D. In season it is similar to Marglobe. The fruits are large, of a deep globular shape with well rounded stem ends, thick outer and inner walls and few seeds. They ripen to a good color and are reputed to be less susceptible to cracking than Marglobe. Whether this variety will ripen early enough to be profitable in Michigan remains to be determined.

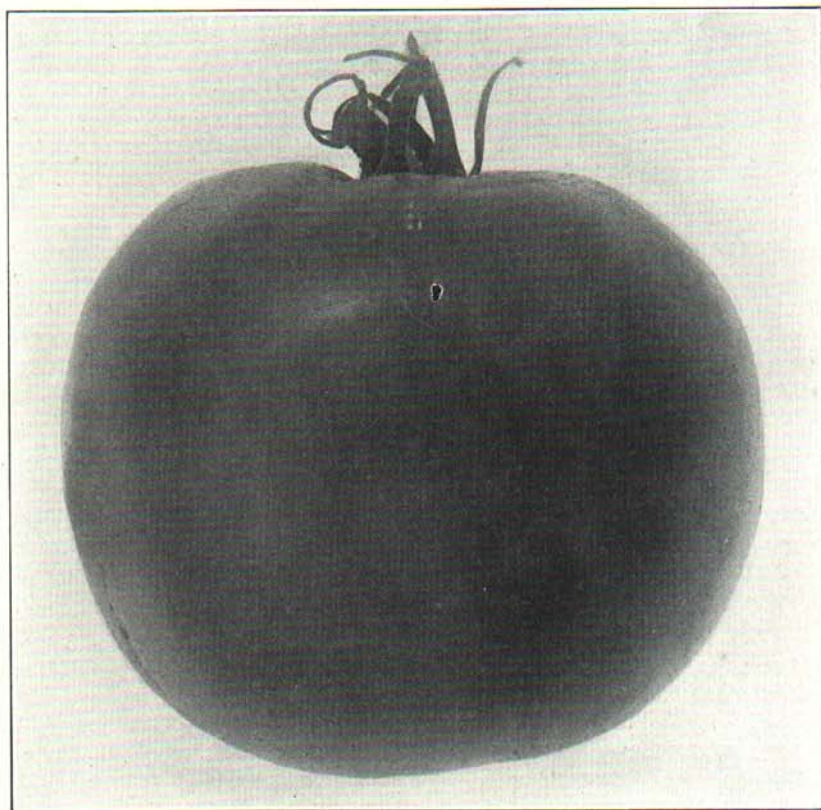


Fig. 8. Marglobe, a wilt-resistant variety of high quality.

Seed Selection

Tomato seed of the same variety from different sources may produce plants which vary greatly in productivity, earliness, quality, and type. Growers have learned that the very best seed obtainable is a good investment. When the grower buys his seed he should deal with a reliable seedsman. Some growers prefer to save their own seed and if they thoroughly understand the methods followed in the selection of desirable types, it is possible for them to build up superior strains which may be better adapted to their conditions.

When selections are made the grower should make the plant and not the fruit the basis of selection. A strain can not be improved by selecting the largest and most perfect fruit at the packing shed. For most practical purposes, the tomato may be considered as being self-pollinated, as only a very small percentage of the flowers are cross-pollinated. Several inspections should be made of the plants in the field during the growing and ripening seasons. Plants that show resistance to disease, productivity, earliness, good type of fruit, and other desirable characters should be selected and marked. After the final selections have been made the seeds from each plant should be saved separately. This may be accomplished by squeezing the pulp and seeds of the fruits into a Mason jar and adding a small quantity of water. This should be allowed to ferment until the seeds separate from the pulp and settle to the bottom. Under ordinary conditions this condition is reached in two days if the contents are stirred several times a day. The fermented pulp may be floated off and the seed cleaned by adding water and repeating the washing process. It should be placed on screens or cloths to dry.

The following season the individual plant selections should be planted separately in small plots to test their uniformity of productivity, earliness, fruit type, and other qualities. Seed to be used for the crop the next year should be saved from the most desirable plant selection. If the grower does not follow a procedure similar to the one outlined above, he should not try to save his seed as no improvement will be made in the varieties.

Diseases*

The tomato is attacked by many diseases but the most serious in Michigan are Septoria leaf spot, Fusarium wilt, bacterial canker, mosaic, and blossom-end rot. The grower should be acquainted with the characteristics of these diseases in order that he may be able to reduce losses caused by them.

Septoria leaf spot, commonly called blight, is likely to be the most serious disease of tomatoes if the season is rainy; it may not be troublesome in a dry year. The disease first attacks the lower leaves and gradually advances upward on the other leaves of the plant. The infected leaves are covered with small circular spots which are either black or more commonly grayish-white with a black border. Similar spots may be found on the stems but the disease is not found on the fruit. As the disease advances, the spots dry, the leaves turn yellow, die, and drop from the plant. The decrease in the leaf area of the plant reduces the yield and exposes the fruit to sunburn.

Losses from leaf spot may be reduced by using clean soil in the plant beds, spraying the plants in the plant bed with 2-2-50 bordeaux, rotating the fields used for tomato growing, spraying the plants in the field with 4-4-50 bordeaux, and the cleaning up and burning of trash and old tomato vines after each crop.

*See Michigan Circular Bulletin No. 139, "Tomato Diseases in Michigan," for more detailed descriptions and control measures of tomato diseases. The brief description and control measures given here have been approved by M. C. Strong of the Botanical Section of the Experiment Station.

Fusarium wilt, also known as summer blight or merely wilt, is present wherever tomatoes are grown, but in Michigan it usually causes serious losses only in unusually warm seasons such as 1930 and 1931. The disease is characterized in its early stages by a wilting of the plant and an upward and inward rolling of the leaves. The leaves turn yellow and slowly die. A cross section of the infected stem shows a dark brown discoloration between the pith and bark.

Since the fungus causing wilt can live in the soil for several years, control measures must consist of long crop rotations and the use of wilt-resistant varieties. The use of resistant varieties is the most practical control and the Marglobe is the most important resistant variety.



Fig. 9. A tomato plant defoliated by leaf spot with the fruit exposed to injury from sunscald. This disease may be controlled by timely applications of Bordeaux sprays.

Bacterial canker is the most serious bacterial disease of tomatoes in this state, and in 1927 a severe epidemic occurred in Michigan. It is prevalent in many of the southern states and was reported in several sections of Michigan in 1935. The disease is seed-borne and may occur in two different ways. First, the seed may be internally infected, in which case the seedlings show the general effects of the disease, usually as a dwarfing and wilting of single branches or the entire plant. This type of infection causes a brown spongy decay of the center of the stem and can be easily detected by cutting the stems. Under certain conditions the bacteria reach the surface and are washed to the fruit where the typical bird's-eye spots are formed. Second, the bacteria carried on the surface of the seed may produce a form of the disease which results primarily in the spotting of the fruits. The spots on the fruit

are small, with a rough, brownish center, surrounded by a white halo. The spots usually occur in groups.

Control of bacterial canker is very difficult because spray and dust treatments are not effective. Since the disease may be carried by seed, fruits should be saved only from fields where the disease has not occurred. Experiments have indicated that the disease is destroyed in the seed by proper fermentation. Certified seed produced under state inspection is now available. One source of infection is southern-grown plants, and for this reason only home-grown plants are recommended. Soil contamination in seed beds and greenhouse may be overcome by sterilization. Rotation of crops for a period of two or more years with-

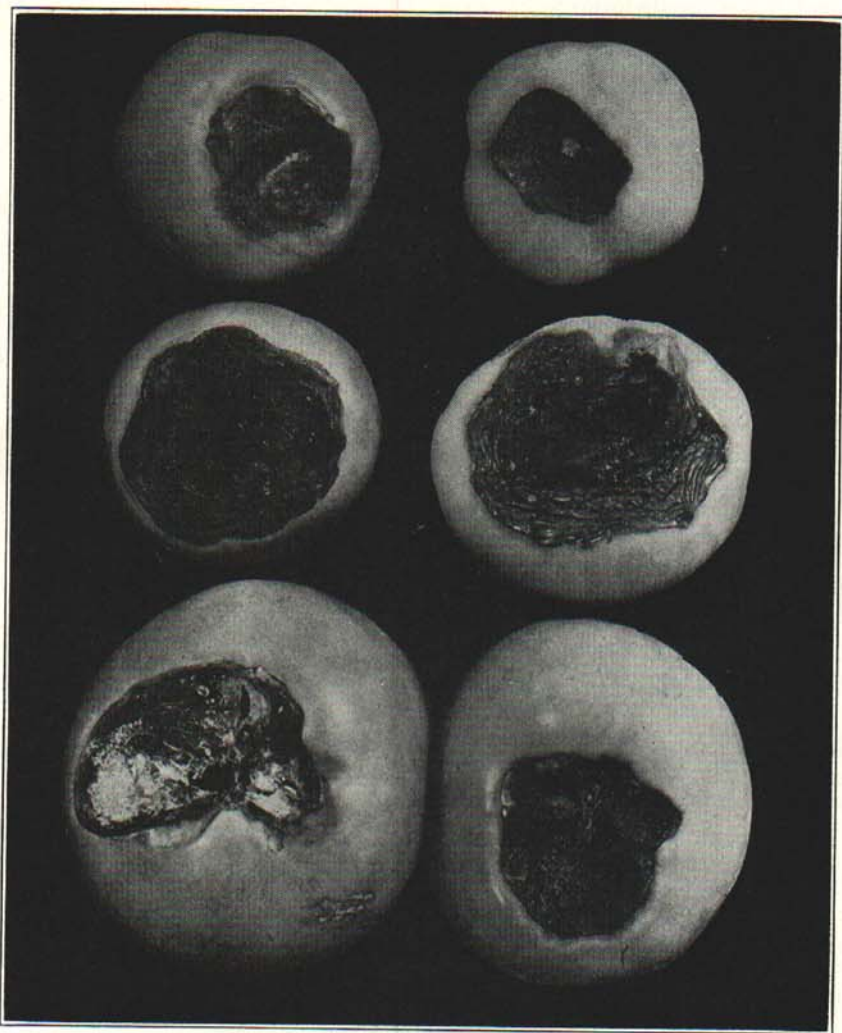


Fig. 10. Tomato fruits affected with blossom end rot. The mold growing on the large fruit is secondary.

out tomatoes is effective in dealing with field infections. It is advisable to pull up and burn diseased plants as soon as they are discovered, to prevent the spread of the disease.

Mosaic affected plants show abnormal leaf development, with a mottling of dark and light green areas predominating. At times diseased plants may have fern-like leaves. In severe cases the yields are greatly reduced.

The disease is spread largely by insects, and the growers when pruning and transplanting the plants. The control consists of using disease-free plants the eradication of all horse nettles, ground cherries, and related weeds near the plant beds and fields early in the season; and by controlling plant lice and other carriers by spraying.

Blossom-end rot affects only the fruit and occurs only at the blossom end. The first indication of the disease is a small yellowish spot around the dried-up blossom. This spot enlarges; takes on a dark brown or black color, and shrinks, resulting in a sunken area. Irregular water supply, especially a sudden check at the time the young fruit is forming, is the chief cause of the disease.

Cultural practices that conserve moisture aid in reducing the loss from this disease. Shallow cultivation, mulching the soil with straw or hay, and spacing the plants farther apart will all aid in controlling the disease. Irrigation will completely control blossom-end rot, if sufficient water is applied at proper intervals.

Insects

Tomatoes, as a rule, are not infested to any great extent by insects, and usually the loss thus occasioned is small. Flea beetles are often numerous and cause some injury to the foliage, but they are very seldom severe enough to warrant application of spray or dust. Bordeaux, as applied for leaf spot, acts to some extent as a repellent for the beetles.

The large green tomato worms may be controlled by dusting or spraying with arsenate of lead or by hand-picking.

Cut-worms, which often destroy many plants early in the season, may be held in check by a poisoned bran mash consisting of one pound of paris-green, 20 pounds of bran, one-half gallon molasses, four ounces amyl acetate, and a little water. This is broadcast over the ground. The quantity just indicated should cover two acres. The material is poisonous, and livestock or poultry should be kept out of treated areas.

Harvesting and Marketing

After a crop of tomatoes is produced, the harvesting and marketing of the crop should be given special consideration if the grower expects to realize the greatest returns. The tomato is a highly perishable vegetable and many problems enter into the handling of the crop from the time it is picked until it reaches the consumer. The wide variation in the prices paid for tomatoes on most markets is due to great differences in the quality and appearance of the pack. In general, the most important factors are condition, number of growth cracks, and the type of pack, while color and size of the fruit are of secondary importance.

Condition is especially important, as high premiums are usually paid

for firm tomatoes. Soft tomatoes must always be sold at lower prices. When tomatoes are eaten on the farm, they may be picked when they are dead ripe, but those intended for market can not be picked at that stage since by the time they are packed, trucked to the market, go through the commission merchant's and the retailer's stores, and finally reach the consumer a large part of them would be unsalable. For this reason, on most markets, firmness is far more important than color or size. Tomatoes that show growth cracks should not be packed with fancy tomatoes. Where an extra fancy pack is put up, it will usually pay the grower to put tomatoes of the same size and color in a single package. Each tomato should be placed stem end down in the basket so that when the packing is finished the fruit will be in definite layers. If this is not done, the grower should at least pack the upper layer in this manner as the finished pack makes a much better appearance on the market and will usually bring a higher price. All stems should be removed as they may puncture the skins of other fruits. If the fruits have been sprayed with bordeaux or are dirty, they should be wiped with a dry cloth. The container in which tomatoes are marketed should not be too large because, where ripe fruits are packed in bushel baskets or boxes, the bottom layers become crushed and leaky. There is no standard type of container used but the four, eight, and twelve quart climax and splint baskets are well suited for the purpose.

When the crop is grown for the cannery, tomatoes should be allowed to ripen on the vines, as the quality and color of the canned product depends on the maturity of the fruit. Some manufacturers of tomato products are purchasing tomatoes on U. S. Grades. These grades provide a definite basis for contracts between the canner and the grower, and are meeting with increased favor. The grades are such that variations in commercial value are recognized and they are still simple enough to be practical in actual operation. The grower should understand at the beginning that the only grading required of him is the removal of culls. The U. S. Grades serve as a basis for sampling of the tomatoes as they are delivered to the cannery, where private or official inspectors determine the percentages of U. S. No. 1, U. S. No. 2, and cull tomatoes and the grower is paid accordingly. Buying and selling on grade has been found to encourage better production and better handling, while the practice of paying a flat rate for everything accepted has discriminated against the best growers. Likewise, it has been found that graded stock can be canned at a minimum cost.

U. S. Grades for Cannery Tomatoes

U. S. No. 1 shall consist of tomatoes which are firm, ripe, well colored, well formed; free from molds and decay and from damage caused by growth cracks, worm holes, catfaces, sunscald, freezing injury, or mechanical or other means. (See Minimum Size.)

U. S. No. 2 shall consist of tomatoes which do not meet the requirements of the foregoing grade but which are ripe and fairly well colored and which are free from serious damage from any cause (see minimum size).

Culls are tomatoes which do not meet the requirements of either of the foregoing grades.

Minimum Size

The **Minimum size** may be fixed by agreement between buyer and seller. Tomatoes below this specified minimum size shall be classed as Culls.

Definitions of Terms

As used in these grades:

"Firm" means that the tomato is not soft, puffy, shriveled, or water-soaked.

"Well colored" means that the tomato shows at least 90 per cent good color.

"Fairly well colored" means that the tomato shows at least two-thirds good red color.

"Well formed" means that the tomato shall not be extremely flat or otherwise badly misshapen.

"Damage" means any injury which cannot be removed in the ordinary process of trimming and peeling without a loss of more than 10 per cent (by weight) of the tomato in excess of that which would occur if the tomato were perfect.

"Serious damage" means any injury which cannot be removed in the ordinary process of trimming and peeling without a loss of more than 20 per cent (by weight) of the tomato in excess of that which would occur if the tomato were perfect.

