Early Tomato Production in Michigan
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MICHIGAN STATE COLLEGE

Agricultural Experiment Station • Department of Horticulture

EAST LANSING

HOW TO PRODUCE EARLY TOMATOES

A. GROWING THE PLANTS

1. Select an improved early variety such as Early Wonder, Stokescross No. 2, Valiant or Longred.
2. Sow seed in sterilized soil or disease-free medium in a glasshouse 8 to 10 weeks before field setting.
3. Germinate seed and start seedlings at high temperatures (75 to 85° F.), then gradually lower temperature to 60° F. just before field transplanting.
4. Do not crowd seedlings. Allow at least 16 to 20 square inches for each plant for 3 to 4 weeks before setting in the field.
5. As the plants grow, add an all-soluble fertilizer high in phosphorus when watering.
6. Harden plants by exposing them for a few days in a coldframe and by keeping them on the "dry side."

B. FIELD OPERATIONS

1. Select a well drained sandy loam soil high in organic matter.
2. Plant on east or southeast slopes having natural wind protection and use windbreaks of snow fence, evergreens or other plantings.
3. Apply 1,000 to 1,500 pounds per acre of a 4-16-8 or a 4-16-16 fertilizer. One-half to two-thirds of the fertilizer should be broadcast and plowed in, the remainder placed as a band 2 to 3 inches to each side of the row and about 4 inches deep.
4. When transplanting, retain the soil on the roots and use a starter solution of all-soluble fertilizer high in phosphorus.
5. Use large paper plant protectors for insurance against wind and frost hazards.
6. Control insects and diseases in plant bed and field by periodic dusting and spraying with a basic copper or organic fungicide and methoxychlor.
7. Apply fruit-setting chemical sprays to flower clusters when night temperatures go below 60° F.
8. Irrigate when desirable for frost protection, for addition of fertilizer in water, and for higher fruit quality.

C. HARVESTING AND MARKETING

1. Pick fruit just as the color begins to change from green to a shade of red, and hold for proper stage of ripeness.
2. Grade and pack according to official regulations.
3. Establish a sales outlet before crop is ready for market.

Early Tomato Production In Michigan

By S. H. WITTWER and A. N. REATH

The tomato originated in the highlands of South America near the Equator. Sunlight was adequate, days were fairly uniform in length, and moderately warm temperatures prevailed throughout the year. However, tomato growing has now been adapted to many areas not so well suited to its culture. In Michigan the growing season is short, and ideal temperatures for growth and fruit setting occur only for brief intervals in midsummer. Because of the demand for early "home-grown" fruit, growers are anxious to utilize almost any method for forcing earlier production.

This bulletin is written in answer to frequent requests for an outline of some of the essential principles in growing earlier tomatoes. Many of the suggestions for earliness are based upon several years of research at the Michigan Agricultural Experiment Station in East Lansing and the Upper Peninsula Experiment Station at Chatham. Emphasis is on early market production rather than on growing the crop for processing. However, in many sections of Michigan, earlier production is equivalent to greater total yields because of the short growing season.

AREAS OF PRODUCTION

Tomatoes can be grown in all parts of Michigan. Large-scale commercial production for the early market, however, is limited to a few areas in the lower peninsula. These include southeastern and southwestern Michigan and the Bay City regions. They are designated by the letter "A" on the accompanying map (Fig. 1). Field setting may be done as early as May 10 and even earlier if special plant protection is provided. The first ripe tomatoes in these areas may be harvested as early as July 4. Heavy production usually does not begin before August 1. In addition to early market production, most of the tomatoes for processing in Michigan are grown in these three locations. Usually temperatures are high enough and the growing season is long enough for satisfactory production from medium-late canning varieties such as Rutgers, Early Baltimore, Garden State and Stokesdale. Ten-year (1941-50) averages of maximum and minimum temperatures from May 15 to July 1 are given in Table 1 for Detroit (southeastern area) and South Haven (southwestern area). Factors favoring early production in these localities are not only the higher temperatures but the moderating in-

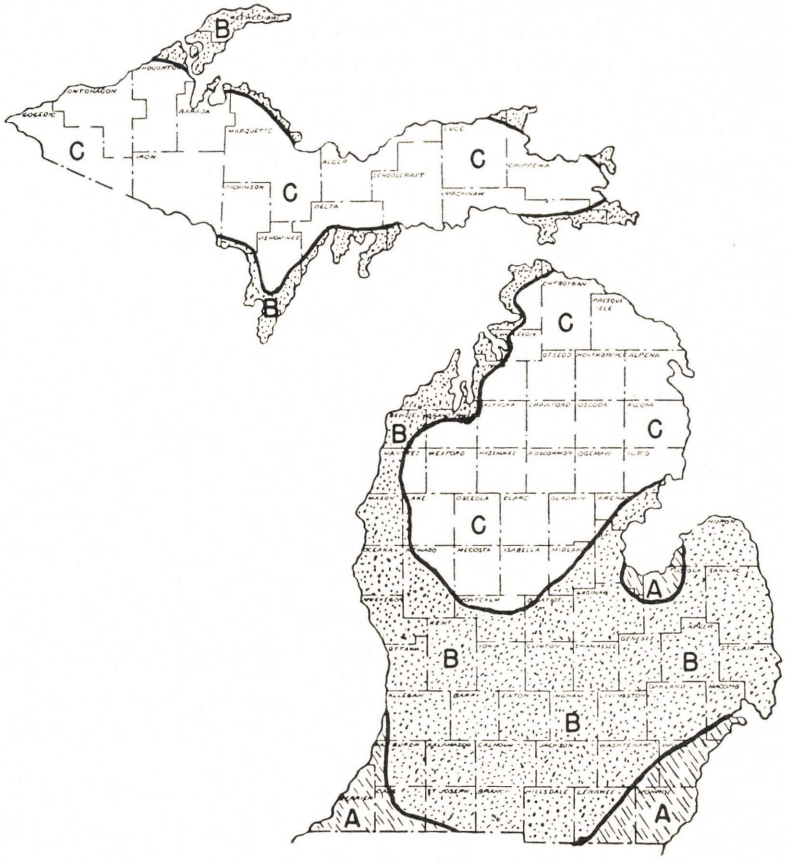

Fig. 1. General climatic areas in Michigan as related to early tomato production. A. Earliest, where field setting of plants may occur by May 10 and considerable fruit is harvested in July and early August. B. Field setting of plants not recommended before May 25 to June 5. First fruit is usually harvested about August 1. C. Late, suitable only for earliest self-topping varieties. Field setting of plants is not safe before June 10 and ripe fruit is seldom harvested before August 25.

fluences afforded by adjacent bodies of water (lakes) and the generally desirable soil types.

Areas designated by the letter "B" comprise central lower Michigan and certain areas adjacent to the lakes in upper Michigan. These regions are suitable for home and market garden production of early and mid-season types of tomatoes. Limited canning operations occur, but the bulk of fruit is sold locally on the fresh market in the larger towns and cities. Field setting of transplants is usually recommended for about May 25 to June 5. Harvesting of ripe fruit usually commences about

August 1 with the peak of production about September 1. Medium-late varieties, such as Rutgers, are seldom productive enough because of delayed fruit set and early frosts and are not recommended. Typical maximum and minimum temperatures for the areas are provided in the records (Table 1) of Lansing (lower peninsula) and Escanaba (upper peninsula). Although generally lower temperatures occur at Escanaba than in central lower Michigan, the moderating effects of the lakes are more pronounced.

The third area, designated by the letter "C", includes the eastern and central portions of the northern part of the lower peninsula and most of the upper peninsula. The growing season is short and the nights even in summer are cool. Production in these areas has been carried on largely by home gardeners; a few commercial market gardeners around the larger towns grow tomatoes for market and the tourist trade. Extreme measures are frequently taken to produce some ripe fruit before frost. Only the earliest varieties of the self-topping bush type (determinate) are successful. Field setting, even with plant protectors, is not generally safe before June 10. Ripe fruit is seldom harvested before August 25. Temperatures for these areas during May

*Table 1—Ten-year (1941-50) average maximum and minimum temperatures, in degrees F. from May 15 through June 30**

Date	Detroit		South Haven		Lansing		Escanaba		Grayling		Newberry	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
May 15–17	66	49	65	47	66	47	56	41	64	37	59	38
18–20	67	49	68	47	66	47	57	42	65	37	64	39
21–23	72	52	69	49	70	49	63	45	70	42	68	42
24–26	72	51	69	49	70	49	61	45	70	42	65	43
27–29	74	53	73	50	73	50	63	47	71	42	68	43
30–												
June 1	75	55	75	54	74	52	65	49	71	44	68	47
June 2– 4	75	56	74	54	73	54	65	49	72	47	68	46
5– 7	78	55	74	54	74	53	65	48	72	46	66	45
8–10	75	55	73	54	74	53	67	50	75	45	71	45
11–13	77	59	77	56	76	57	69	53	75	47	71	49
14–16	77	59	74	56	75	57	68	51	73	48	70	46
17–19	77	59	75	55	75	55	69	52	74	47	71	46
20–22	81	60	77	58	78	58	72	55	77	50	74	51
23–25	85	64	81	62	82	61	74	58	80	56	77	54
26–28	87	66	84	65	84	63	74	59	83	57	79	54
29–30	85	65	83	62	83	62	73	58	83	56	77	52

*Data compiled from United States weather bureau records, East Lansing, Michigan.

and June are recorded (Table 1) for Grayling in the lower and Newberry in the upper peninsula.

It is obvious that early tomato production in Michigan is limited by late spring and early summer temperatures which are too cool for optimum growth and fruit setting. Only in midsummer in the most favored localities do night temperatures fall within the optimum range of 60° to 70° F.

VARIETIES

Growers of early tomatoes are perennially interested in new and improved varieties. All too often, blame for crop failure is mistakenly placed on the variety or seed planted. Every tomato grower should keep well informed as to the better sources of seed supply in order that he may obtain the best strains of recommended varieties. The range of varieties locally preferred by growers for early tomato production in Michigan will extend from Early Chatham and Victor, at the one extreme, and to Stokesdale and Longred at the other. The most popularly grown early tomatoes in Michigan's lower peninsula are Valiant, Stokesdale, and improved selections of Victor. For most areas of the upper peninsula only bush types, such as Early Chatham and Victor, are successful.

In Table 2, twenty-four varieties are listed in the order of their comparative earliness. Fruit sizes listed suggest that the earliest varieties are also the smallest. The midseason to medium-late varieties,

Table 2—Some varieties of tomatoes for Michigan (listed in approximate order of earliness)

Early varieties		Midseason to late varieties	
Name	Fruit size (ounces)	Name	Fruit size (ounces)
Early Chatham	3.0	John Baer	4.8
Stokescross No. 2 (F_2)	4.5	Gill's All Purpose	4.5
Earliana x Valiant (F_1)	4.5	Longred	5.3
Faribo Hybrid E (F_1)	4.3	Stokesdale	4.8
Early Scarlet	4.0	Pritchard	4.8
Montmorency	4.5	Wasatch Beauty	5.0
Victor	5.0	Lakeland	4.8
Early Wonder	5.2	Wisconsin 55	6.5
Valiant	5.3	Stokescross No. 4	5.7
Gem	5.2	Gulf State Market	5.0
Eureka Hybrid 42 (F_1)	5.5	Jefferson	6.1
Firesteel	5.5	Rutgers	6.1

differing from earlier varieties by only a few days in maturity of first fruit, are frequently grown for early production. Many growers are willing to sacrifice some earliness for the better fruit quality found in many of the midseason types.

Most of the earliest commercially acceptable tomatoes in experimental trials in Michigan have been hybrids. Whether the extra cost of seed for hybrid tomatoes is justified has not as yet been ascertained. Generally, the earliest hybrids show the most promise if they are grown on productive soils with irrigation. The ideal early variety is still lacking. Almost all of the earliest tomatoes are inherently small, exhibit various color or fruit shape defects, have poor flavor, and the vines are particularly susceptible to leaf diseases.

Earliness is dependent upon several characteristics, including: 1) the time from seeding to flowering, 2) the time from flowering to fruit setting, 3) the number of flowers produced early, 4) the percentage of the first flowers that will set fruit, and 5) the ability to set some fruit when average night temperatures go below 59° F., the lowest temperature for good fruit set. Varieties differ considerably in those characteristics. The time from seeding to first flowering is approximately the same for Victor and Valiant. Victor, however, because of determinate vine type (self-topping) produces more flowers early. Consequently, though the first ripened fruit may be picked at the same time on the two varieties, Victor will usually exceed in quantity of fruit harvested during the first few weeks of picking. The interval between flowering and fruit setting is usually dependent on the night temperatures prevailing. Under optimum conditions fruit setting immediately follows flowering. Much of the "earliness" of tomatoes is attributable to their ability to set some fruit while average night temperatures are still cool (55° to 60° F.). Fruit will not set naturally on a late variety such as Rutgers until average night temperatures approach 65° F.

The following varieties offer promise for early production in Michigan:

Early Chatham—This tomato, developed at the Upper Peninsula Experiment Station at Chatham, is a self-topping or bush type. It has consistently produced ripe fruit in the coldest areas, especially in the upper peninsula of Michigan where all others, with the possible exception of Victor, have failed. Fruit is small, however, and quality is poor (Fig. 2).

Fig. 2. The Early Chatham tomato. Note the bush (self-topping) vine and closely spaced clusters and relative fruit size as suggested by the 4-quart basket. In Michigan's coldest areas Early Chatham has consistently yielded the most ripe fruit of all varieties tested.

Stokescross No. 2—An improvement of an Earliana type, this is perhaps the earliest of several similarly improved varieties including Earliana x Valiant, Faribo Hybrid E, and Early Scarlet. It is a second-generation (F_2) hybrid. Fruits tend to be small, have green shoulders, and show a tendency towards severe ring cracking and sunscald. This type has the most promise for earliness on highly productive soils and with irrigation.

Victor—This variety is a self-topping or bush type of larger fruit size and is somewhat later in maturity than Early Chatham. It has the uniform fruit color characteristic. Several promising selections or improvements of the original Victor have been made. These include Early Wonder, Gem and Urbana. Early Wonder has shown exceptional merit as an improved Victor in Michigan. Some promising Victor type hybrids have also been recently observed in experimental trials.[1]

Valiant—Perhaps the most important single early variety now grown in southern Michigan is Valiant. It is early and has good size.

[1]An especially early and high quality selection is the 49-47 Hybrid developed by the Peto-Hollar Co., Rocky Ford, Colorado.

Approximately 100 pounds of 0-20-0 commercial fertilizer per ton of manure is suggested. If barnyard manure is not available, clover or alfalfa should be included in the rotation.

Tomatoes will tolerate a rather wide range of soil acidity, but they will grow best if soils are selected which are only slightly acid. Lime should be added as required to maintain the soil pH from 6.3 to 6.5. From 2 to 3 tons per acre is the usual application.

Fertilizer applications for early tomato production should be adequate to maintain a high level of soil phosphorus. Analyses such as 4-16-8 or 4-16-16 are suggested. From 1,000 to 1,500 pounds per acre is usually satisfactory. A part of the fertilizer should be broadcast and plowed in when the land is being fitted. The remainder should be placed as a band 2 to 3 inches to each side of the row and about 4 inches deep. The band placement can be applied either before, after, or at the time the plants are set. The greatest response from a limited amount of fertilizer will be obtained where the fertilizer is applied in bands close to the row. Band placements for tomatoes, however, should not exceed 800 pounds per acre. Fertilizer applications should be supplemented with a starter solution high in soluble phosphorus which is applied at the time the plants are set in the field.

PLANT GROWING

Tomato plants grown locally in greenhouses or hotbeds are essential for early tomato production in Michigan. Early crops cannot be grown by seeding direct in the field even with the use of plant protectors. Southern shipped-in plants are satisfactory for processing crops in the warmer areas but fail to satisfy the market gardener interested in early crops.

Growing Structures—A small greenhouse or sash house is essential. Only in such structures can the temperature, humidity, and light be controlled satisfactorily for starting the seedlings early. Adjoining hotbeds or coldframes are desirable for hardening and conditioning the older plants prior to field setting.

Seeding Dates—Seed should be sown about 8 to 10 weeks before it is anticipated that the plants will be transplanted to the field. This would be about March 1 - 10 in the earliest areas; about March 20 to April 1 in central lower Michigan and in northern areas near Lake Michigan. In the coldest areas seeding should be delayed until April 10. The exact time required to grow plants of suitable size for trans-

planting depends upon temperatures maintained and management practices in the plant house. Seeds are frequently sown too early and, consequently, the plants may be held and hardened to the point that they will not resume growth quickly when set in the field.

Seed and Seeding Media—Disease control begins with the seed. Frequently, tomato seed of certain varieties may be purchased which is certified against seed-borne diseases such as bacterial canker. Recommended treatments for non-certified seed consist of soaking it in water at a temperature of 122° F. for 25 minutes, following which the seed is cooled and allowed to dry. Then "Ceresan," "Arasan" or some other seed dust treatment may be applied. Dry tomato seed may also be treated by soaking it for 5 minutes in cold water containing ¾ of a teaspoon of "New Improved Ceresan" per gallon. "Damping-off," a condition in which the young plants topple over at about the time they emerge, can usually be avoided if seed is sown in soil and/or sand mixtures which, along with the flats, have been sterilized by heat or chemical treatment. If sterilization facilities are not available vermiculite (No. 2 grade), which is naturally free of disease organisms, can be used. Vermiculite or mixtures of vermiculite and soil provide ideal seeding media that hold moisture, are well aerated, and produce excellent roots on the seedlings, most of which can be retained during transplanting (Fig. 3). Seeds should not be sown too thickly. Earliest tomatoes are harvested from plants given sufficient space even in the seedling stage. A common practice is to seed at the rate of 5 to 10 seeds per inch in rows 2 to 3 inches apart, covering the seed to a depth of ½ inch. Heavier rates of seeding may result in spindly, weak plants and increase the hazard from damping-off. Custom-made hand seeders for more rapid and precise seeding in flats are available.[2] After the seeds are planted, the young plants will emerge in a few days if the soil is kept moist.

Temperatures for Germination of Tomato Seed—In sufficiently moist soil tomato seed will germinate if temperatures are 50° F. or above. However, at 50° F., 25 to 30 days are required for the seed to come up, as compared with only 4 to 5 days at 85° F. Tomato seed will germinate most rapidly at 85° F. Much time and space can be saved if the warmest areas in a plant house near a stove or over heat pipes are selected for placing the seed flats. Seed germination can also be hastened in sunny weather if a thin pane of glass is placed over the seed flat. This helps to hold in the heat and prevent drying. High

[2]Harold J. Kern and Son, Perrysburg, Ohio.

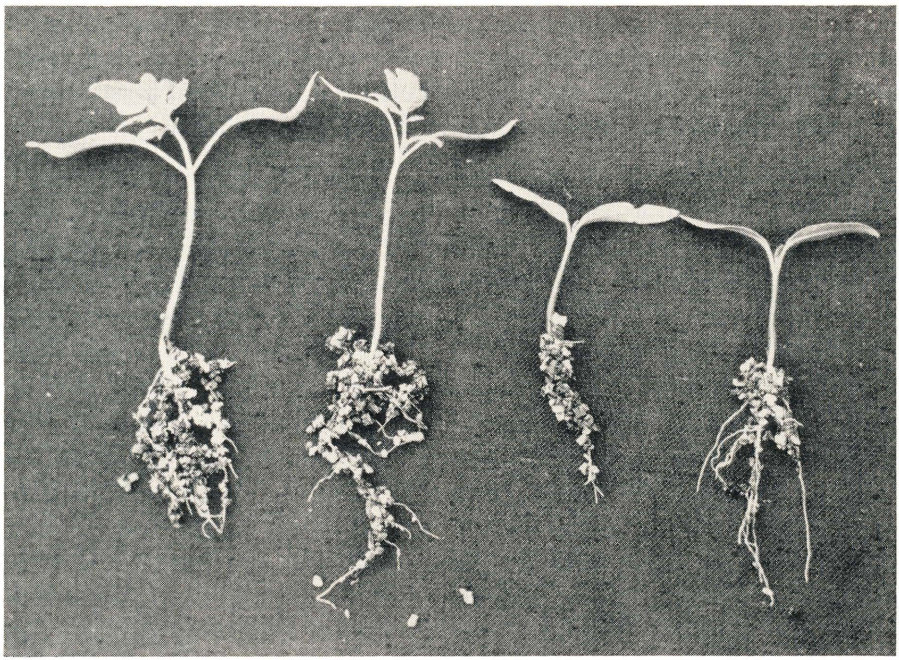

Fig. 3. Three-week-old tomato seedlings grown in vermiculite and started at 80° F. (left) and 60° F. (right) night temperatures. Note the well developed intact roots which are not damaged in transplanting and the pronounced effect of higher-than-usual temperatures (left) on early growth.

temperatures approaching 85° F. are desirable for best and most rapid seed germination (Fig. 3). As the seedlings emerge and increase in size, temperatures should be gradually lowered. Optimum night temperature after germination until the first true leaves have developed is about 75° F. Following "pricking-off," the temperature can be dropped to 70° F. and a week or so later to 65° F. It is realized that growers cannot always adjust temperatures according to such a pattern. They are listed merely as goals to work toward (Fig. 4).

Transplanting of Seedlings or "Pricking-Off"—Tomato plants will usually develop their first true leaves within 3 weeks or less from seeding, depending on temperatures maintained. At this time they should be transplanted to a soil high in organic matter. Three-week-old plants suitable for pricking-off are shown in Fig. 3. These seedlings were grown in vermiculite, the larger plants at a temperature of 80° F., and the smaller ones at 60° F. The larger plants, with prominent true leaves, are of a more desirable size for transplanting. Note that there

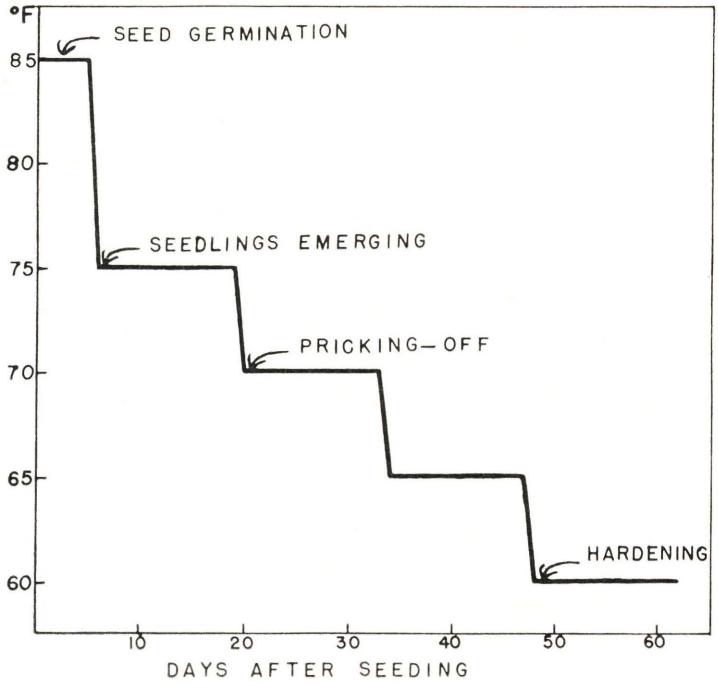

Fig. 4. Optimum temperatures for the production of tomato transplants change as the plants grow. The initially high temperature of 85° F. suggested for seed germination should be followed by a gradual reduction to 60° F. prior to field setting.

is little damage to the root systems in pricking-off seedlings grown in vermiculite.

A good soil mixture for transplanted seedlings can be prepared by mixing and screening together 2 parts of loam soil, 2 parts of muck, leaf mold or well rotted manure, and 1 part of sand. One-fourth to ½ pound of a complete fertilizer high in phosphorus (such as 4-16-4, 4-16-8) is sufficient for mixing with each bushel of soil. Relatively small quantities of fertilizer should be used in starting seedlings. Considerable stunting and plant injury frequently result when growers attempt to supply all the fertilizer needs of crops in the beginning by adding large quantities to the transplanting soil. A better procedure is to add the fertilizer as the plants need it. The fertilizer requirement increases as the plants grow. This increasing need can be supplied by watering the seedlings with solutions of all-soluble complete fertilizer high in phosphorus. A number of these are listed with recommendations of the manufacturers (Table 3).

Fig. 5. Seven-week-old tomato plants grown at spacings of 4 x 4 inches (left), and 2 x 2 inches (right). Only with adequate spacing can the stocky, well formed plant be grown which is essential for supporting an early crop of fruit. Note flower buds on the plant grown at the wide spacing.

An important consideration in early tomato production is that the young seedlings following pricking-off be given plenty of space in which to grow. A recommended practice is to allow from 16 to 20 square inches per plant. The type of plant container selected is seldom as important as the space allowed between plants. Only with adequate spacing can the stocky well-formed plant be grown which is essential for supporting an early crop of fruit (Fig. 5). A frequent lack of sunlight necessitates that seedlings be widely spaced for earliest fruit production.

Hardening—It has been demonstrated by experimental trials in Michigan that the time necessary for growing early tomato plants of suitable size for field setting may be reduced by several days if high temperatures are maintained for seed germination and early growth. The procedure is to lower gradually the night temperature, thus slowly checking growth, as the plants approach the time they are to be set in the field. Gradual conditioning of plants to out-of-door conditions is

Table 3—All-soluble fertilizers for plant growing, starter solutions, sidedressing and leaf feeding

Trade name	Source	Analysis	Recommendations		Additional nutrients
		N P K	To soil	To foliage (Lbs./100 gal. water)	
Take-Hold	Victor Chem. Works, Chicago, Ill.	10-52-17	6 lb./100 gal. water	4–6	
Bonro	Swift & Company, Plant Food Division, Hammond, Ind.	10-52-17	6 lb./100 gal. water	4–6	
Armour's All-Soluble Plant Food	Armour Fert. Works, Chicago Heights, Ill.	15-52-9	6 lb./100 gal. water	4–6	
Plant Marvel	Plant Marvel Labs, Chicago 28, Ill.	12.6-31.5-14.5	1 lb./250 gal. water	2	Trace elements and vitamins
Dixco	Marion Chemical Co., Marion, Ohio	15-30-15	1 lb./50 gal. water	3	Trace elements
Nu Way	Nu Way Plant Food Co., Streator, Ill.	15-30-15	3 lb./100 gal. water	2–3	Trace elements
Plant Prod	Plant Products Company, Blue Point, L.I., N.Y.	15-30-15	3 lb./100 gal. water		
Kap Co No. 1	Kelly Ag. Products, McKeesport, Pa.	15-30-15	3 lb./100 gal. water	2.5 indoor 4–6 outdoor	Trace elements
Kap Co No. 2	.....	20-10-20	.....	2.0 indoor 4.0 outdoor	
HyGro	McCormick & Co., Inc. Baltimore 2, Md.	13-26-13	5 lb./100 gal. water	5	Trace elements and hormone (indolebutyric acid)
Haviland's Soluble Fertilizer No. 1	Haviland Products Co., 421 Ann Street, Grand Rapids, Mich.	23-21-17	.....	4–6	Vitamin B[1]
No. 2	.....	16-26-13	.....	4–6	Vitamin B[1]

Table 3—All-soluble fertilizers for plant growing, starter solutions, sidedressing and leaf feeding

Trade name	Source	Analysis	Recommendations		Additional nutrients
		N P K	To soil	To foliage (Lbs./100 gal. water)	
V H P F	Miller Chem. & Fert. Co... Baltimore, Md.	6-25-15	12-18 lb. acre (in water)	6	Trace elements and hormones
Ra-Pid-Gro	Rapid Gro Corp. Dansville, N. Y.	23-21-17	.....	4–6	Trace elements and vitamins
Plantabbs	Plantabbs Corp. Baltimore, Md.	11-15-20	400 tablets/100 gal. water	.....	Vitamins
Na-Churs	Na-Churs Plant Food Co. Marion, Ohio	5-10-5	1 pt.-1 qt./50 gal. of water	.....	Trace elements
Gro-Crop	Gro-Crop Sales Co. Box 863 Columbus, Miss.	5-10-5	1 to 2 tablespoons /gal. water or as needed for particular crops and soil conditions	.....	Trace elements
Chateliers Plant Food	Chateliers Laboratories St. Petersburg, Fla.	8-8-20	1 lb./100 gal. water	2–3	Trace elements, vitamins, hormones
Hyponex	Hydroponic Chem. Co. Copley, Ohio	7-6-19	1 lb./100 gal. water	.....	Trace elements and vitamins
Atlas Fertilizer	Atlas Fert. Emulsion 1 Drumm Street San Francisco, Calif.	5.7-2.8-2.7	1 tablespoon/gal.	.....	Trace elements, vitamins, and amino acids
Nu-Green	E. I. Du Pont De Nemours & Company Wilmington, Del.	44-0-0	.....	4-6	

essential. A few days' exposure to the wind, sun, lower temperatures and, particularly, to drier soil conditions is desirable. Properly hardened tomato plants accumulate carbohydrate reserves for rapid field recovery. Such plants frequently develop a slight bronzing of the outer leaves. Moisture control is very essential for hardening. Roots should be prevented from growing out of containers and obtaining moisture from the ground below. Flats of plants should be moved frequently and pots rotated. Several days prior to field setting, the plants should be kept dry and allowed to wilt occasionally. Experimental studies indicate that withholding moisture is a more effective and desirable hardening treatment than is lowering the temperature. Hardening temperatures, however, should not be above 60° F. Also, relatively high levels of soil phosphorus and potassium, accompanied by a low nitrogen level, should be maintained. Frequent watering with recommended solutions (6 pounds per 100 gallons of water) of all-soluble fertilizers low in nitrogen will accomplish this. Tomato plants properly hardened by low levels of soil moisture and moderately low temperatures will produce normal flowers and fruit on the first clusters. Sufficient reserve food will also have accumulated, which is essential for rapid root regeneration and recovery following transplanting.

Desirable transplants are stocky. This can be achieved only by widely spacing the plants in the bed, and by proper hardening procedures. Most desirable tomato plants for early production are 8 to 10 inches high, have stems the thickness of a lead pencil, and have well developed buds. Some growers prefer to have plants with flowers open on the first cluster before field setting. On the left in Fig. 5, a desirable type of tomato plant for the early crop is illustrated. It was given adequate space in the plant bed, and has a thick stem and well developed flower buds on the first cluster. To the right is a tomato plant of the same age but grown under crowded conditions of 75 to 100 seedlings in a single flat. They are commonly designated as "stick plants" in southwestern Michigan and are more suitable for the canning tomato crop than for early market production.

If properly hardened, tomato plants need not be pruned or topped. Such procedures generally delay early fruit harvests unless plants are started exceptionally early and the side shoots have time to develop. A few growers of early tomatoes have adopted the practice of topping the plants a week or so before field setting. The main shoot is removed and several lateral buds grow out to replace it. The values of such a

procedure for early fruit production are questionable. However, the quantity of second early fruit harvested may be increased.

Transplanting to the Field—Generally, field transplanting should not occur before the average date of the last killing frost. This is usually about May 15 in southern lower Michigan. Little is gained in planting earlier because air and soil temperatures are too cold for growth. However, the use of plant protectors may permit field setting 1 to 2 weeks earlier than otherwise would be possible.

Warm, humid, and calm weather following a period of bright sunshine would provide ideal conditions for field transplanting. Seldom, however, are growers so favored. Transplanting should be avoided on bright windy days. The most serious weather damage on newly set transplants is usually inflicted by the wind. A few days of fairly quiet weather in the field will do much to condition the plants against future wind damage.

An effort should be made to retain the soil on the roots at transplanting. This acts as a reservoir for moisture and nutrients, and the plants continue to grow without wilting. It is usually desirable to water thoroughly the plants with a fertilizer or starter solution just before moving to the field.

Since the soil is usually retained on the roots at transplanting, mechanical transplanters are seldom suitable for setting the early crop. However, some vine crop growers have developed semi-mechanical methods of setting cantaloupe and cucumber plants that are suitable for setting large tomato plants. Furrows of the proper depth are prepared. Two men working together place the plants in the furrow as they ride on a platform which is pulled slowly down the row. An attachment follows which brings the soil around the transplants as they are placed in the furrow. Most early tomato plants are hand set. They are usually placed in furrows and later covered. However, plants may be set in individual holes prepared with a post hole digger or shovel.

Transplanting should not be done when the soil is too wet. "Mudding in" tomato plants not only puddles the soil but greatly reduces soil aeration. One of the most important factors essential for rapid recovery and root regeneration of tomato transplants is a well aerated and porous soil. If possible, the soil should be worked just before transplanting and be in a moist, yet loose and friable condition.

Starter Solutions—An all-soluble fertilizer high in phosphorus should be added to the water used at transplanting. This mixture of water and fertilizer is commonly termed a "starter solution" and may be applied to the plants several times at daily intervals just before transplanting as well as immediately following field setting.

The marked productive efficiency of small quantities of **concentrated all-soluble fertilizer high in phosphorus** applied to tomato transplants in Michigan has been demonstrated. Plant starters composed in large part of all-soluble phosphate exhibit a pronounced influence on early yields regardless of other fertilizer treatment or natural soil productivity. The importance of available fertilizer, particularly soluble phosphorus in close proximity to the root systems of newly set tomato plants, cannot be over-emphasized. Phosphorus hastens maturity. It promotes rapid early growth. Larger numbers of blossom clusters, blossoms, and fruit are produced early. In the usually cool late springs in Michigan, soils release little or no phosphorus to young tomato plants having limited root systems. Without adequate phosphorus, growth and fruiting are delayed until the weather becomes warmer. Sufficient soluble plant food close to the roots will assist in stimulating growth of tomato transplants in cool weather. This is the basis for using starter solutions.

Table 3 lists many of the all-soluble fertilizers currently available for plant growing and for preparing starter solutions. The materials are arranged in approximate order of their phosphate contents, with recommendations as supplied by the manufacturers. Usual recommendations consist of adding 1 to 1½ ounces per gallon of water or 3 to 5 pounds to 50 gallons of water. One quarter to ½ pint of solution is applied per plant. This represents a fertilizer application approximating only 10 pounds per acre. When tomato plants are small, their needs for plant food are small, but it is essential for early production that the needs, however small, be satisfied. With potted plants, plants in bands or plants widely spaced in flats, the starter solution may be added before transplanting as well as in the transplanting solution. Many growers find it profitable to water their plants occasionally with all-soluble complete fertilizers high in phosphorus, medium in potassium and low in nitrogen. The fertilizer solutions are added more frequently as the time for field setting approaches. Under most conditions, all-soluble complete fertilizers should be purchased for their contributions of nitrogen, phosphorus and potassium rather than for

additional nutrients of questionable value (vitamins, hormones, trace elements, amino acids).

Effects of Spacing on Earliness—Early yields have been found to be directly proportional to the number of plants set per acre. This is because early yields are proportional to the number of early flower (crown) clusters, which number depends on the number of plants set per unit area. A modification of the closer field spacing would be to grow two plants instead of one in the same container and eventually in each hill in the field (Fig. 6). The possibilities of harvesting more early fruit by such a planting procedure deserves consideration. When field space is limited, many early tomato varieties, especially the self-topping types, could be set 1½ to 2 feet apart in rows spaced 4 to 5 feet apart. It has been demonstrated that early yields, as well as total yields per unit area, are increased without significant reductions in fruit size.

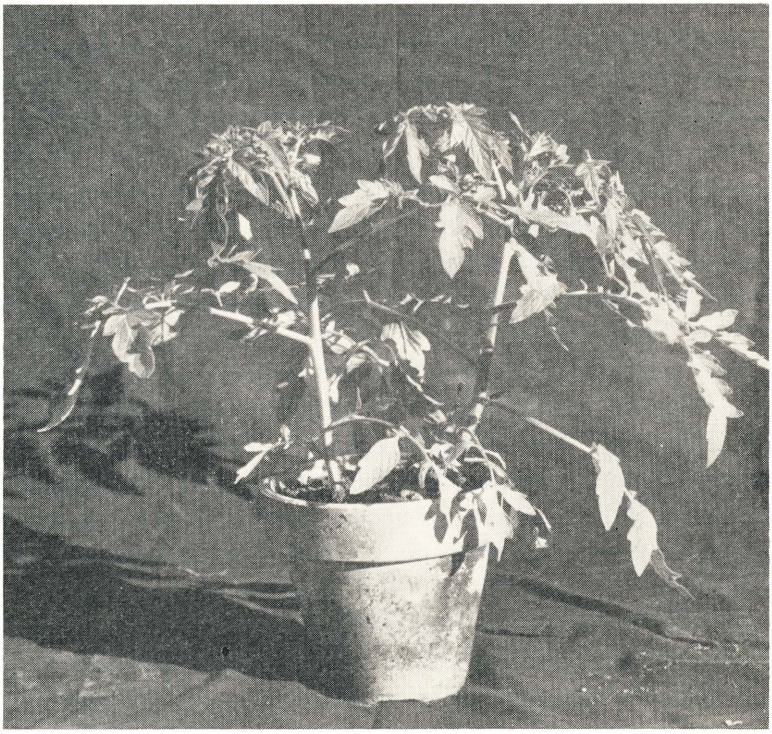

Fig. 6. Starting two plants in the same container and setting two plants per hill in the field double the potential number of early flower clusters and may result in significant early yield increases.

SPECIAL CONSIDERATIONS IN PLANT GROWING FOR PROMOTING EARLINESS

Growing Temperatures—Reference has been made to the importance of adjusting night temperatures according to the age of the plant. During the night is when most plant growth occurs. Carbohydrates are manufactured by the leaves during the day and moved to the growing tips and developing fruit at night. Food moves most rapidly from the leaves to the tips of the tomato plant, where it is used in new growth, if the nights are cool. For this reason, night temperatures should be provided which are several degrees lower than day temperatures. Night temperatures should also be somewhat cooler as tomato plants increase in size. With increasing plant size, the distance that carbohydrates must be moved from the leaves to the growing regions increases. The leaves that manufacture the food for new growth become farther and farther away from where most of the new growth occurs. Thus, for the tomato, night temperatures should be cooler than day temperatures and should decrease with increasing plant size.

Supplementary Light—Artificial lights for supplementing sunlight may be of some benefit in starting tomato plants in dark cloudy weather of early spring. Solar radiation records suggest that Michigan receives less sunlight than any other general area in the United States. Sunlight is definitely a limiting factor in plant growth. The usual remedy is to allow more space between plants. It has also been demonstrated by experimental trials in Michigan that fluorescent lights (preferably 40-watt daylight or white bulbs), placed 10 to 15 inches directly above seedling flats, produce stockier and more vigorous seedlings. The usual practice is to turns the lights on each day at 6 p. m. and then off again at 11 p. m. This adds to the normal light received. Artificial lighting may be practicable for use over seedling flats where a large number of plants are confined in a small area. The general effects of extra light on tomato plants grown at two night temperatures are illustrated in Fig. 7.

Plant Containers—The merits of numerous containers have been proclaimed by their respective manufacturers for tomato plant growing. Clay pots, wood veneer and paper bands, nitrogen-treated bands and pressed peat and manure pots, as well as others, confront the grower. Equally good plants can be grown in any of these types of containers.

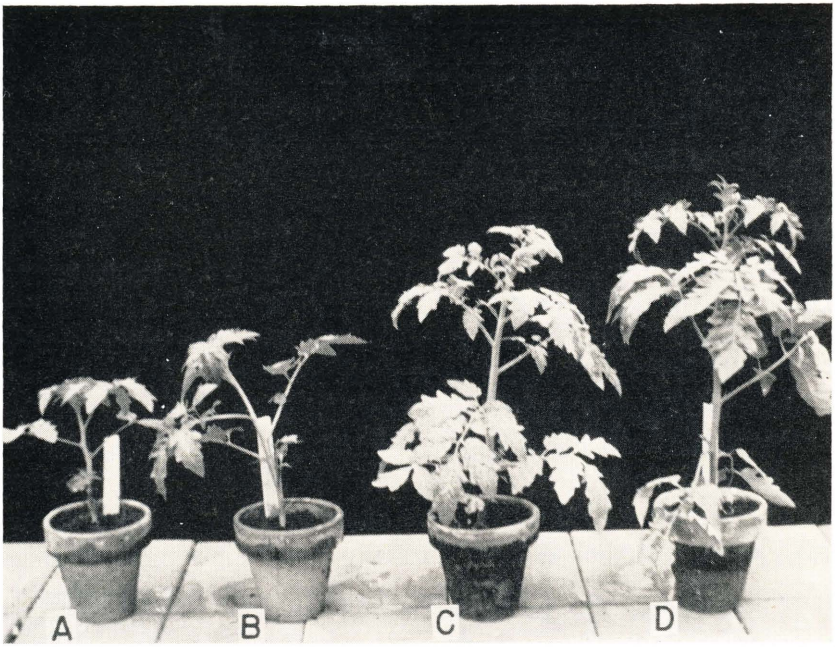

Fig. 7. Seven-week-old tomato plants grown at 60° F. night temperatures (A and B) and plants started at relatively high night temperatures (80° F.) and then temperatures gradually reduced to 60° F. (C and D). B and D received extra light (fluorescent) from 6 to 11 p. m. in the seedling flats.

However, the purchase of any container on the basis of its fertilizer, hormone or vitamin contribution is usually a poor investment. Generally, it is much better and cheaper to add fertilizers in the soluble form as the growing plant's needs increase. Expenditures for other so-called growth factors (vitamins, hormones) are not recommended.

Many growers of both early tomatoes and tomatoes for processing use no container for tomato plants other than wooden flats. The plants for an early crop are given sufficient space, usually 12 to 16 plants per flat, and are lifted either with or without a ball of earth around the roots at the time of field setting. Plants for a processing crop are given less space in the flats. Flats are frequently the cheapest type of plant container. In addition, plants in flats can be easily handled as convenient units during hardening and in transporting for field setting.

Disease and Insect Control—Tomatoes are frequently grown on the same soil year after year. This is not a recommended practice. To lessen ravages of diseases and insects, tomatoes should not be grown on soil that has had a previous crop of tomatoes, potatoes, peppers or

eggplant within the past 3 years. Early blight, flea beetles, leaf hoppers, and aphids are frequently very destructive just after young tomato plants have been set in the field. Unless controlled, these pests may seriously delay growth and early fruiting. Early blight control begins in the plant bed. Tomato plants should be sprayed or dusted at weekly intervals in the seed bed, and beginning again after the first cluster of fruit has set in the field, with a fixed copper or one of the organic fungicides. The equivalent of 2 pounds of metallic copper per 100 gallons of water should be used in sprays. One spray (or dust), applied 4 to 5 days before field setting, should contain an insecticide such as methoxychlor or rotenone for control of flea beetles. Methoxychlor should be applied as a spray containing 2 pounds of 50-percent wettable powder in 100 gallons of water, or as a 5-percent dust. Methoxychlor is safer on tomatoes and is preferred to DDT for flea beetle control. Rotenone sprays consisting of 3 pounds of 5-percent concentrate per 100 gallons of water or ¾-percent dust preparations give good control of flea beetles and aphids. This insecticide can be used at any time on tomatoes without danger of poisonous residues. If aphids are severe, it may be advisable to use TEPP (tetra ethyl pyro phosphate), 1 pint of the 50-percent liquid concentrate to 100 gallons of water. Labels should be carefully read for safe use of TEPP.

With large acreages of tomatoes, DDD (dichloro-diphenyldichloroethane), also called TDE, gives perhaps the best control for hornworms. It may be used either as a 5-percent dust or as a spray with 2 pounds of the 50-percent wettable powder to 100 gallons of water. For best control, early treating is necessary. DDD should not be applied later than 30 days before harvest because of poisonous residues. In small areas of slight infestations of hornworms, hand picking in the early morning when they can be seen is a good means of control.

Cutworms can be controlled when tomato transplants are set out by dusting or spraying DDT on the soil as a band around the plants.[3]

PLANT PROTECTORS

Some degree of protection for newly set transplants is usually provided by most growers of early tomatoes. Probably the greatest weather hazard encountered is wind. High-velocity winds and driving rains frequently twist and break the stems, shred the leaves, and destroy the vigor of newly set transplants. Considerable wind protection may be

[3]Acknowledgment is extended to Ray L. Janes, Extension Specialist in Entomology, and to Miriam C. Strong, Assistant Professor of Botany and Plant Pathology, for their insect and disease control recommendations.

afforded by special windbreaks such as snow fence and evergreens and by setting rows of plants in furrows. For emergency frost protection, using baskets upside down or newspapers, or even temporarily burying the plants may save many a crop. Many unique methods of plant protection, with resulting dividends in earliness, have been devised by tomato growers. Used street car windows, bottomless tubs and baskets, and discarded glassware have been utilized.

Considerable protection against late frosts is also possible with certain translucent types of paper protectors. Several years of detailed experimental studies on tomato production in the upper peninsula of Michigan have established that paper plant protectors hasten maturity and enable production of ripe fruit in many areas where tomato growing would not otherwise be feasible. At the Upper Peninsula Experiment Station tomato plants have been protected from freezing with paper-type protectors when temperatures dropped as low as 25° F. Three years' results (1948-49-50), utilizing large paper protectors (Super Hotents), with and without fruit-setting sprays, definitely indicated that the plant protectors were a good investment for hastening maturity of early fruit in both East Lansing and at Chatham. The equivalent of more than a pound of earlier fruit has been consistently harvested from protected plants irrespective of variety. The beneficial effects of large paper protectors on tomato plant growth are primarily that of a shielding against wind and rain. They also act as a reservoir for conserving the heat of the sun during the day. Generally much higher temperatures are maintained immediately around the plant. Newly set transplants under ventilated protectors have been noted to grow much more vigorously than comparable plants in the open.

The use of plant protectors over hills of direct-field-seeded tomato plants is not practicable in Michigan. Repeated tests have shown that the earliest tomatoes are invariably produced from transplanted seedlings. Plant protectors as aids in early tomato production are suggested only for use with transplants.

In Fig. 8 are a number of common types of paper and plastic protectors[4] illustrating their comparative sizes. Only the largest paper protector (Super Hotent) is large enough to accommodate a tomato plant of suitable size for field setting.

In practice the protector is set over the plant immediately following transplanting by means of a metal setter. Soil is firmed around the

[4]Paper protectors shown are the Hotent, Hotkap, and Super Hotent, manufactured by the Germaco Products Division, 741-747 Terminal St., Los Angeles, California. The plastic protectors were supplied by the General Plastics Corporation, 1400 N. Washington St., Marion, Indiana.

base of the protector to hold it in place. A hole 1 to 2 inches in diameter is then cut out on the south side or the top for ventilation. This prevents excessively high temperatures and condensation of moisture within. The protector should remain around the plant for 2 to 4 weeks. During this time the opening in the top is gradually enlarged permitting the plant to grow, to flower and fruit, and to finally emerge out of the protector (Fig. 9). This allows a gradual hardening and exposure to the wind and direct rays of the sun. A stimulation of vegetative growth and flowering during cool, windy and wet weather is usually the chief benefit derived from using plant protectors. Fruit setting is seldom promoted.

FRUIT SETTING AND FRUIT-SETTING CHEMICALS

Night Temperatures and Fruit Setting—Poor fruit set on early tomatoes in Michigan usually results from night temperatures which are too cold. Early plantings begin to flower before the weather has warmed sufficiently for good fruit set. Best night temperatures for fruit

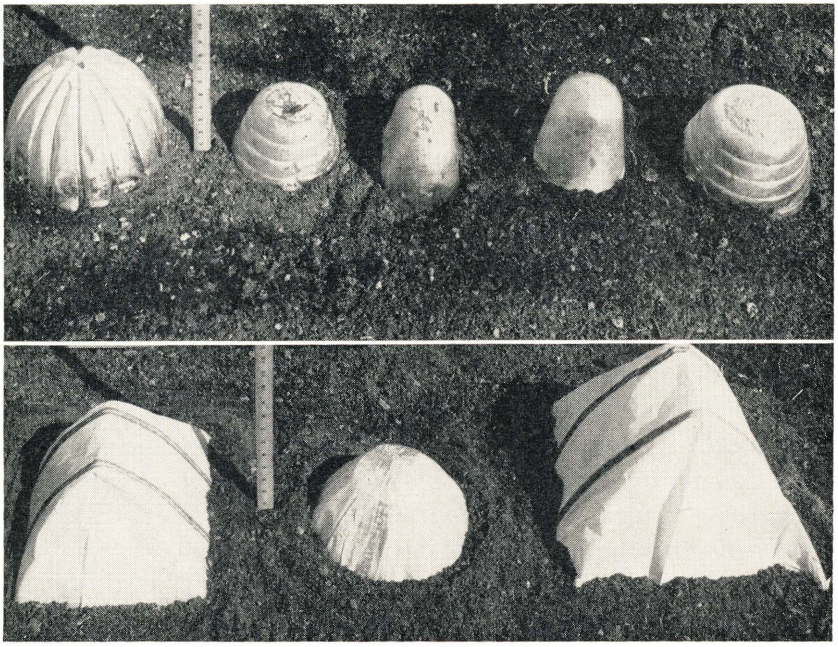

Fig. 8. Possible types of protectors for starting field tomato plants. Top, several plastic protectors not fully evaluated, experimentally, as aids in early production; bottom, left to right, the Hotent, Hotkap and Super Hotent. Relative sizes are suggested by the inserted yardstick marked in inches.

Fig. 9. Early tomato plants growing out of Super Hotents. Even at this late stage considerable wind protection is offered by the shell of paper remaining around the plant. Photograph taken June 10, 1950, East Lansing.

setting on most tomato varieties range from 59° to 68° F. Some of the earliest varieties, however, will set some fruit, if the days are warm and sunny, when average night temperatures are as low as 55° F. Averaged, day-by-day minimum night temperatures in most parts of Michigan show that not until the last few days of June are temperatures usually warm enough at night for fruit to set properly on tomatoes (Table 1). Typical of night temperature patterns is that which prevailed in East Lansing from May 15 to June 30 in 1948; it is shown in Fig. 10. The shaded area represents the temperatures, seldom approached in May and June, at which tomatoes will normally set fruit.

One practical reason for knowing the controlling influence that night temperatures have on tomato fruit setting is that the first big flush of local tomatoes on the market is usually predetermined by a period of night temperatures in the area favorable for fruit setting. These periods of ideal fruit setting night temperatures (59° to 68° F.) precede fruit ripening by 45 to 50 days. Tomatoes will ripen in Michigan approximately 47 days after fruit setting occurs.

Earliness in tomato varieties is in part the ability of the variety to set fruit when the nights are still cold. Temperatures at night in the forties and lower fifties, during flowering, will cause the flowers of all commercial varieties either to drop off or fail to develop (Fig. 11).

Fruit setting may be delayed for several days or even weeks. Growers specializing in the production of early market tomatoes almost invariably have problems of getting a good set of fruit on the first clusters. The plants are usually transplanted into the field while nights are still too cold for fruit set. One alternative, which is not too practical, is to delay field setting and hold the plants in the greenhouse or hotbed in which 59° F. night temperatures or above can be maintained until the first flower cluster has set fruit.

Fruit-setting Chemicals (Hormone-like Sprays)—In cold weather tomato fruit does not set because the pollen grains which bring about fertilization in the flower do not grow and germinate. Since fertilization does not occur, no natural hormones are produced. Without hormone stimulation fruit does not set.

Recent experimental findings of the Michigan Agricultural Experiment Station have demonstrated that artificially produced, hormone-like chemicals can be applied as sprays on the flowers during periods when the natural hormones should be, but are not, produced. By means of this artificial treatment, fruit can be set in spite of cold night temperatures, and ripe fruit may be harvested from 1 to 3 weeks earlier

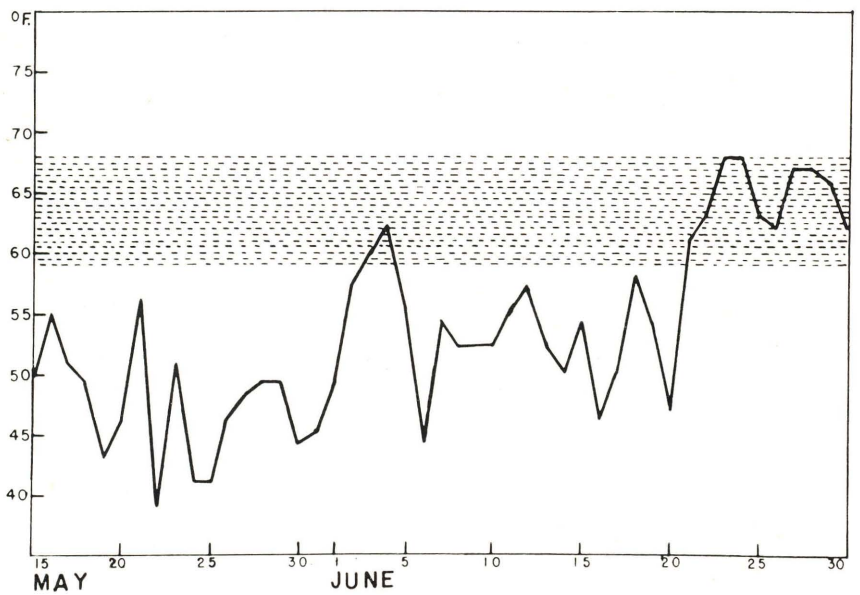

Fig. 10. Average night temperatures, May 15 through June 30, 1948, in East Lansing. Shaded portion (59 to 68° F.) indicates optimum range for fruit setting. Temperatures continuously suitable for fruit setting did not occur before June 21.

(Fig. 11). If temperatures, however, range from 59° to 68° F. at night, usually no difficulty with fruit setting is encountered, and, thus, very little, if any, benefit will result from hormone treatment in this temperature range. Fruit size, however, is slightly increased whenever hormone chemicals are applied.

The fruit-setting chemical is sprayed on the first cluster when the majority of its flowers have fully opened. Sprays applied earlier may result in many defective fruit. Spraying should be repeated at 5-day to weekly intervals on later appearing flowers and flower clusters as long as night temperatures remain cold (below 59° F.). However, no more than a total of three applications should be used. All spraying should be confined as much as possible to the flower clusters. This necessitates hand labor and the use of small sprayers having nozzles which produce a fine cone-shaped mist. The proper method of applying the hormone spray with a suitable type sprayer is illustrated by Fig 12. The objective should be to wet the flowers with the spray. It is not necessary to squirt the spray directly into the blossom. The spray should be directed down and at the flower cluster, but away from the

Fig. 11. Earliness in tomatoes as influenced by hormone-like chemicals. Left, flowers which failed to develop into fruit when night temperatures averaged below 59° F.; right, fruit, from a comparable flower cluster which received a spray consisting of 30 parts per million of para-chlorophenoxyacetic acid. Photographed June 5, 1948, in East Lansing.

Fig. 12. Application of a "hormone" spray for stimulating fruit setting. Clusters should be sprayed when the flowers are fully open. The spray is directed down and at the flower clusters but away from the growing tip and young leaves.

growing tip of the plant. Dousing the foliage with the spray will cause serious distortions of the leaves and stems and temporary stunting with fern-like growth. **Do not spray the whole plant.**

Best results with chemical sprays for inducing earlier fruiting on tomatoes are obtained when growers maintain a high level of soil fertility, especially on early varieties, and where facilities are available for irrigation. Because plants must carry a heavy load, ample plant nutrients and water must be provided. "Hormone" sprays for improving fruit set on tomato plants protected by Super Hotents or other structures appear particularly promising. The first sprays may be applied by directing the nozzle of the sprayer through the holes made for ventilation. Comparative fruit setting results obtained with and without the hormone spray are illustrated in Fig. 13. All varieties of

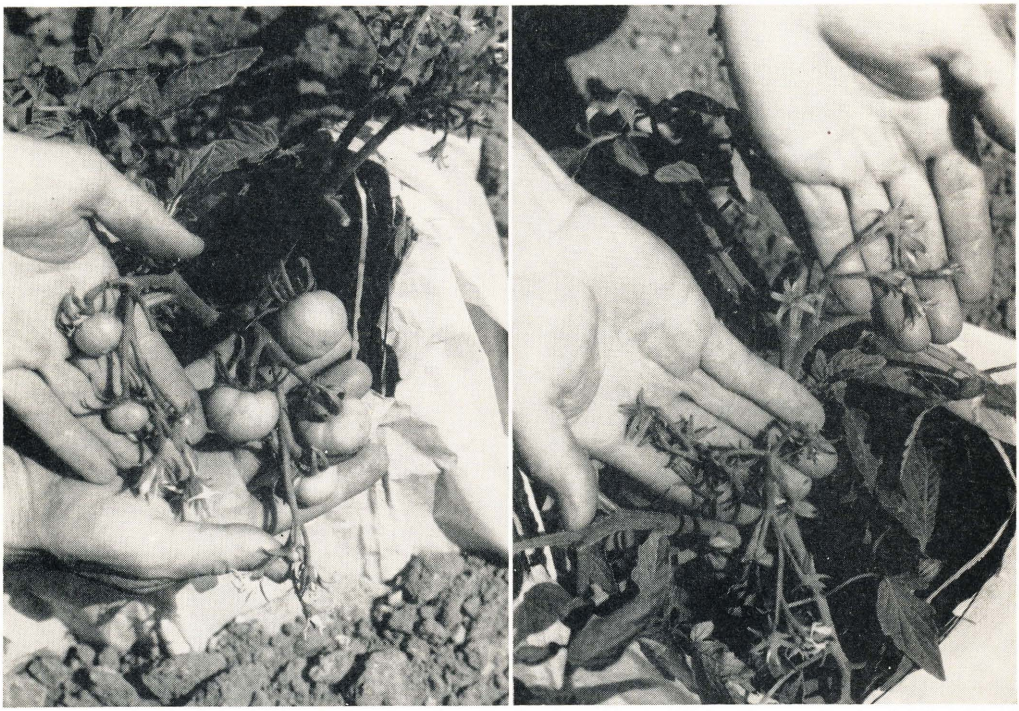

Fig. 13. Tomato plants (variety, Victor) growing out of Super Hotents. Right, flowers but no fruit have set; left, a similar plant, the flowers of which were sprayed with a "hormone" preparation consisting of 30 parts per million of para-chlorophenoxyacetic acid. Photographed June 5, 1950, East Lansing.

tomatoes have responded favorably to hormone sprays. Especially good results have been obtained with varieties having the uniform coloring or ripening characteristics, such as Early Chatham, Victor, Early Wonder, and Longred.

Stock solutions of fruit setting chemicals with directions for usage are available. A partial list of products, their chemical ingredients and manufacturers are listed in Table 4.

Several hundred chemical compounds are known to stimulate, to some degree, the setting of tomato fruit. Only a few of these, however, are satisfactory as sprays for commercial use. Para-chlorophenoxyacetic acid, with the possible exception of one other chemical, alpha-ortho-chlorophenoxypropionic acid, has given the best results in Michigan. Its recommended dosage is a spray concentration of 25 to 30 parts per million. As noted in Table 4, it is the active ingredient in Sure-Set and Tomato-Tone. The alpha-ortho-chlorophenoxypropionic acid at 75 to 80 parts per million shows great promise as a fruit-setting agent and

apparently does not injure the plant in any way if the spray is confined to the flower clusters.

Growers should beware of any manufacturing concern that recommends its particular fruit-setting chemical product for whole plant spraying. Over-all plant sprays cover all aerial parts including unopened flowers and young buds. It is an unavoidable paradox in whole plant spraying that if a hormone is of sufficient strength to set fruit on open flowers, it simultaneously stops the growth of developing flower buds. Thus, temporary increases in early yield are quickly followed by drastic reductions in fruit harvested after the first week or so of

Table 4—Preparations of hormone chemicals for improving the early fruit set of tomatoes

Product	Active chemical ingredient	Manufacturer
Sure-Set	Para-chlorophenoxyacetic acid	Dow Chemical Company Midland, Mich.
Tomato-Tone	Para-chlorophenoxyacetic acid	American Chemical Paint Company Ambler, Pa.
No-Seed (blossom-set)	B-naphthoxyacetic acid	Science Products Company Chicago, Ill.
Seedless-Set	A phenoxy acid	Plant Products Corporation Blue Point, N. J.
Tomato Fix		Wm. T. Thompson Company Los Angeles, Calif.
Horme X		Benson-Maclean Bridgeton, Ind.

picking. Hormone sprays, if used successfully, must be applied to flower clusters where the chemical is confined as much as possible to open flowers; and the greatest benefits in earliness will be derived during weather when night temperatures are below 59° F.

SPECIAL CULTURAL PRACTICES IN THE FIELD AFFECTING EARLINESS AND FRUIT QUALITY

Irrigation—Irrigation facilities pay dividends in early tomato production. Portable sprinkling systems are most widely used. With irrigation, early field setting of plants need never be delayed because of drought. During dry periods, soaking the soil may prevent a check in plant growth and, thus, encourage earlier maturity. It may also practically eliminate dry rot (blossom-end rot) and greatly reduce damage from cracking. Top dressings of soluble fertilizers can be made readily available, and irrigation water may provide the most

convenient means of supplying fertilizer to the growing crop. Small fruit size is a common defect of the early tomato. By using irrigation, significant increases in fruit size have resulted. The cost of installing an irrigation system is frequently paid for in two or three seasons by the increased yield and improved quality of the fruit.

The advantages of irrigation for frost prevention are seldom fully appreciated. Growers of some of the earliest tomatoes utilize sprinkling systems for frost protection early in the season and to extend the harvest in the fall. The usual practice is to allow the water to fall on the plants during the period when freezing may occur. On any one day, however, this is seldom more than a few hours in the early morning.

Staking—Growing staked tomatoes is a specialized procedure. Less than 10 percent of the tomatoes for the early market in Michigan are grown on staked plants. The extra cost of production per acre for labor and materials is probably the greatest contributing factor. Also, some of the early bush-type varieties commonly grown are not adapted for staking. The practice of staking and pruning to either single or double stems does, however, permit more plants per acre and results in the production of more early fruit per acre. There is also evidence that fruit size is increased. Fruits kept off the ground are usually of better quality and are easier to pick. Disease problems are not generally so serious on staked tomatoes because there is better air movement around the plant. However, fruit cracking and sunscald may be increased by staking. Plants to be staked should be spaced closer in the row with the distance between rows increased to allow use of power equipment. Valiant and Stokesdale are suitable varieties for staking. Most of the staked tomatoes are grown in the heavier soils of southeastern Michigan.

Fertilizing the Growing Crop—While it is possible to supply large quantities of superphosphate to the soil without injury to young plants and without loss from leaching, nitrogen and potash salts may cause much injury. Also, if the entire amount of nitrogen and potassium is applied at the beginning of the season, the loss from leaching may be appreciable, especially if irrigation is practiced. Since the tomato's requirement for plant nutrients is very low at first and increases greatly when heavy fruit setting begins, it is usually desirable to sidedress. The sidedressing mixture should be high in nitrogen and potash. On most light soils one or two applications of 150 pounds per acre of

a 50-50 mixture by weight of ammonium nitrate and muriate of potash may be satisfactory. If plants are large, considerable root injury may be avoided if this sidedressing mixture is applied in the middle of the row during one of the late cultivations. Roots of tomato plants will absorb available plant food a considerable distance from the stalk. As previously mentioned, additions of soluble plant food to water used in portable irrigation systems provides one of the most satisfactory methods of feeding a growing crop.

There is interest in the possibilities of fertilizing growing tomato plants with nutrient sprays. It has been demonstrated by recent research at the Michigan Agricultural Experiment Station that the leaves of the tomato plant will absorb and utilize fertilizer. Early fruit production has been stimulated by several weekly sprays of urea at a concentration of 4 to 5 pounds in 100 gallons of water (Table 3). Similarly promising results have been obtained by sprays using o-phosphoric acid at a concentration of 0.3 percent (roughly equivalent to 2½ pounds of o-phosphoric acid per 100 gallons of water). Fertilizer sprays applied to the leaves of plants must be made up as weak solutions. A wetting agent, detergent, or soap should be added to insure a uniform film of spray on the leaves to avoid burning. Leaf feeding will not replace soil fertilization but it does have possibilities for stimulating early fruit production. Additional nutrients can be supplied to the growing crop during critical periods of fruit setting or when root absorption may be limited by cold wet soils.

Cultivation—Shortly after the crop has been transplanted, deep cultivation between the rows in wet years encourages aeration, drying, and warming of the soils. As the plants grow, cultivations should be progressively more shallow and farther away from the plant to avoid root injury. Late cultivations should be only deep enough and often enough to control weeds. When the vines begin to cover the ground between rows, cultivations should be discontinued. There is frequently a tendency to overdo cultivation in the belief that in some manner the crop is benefitted. If the plants are large, even shallow cultivations disturb the roots and retard growth.

If plants are set on the square or in check rows, cross cultivation is possible and much of the labor of hand hoeing is eliminated.

HARVESTING AND MARKETING

Quality in market tomatoes is as essential as earliness. Modern transportation which can deliver produce in an over-night haul from

areas 300 to 400 miles to the south has materially reduced the high price on the first of the home-grown crop in Michigan, if the quality of home-grown fruit is disregarded. The market still prefers good locally grown produce, but it must be of a grade and pack equal or superior to products being shipped in.

Maturity—The stage of maturity at which tomatoes are marketed will depend entirely on preference of the buyer. It is essential to know and understand the degree of ripeness desired by the particular buyer or market to which tomatoes are being sold. Local stores usually prefer tomatoes fully pink or firm red in condition for immediate sale. Dealers buying tomatoes for sale in the wholesale trade or for shipment may want pink fruit, just beginning to show color, or in some cases mature green. In picking tomatoes, damage from cracking, sunburn and other blemishes can be substantially reduced if the fruit is harvested as soon as the first pink appears and held in a shed or basement for further ripening if the market demands more maturity. Ordinarily, in midsummer in Michigan no special storage facilities are needed since outside temperatures usually range between 60° and 80° F., making ideal conditions for fruit ripening and coloration. The practice of picking just as soon as any color appears will not only increase the percentage of No. 1 fruit harvested but will enable a grower to fill orders for any particular stage of maturity on much shorter notice than when fruit is allowed to ripen fully on the vine.

During hot weather, the tomato field must be picked more frequently and closer than during cool periods to avoid having over-ripe fruit.

Grade—Grading laws in Michigan require that the grade and name and address of the grower appear on every container of tomatoes offered for sale. The grade may be indicated as No. 1, No. 2, or "Unclassified". The crop should be carefully graded to separate No. 1, No. 2 and cull fruit. The practice of merely removing the worst culls and marking the pack "unclassified" invariably brings a lower average price per pound than can be secured if the crop is carefully graded.

No. 1 tomatoes should be of one variety, mature but not over-ripe or soft, well formed, fairly smooth, and free from decay and damage caused by dirt, bruises, cuts, sunscald, sunburn, puffiness, insect or mechanical injury, and disease. They should be free from serious damage due to growth cracks and catfaces or blossom scars. Blossom scars should be smooth and not exceed ¾ to 1 inch in diameter. Com-

plete grade standards can be obtained from the Michigan Department of Agriculture, Lansing, Michigan.

Pack and Container—Recent market surveys have indicated a marked preference for the 8-quart corrugated cardboard basket as a container for Michigan tomatoes. Fruit is packed two layers deep in this container with a thin cardboard divider between the layers and a cardboard lid on top. The basket packed in this way holds approximately 10 pounds of fruit. Under no circumstances should the container be filled so full that fruit is heaped above the top edge of the basket. Handling is made much more difficult, more damaged fruit results, and the customer receives a poorer grade of product in the heaped pack.

The 8-quart (10-pound) cardboard basket has brought a premium of as much as 3 cents a pound as compared with tomatoes packed in other types of containers on the Benton Harbor market.

Selling—While a high quality early crop is much easier to sell than a poor quality late one, good salesmanship is necessary if the maximum return is to be expected.

An essential part of good selling consists of providing good service as well as a quality product. Buyers should be contacted ahead of the time the crop is ready for sale. They must have an opportunity to discontinue shipments from other areas if they are to purchase the local crop.

Produce should be available to buyers in sufficient quantities of a similar grade and pack to fill their needs. To provide this service, several growers may need to supply cooperatively one outlet.

Deliveries must be dependably made on time, at the specified place and under the conditions agreed upon when the order is placed. Most buyers are usually eager to cooperate with a grower who can provide them with a dependable supply of uniform, good quality, early produce.[5]

[5]Acknowledgment is given J. W. Rose, Extension Specialist in Vegetable Crops, Michigan State College Cooperative Extension Service, for his assistance in preparing the section on harvesting and marketing.