



Commercial Tomato Production in Michigan

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THE TOMATO is a warm season crop, requiring a relatively long growing season, 100 to 130 days from seed to ripe fruit. Four to six weeks of this period may be spent in the greenhouse or hotbed before transplanting to the field.

In 1962, Michigan commercial growers produced 7,100 acres of tomatoes for processing and 7,500 acres for fresh market. The 1962 average yield for Michigan processing tomatoes was 13.8 tons per acre. A "good" yield should be 20-25 tons. The average 1962 yield for fresh market tomatoes was 160 bushels per acre. A "good" yield should be 300 bushels per acre. In 1962 the average price received for processing tomatoes was \$28.30 per ton; for fresh market tomatoes, \$3.25 per bushel.

VARIETIES

Fresh Market	Processing
<i>Early</i>	<i>Early</i>
Fireball	Fireball
<i>Second Early</i>	<i>Main Season</i>
Moreton Hybrid	Heinz 1350 (Fusarium and Verticillium wilt Res.)
<i>Main Season</i>	Heinz 1370 (Fusarium wilt Res.)
Heinz - 1327	VF 145B (Field seeding) - Trial
Cardinal Hybrid	Roma (Plum Type - Fusarium Res.)
Heinz - 1370 (Fusarium wilt Res.)	
Big Boy	

These varieties have performed well in trials in Michigan. Many other excellent tomato varieties are available. For descriptions refer to seed catalogs or write to the Department of Horticulture, Michigan State University.

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SEED TREATMENT

For seed that has not been previously treated, thoroughly mix Ceresan M with the seed at the rate of ¼ teaspoonful (as a dust) to 1 pound of seed or ¼% of weight of seed. This will provide seed protection from organisms causing damping-off or bacterial canker. If using a soil germinating temperature that is slightly higher than average temperature for good growth, Ceresan M can affect growth enzymes of the seed and may stop germination. Hence, germinating temperatures should be maintained between 65-75° F.

TRANSPLANTS

For processing: To obtain high yields and large fruit size, the plants should develop a good root system and foliage growth in the field before fruit setting occurs. This is important for Fireball or any variety which produces flowers early and sets fruit over a wide range of temperatures. Good yields and fruit size are obtained by using young, unhardened transplants that were grown with a small area (less than 4 square inches) per plant in the flat. Seeding directly in flats and increasing the number of plants per flat may be a means of competing price-wise with tomato plants shipped in from the south. The transplant age should be 4-5 weeks but there should be no plants showing visible buds. A plant growing temperature of 60-70°F is recommended for the first 2-3 weeks after seeding; thereafter the temperature should be 50-60°F.

For fresh market: In order to obtain a large early yield, the transplants should be good, sturdy plants (with a large stem diameter) but they should not have any open flowers, although some buds may be present. This type of transplant is best obtained by growing plants with a large area (9-16 square inches)

TABLE 1: DATES OF 32° F TEMPERATURE AT 50%, 25% AND 10% PROBABILITY OF OCCURRENCE IN SPRING AND FALL¹

Locations	50%	25%	10%	10%	25%	50%
(Detroit west to So. Haven)	Apr 24- May 10	May 3- May 18	May 10- May 25	Sep 20- Oct 7	Sep 28- Oct 15	Oct 6- Oct 23
(Port Huron west to Grand Rapids)	Apr 25- May 8	May 3- May 16	May 10- May 23	Sep 22- Oct 11	Sep 30- Oct 19	Oct 9- Oct 27
(Bad Axe, Bay City west to Ludington)	May 6- May 17	May 14- May 25	May 21- June 1	Sep 16- Oct 7	Sep 24- Oct 15	Oct 2- Oct 23

¹Source - U.S. Dept. of Commerce, Weather Bureau records.

per plant in the flat, obtainable by using 3 or 4 inch diameter pots or other containers. A transplant age of 4-6 weeks and a plant growing temperature of 60-70°F is recommended. Remove open flowers or fruits if they are evident at the time of transplanting.

It should be obvious that the type of transplant recommended for processing is different from that recommended for fresh market and thus growers should provide separate acreage for processing and fresh market tomatoes.

FIELD SEEDING

Seeding directly in the field should only be done on a trial basis until you are confident you can satisfactorily adjust to the required cultural practice changes. The Fireball variety has proven to develop vigorous seedlings, a concentrated fruit set and has performed well when correctly grown. VF 145B was developed specifically for field seeding in California and has performed well in field seeding trials in the northeast. About 1/2 to 3/4 pound of seed is needed per acre with 3 to 4 foot spacing between rows for Fireball and 4 to 5 foot spacing for VF 145B. Field seeding should take place in early May but in case of adverse weather conditions, seeding may be delayed until as late as the last week in May. Drop 6 to 10 seeds per foot and cover 1/2 to 1 inch deep. Note fertility suggestions (FERTILIZATION) and control flea beetles at emergence (INSECT CONTROL). Thin the Fireball seedlings by removing clumps of plants, leaving singles 5-10 inches apart in the row. For other field seeded varieties, thin to single plants spaced 8-10 inches apart in the row.

FIELD SPACING FOR TRANSPLANTS

Large vined varieties (Moreton Hybrid, Heinz-1370, etc.): Rows 5-6 feet apart; plants 24-30 inches apart in a row.

Small vined varieties (Fireball): Rows 3-5 feet apart; plants 15-20 inches apart in a row.

TIME OF PLANTING

Tomato transplants will be killed by a 30° frost. Field seedlings may survive by being close to the

source of heat radiated from the soil when nearby transplants are frozen back severely. Early fresh market tomatoes are sometimes planted when there is a 25-50% probability of a 32° frost. Canning tomatoes and main crop fresh market plantings are more likely to be planted later when there is no more than 10% probability of a killing freeze. However, crops for processing or late fresh market sale must be planted early enough to mature most of the crop before the canner quits receiving tomatoes, the cold weather prevents proper ripening, or fall freezes occur.

The occurrence of spring and fall killing temperatures varies widely from one location to another. Table 1 presents only general indications of possible planting dates. Consult other sources for details of local conditions.

SOIL MANAGEMENT PRACTICES

Cover crops: Plowing under a sod is highly recommended. Since this is generally impractical on many vegetable farms, a winter cover crop of rye or ryegrass is strongly recommended. Plow down approximately 50 pounds of nitrogen (either alone or in a mixed fertilizer) with all sod crops or heavy cover crops unless they were recently fertilized with that amount.

Soil pH: Tomato plant growth is particularly sensitive to low soil pH conditions. Maintain a soil pH between 5.8 and 6.5. The amount of lime to be applied for soils with a pH lower than 5.8 can be determined from a soil test. Soils with a higher pH than 7.0 may require micronutrients such as manganese.

FERTILIZER PRACTICE

Transplants: The nutrient requirements of tomatoes vary with soil type and previous fertilizer practices. The soil should be tested. In general, the quantities of P₂O₅ and K₂O in Table 2 are suggested for a 20 ton processing tomato yield on mineral soils.

Apply 50-75 pounds of nitrogen per acre with the phosphorus and potassium recommended in Table 2. Use a starter fertilizer that is high in phosphorus in the transplant water at the time of field transplanting.

TABLE 2: POUNDS OF P_2O_5 AND K_2O RECOMMENDED PER ACRE
BASED ON SOIL TEST RESULTS

Phosphorus soil test (lbs./A)	Pounds P_2O_5 per acre recommended*		Potassium soil test (lbs./A)	Pounds K_2O per acre recommended*	
	Sandy loam	Clay loam		Sandy loam	Clay loam
10	160	200	25	300	200
25	140	175	50	225	150
40	120	150	100	175	100
55	100	125	150	125	75
70	80	100	200+	100	50

* Multiply pounds P_2O_5 by 0.44 to obtain pounds P and multiply pounds K_2O by 0.83 to obtain pounds K.

For example, you may use 3 pounds of 10-52-17 per 50 gallons of water (1 ounce 10-52-17 per gallon of water) and place about one pint at the base of each plant.

Sidedress: Apply 60-100 pounds of nitrogen per acre on Fireball and other early determinate varieties, starting 2 to 3 weeks after field transplanting. Apply 30 pounds N to other varieties when first fruits set.

Field Seeding. A band of 200 pounds per acre of 6-24-12 fertilizer (or similar analysis) 2 inches deep and 2 inches to the side of the row is suggested. Total amount of fertilizer recommended would be the same as for the transplants. Drill in or plow sufficient fertilizer to make up the difference. Sidedress as recommended above.

WEED CONTROL

Transplants

Diphenamid: This herbicide kills weed seeds without injury to tomato plants and should be applied either immediately after transplanting or after the first thorough cultivation at 4-6 pounds per acre active. This is especially good for annual grasses. Rain or irrigation is needed for best results. *Follow directions printed on the label.*

Solan: Apply Solan on very small weeds since it kills only by contact. Large weeds, especially grasses will not be killed. If weeds and tomatoes are growing rapidly due to high moisture and temperature, apply 2 pounds per acre ($\frac{1}{2}$ gallon liquid concentrate). Under slower growing conditions, apply 3 to 4 pounds per acre ($\frac{3}{4}$ -1 gallon liquid concentrate). Residual activity is short; repeat applications may be needed if new weeds become evident. Spraying only over the row will reduce costs. Do not apply within 30 days of harvest. *Follow directions printed on the label.*

Amiben: Apply 4 pounds per acre granular after transplants become well established.
Field seeded — Early season weeds.

Diphenamid: Apply at seeding 4 pounds per acre active. Rain or irrigation is needed for best results. This should control weeds for most of the summer.

Solan: Since Solan is extremely toxic to small seedling tomatoes, apply 4 pounds per acre (1 gallon liquid concentrate) just prior to crop emergence. Banding can be used to reduce costs but spray a strip over the row of at least 12 inches wide. Tomato plants gradually become tolerant to Solan and no damage has been observed from direct plant application after first bloom.

Herbicide materials are constantly changing. Please consult the most recent edition of Extension Bulletin E-433, Chemical Weed Control for Horticultural Crops, and follow directions printed on the label.

IRRIGATION

General: It is difficult to give exact recommendations as to when a grower should irrigate. However, some growers wait too long before starting irrigation. If more water were applied to Michigan tomatoes yields could be considerably increased. A rule of thumb might be to start irrigating when about $\frac{1}{2}$ of the available soil water is used. Irrigate either before or after transplanting during dry weather to save transplants and encourage rapid root and top development. Apply water slowly so that it will not stand on the surface and destroy soil structure. Reduce the rate of water application when the crop begins to ripen.

Amount: Many growers remark that irrigation is nothing like the natural rainfall. Most of this reasoning results from growers not applying enough water at a given irrigation. The tomato is deep rooted and during dry periods many soils require at least 2 inches of water for most of the root system to have adequate water. Using irrigation correctly means a longer time between irrigations and a much more efficient use of water. During relatively warm, dry weather, from 1 to 2 inches of water is required each week by large plants.

INSECT CONTROL

Flea Beetles: For field seeding use Thiodan, 1 quart per acre 25% EC (Emulsifiable Concentrate) or 2 pounds per acre 25% WP (Wettable Powder). With field seeding, control is very important as soon as the

plants emerge. For transplants use Dieldrin, 1 tablespoon of 50% WP or 2 teaspoons of 15% EC to 1 gallon of water. Apply to plants before field transplanting for protection immediately after planting. Apply thereafter when flea beetles first appear. Use the amount of dieldrin as for potato beetle. After plants begin to grow, control is generally not needed.

Cutworms: Dieldrin as suggested for potato beetles also controls this insect.

Aphids: Thiodan, 1 quart 25% EC or 2 pounds 25% WP. Apply when they first appear and repeat at regular intervals as needed.

Potato Beetles: Dieldrin 1 pound per acre 50% WP or 1 quart per acre 15% EC. Use on plants in the field.

Worms: Thiodan, 1 quart per acre 25% EC or 2 pounds per acre 25% WP. Apply when fruits begin to form for fruitworms or when first larvae appear for hornworms, usually about mid-July.

Warning: Do not apply Thiodan within 1 day of harvest; dieldrin within 7.

Drosophila (fruit fly): Use Diazinon spray, (1 pint per acre of an emulsion containing 4 pounds of active ingredient per gallon or 1 pound per acre 50% WP) or aldrin granular treatment (20 pounds of 2 1/2% material per acre). This is usually applied during the last half of picking season and can be applied to ripened fruit on the vine. Do not use Diazinon or aldrin within 1 day of harvest. Pyrethrins (0.1%) plus 1% piperonyl butoxide dust can be applied every 24 hours to filled hampers in the field and yard.

For control of other insects, or for using alternative insecticides, check the most recent edition of Extension Bulletin 312.

DISEASE CONTROL

Flat Treatment: To eradicate weed seeds and control damping-off use steam sterilization; if not available, sterilize soil and/or flats with methyl bromide. If using chemical sterilization, fill flats with soil and stack flats with at least 1/2 inch air space between each flat. Cover stacked flats with plastic and inject under the thoroughly sealed plastic cover 1 pound methyl bromide per 100 square feet of flat surface. Soil, air temperature and the liquid methyl bromide should all be above 50° F. Remove cover after 24-48 hours and allow soil to aerate for 24-48 hours. This operation should only be done in well ventilated areas. *This chemical is dangerous to humans and growing plants. Follow instructions on manufacturer's label.*

Field Fungicides: For the control of early blight, late blight, anthracnose and bacterial spot, use a mixture of maneb, 1 1/2 pounds per acre 80% WP plus fixed copper 3 pounds per acre 53% WP. Make the first

application when fruits are visible on the first cluster (late varieties) or just after blossoming (early determinate varieties like Fireball). Continue thereafter at 7-10 day intervals, depending upon weather, until 5-6 sprays are applied. Spray more frequently in rainy or cloudy periods. Both maneb and fixed copper can be used up to the day of harvest if required.

For control of other diseases, or for using alternative fungicides, check the most recent edition of Extension Bulletin 312.

COMMON PROBLEMS

Catfaced and mishapen fruit result from improper pollination, adherence of flower parts to the ovule, etc. They are more common on fruits in which the blossoms had set fruit in adverse weather conditions, particularly low temperatures and hence they are more common on early harvests.

Blossom-end rot is worse on drouthy soils and in dry seasons. Avoid root pruning that results from cultivating close to plants and avoid excessively high salts due to over fertilizing which can suppress calcium uptake. Maintain adequate moisture supply by irrigation.

Poor color development can be caused by either low or high ripening temperatures. The best red color development occurs at ripening temperatures around 65-70° F. Higher temperatures speed up the ripening process but final fruit color is not as good. Normal color development in tomatoes is affected when summer temperatures rise over 85° F for prolonged periods or when they fall below 50° F.

Severe wilting when soil moisture is adequate may be due to injury from the roots of nearby black walnut trees.

HARVESTING

Tomatoes for processing are picked red ripe, put in field containers and moved directly to the canning plant.

Fresh market tomatoes can be picked at stages of maturity ranging from mature green to ripe depending on the market. Fruits harvested when they first turn pink are usually more firm and have fewer cracks.

MARKETING

Michigan fresh market growers must do an increasingly better job of grading to remain competitive with other areas. The fruit should be uniform in size, shape, and maturity and free of major cracks, disease and blemishes.

SMALL PLOT CALCULATIONS

If applying fertilizer, herbicides, insecticides or fungicides to small areas, multiply the pounds per acre given by the factor 0.023 to obtain pounds recommended for each 1,000 square feet of soil surface.