

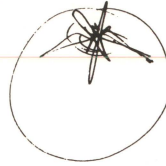
AGRICULTURAL GUIDE

Published by the University of Missouri-Columbia Extension Division

Commercial horticulture

Fresh market tomatoes

Arthur E. Gaus, Henry F. DiCarlo, John B. Lower
Department of Horticulture
College of Agriculture



DEC 29 1983

In Missouri, there are opportunities for producing and marketing fresh market tomatoes, if growers can achieve high yields of uniformly high quality tomatoes. Resources essential for profitable production are productive land, sufficient water for irrigation, and adequate family labor. Timely and thorough implementation of cultural practices is required through all stages of production.

Yields and prices

For a number of reasons, *average* tomato growers achieve yields (and profits, if any) far below their potential. Commonly, yields of marketable fruit are about 3 pounds per plant; however, yields approaching 10 pounds per plant might be attained. Table 1 illustrates the effect of yields, prices, and production costs on profits.

Table 1. Estimated returns from staked tomatoes at various levels of yields, prices, and costs.

Marketable yield per plant ^a (lbs.)	Price per pound (¢)	Cost per acre ^b (\$)	Profit per acre ^c (\$)
3	15	3,000	-550
3	25	3,000	1,083
3	35	3,000	2,717
6	15	4,000	900
6	25	4,000	4,167
6	35	4,000	7,434
9	15	5,000	2,350
9	25	5,000	7,251
9	35	5,000	12,151

^aPlant spacing: 2 x 4 ft. (5,445 plants per acre).

^bEstimated production costs (fertilizers, sprays, stakes, irrigation, labor, etc.) to achieve projected yields in column 1.

^cNet income over production costs.

Labor requirement

Tomatoes are probably the most labor intensive vegetable crop grown in Missouri. Tomatoes require hand-labor operations such as staking or trellising, pruning, tying, fertilization, cultivation, irrigation, and harvesting. Total pre-harvest labor requirements may exceed 300 hours per acre. Substantial additional labor will be required for harvesting and packing; how much is determined by yields.

Site selection

Deep, fertile, upland soils and medium-textured, bottomland soils are most suitable for tomato production. Select previously cultivated land, or else allow a year of preparation to eliminate perennial grasses, weeds, and woody vegetation.

Upland sites provide some frost protection for the earliest plantings. Delay bottomland plantings until danger of frost is past. Cold spring winds are hard on newly transplanted tomatoes. A windbreak, whether a protective hillside, a planting of trees, or strips of rye left in the fields, offers much protection and speeds maturity.

Plant protection devices, such as waxed caps or plastic covers are helpful in protecting the early, young plants. But you should weigh the labor and costs of using these devices against your anticipated increases in yields or the expected harvest date.

Soil improvement

The tomato plant uses many soil nutrients. Many Missouri soils are naturally low in one or more of the essential elements. Previous cropping or soil erosion may also have depleted these elements. A soil test is the only reliable method of determining soil nutrient levels. University Extension Centers offer soil testing services. Obtain soil sampling instructions (UMC

Table 2. Desirable soil nutrient levels for tomatoes^a

	Phosphorus	Exchangeable potassium	Exchangeable magnesium	Exchangeable calcium
Sandy or gravelly loam	100—125	225—325	150—300	2,000—3,000
Medium silt loam	125—150	325—425	300—450	3,000—4,500
Heavy loam and clays	150—175	425—500	450—600	4,500—7,000

^aPounds per acre by Missouri test.

Table 3. Preferred hybrid tomato varieties for Missouri^a

Variety	Maturity (days)	Fruit color	Fruit size	Resistance	Other
Avalanche	70	Red	Medium-Large	F ₁	Firm
Better Boy	70	Red	Medium-Large	F ₁ V ₁ N	Firm
Conquest	70	Red	Medium +	F ₁ V ₁ N	Firm
Jet Star	72	Red	Medium	F ₁ V ₁	Firm
Pink Delight	70	Pink	Medium +	F ₁	Firm
Show Me	70	Red	Medium-Large	F ₁	Very Firm

^aIndeterminant types for staking or trellising. All are crack resistant under normal growing conditions.

^bF₁ means fusarium wilt; V₁ means verticillium wilt; and N means nematodes.

Guides 6950 or 9110), and submit a sample. Your report will indicate nutrient levels and fertilizer recommendations for growing the crop. Soil nutrient levels should be in the ranges shown in Table 3.

Soil for growing tomatoes should have at least 2.5 percent organic matter. Organic matter serves as a storehouse of plant nutrients, provides good soil tilth, and enhances soil moisture relationships. On soils with less than 2.5 percent organic matter, incorporate some form of green manure into the soil.

One of the hybrid sudan-sorghums (such as Sudex) can be grown during the summer months. Either rye grain or perennial ryegrass can be grown as a fall, winter, and early spring, green manure crop. Before planting tomatoes, allow at least three weeks for the rye grain or ryegrass to decay after turning it under. Up to 30 pounds of nitrogen per acre can be plowed down with the green manure crop to assist in breakdown of the organic material.

If the soil test shows deficiencies in phosphorus, potassium, calcium, or magnesium, apply the corrective treatments before planting the green manure crop. This way they'll be well worked into the soil.

Soil pH is also important in growing tomatoes. Tomatoes grown on soils with a pH of 6.0 to 7.0 are less likely to show blossom end rot symptoms on the fruit. An ideal pH is 6.4 to 6.8.

Varieties

Dozens of tomato varieties are available from seed companies. Many are adapted only to specific areas of the country. Generally, avoid tomato varieties with

large fruits, green shoulders, a tendency to crack, late maturity, and little or no disease resistance. Table 2 lists those tomato varieties most likely to perform satisfactorily in Missouri.

Tomato plants

Generally, it's best to grow your own tomato plants. However, if you have had no experience in growing plants or have no facilities for growing them, it's advisable to purchase them from a reliable, established plant grower.

Make arrangements with a local greenhouse operator to grow plants for you. Decide on the varieties, who will purchase the seed, the number of plants needed, the approximate delivery date, whether plants will be delivered potted or bare root, and the cost.

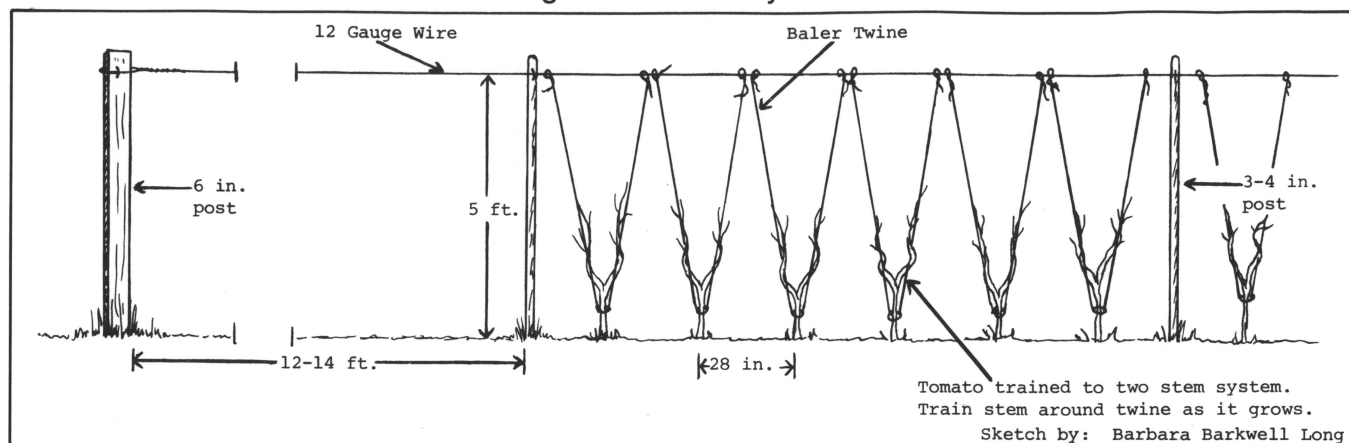
Buying plants from distant areas is unsatisfactory because they may arrive in poor condition, you may have poor choices of variety, and there's a possibility of introducing disease and nematode problems into your fields.

A good tomato plant is 6 to 8 inches in height, has a stocky stem about pencil size, and foliage of good color and condition.

Plant spacing

Generally, tomatoes are planted in rows 4 to 5 feet apart, depending upon the tillage equipment to be

Figure 1. Trellis System



used. Plants are spaced 18 to 28 inches apart in the row, depending upon the variety and the training system used. Therefore, the number of plants required per acre may vary from 3,787 to 7,260.

Transplanting

To decrease the possibilities of plant damage or loss caused by transplanting shock, follow these practices.

- Water plants an hour or so before transplanting.
- Protect plants from direct sun and wind exposure before setting.
- Water plants in with a starter solution. Use a high phosphate water soluble fertilizer such as 10-52-17 or 15-30-15 at a rate of 3 pounds per 50 gallons of water. Use about $\frac{1}{2}$ pint of solution per plant.
- Check the transplanter operation to make sure the soil is firm around the roots and the plant is set at the proper depth.

Plant training and pruning

Fresh market tomatoes are usually trained to one of two systems: the wood or steel stake or the wire string trellis. For staking, $1\frac{1}{2}$ -inch square or 1×2 -inch wood stakes, or $\frac{3}{8}$ - to $\frac{1}{2}$ -inch steel stakes that are 6 feet long are most commonly used. Drive the stake about 10 inches into the ground. Stakes should be about 4 inches to the side of the plant but still in the row. Stake plants within two or three weeks after transplanting.

Tie the vines to stakes with jute tomato twine, other soft cord, or twine. Arrange the stem of the tomato, so the blossom clusters face away from the stake. Allow about an inch of give between the stake and the vine to permit future stem expansion.

Train staked tomatoes to a single stem. To establish a single stem, remove all side shoots or *suckers* on the main stem when they are 2 to 4 inches long. A sucker is a shoot that grows where a leaf attaches to the main stem. Remove suckers every five to seven days early in the growth of the plant. Later, after fruit development is well under way, suckers grow more slowly, and the interval may be lengthened.

The wire-string trellis training system uses 3- to 4-inch posts, spaced 12 to 14 feet apart and about 5 feet out of the ground. One 12-gauge wire is strung tightly across the top of the posts. If 6-inch end posts are placed deeply and firmly in the soil, bracing posts or *dead men* are not likely to be needed. Tomatoes are planted about 28 inches apart and trained to two stems. String, of a sturdy type that will last a season, is tied at the top wire, looped around the tomato stem just below the juncture of the two stems, and tied again at the top wire (in a V shape). See Figure 1.

When training tomatoes to a wire-string trellis, allow the sucker *just below the first flower cluster* to grow and form a second stem. Hormonal action of the plant causes this particular sucker to grow rapidly and assume a second stem. Remove all other suckers as they develop on each stem. Periodically, wrap the plant stems around the string for support.

Cultivation and weed control

The principal reason for cultivation is to eliminate weeds. Weeds not only compete with the tomato for light, moisture, and plant nutrients but may also harbor pests and viruses. Cultivate the crop as needed unless or until herbicides have been applied. Any cultivation should be shallow to avoid root damage.

As plants grow and support systems are established, cultivation within the row becomes more difficult. At that point, you can use pre-emergence herbicides in the row to supplement or replace cultivation and reduce hand labor. Pre-emergence herbicides labelled for tomatoes can be applied in a band up to 2 feet wide within the row. Middles may be left untreated to be cultivated.

Another method is to use a pre-plant herbicide, which can safely be incorporated into the soil before planting.

Using herbicides, either pre-plant or soon after planting, offers two advantages. Weeds within the row can be controlled, and that reduces the need for hand cultivation. Also, weed invasion is reduced on soils too wet for cultivation.

Several herbicides are approved for use on to-

matoes, but recommendations are subject to change from year to year. Ask at your local extension center for the latest herbicide recommendations.

Fertilization

Before planting, apply 20 pounds of nitrogen, 40 pounds of phosphorus and 40 pounds of potassium (20-40-40) per acre. Apply fertilizers about 6 inches deep in the row ahead of row bedding or ridging. If you're planting on level soil, place the fertilizer about 4 inches to the side of the row and about 4 inches deep, preferably within a week or two after transplanting.

Side dress with 30 pounds of nitrogen per acre. It is preferable to use calcium nitrate as the fertilizer source. Your second choice would be ammonium nitrate. Begin side dressings when the first fruits are about 2 inches in diameter. Make repeated side dressing applications every three or four weeks as long as the foliage and vines are healthy and productive. Apply the nitrogen side dressing in a band just outside the foliage spread. Be sure to keep the dry fertilizer off of the foliage. Nitrogen can also be applied through the irrigation system.

Irrigation

Tomato plants should never be allowed to suffer from a water shortage. Good yields and high quality fruit are the result of steady, even plant growth.

To maintain a soil moisture level of not less than 50 percent of field capacity, the soil should receive about 1 inch of water a week during May, 1½ inches a week during June and September, and 2 inches a week during July and August. If rainfall does not meet these requirements, irrigate to make up the difference. Determine your irrigation needs by using one of several types of moisture meters. A common mistake many growers make is waiting too long to irrigate.

Trickle irrigation may be the most effective method of irrigation for tomatoes. It's chief advantage is *daily* application of a measured amount of water to satisfy the needs of the plant. Moisture stress is almost eliminated. The main disadvantage of trickle irrigation is the initial cost of establishment.

Insects

Several serious insects are likely to be present every year on tomatoes. A regular spray program with malathion plus methoxychlor or carbaryl (Sevin) or with diazinon controls most insects.

Because insecticides are usually applied with a fungicide, use only wettable powder insecticides, so you avoid plant damage. Generally, begin spraying insecticides within a week after transplanting and continue throughout the season at about weekly intervals. Follow label directions for amounts of materials to use and for intervals between application and harvest. Also note precautions.

Aphids

Aphids, also called plant lice, are small, slow moving, green or red, soft-bodied, sucking insects, usually appearing on young, growing shoots. They are most prevalent during cool periods in early spring or late fall. Aphids can carry and transmit viral diseases. They must be controlled with insecticides.

Cutworms

Cutworms may be gray, brown, or mottled in appearance, and up to 1½ inches long. Generally, they hide in the soil during the day and come out at night to feed on the tomato stems. Usually cutworms cut off the entire plant about an inch above the soil line. Avoid planting on recent pasture or sodland or near cultivated farmland where cutworm populations may be high. Diazinon or carbaryl insecticides can be used as a directed spray to the base of the tomato plant at time of transplanting. Allow 1 or 2 percent extra plants as replacements for those damaged by cutworms. Most cutworm damage occurs within two weeks of transplanting.

Flea beetles

Flea beetles are small, black jumping insects that eat small, round holes in tomato leaves early in the season. Watch for the earliest damage and use an insecticide.

Hornworms

These large, green worms, with a sharp *horn* on one end, can eat a large amount of foliage in a day or two. But the worms are rarely numerous in the field.

Do not destroy any hornworms with numerous small white cocoons over their backs. These cocoons contain parasitic wasps that attack other hornworms.

Stink bugs

These brown or green, shield-shaped insects give off a disagreeable odor when handled. They suck juices from the plant and cause hard, whitish spots just under the skin of the tomato fruit. They must be controlled by insecticides.

Tomato fruit worm

These vari-colored green, brown or pink worms eat holes in green or ripe tomato fruit. Damage is worse when tomatoes are planted near sweet corn. (The corn earworm is the same insect). This insect can be very damaging and must be controlled with an insecticide.

Spider mites

The two-spotted spider mite, about the size of a grain of salt and very light-tannish in color, can become abundant during hot weather. These mites spin very fine webs, mostly on the undersides of leaves. They feed by extracting the contents of leaf cells. They are

hard to find and usually difficult to control. Malathion (25W) and dicofol (Kelthane 4F), applied in combination in two applications about a week apart, will usually control this pest.

Diseases

Tomato diseases can be devastating. Some are soil borne and become systemic (affect the entire plant). Examples are fusarium and verticillium wilts. Others are primarily foliage diseases that reduce the photosynthetic capacity of the plant. A few diseases attack the fruit.

For a disease control program to work, consider varietal resistance, good site selection, and proper handling of plants in transplanting and training. Employ a thorough spray program with recommended fungicides. Begin it within a week after transplanting and continue at about weekly intervals at least until harvest begins. Fungicides most commonly used for tomatoes include maneb, mancozeb, benomyl and chlorthalonil. Follow label directions for amounts of fungicides to use and for intervals from last spray to harvest. Use precautions.

Fusarium wilt

This disease is a soil-borne fungus that persists for a long time once established in the soil. The fungus invades the roots, grows in the water-conducting tissues of the stem, and plugs up the conducting tissue. The fungus grows best in soil temperatures of 80 degrees F or more. Plants wilt slightly, begin showing progressively more yellowish leaves from the bottom of the plant upwards, and within a few weeks may become severely stunted. The water-conducting tissue in the stem usually appears dark brown in color if infection is severe or if the variety is very susceptible. Use resistant varieties or plant disease-free plants on non-infected soils.

Verticillium wilt

This is another soil-borne fungus disease that persists for a long time in the soil once it becomes established. It's probably not as prevalent in Missouri as fusarium wilt. The fungus is most active at soil temperatures between 70 and 75 degrees F. Symptoms of verticillium wilt include yellowing, withering, and dropping of older leaves. Younger leaves have a dull finish, and leaflets curl upward at the margins. The disease affects the plant uniformly with a general stunting and loss of foliage as the season progresses. The water-conducting tissues at the base of the plant show a dark color when cut. Use resistant varieties or plant disease-free plants on non-infected soils.

Early blight

Early blight is a foliage fungus disease very prevalent from late May through June. Target-like brown spots, ¼ to ½ inch in diameter, appear on leaves mostly on

the lower half of the plant. Numerous spots cause leaves to yellow, brown, and shrivel. Plants become devitalized, and yields are reduced. Fungicide protection is necessary.

Septoria leaf spot and gray leaf spot

These are two summer foliage fungus diseases. They appear as small, circular spots about ⅛ inch in diameter. When numerous, they will completely defoliate the plant. Fungicide protection is necessary.

Anthracnose

This is a fungus disease on the ripening tomato fruit that may lead to severe fruit rot, especially on unsupported tomato plants. Fungicides used for the control of early blight and the leaf spots will control Anthracnose.

Tobacco (tomato) mosaic

Mosaic is a virus of which there are several strains. The virus can infect tomatoes, tobacco, peppers, eggplants, petunias, and such weeds as poke, ground cherry, and horsenettle. Some strains of this virus produce only yellowish, mottled areas on the young leaves. Other strains can cause severe symptoms on the fruit. This blotchy ripening is characterized by white to yellow blotchy patches radiating from the stem end of the tomato fruit and penetrating most of the outer wall. It is believed that blotchy ripening is caused by a direct infection of the tomato blossom by the virus. This form of mosaic can seriously reduce both the appearance and quality of the tomato. Prevention at the present time includes:

- controlling insects, particularly aphids;
- eliminating weed carriers of mosaic;
- avoiding the use of tobacco in any form if *you handle or brush against* tomato plants;
- removing plants showing symptoms, if they are not numerous;
- dipping hands in a powdered milk solution at frequent intervals before tying, pruning and harvesting (this is to deactivate the virus and prevent mechanical transmission).

Resistant varieties are now being developed, but commercial varieties now available do not have resistance to the blotchy ripening phase of the virus.

Nematodes

Nematodes are common and very damaging in the light sandy and sandy loam soils of southeast Missouri. The root knot nematode is the most damaging to tomatoes. Plants with nematodes attacking the roots exhibit various degrees of poor growth and moisture stress. Roots damaged by the root knot nematode are abnormally enlarged, warty or *knotty*, and incapable of sustaining the plant.

To reduce the potential for build-up of root knot

nematodes, rotate tomatoes with non-susceptible crops, or plant on soils where non-susceptible crops have been grown for the past several years.

There are nematode resistant varieties. (See Table 2). Another option is to use a soil fumigant before planting the tomato crop.

Physiological disorders

These disorders are disturbances of the normal physiology of the tomato plant and are usually the result of nutrition, water, or environmental stresses.

Blossom end rot

Blossom end rot appears first as a depressed, brown, rather dry rot, the size of a dime to a half-dollar on the blossom end of the fruit. Secondary infections may occur and cause the whole fruit to rot. It is caused by a combination of calcium deficiency coupled with wide fluctuations in available moisture. Where possible, use calcium nitrate as the source of nitrogen and maintain an even moisture level.

Catfacing

This disorder refers to badly formed tomatoes, especially on the blossom end. Cold weather at time of bloom intensifies the deformities. *Beefsteak* type tomatoes, especially on the early fruit, are most severely affected by catfacing.

Leaf roll

Older, lower leaves may roll upward and become stiff and leathery. More common on trained and pruned plants, leaf roll is generally triggered by excesses of moisture or by drought conditions.

Flower drop

Failure of tomato flowers to set can occur when temperatures are lower than 55 degrees F or higher than 90 degrees F. Varieties differ in their ability to set fruit at these temperature extremes.

Chemical injury

Drift from 2, 4-D chemicals can cause distorted leaves, twisted stems, dropping of flowers, and abnormal fruit. The drift may originate from a mile or more away. When spraying tomatoes, do not use sprayers previously used with 2, 4-D herbicides.

Harvesting

Normally, most tomato varieties should be harvested in the pink to early red stage for local market sales. At this stage fruit have satisfactory firmness for proper handling and sufficient color development to make them attractive to consumers. Some of the new *very firm* tomatoes, such as Show Me, should not be harvested until fruit has developed full color on the vine.

When harvesting tomatoes, remove picking containers from the field as soon as possible. Provide some sheltered or shaded area for grading and packing. Use clean containers such as baskets or cartons for delivering tomatoes to the market.

Marketing

You'll get the best prices if you provide firm, well-formed, well-colored, blemish-free, uniformly sized tomatoes. Depending on the area, most fresh market tomatoes in Missouri are planted for early markets, from mid-June to mid-July.

Usually by early August, the prime production and market period is over. However, with newer, more heat tolerant varieties, irrigation and rigid pest control, tomato plants can be made to produce until the first frost. There may be a period or two during the extremely high temperatures of July and early August when fruit set will be light.

But many of the recommended varieties will resume fruit set as soon as the temperatures moderate. So where favorable market conditions exist, the season for fresh market tomato production can be extended throughout the summer and into the fall.