TOMATOES

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Tomatoes are one of our most popular vegetable crops. They are not only a mainstay of local and farmers markets, but also a popular retail bedding plant crop. Although they are widely adapted throughout Kansas, tomatoes are a crop that requires careful management and intense labor. Crop production can be extended for several months with careful attention to fertility, pest management, crop care and timely harvest.

CLIMATE AND SOILS

Because tomatoes are easily injured by frost, planting should be delayed until risk of frost injury has passed. Normally, commercial tomato planting dates range from mid-April in southeast Kansas to mid-May in western Kansas. Early May plantings are common throughout most of northeast and central Kansas. Tomatoes do not set fruit when night temperatures drop into the 50s consistently. In addition, tomatoes will not develop properly when daytime temperatures exceed 95°F (especially with hot, dry winds).

Tomatoes respond to regular, uniform watering. Planting tomatoes in a location where irrigation is not readily available is risky. Drip/trickle irrigation systems are ideally suited for tomato crop production in Kansas.

Strong winds can be a serious problem in tomato production, resulting in breakage of the vines. Bacterial or fungi organisms may enter the plants through wind-abraded injuries. Most tomato culture systems support the plants and fruit in a vertical direction and wind blowing over trellises can be a serious problem. Permanent or temporary windbreaks can be useful in tomato crop management by reducing wind injuries.

Tomatoes thrive in deep, well-drained, sandy to loamy soils. Tomatoes, however, can generally be grown on most Kansas soils. Sandy soils warm up earlier, drain faster following heavy rains, and allow for field operations despite wet conditions.

Soils should be prepared early by incorporating cover crops and organic matter well before planting season. A winter cover crop, such as rye, wheat, oats, or hairy vetch, can be tilled in strips to allow windbreaks every four to five rows in the tomato planting. A cover crop should be turned under at least three weeks prior to planting the tomato crop. Tomatoes do well on raised planting beds or plastic-covered beds firmed to encourage water movement and consistency.

Rotation is an essential practice in commercial crop management to reduce disease problems. Tomatoes are highly productive in areas where a cover crop or legume has been grown previously. Make sure that any herbicides or chemicals used on crops the previous season do not have a residual carry-over into the tomato crop. Tomatoes can be sensitive to herbicide carry-over.

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A soil analysis should be conducted for this high-value crop. Sample the soil to a depth of 8 to 10 inches at several representative locations in the tomato field and send approximately 1 pint of soil to your local K-State Research and Extension office for testing. If you use another soil testing laboratory, make sure they can provide recommendations for fertility additions from soil test results.

FERTILIZERS

Tomatoes require fairly high levels of several fertilizer elements. In addition, to be productive over a period of several months, a tomato crop requires a continuous fertilizer supply. Amounts of phosphate and potash should be based on soil test results. The tomato crop requires from 75 to 150 pounds of available phosphate, which should be added prior to soil preparation in the spring and incorporated into the plant root zone. Potassium (or potash) is generally available in abundant quantities in many Kansas soils. Addition of potassium will generally not be necessary except on very sandy soils or in soils in southeast Kansas.

Nitrogen is a critical element for tomato growth and production. Many Kansas soils do not hold nitrogen in the plant root zone from season to season, so additional nitrogen is usually required. Manure or cover crops may provide some of the crop's nitrogen needs as indicated by a soil test. Approximately 30 to 40 pounds of nitrogen is usually added prior to soil preparation to provide the immediate nutrient needs of the developing crop. Once the first fruits are marble-size, additional applications of nitrogen are side-dressed (placed along the plant row) or injected into the irrigation water (fertigation). An additional 30 to 50 pounds of nitrogen per acre is applied in side-dressed treatments or added on a more frequent basis through fertigation. Excessive applications of nitrogen in tomatoes may cause excessive vine growth and fruit quality problems.

Another important practice in tomato production is the use of a starter fertilizer, a mild fertilizer solution in the water used around each plant at transplanting. Starter fertilizers have soluble phosphate and nitrogen in a ratio of about 3 to 1. The high phosphate with some nitrogen encourages earlier root growth and rapid plant establishment. Many commercial starter fertilizers have directions for mixing, usually about 2 to 3 pounds of fertilizer material in 100 gallons of water. About 1 cup of starter fertilizer solution is added around each plant.

SETTING PLANTS

Commercial tomato crops are usually established by setting transplants since earliness and consistency of plant stands can be assured when using plants that are already growing. Refer to the K-State Commercial Production guide, "Transplants," MF-1103, for suggestions for growing your own transplants. Transplants can also be purchased from local greenhouse suppliers or as containerized transplants produced in southern states. If you purchase plants, inspect them carefully upon arrival and reject them if any serious quality problems are noted. Hold plants in a cool location (45° to 50°F) if you are not able to transplant them immediately. Plants growing in greenhouse conditions should be moved outside into a protected location for three or four days prior to planting. This acclimation process is important to reduce "shock" during transplanting. The K-State Commercial Production Guide, "Farming a Few Acres of Vegetables," MF-1115, has names and addresses of commercial plant growers/suppliers as well as transplanting equipment.

Transplanting should be done carefully to prevent injury to the plant root system. Firm the soil well around the root system and apply starter fertilizer solution in the transplanting hole. Transplanting machines can mechanize the process; some can be used only on bare ground plantings while others can set plants through plastic. Most transplanters have water tanks to inject water into the planting hole as the plants are set.

Spacing: Most commercial tomatoes are grown in rows 5 to 6 feet apart. This allows room to move between the rows for spraying, harvesting and other management practices. Plants are usually set from 18 to 24 inches apart in the row, depending on the size of the plants and the culture system used. Small-vined tomatoes, and those grown in stake or "weave" systems, are spaced 18 inches apart while those in cage or ground culture systems can be spaced about 24 inches apart. Approximately 4,000 to 6,000 plants per acre will be needed (discounting areas at the ends of the field).

Variety	Season	Crack Resistance	Firmness	Disease Resistance	Vine Type
Jet Star	Early	Good	Fair	VF	Indeterminate
Show Me	Mid	Fair	Good	VF	Indeterminate
Sunny	Mid	Fair	Good	VF	Determinate
Flash	Early	Fair	Good	VF	Determinate
Mountain Pride	Mid	Good	Good	VF,F2	Determinate
Celebrity	Mid	Fair	Fair	VFNT	Determinate
Pik Red	Early	Fair	Fair	VF,F2,N	Lg. Determinate
Merced	Mid	Good–Fair	Good	VFN	Determinate
Trial—					
Carnival	Mid	Good	Good	VF	Determinate
Market Pride	Mid	Good	Good	VFNT	Determinate
Mountain Spring	Early-Mid	Good	Good	VFNT	Determinate
Daybreak	V. Early	Good	Good	VFNT	Determinate
Tango	Mid-Late	Good	Good	VFNT	Lg. Determinate
Mountain Delight	Early	Good	Good	VFN	Determinate
Mountain Gold (yellow fruit)	Mid	Good	Good	VFNT	Determinate

(Disease resistance: V=verticillium wilt, F or F2= races of fusarium wilt, N=nematodes)

VARIETIES

Choosing from the many varieties available must be done by considering the plant size needed, fruit characteristics for your marketing system, adaptability in your location, disease resistance, and individual preferences. Several seed companies offer similar varieties, so seed company preference may be involved as well.

Tomato plants vary in the size and configuration of the vine. Standard or large-vined tomatoes are referred to as **indeterminate** types (the size of the vine is indetermined or continues to grow larger and larger through the season). Smaller-vined types are called **determinate** (the size of the vine is determined or limited). Several newer varieties produce a vine that is somewhere in between and may be referred to as **semi-determinate**. Determinate vines are easier to manage in stake, weave or similar culture systems.

Fruit size, shape and uniformity are also important. Growers selling by the box or pack may want uniformity while those selling in a farmers market may be able to use tomatoes of various sizes. The table above lists common varieties with some general observations about each.

Many new tomato varieties are developed each year. They can be tested by planting a few plants to determine characteristics for your operation. Additional special types of tomatoes may meet certain market demands. Large beefsteak types or canning tomatoes are often requested in local markets.

Tomatoes for local markets are generally harvested when the fruits are slightly colored. Firmness, consistency, and quality are important characteristics, in addition to fruit shape, size and freedom from defects.

MULCHES AND IRRIGATION

Tomatoes respond favorably to an even, consistent supply of water through the growing season. For this reason, mulching and the use of drip irrigation are especially beneficial. Black plastic applied early in the season results in earlier production. Apply drip irrigation tubing approximately 3 to 4 inches from the plant row. Soil moisture sensing devices such as tensiometers or gypsum block sensors are suggested to closely regulate the soil water status. Later in the season, a straw or similar organic mulch can be used. Make sure the soil has warmed before applying organic mulches.

PRUNING AND TRAINING

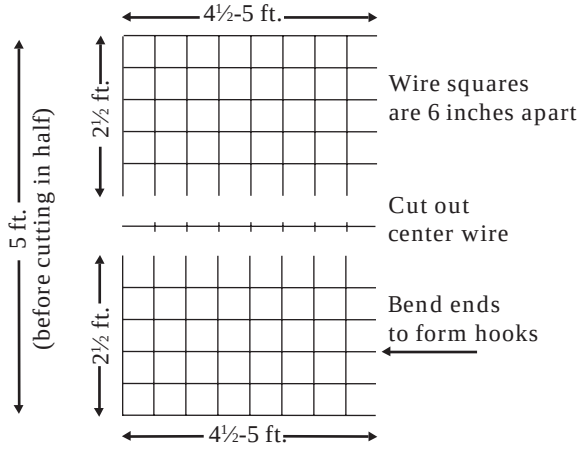
One of the goals of a pruning and staking system is to control the size and shape of the plant and to support the vine in such a way that it adapts to the method of growing that you are using. Tomatoes produce a vine that continues to bear over an extended period of time, so there will be ripening fruits, developing fruits, and flowers on the plant through the season. One of the goals of pruning is to reduce vine growth to encourage slightly earlier and larger fruit. Pruning in Kansas must be done sparingly and with varieties that produce adequate foliage to cover the fruit from our intense summer sun. Following, are several systems that can be used, each with some advantages and disadvantages.

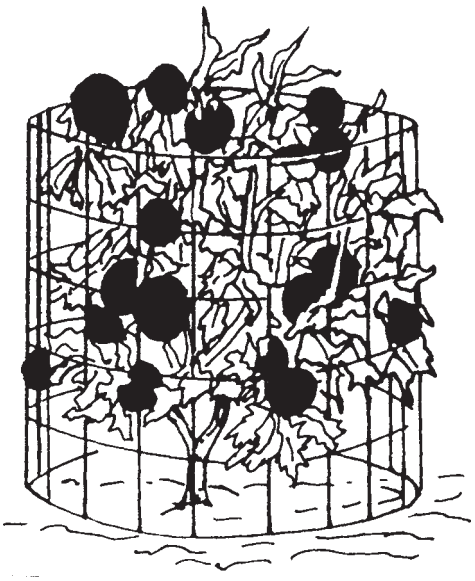
Pruning suckers

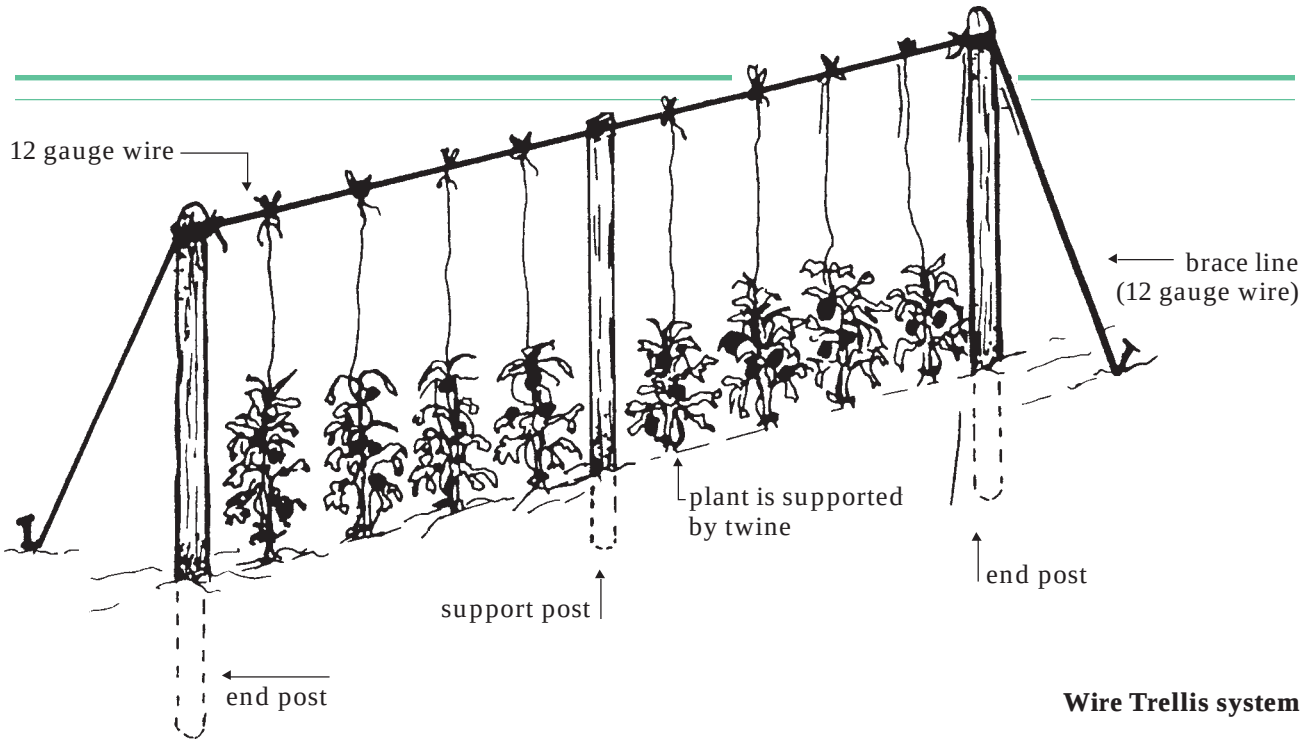
Cages: Individual wire cages require the least effort to maintain through the season, although cages are expensive to purchase and to store. Fruit quality is usually good since adequate foliage is left on the vines. Commercial cages are usually referred to as "half cages" since they are constructed from a half sheet of concrete reinforcing wire cut into 4- to 5-foot lengths *(see below)*. The center wire is cut to allow the points to stick in the ground to support the cage. A cage 20 to 25 inches in diameter works best. Cages are put on the plants two to three weeks after planting. Disadvantages of cages are that weeding around plants is difficult and wire supports may puncture drip irrigation tubing when placed on plastic / drip beds.

Wire Trellis: In this system, support posts are placed at each end of the row and a wire (or wires) are run along the top of the posts. Each plant is supported by a vertical string support and the plant is twined around the string with pruning *(page 5)*. This system does require pruning but is faster than tying individual plants to stakes. Plants are usually spaced 2 feet apart in the row with a support post every 5 to 10 feet in the row. The top wire should be 12-gauge wire and the support posts well anchored in the soil. This system is best adapted to indeterminate varieties.

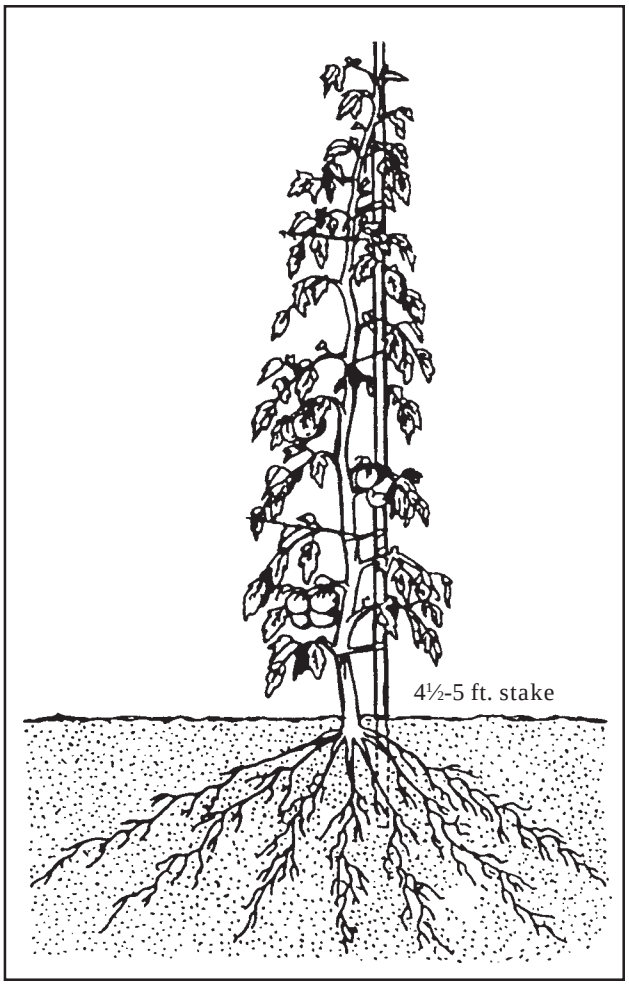
Construction of commercial cages or "half cages"





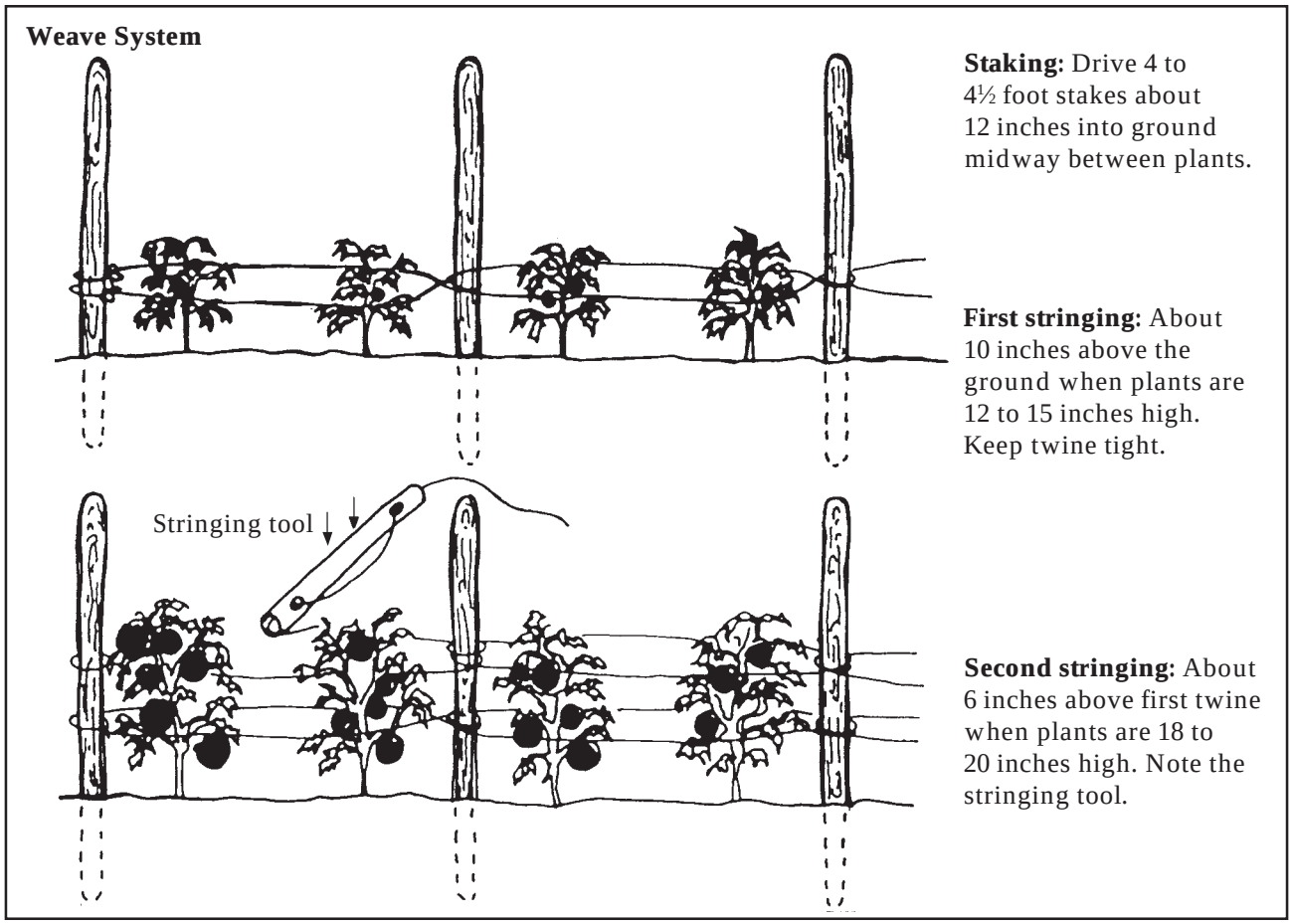


Wire Trellis system



Single stem tomato plant tied to a stake

Commercial field of single stem tomato plants



Individual Stakes: Supporting each plant with a wood or steel stake requires considerable labor in pruning and tying. However, this system is excellent for encouraging early yields and providing support for season-long production. Stakes should be approximately 4 to 5 feet long with 10 to 14 inches driven into the ground *(see page 5)*. A wood stake 1¼ to 1½ inches is necessary. If wood stakes are not available, ⅝-inch steel reinforcing rods can be used. Make sure rods have a ribbed surface (oak or similar hardwood stakes are preferred). Plants are tied to the stakes with soft twine, cloth, plastic ties or similar materials, usually when the first fruit clusters start to form; a tie is made every 12 to 15 inches up the stem as the plant grows.

Weave System The weave system, above, is a modification to lessen the labor of tying individual plants. In this system, a stake is driven between every two or three plants. Then a string is tied to the end stake and woven around the plants and looped tight around each stake. At the end of the row, the string is woven back on the opposite side of the plant to support the plant. The first string is run about 12 inches high with additional strings run at succeeding 12- or 15-inch heights with three or four stringings through the season. Plants are pruned prior to weaving.

A "stringing tool" can be made of a wooden or PVC rod about 24-30 inches long with holes cut in each end. This tool eliminates stooping or bending and allows the string to be tightened as the twine passes through the operator's fingers. Plastic twine for this purpose can be purchased from several horticultural suppliers.

HARVESTING, HANDLING AND MARKETING

Tomatoes are usually harvested in early morning when the field heat is not intense. Tomatoes can be harvested at various stages of ripeness. However, most Kansas markets use turning to ripe maturity stages, usually when some slight degree of color is

Designation	Size	Minimum (Inch)	Maximum (Inch)
Maximum Large	4 × 5	$3^{15}/_{32}$	larger
Extra Large	5 × 5		
	5 × 6	$2^{18}/_{32}$	$3^{15}/_{32}$
Large	6 × 6	$2^{17}/_{32}$	$2^{18}/_{32}$
Medium	6 × 7	$2^{9}/_{32}$	$2^{17}/_{32}$
Small	7 × 7	$2^{4}/_{32}$	$2^{9}/_{32}$
Extra Small	7 × 8	$1^{28}/_{32}$	$2^{4}/_{32}$

showing on the fruit. Tomatoes are usually "pre-cooled" immediately after harvest in refrigerated storage rooms (about 50°F). Storing at cooler temperatures may injure the fruit. Tomatoes will ripen faster at warmer temperatures, so if rapid ripening is needed, move the fruit to 70° to 80°F locations to speed up the ripening process.

Tomato fruit should be clean and bright for best market appeal. This may require individual wiping or gentle buffing to remove water stains, dirt or dust. Commercial tomatoes are generally sold in boxes or cartons containing 20 to 25 pounds with the tomatoes stacked only two high to reduce fruit bruising. Tomatoes are often sorted according to size and packed in similar sizes with number designations by length and width of a standard carton. Size 5 × 5 means that 5 rows of 5 tomatoes each will fit in each of the double layers in a tomato carton (25 in each layer or 50 tomatoes in the box). Thus, the buyer immediately knows the count of the box as well as a general indication of size. Common tomato sizes are listed in the table above.

Selling tomatoes of mixed sizes depends on the market. Discuss with the buyer the pack, size, count, or degree of ripeness that is needed.

INSECTS AND THEIR CONTROL

Hornworms, fruitworms, aphids and mites are the most common arthropod pests of tomatoes in Kansas. Insects pests are not a serious problem in commercial tomato plantings during most seasons.

Mites: The two-spotted spider mite is the most common species of mite found in Kansas tomatoes. Mite problems become worse in hot, dry weather. Female mites overwinter in plant debris near the growing site. During the growing season, they lay eggs which develop into eight-legged nymphal stages and finally into adults. Development can occur within a week during hot, dry conditions. Mites are most severe on the undersides of leaves and the first indication of problems is a lightening or whitening of the foliage—especially on the upper plant. Later the leaves develop a pale, bronzed appearance and the foliage eventually dies. Mite populations are difficult to recognize and control often is delayed until a serious problem develops. If a serious mite problem was present the previous season, reduce debris and similar carry-over potential. Spray placement is critical: Direct sprays to undersides of leaves and use spreader-stickers to improve spray penetration into the hairy tomato leaf. Chemical controls include:

Insecticidal soaps
Horticultural oils
Kelthane
Disyston
Malathion

Hornworms: Two types of hornworms are found on tomatoes. The tobacco hornworm has a red "horn" on its tail with 7 oblique stripes on the body, while the tomato hornworm has a black horn and eight stripes that "hook" backwards on the body. The worms develop into large moths which are seen flying at dusk. Moths emerge in May to lay eggs on the tomato and its relatives. Since the worms are large, easy to see, and consume much foliage in a short period, hand picking is a suggested control. Chemical controls include:

Bt formulations (Condor, Cutlass, Dipel, Larvo, MVP, Steward, Vault)
Thiodan
Asana
Guthion
Proxol (Hornworms only)
Penncap-M

Fruitworms: Tomato fruitworms are the same insect larvae as the corn earworm. Earworm moths migrate from southern states to lay eggs on plants through the season. Since corn is a preferred host, fruitworms in Kansas are a relatively infrequent pest. Control would be similar to hornworm.

Aphids: Aphids feed by sucking sap from plants and high populations result in stunting and distortion of plant growth. They can also transmit virus diseases which can cause serious problems in developing tomato plants. Aphids are generally a problem earlier in the growing season in Kansas. Chemical controls include:

Insecticidal soaps
Horticultural oils
Thiodan
Malathion
Diazinon
Dimethoate
Asana
Guthion
Disyston

Grasshoppers, cutworms, or flea beetles may be a problem in certain seasons. Consult your local K-State Research and Extension office for specific controls.

DISEASES

Following is a short discussion of some of the more common tomato diseases in Kansas and their control. Several other diseases also can cause significant damage to the tomato crop. Make sure you accurately identify the disease before applying fungicides. Your local county Extension agent and other specialists at Kansas State University can help identify pest problems of tomato.

Bacterial Diseases

The three major bacterial diseases of tomatoes in Kansas are bacterial speck, bacterial spot, and bacterial canker. Their symptoms are similar.

Bacterial speck and bacterial spot cause leaf and fruit spotting. The small, ⅛ to ¼ inch leaf spots of both diseases are usually surrounded by a yellow halo. The lesions of bacterial spot tend to have a greasy appearance; those of bacterial speck do not. The two diseases are more easily distinguished by symptoms on the fruit. Bacterial spot results in relatively large (¼ inch), very rough and cracked fruit spotting, while bacterial speck lesions also are slightly raised, but typically much smaller (1/16 inch). Bacterial speck lesions do not crack or become scaly.

Bacterial canker usually does not result in leaf spotting, but instead causes small petiole and stem cankers and wilting of leaflets on a portion of the plant. Yellowish streaks may also develop down the petioles and onto the main stem. A yellow discoloration of stem tissue may be observed if the stem is split open. The diagnostic feature of bacterial canker is the formation of fruit spots. Initially, these lesions may be confused with those caused by bacterial speck or spot; however, with bacterial canker, the fruit spots are surrounded by a distinct white halo.

Control: Bacterial diseases are extremely difficult to control once they are established in the field. Every effort should be made to prevent disease development.

a) Sanitation. Because bacterial pathogens may survive one or more years in crop debris in the field, plan to deep-plow all debris in the fall and follow a two-year crop rotation. Additionally, these bacteria can survive on weed hosts; cultivation of weeds during the growing season will help reduce bacterial populations.

b) Seed treatment. All three bacterial pathogens may survive in or on the seed coat; this is a primary means of introducing the pathogen into the field. Purchase treated seed from a reputable dealer. Untreated seed may be soaked in hot water (120°F) for 25 minutes to eliminate bacteria from the seed coat. After soaking, blot the seed dry and treat with 6 oz / cwt or l tsp / lb thiram 50 WP. Always check the hot water treatment on a small lot first and test the germination percentage. Unfortunately, hot water treatment may reduce seed germination.

c) Antibiotic treatments. Young seedlings in the greenhouse or transplanting flats may be protected against bacterial speck and spot with streptomycin sprays. Make the first application when the first true leaves are formed and continue at four- to six-day intervals until transplanting. Streptomycin may not be used after transplanting.

d) Preventive sprays. A tank mixture of maneb or mancozeb plus a fixed copper compound applied on a preventive schedule is the most effective means

Fungicides labeled for use on tomato to control early blight (EB), Septoria leaf spot (SLS), anthracnose (AN), bacterial speck and bacterial spot (BS). Y = yes, labeled; N = not labeled.

Chemical	Rate per Acre	Waiting Interval	Disease			
			EB	SLS	AN	BS
CHLOROTHALONIL						
Bravo 720	1.5–2 pt	0	Y	Y	Y	N
Ridomil/Bravo 81W*	2–3 lb	7	Y	Y	Y	N
BRAVO C/M*	2–6 lb	5	Y	Y	Y	Y
CAPTAN 50 WP	4–6 lb	0	Y	Y	Y	N
MANCOZEB**						
Dithane M45 80 WP	1.5–3 lb	5	Y	Y	Y	N
Dithane M45 F	1.4–3 lb	5	Y	Y	Y	N
Manzate 200 80 WP	1.5–3 lb	5	Y	Y	Y	N
Ridomil/MZ 58*	1.5–2 lb	5	Y	Y	Y	N
COPPER COMPOUNDS						
Kocide 101	2–4 lb	0	Y	Y	Y	Y
Kocide 606	3–4 pt	0	Y	Y	Y	Y
K-Cop Flowable	3–4 gal	0	Y	Y	Y	Y
Tri Basic Cu Sulfate	2–4 lb	0	Y	Y	Y	Y
Tenn-Cop 5E	2 qt	0	Y	Y	Y	Y
C-O-C-S Count N	2–3 lb	0	Y	Y	Y	Y
Copper Count N	.3–.8 gal	0	Y	Y	Y	Y
Top Cop Tri Basic	2 qt	0	Y	Y	Y	Y
SULFUR COMPOUNDS						
Top Cop	2–3 qt	0	Y	Y	Y	Y

Ridomil has been tank mixed with chlorothalonil and mancozeb to offer protection against certain types of fruit and root rots. Since these fruit rots are not common in our state, it usually is not necessary to includeRidomil in the spray schedule. Bravo C/M is a mixture of chlorothalonil, copper oxychloride, and maneb and is used to control fungal and bacterial diseases.

**The future use of mancozeb products on tomatoes is questionable. Please read and follow all label instructions carefully.

Trade names are used for product identification. No endorsement is intended, nor is criticism of similar products.

of controlling bacterial speck and spot in the field. The chemicals should be mixed 90 minutes before application. Applications should begin at bloom and continue at four- to six-day intervals until the first-formed fruit are one-third their final size. If bacterial diseases are still a problem, continue with the maneb-copper sprays; otherwise, switch the spray program to fungicides listed for fungal foliar diseases. The use of mancozeb and maneb on tomatoes after 1993 is in question. Please check the labels carefully.

Fungal Foliage and Fruit Diseases

Early blight and Septoria leaf spot are the most common fungal leaf spots in the state. Early blight results in the formation of irregular, brown leaf lesions that form first on the oldest (nearest the ground) leaves. Often concentric rings form within the lesion, giving the spots a target-like appearance. Symptoms of Septoria leaf spot first appear as small, water-soaked spots on the lower leaves. These spots generally are smaller and more numerous than those resulting from early blight. Eventually, the center portion of the Septoria lesion turns light tan or gray while the margin remains dark.

Fruit anthracnose is a frequent problem on ripening fruit later in the growing season. Small, slightly sunken lesions develop on the fruit surface. The spots quickly enlarge, become deeply depressed and develop a water-soaked appearance. Black concentric rings form in the center of the lesions.

Control: Sanitation measures in the fall will reduce the amount of inoculum available for infection the following year. Tomato debris should be deep-plowed to hasten decomposition. Crop rotations of two or more years are recommended. Seed treatment with thiram (discussed in the bacterial disease section) will help reduce the incidence of these diseases. Proper staking of plants increases air movement and keeps fruit off the ground.

Several fungicides are available for control of early blight, Septoria leaf spot, and anthracnose (see table). Applications should begin at bloom and continue through harvest (see waiting intervals for each fungicide). A copper-maneb or copper- mancozeb mixture applied at five- to seven-day intervals during fruit set is recommended to control both bacterial and fungal foliage diseases. Late-season applications of chlorothalonil, mancozeb, maneb, or other labeled fungicides on a seven- to 14-day interval should be sufficient to control the fungal foliar and fruit diseases during fruit maturation.

Wilt Diseases

Two major wilt diseases of tomatoes are Fusarium and Verticillium wilt. Fusarium wilt, the most prevalent, occurs in midsummer when air and soil temperatures are high. The stem remains firm and green on the outside, but exhibits a narrow band of brown discoloration in the vascular tissue. The discoloration can be viewed by slicing vertically through the stem near the soil line and looking for a narrow column of browning between the central pith region and the outer portion of the stem. Verticillium wilt tends to develop during the cooler periods of late spring. Symptoms may be similar to Fusarium wilt, so laboratory analysis may be required to distinguish between the two diseases.

Control: Crop rotation is of limited value for these wilt diseases since both fungi may persist in the soil for many years. The *Verticillium* fungus also has a wide host range and may survive in weed hosts within a field. The most feasible means of controlling these wilt diseases is the use of resistant or tolerant cultivars (see suggested cultivars). Most commercial varieties have resistance to one or both of these wilt diseases. To date, only race 1 of the Fusarium wilt fungus has been identified in Kansas; therefore, all varieties with resistance to race 1 can be planted in our state.

Virus Diseases

Many viruses attack tomato plants, but the three most common virus diseases are tobacco mosaic, cucumber mosaic, and spotted wilt.

Tobacco mosaic results in light and dark green mottled areas on the leaves. The dark green areas tend to be somewhat thicker than the lighter portions of the leaf. The mottling is seen more easily if the affected plant surface is partially shaded. Stunting of young plants is common and often is accompanied by a distortion and fern-like appearance of the leaves.

Plants infected with the **cucumber mosaic** virus develop a slight yellowing and mottling of the older leaves. Expanding leaves typically become twisted, curl downward, and develop a “shoestring” appearance as the leaf surface is restricted to a narrow

band around the midrib of the leaf. Diseased plants are stunted and unproductive.

Spotted wilt used to be considered a minor disease in Kansas, but it has become widespread the past several years. Early symptoms are difficult to diagnose and may be confused with other virus or wilt diseases. Young plants may show an inward and downward cupping of the leaves. There also may be a bronze color on the upper leaf surface. In severe cases, the upper portion of the stem may show brown streaking and necrosis. The most characteristic symptom of spotted wilt appears on the fruit: small yellow concentric rings form on young fruit. Typically, a raised area within the ring gives the fruit a bumpy or warty appearance.

Control: Sanitation is the primary means of controlling tobacco mosaic and cucumber mosaic viruses. Infected plants should be removed immediately to prevent spread of the pathogens. The tobacco mosaic virus can be mechanically transmitted and persists for long periods in infected plants or tobacco products. Use of tobacco products during cultural practices should be avoided. Cucumber mosaic virus can overwinter in perennial weeds and may be transmitted to healthy plants by aphids or by mechanical means. The virus cannot withstand drying, or persist in the soil. It also is more difficult than tobacco mosaic to transmit into the field. Cucumber mosaic can be prevented by removing weed hosts of the virus by cultivation and by controlling aphids with insecticides.

The spotted wilt virus is vectored by several species of thrips. Control measures should be directed towards sanitation (removal of infected plants) and controlling thrip populations.

Nematodes

The root knot nematode can cause severe damage to tomato plantings. Affected plants may show symptoms of nitrogen, potassium, or phosphorus deficiencies even though adequate levels of these minerals are present in the soil. Severely infected plants wilt during hot daytime temperatures, then recover at night. The most characteristic symptoms of the disease occur below ground. Roots develop small tan galls which fuse to cause extensive swelling and distortion of the root system. The roots also become much shorter and bushier than on healthy plants.

Control: Root knot should be prevented by avoiding the introduction of nematodes into the field. Carefully check and discard transplants showing swelling or galling of the roots. Never introduce soil into a field from areas where root knot is known to be a problem. Rotation periods of three to five years with corn or other non-host plants will reduce nematode populations in the soil. Several varieties of tomato are available with resistance to the root knot nematode.

WEED CONTROL

Weeds seriously compete with tomatoes for water, nutrients and space. Weed control is critical for good production and high quality fruit.

If cultivation is used for weed control, use shallow cultivation near tomato plants. Chemical weed control materials can be applied prior to transplanting or after the crop has been planted (over the top of the tomato plants).

Devrinol 50DF: Apply to seeded or transplanted tomatoes and incorporate 1 to 2 inches. Use low rates on sandy soils. Carry-over may affect corn, small grain, alfalfa, or lettuce. Germinating annual broadleaf and grassy weeds.

Tillam 6E: Apply prior to transplanting and incorporate 2 to 3 inches deep. Use low rates on sandy soils. For grassy weeds and nutsedge.

Gramoxone Extra: Use between rows and shield to prevent spray contact with foliage. Used for in-row weed control between rows. Kills all green vegetation on contact.

Treflan 4E: Apply before transplanting and incorporate 2 to 3 inches.

Amiben 75DS: Apply to established tomato plants after cultivation when the leaves are dry.

Lexone / Sencor: Apply before transplanting and incorporate 2 to 3 inches or apply at a lower rate over the top of well-established tomato plants. Apply only during warm, sunny weather.

Post: Controls only grasses but can be used over the top of established plants. Use 1 qt. of Crop Oil Concentrate. Do not use within 20 days of harvest.

YIELDS AND RETURNS

Tomatoes require considerable labor and expense. Therefore, the land used needs to be carefully considered to ensure that you can do an adequate job of managing the crop, harvesting, and marketing.

Customary yields are from 10 to 20 pounds of marketable fruit per plant through the season. The harvest period may begin in early July and extend until early October. Many growers prefer to harvest for only a month or so from a planting and continue the marketing season by having a later planting coming into production.

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Cost-return projection for tomato production in Kansas

Variable Costs per Acre	Total
1. Fertilizer	$ 22.06
2. Seed, transplants	320.00
3. Herbicides	44.00
4. Insecticides	22.50
5. Fungicides	9.50
6. Nematicides	0.00
7. Labor	3,795.00
8. Fuel and Oil	55.72
9. Repairs	102.50
10. Water	20.00
11. Utilities	0.00
12. Custom hire	0.00
13. Supplies	2,000.00
14. Marketing	2,500.00
15. Other	300.50
A. TOTAL VARIABLE COSTS	$9,191.77
Fixed Costs Per Acre	
16. Interest on land and buildings	60.00
17. Taxes on land and buildings	10.00
18. Rent for rented land	0.00
19. Depreciation on machinery	75.00
20. Interest on machinery	45.00
21. Depreciation on buildings	12.50
22. Depreciation on irrigation equipment	165.00
23. Interest on irrigation equipment	99.00
24. Insurance	6.63
B. TOTAL FIXED COSTS	$ 473.13
C. TOTAL COSTS	$9,644.90
D. YIELD PER ACRE (Cartons)	2,500.00
E. PRICE PER UNIT (Price / Carton)	6.00
F. RETURNS PER ACRE	$15,000.00
G. RETURNS OVER VARIABLE COSTS	5,808.23
H. RETURNS OVER TOTAL COSTS	5,355.10
I. VARIABLE COSTS PER UNIT (Carton)	3.68
J. TOTAL COSTS PER UNIT (Carton)	3.87

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