



Green foliage, white flowers, and bright red fruit make strawberries a colorful addition to a garden. Although they are relatively easy to grow, success depends on careful attention to cultural requirements. Small plantings that are well cared for produce more fruit than large ones that are neglected. With proper cultural practices, 1 foot of row should produce at least a quart of berries.

Site Selection and Soil Preparation

Select a sunny, well-drained location. Standing water inhibits plant growth and vigor and contributes to disease. Low areas with poor drainage can be built up by using landscape timbers or other materials to hold mounded soil. Select a site that is higher than the surrounding area. Cold air settles into low areas, leaving strawberries vulnerable to late spring frost, which can kill blossoms and reduce or eliminate the crop. Strawberries may need to be irrigated during dry periods, so keep this in mind in choosing a location.

Strawberries prefer loamy or sandy soils, which must be irrigated and fertilized for healthy plant growth. Heavy, clay soils also work if well-drained to avoid root rot. Strawberry plants thrive in soils with at least 2 percent organic matter, which can be added in the form of compost, rotted manure, straw, hay, old silage, grass clippings, or peat moss. Soil improvement should begin at least one year before planting.

Plow and cultivate sodded or weedy areas. This breaks down the sod, kills grass that can inhibit production, and eliminates weeds and white grubs. Little can be done to correct these problems once plants are established. Tilling immediately before planting is not recommended.

Recommended Varieties

Choose vigorous, virus-free plants from an established nursery. This eliminates concern about plants drying out during shipment and increases the chance of finding varieties adapted to local conditions. Varieties grown in northeast

Kansas may not produce as well in other areas of the state. Before trying a new variety, make sure it has been tested locally before ordering a large number of plants.

June-bearing varieties produce one crop per year sometime between mid-May and mid-June, depending on the environment and location. Plant an early variety, a mid-season variety, and a late-season variety to harvest ripe fruits over a longer period. Everbearing and day-neutral varieties produce one crop during the normal harvest season and a second crop late summer to fall. Strawberry varieties adapted to environmental conditions of Kansas and surrounding states are listed in Table 1.

Planting Strawberries

In Kansas, strawberries should be planted in mid-March to early April when weather conditions are favorable for growth. Planting should begin as early as soil can be worked. Have soil analyzed by a soil testing laboratory to make sure it contains nutrients to support plant growth. Test for organic matter, phosphorus, nitrogen, potassium, and

soil pH. Add nutrients before planting based on results. To find out how to collect and submit soil samples for testing, contact your local K-State Research and Extension office.

Strawberries grow best in soil with a pH of 5.8 to 6.5. If soil fertility information is not available, work 10 to 12 pounds per 1,000 square feet of 10-10-10 or similar fertilizer into the top 6 inches of soil.

Picking up a few, vigorous container-grown plants from a garden center may be the best option for a small garden. Dormant strawberry plants are more economical as long as the roots have not dried out. Plants not set out immediately should be stored at 40° F. Temperatures greater than 50° F can reduce plant vigor and survival. When ready to plant, remove dead leaves and prune off the lower third of the root system. Place strawberry bundles in a bucket with enough water to keep roots moist while planting.

Setting Out Plants

Set plants with leaves, stems, and apical buds above the soil surface and the

Table 1. Strawberry cultivars for Kansas and surrounding states

Cultivar	Harvest *	Season	Size	Flavor	Freezing Quality
June-bearing					
Allstar	9	Mid	Large	Good	Good
Cavendish	6	Early mid	Very large	Very good	Very good
Earliglow	0	Early	Medium	Excellent	Very good
Guardian	9	Mid	Very large	Good	Good
Honeoye	6	Early mid	Large	Good	Excellent
Jewel	12	Late mid	Large	Very good	Excellent
Lateglow	9	Mid	Very large	Very good	Very good
Red Chief	7	Early mid	Medium	Good	Excellent
Sparkle	12	Late mid	Medium	Excellent	Excellent
Northeastern	0	Early	Large	Very good	Very good
Latestar	12	Late mid	Medium large	Good	Good
Everbearing					
Albion			Large/Very large	Excellent	Good
Monterey			Large	Good	Good
Portola			Large/Very large	Good	Fair
San Andreas			Large	Excellent	Good
Seascape			Large	Excellent	Good

* Number of days after Earliglow

crowns even with the ground (Figure 1). The crown will dry out if plants are set too shallow and smother if it is planted too deep. Spread the roots slightly and pack soil around the root system. Gently firm the ground around the plant to avoid injuring the crown.

If fertilizer was not worked into the soil earlier, fertilizer solution can be applied to plants to promote rapid growth. Mix 2 to 3 level tablespoons of 12-12-12, 18-46-0, or 16-32-0 N-P-K fertilizer into 1 gallon of water, stirring until dissolved. Let it stand for several hours. Then apply 1 cup of fertilizer solution around each plant.

Mulching for Winter

Young plants and established beds should be mulched for protection during the winter. Extreme cold can kill fruit buds and injure roots and crowns. Alternate freezing and thawing during winter can also damage plants. The mulch layer insulates plants from extreme temperature fluctuations. Winter mulch should be applied after plants have been exposed to several frosts and stop growing, but before heavy freezes are expected. The period between Thanksgiving and Christmas is usually a good time to cover strawberries with mulch.

Wheat straw works well and is readily available. Break bales so heavy chunks do not smother plants. Spread a 3-inch layer of mulch over the strawberry bed. The problem of wheat and weed seeds in the straw can be controlled by thoroughly soaking the bales during the summer to encourage seeds to germinate. As plants push through the straw in the spring, remove part of the mulch from the top of the plant. Leave the rest to conserve moisture and keep the fruit off the soil.

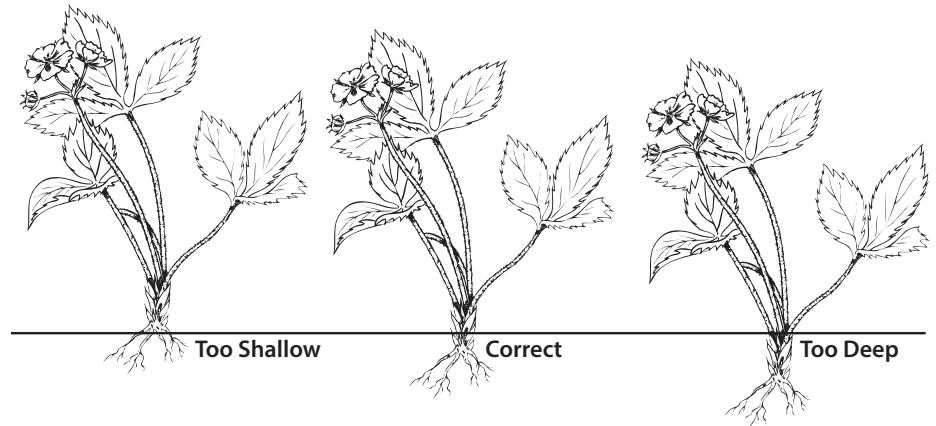
Irrigation

Strawberry plants need extra water as fruit develops. In Kansas, irrigation can increase production by 25 to 50 percent. Apply enough water to penetrate soil 6 to 10 inches where roots are concentrated. Do not apply water faster than the ground can absorb. Sandy soils need more frequent and smaller amounts of water than heavier soils.

Caring for First-Year Plants

Survival, root development, and fruit bud formation of strawberry plants and runners depend on adequate soil moisture. Shallow-rooted strawberry plants require frequent watering after transplanting. Plants need about an inch of water per

Figure 1. Planting depth



week during the growing season and up to 2 inches per week during July and August. If it doesn't rain, water once a week during the spring, early summer, and early fall, and twice a week July and August.

Freeze Protection

As plants begin to bloom, flowers become susceptible to freezing temperatures. Overhead sprinklers can protect flowers from freezing temperatures. Start sprinklers before the temperature reaches 32° F and run them until temperatures warm and the ice melts. Deliver a fine mist rather than a lot of water.

Protect small strawberry beds by covering the plants with canvas or blankets. To trap the maximum amount of heat, apply the covering at sunset on nights when frost is expected.

Harvest

Fruit is ready to pick when it is completely red. White areas on the fruit indicate that it is not fully ripe. The green cap should be left on to keep the fruit firm. Berries should be picked every other day for best quality. Daily picking may be necessary during hot weather because fruit matures quickly and becomes soft. Pick berries early in the day when it is cool and immediately place them in a cool, shady location. Strawberries deteriorate rapidly after picking. Berries not used immediately should be stored at 32 to 40° F to retain quality.

June-Bearing Strawberries

There are three systems for planting June-bearing strawberries. In Kansas, the matted row system is the most common. Mother plants produce daughter plants from runners that add to the row, forming a matted row that is the fruit-bearing area the following year.

Plants are set 18 to 24 inches within a row and 48 inches between rows.

Daughter plants are not allowed to spread beyond 20 inches wide as most strawberries are borne on the edges of the row rather than the center. Tilling or hoeing the edges of the row is usually required to keep the row width under control. This often must be done twice during the growing season.

The spaced-plant system is another method of planting strawberries. Mother plants are set 6 to 12 inches apart within a row, and most daughter plants are removed, with only a few allowed to root. This system requires more plants and labor than the matted row system. Another technique is to prepare elevated beds 3 to 4 inches high. Elevated beds or ridges are suitable in heavier soils with slow drainage. However, strawberry plants grown on raised beds should be irrigated more frequently than those in a matted row system.

Renovating Beds

Healthy strawberry plantings will remain productive for three or four harvest seasons. Renovate after harvest to maintain plant vigor. Till or hoe each row, leaving a band of plants about 10 inches wide. Another method is to remove small, weak plants throughout the bed, leaving a healthy plant every 4 to 6 inches. Because roots form above older roots on the crown, adding an inch of soil over the tops of the crowns is beneficial. Follow with a sidedressing of balanced fertilizer such as 10-10-10 or 12-12-12 at the rate of 1 pound per 25 feet of row.

For the rest of the season, handle plants in the same way as young transplants the first season. Control weeds by hoeing or cultivating. Mow one week later to remove stems and leaves and leave the crowns undisturbed. Irrigate as needed.

Mother plants form runners during the summer, developing small plants at

the end called daughter plants. As they grow, daughter plants build up food reserves, and form fruit buds in the fall for next year's crop. Strawberry plants must be healthy for new plants and fruit buds to develop. Removing blossoms of June-bearing plants the first spring allows plants to set more fruit the second year.

Control weeds to keep them from competing for moisture, light, and nutrients, which can reduce yields and berry quality. To avoid root injury, hoe or cultivate shallowly, loosening soil to encourage rooting of daughter plants.

August Fertilization

Spring-bearing strawberry plants develop fruit buds for the next year's crop as days grow shorter in September and October. Vigorous plants develop more fruit buds than weak plants. A nitrogen application in early to mid-August will stimulate plant growth and increase fruit bud development. Apply about $\frac{1}{4}$ to $\frac{1}{2}$ pound of urea (46-0-0) or $\frac{3}{4}$ to 1 pound of 12-12-12, or equivalent, N-P-K fertilizer per 25 feet of row. Follow with $\frac{1}{2}$ inch of water applied through a sprinkler to dissolve and move nitrogen into the soil.

Everbearing Strawberries

Everbearing and day-neutral cultivars differ from June-bearing varieties in their vegetative growth and fruiting characteristics. These plants generally do not develop as many runner plants, so they need to be planted closer together in the bed. Place plants 6 to 9 inches apart in single rows or 8 to 12 inches apart in double or triple rows with rows 8 to 12 inches apart.

Everbearing and day-neutral strawberries bear fruit in the spring and again in the fall. High temperatures normally stop bearing during the summer. During the first summer after planting, remove all flower blossoms until about July to let plants build up a food reserve. The first fruit may ripen as early as August 1 and continue until frost. Remove all runners during the first season for plants set in the hill system. This forces multiple crowns which will increase fruit production.

A summer mulch of old hay, straw, ensilage, sawdust or similar material can be spread in a thin layer around the plants to conserve moisture and keep fruit clean. Weed control and irrigating practices are the same as for June-bearing varieties.

Cultural practices for the second and following seasons are the same as for June-bearing varieties. The major difference is that everbearing and day-neutral plants will benefit from nitrogen fertilizer in the early spring. Urea can be applied at the rate of $\frac{3}{4}$ teaspoon per hill or use a high nitrogen lawn fertilizer such as a 27-3-4 or 25-4-4 or something similar at $1\frac{1}{2}$ teaspoons per hill. Make sure the lawn fertilizer does not contain a weed preventer or weed killer.

Space-Saving Planting Methods

A strawberry pyramid or strawberry barrel can solve the problem of lack of space for a strawberry bed. These growing structures require extra care to prevent plants from drying out and extra protection from winter injury because plants are not as well-insulated by soil. Everbearing and day-neutral strawberries are best adapted to these approaches. Strawberry ladders or hanging baskets are other decorative uses for strawberry plants.

A terraced bed such as strawberry pyramid may be constructed using retaining walls of wood, corrugated aluminum or other rigid materials. Each level of the terrace should be 8 to 12 inches wide, and 6 to 8 inches deep with plants spaced 12 inches apart.

A strawberry barrel can be a decorative addition to a patio, terrace or deck. The barrel, generally 50- to 55-gallon size, should be mounted on casters so it can be rotated in full sunshine. A water delivery system is necessary to give each plant an optimum supply of moisture. The barrel also needs good drainage. About 70 plants can be set on the outside surface and additional plants on the top.

A good soil mixture for a pyramid or barrel consists of one part sand, one part peat moss and two parts garden soil. Peat moss can be replaced with compost or well-rotted manure. About 2 cups of complete fertilizer such as a 12-12-12 should be mixed into each bushel.

For winter protection of vertical structures, use fence posts to support wire mesh 6 inches from the plants around the perimeter of the structure. Next, fill the space with wheat straw. Apply mulch in late fall, following the recommendation for field plants. In the spring, remove the mulch when leaves start to grow.

Disease and Insect Management

Selecting a good growing site, planting certified virus- and disease-free plants,

maintaining the plants in healthy growing condition, narrow plant rows and good weed control will limit strawberry losses from disease and insect problems. A well-maintained planting is less susceptible to disease and insect pests, thus less pesticide application is required. A brief description of the most common diseases and insects are provided in the following sections.

Fruit Rot Diseases

Gray Mold or Ash Mold (*Botrytis cinerea*) is one of the most common fruit rots, found on both green and the ripening strawberries. Rotted fruit becomes discolored, turning brown just as it begins to ripen, and often becomes coated with a soft, gray fungal growth, especially during wet weather. Dense foliage, often following a spring application of nitrogen fertilizer, provides the right conditions for the disease to develop.

Leather Rot (*Phytophthora cactorum*). This disease can be very important in years of favorable environmental conditions. Green and ripening berries that are touching the ground in fields with poor drainage after prolonged warm rains turn grey-brown and mushy. The stems rot, and the berry turns brown and dries out after a few days, giving it a leathery appearance.

Anthracnose Fruit Rots (Black Spot). Several species of fungi are known to cause anthracnose diseases of strawberry fruit. One or more tan or light brown, water-soaked lesions develop into circular, tan to dark brown, compact, sunken lesions on unripe to ripe fruits. Affected tissue is firm and dry, and affected fruits may be completely mummified.

Soilborne Root Diseases

Black Rot. The exact cause of this root rot is unknown, however, any condition that leads to root injury will produce symptoms of black rot. Several factors are associated with this disease: soilborne fungi, nematodes, drought, winter injury, excessive fertilizer, and soil moisture. Symptoms include wilting, stunting, yellowing, and gradual withering and dying of plants. Roots turn brown or black, and many of the fibrous roots rot.

Verticillium Wilt (*Verticillium albo-atrum*) can be very damaging to strawberries. Symptoms appear in the first year of plant growth. The older, outer leaves wilt, while the edges and area between veins turn brown. New growth stops, roots turn black, and the plant collapses during hot, dry weather.

Leaf Diseases

Leaf Spot (*Mycosphaerella fragariae*). Infection usually occurs early in the season during cool, wet weather when leaves are young. Symptoms include round, purplish-red spots up to ¼ inch in diameter on the upper surface of the leaf. The spots develop gray to white centers with purplish borders and may affect all aboveground parts of the plants. The same fungus causes Blackseed on the berry.

Leaf Scorch (*Diplocarpon earliana*). Leaf scorch is the most common leaf disease in Kansas. This disease may infect leaves and other plant parts, damaging the plants and preventing fruit development. It begins with round, dark purplish spots or blotches ¼ inch in diameter on the upper surface of the leaf. The spots turn dark brown, giving infected leaves a scorched appearance.

Table 2 shows the resistance levels of some strawberry cultivars to common plant diseases.

Insects

Strawberry slugs are slow-moving, greenish worms with brown heads. The pest, most destructive in old strawberry beds, chews holes in the leaves, leaving

them ragged-looking, often with only the midrib and some of the larger veins left untouched.

Garden slugs are gray-brown snails without shells that thrive under mulch, eat foliage and fruit, and leave a white slime trail.



Strawberry leaf rollers can be found inside folded strawberry leaves. When opened, a gray-green or bronze-colored worm, 2 inches long, can be found under a cottony web where it feeds on protected leaf surfaces.



Insecticides should be applied before the leaves are folded shut to be effective.

White grubs feed on roots causing strawberry plants to appear wilted and stunted. The problem is more severe when strawberries are planted in ground newly plowed from sod, or in ground that was weedy before planting. White grubs also move into a planting that has stayed in the same spot for three or more years.



Tarnished plant bugs are brownish-gray insects, ⅓ to ¼ inch long with sucking

mouthparts. They damage flowers, buds and very young fruits, deforming berries.

Nurseries

The following list is not exhaustive and does not imply endorsement by K-State Research and Extension.

Farmer Seed & Nursery
P.O. Box 129, Faribault, MN 55021
(507) 334-1623

Hartmann's Plant Company
P.O. Box 100, Lacota, MI 49063
(269) 253-4281

Henry Field's Seed & Nursery
P.O. Box 397, Aurora, IN 47001
(513) 354-1495
www.henryfields.com

Indiana Berry & Plant Co.
2811 Michigan Rd., Plymouth, IN 46563
(800) 295-2226

J.W. Jung Seed
335 South High St., Randolph, WI 53957
(800) 247-5864
www.jungseed.com

C.O. Keddy Nursery
982 Charles Keddy Road
Lakeville, Nova Scotia Canada B4N 3V7
(902) 678-4497

Makielski Berry Farm & Nursery
7130 Platt Rd., Saline, MI 48197
(734) 572-0060

Nourse Farms, Inc. RFD
41 River Rd., South Deerfield, MA 01373
(413) 665-2658
www.noursefarms.com

Peaceful Valley Farm Supply
P.O. Box 2209, Grass Valley, CA 95945
(530) 272-4769
www.groworganic.com

Stark Brothers Nurseries & Orchards Co.
P.O. Box 1800, Louisiana, MO 63353
(800) 325-4180

Table 2. Resistance levels of strawberry cultivars

Cultivar	Leaf Spot	Leaf Scorch	Red Stele	Verticillium Wilt
June-bearing				
Allstar	Resistant	Resistant	Resistant	Resistant
Cavendish	Resistant	Resistant	Resistant	
Earliglow	Susceptible	Resistant	Resistant	Resistant
Guardian	Resistant	Resistant	Resistant	Very resistant
Honeoye	Resistant	Resistant	Susceptible	Susceptible
Jewel	Resistant	Resistant	Susceptible	Susceptible
Lateglow	Tolerant	Tolerant	Resistant	Resistant
Red Chief	Resistant	Resistant	Resistant	Susceptible
Sparkle	Susceptible	Intermediate	Resistant	Susceptible
Northeastern	Tolerant	Tolerant	Resistant	Resistant
Latestar	Not available	Not available	Resistant	Resistant

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