

STRAWBERRIES



Fruit Gardens

BY
SORKEL KADIR

Green foliage, white flowers and bright red fruit make strawberries a colorful addition to a garden. Although strawberries are relatively easy to grow, success depends on careful attention to cultural requirements. Generally, small plantings that are well cared for will produce more fruit than large plantings that receive little care. If proper cultural practices are followed, 1 foot of row will produce at least a quart of berries.

SELECTION AND SOIL PREPARATION

Select a sunny, well-drained site. Standing water might reduce plant growth and vigor and cause disease. Low areas with poor drainage can be built up by using landscape timbers or other materials to hold mounded soil.

Strawberries prefer loamy or sandy soils. Heavy, clay soils may be satisfactory if they are well-drained, or they might cause root rot. Sandy soils require frequent irrigation and fertilization to keep plants growing. Organic matter is essential for healthy strawberry plants. The soil should contain at least 2 percent organic matter, if possible. Compost, rotted manure, straw, hay, old silage, grass clippings and peat moss are good sources of organic matter for strawberry soil. Poor soil may need to be improved for a year or more before strawberries are planted.

Select a site that is higher than the surrounding area. Cold air settles in low areas, and late spring frost may kill blossoms, reducing or eliminating the crop. A source of irrigation during dry periods

should be considered when selecting a site for strawberries.

Areas where sod is growing or where weeds are a problem should be plowed and cultivated one year before planting. This will break down the sod and kill grass that would otherwise reduce plant growth and production. It also will help eliminate weeds and white grubs before planting. Once the plants are established, little can be done to correct these problems. Tilling sod or uncultivated areas immediately before planting is not recommended.

RECOMMENDED VARIETIES

Choose vigorous, "virus free" plants of adapted varieties from an established nursery. Buying from local nurseries eliminates the danger of plants drying out during shipment. Choosing a variety depends on the local environmental conditions. Varieties grown in northeast Kansas may not produce as well in other areas of the state. New varieties should be tested locally before large numbers of plants are ordered.

June-bearing varieties are usually the most productive for home gardens and commercial fields. The plants produce one crop per year over a period from mid-May to mid-June, depending on the environment and location. Plant more than two varieties - an early, a mid, and a late season variety - to insure ripe fruits over a longer harvest period.

Everbearing varieties produce one crop during the normal harvest season and a second crop during late summer and fall. Because of the typically hot

Table 1. Strawberry cultivars for Kansas and surrounding states

Cultivar	Harvest ²	Season	Size	Flavor	Freezing Quality
<i>June-bearing</i>					
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
<i>Everbearing</i>					
Tribute			Medium Large	Very Good	Good
Tristar			Medium Large	Very Good	Good

²number of days after Earliglow

weather in July and August, fruit quality may be poor. Table 1 lists strawberry varieties that are adapted to the environmental conditions of Kansas and surrounding states.

PLANTING STRAWBERRIES

Mid-March to early April is the best time to plant strawberries in Kansas. Weather conditions at this time are more favorable for plant growth. Planting should begin as early as the soil can be worked during this period.

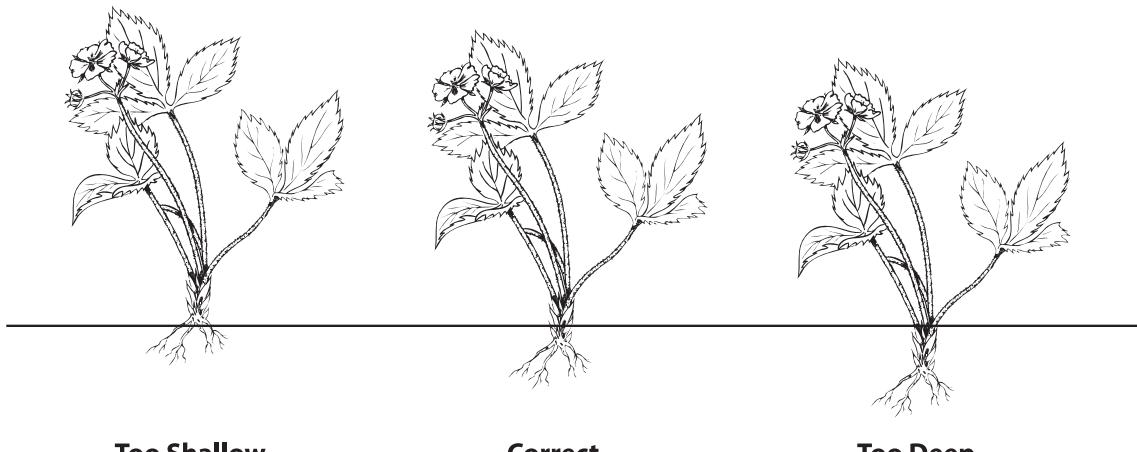
Get a soil test before planting to determine nutrient composition and apply the recommended nutrients to improve the soil. Your local K-State Research and Extension office can provide instructions for collecting and sending samples. Soil samples should be tested for organic matter, phosphorus, nitrogen, potassium content and soil pH. Strawberries are best grown in soil with a pH of 5.8 to 6.5. If soil fertility information is not available, 10 to 12 pounds per 1,000 square feet of 10-10-10 or similar fertilizer can be worked into the top 6 inches of soil.

Dormant strawberry plants that have been kept moist and not allowed to dry out are the most economical plants to select. Garden centers also sell vigorous container-grown plants that are a good option when buying a few plants for a small garden.

Dormant strawberry plants should be kept in cold storage at 40 F, and roots should be kept damp to prevent drying if not planted immediately. Before planting, remove old, dead leaves and prune off the lower one-third of the root system. Place the opened strawberry bundle in a bucket with enough water to keep the roots moist while planting.

One of three systems can be used to plant strawberries. Matted row systems of growing June-bearing varieties are the most common in Kansas. 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 in a bed that is about 20 inches wide.

Diagram 1. Planting depth



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 few allowed to root. This system requires more labor and plants than the matted row system.

Elevated beds 3 to 4 inches high can be prepared before planting. The elevated beds or ridges are suitable in heavier soils where water drainage is slow. However, strawberry plants grown on raised beds should be irrigated more frequently than those in a matted row system.

SETTING OUT PLANTS

New plants should be kept dormant, and roots damp. Survival and vigor are reduced when plants are exposed to temperatures above 50 F and when roots dry out before and during transplanting. If strawberry plants cannot be set out immediately, they should be held in cold storage at 40 F.

Set the plants so leaves, stems and apical buds are above the soil surface and the crowns are even with the ground surface (see *Diagram 1*). If plants are set too shallow, the crown will dry out, or smother if planted too deep.

Spread the roots slightly and pack soil around the root system. Next, firm the ground around the plant, avoiding injury to the crown.

If fertilizer was not worked into the soil earlier, a fertilizer solution can be applied around the 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 fertil-

izer into 1 gallon of water. Stir until dissolved, and allow to stand several hours before applying 1 cup of the fertilizer solution around each plant.

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. Young plants need about 1 inch per week. If rainfall doesn't supply this amount, irrigation is necessary. During July and August, plants require 2 inches per week. If rainfall doesn't occur, slowly apply water to the plants once a week during the spring, early summer, and early fall, and twice a week during mid- and late summer.

Summer is when runners are formed from mother plants and develop small plants at the end called daughter plants. As daughter plants grow, they build up food reserves, and form fruit buds in the fall for next year's crop. Strawberry plants must be maintained in a healthy condition for development of new plants and fruit buds.

Blossoms of June-bearing plants should be removed during the first spring to allow plants to set more fruit the second year.

Weed control is necessary to prevent weeds from competing with strawberry plants for soil moisture, light, and nutrients, causing yield and berry quality reduction. Shallow hoeing or cultivation is needed to avoid root injury. The soil should be left loosened for easier rooting of daughter plants.

AUGUST FERTILIZATION

Spring-bearing strawberry plants develop fruit buds for the next year's crop in September and October as day length gets shorter. Vigorous plants will develop more fruit buds than weak plants. An application of nitrogen early to mid-August will stimulate plant growth, and increase fruit bud development. Apply about $\frac{1}{4}$ to $\frac{1}{3}$ pound of urea (44-0-0), or about $\frac{3}{4}$ to 1 pound of 12-12-12, or equivalent, N-P-K fertilizer per 25 feet of row. Follow the fertilizer application with 2 inches of water applied through a sprinkler to dissolve and move nitrogen into the soil.

CARING FOR ESTABLISHED PLANTS

Young plants, as well as established beds, need mulching for winter protection. Severe cold temperatures can kill fruit buds and injure roots and crowns. Alternate freezing and thawing during winter can also damage plants. A winter mulch should be applied after plants have been exposed to several frosts and growth has stopped, but before heavy freezes are expected. The layer of mulch will insulate the plants from extreme temperature fluctuations. Usually, the period between Thanksgiving and Christmas is a good time to cover strawberries with mulch.

Wheat straw makes good mulch and is generally readily available. A 3-inch layer of mulch should be spread over the entire strawberry bed. Bales need to be broken up so heavy chunks don't smother plants. The problem of wheat and weed seeds in the straw can be controlled by thoroughly soaking the bales during the summer, using irrigation or rainfall, to promote germination of the seeds.

During spring, as plants push through the straw, remove part of the mulch from the top of the plant, leaving the rest to conserve moisture and to keep the fruit off the soil. Add $\frac{1}{4}$ to $\frac{1}{3}$ pound urea per 1,000 square feet as plants start to grow.

IRRIGATION

Strawberry plants need extra water as fruit develops. In Kansas, irrigation can increase production in some years by 25 to 50 percent. Plants need about an inch of water per week during the growing season, especially during July and August.

Apply enough water to penetrate 6 to 10 inches, where roots are concentrated. Don't apply water faster than the ground can absorb. Sandy soils need more frequent and smaller amounts of water than heavier soils.

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 leave them running until the temperature warms up and the ice melts. Deliver a fine mist rather than a lot of water.

Covering the plants with canvas or blankets can protect small strawberry beds. 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 needed during hot weather, because the fruit will mature quickly and become soft. Berries should be picked early in the day when it is cool and immediately placed in a cool, shady place. Strawberries deteriorate rapidly after picking, so berries not used immediately should be stored at 32 to 40 F to retain quality.

RENOVATING STRAWBERRY BEDS

Healthy strawberry plantings will remain productive for three or four harvest seasons. Plant vigor can be maintained by renovating after harvest. 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. Applying an inch of soil over the tops of the crowns is beneficial, because new roots form above older roots on the crown. A side dressing of balanced fertilizer, such as 10-10-10 or 12-12-12, can be applied at the rate of 1 pound per 25 feet of row. For the rest of the season, the plants should be handled the same as young transplants the first season. Weeds should be controlled by hoeing, cultivation, or applying 2,4-D amine formulation to control broadleaf weeds. A week after

2,4-D application, mow the plants to remove all stems and leaves, leaving the crowns undisturbed. Plants should be irrigated as needed to supplement rainfall (see Irrigation section).

CULTURE OF EVERBEARING STRAWBERRIES

Everbearing differ from June-bearing varieties in their vegetative growth and fruiting characteristics. Everbearing plants generally do not develop as many runner plants, so they need to be planted closer together in the bed. They bear fruit throughout the summer, although hot weather conditions in Kansas frequently limit summer production and fruit quality.

During the first summer after planting, remove all flower blossoms until about July to let plants build up a food reserve. The first fruit will ripen about 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 plants will benefit from nitrogen fertilizer in the early spring. Urea can be applied at the rate of $\frac{3}{4}$ teaspoon per hill.

SPACE-SAVING PLANTING METHODS

A strawberry pyramid or strawberry barrel can solve the problem of lack of space for a strawberry bed. These novel growing structures require extra care to prevent plants from drying out, and extra protection against winter injury because plants are not as well-insulated by soil. Everbearing 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. The peat moss could be replaced with compost or well-rotted manure. About 2 cups of complete fertilizer 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. The proper time to apply the mulch is in late fall following the recommendation for field plants. In the spring, remove all 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.

DISEASE

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 alboatum*) 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 fraganis*). Infection usually occurs early in the season during cool, wet weather when leaves are young. Symptoms include round, purplish-red spots up to $\frac{1}{4}$ inch in diameter on the upper surface of the leaf. The spots later 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 earlianum*). 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

Table 2. Resistance levels of strawberry cultivars

Cultivar <i>June-bearing</i>	Leaf Spot	Leaf Scorch	Red Stele	Verticillium Wilt
Allstar	Resistant	Resistant	Resistant	Resistant
Cavendish	Resistant	Resistant	Resistant	Tolerant
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	Resistant
Sparkle	Susceptible	Intermediate	Resistant	Susceptible
Northeastern	Tolerant	Tolerant	Resistant	Resistant
Latestar	not available	not available	Resistant	Resistant
<i>Everbearing</i>				
Tribute	Tolerant	Tolerant	Very Resistant	Resistant
Tristar	Tolerant	Tolerant	Resistant	Resistant



Diagram 2. Garden slug

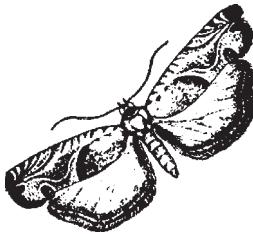


Diagram 3. Leaf roller, adult

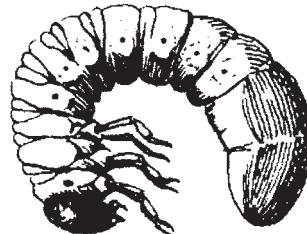


Diagram 4. White grub larva

blotches $\frac{1}{4}$ 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 (*Diagram 2*) are gray-brown snails without shells that thrive under mulch, eat foliage and fruit, and leave a white slime trail.

Strawberry leaf rollers (*Diagram 3*) can be found inside strawberry leaves that are folded together. When opened, a gray-green or bronze-colored worm, 2 inches long, can be found under its cottony web where it feeds on the protected leaf surfaces. For insecticides to be effective, they must be applied before the leaves are folded shut.

White grubs (*Diagram 3*) feeding on roots cause 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, $\frac{1}{6}$ to $\frac{1}{4}$ inch long with sucking mouthparts. They damage flowers, buds and very young fruits, causing deformed berries.

For insect and disease control methods and products see the K-State Research and Extension publication C-592, *Fruit Pest Control*.

NURSERIES

This list of nurseries is not an endorsement by K-State Research and Extension, nor is it exhaustive. Strawberry plants may be ordered from other equally suitable nurseries not included in this list.

Brittingham Plant Farms
P.O. Box 2538
Salisbury, MD 21802
(410) 749-5153

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

Hartmann's Plantation, Inc.
310 60th Street
Grand Junction, MI 49056
(616) 253-4281

Henry Field's Seed & Nursery
415 North Burnett
Shenandoah, IA 51602
(605) 665-9391
www.henryfields.com

Indiana Berry & Plant Co.
5218 W 500
Huntingburg, IN 47542
(800) 295-2226

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

Keddy's Nursery
982 North Bishop Road
Kentville, Nova Scotia
Canada B4N 3V7
(902) 678-4497

Makielski Berry Farm & Nursery
7130 Platt Road
Ypsilanti, MI 48197
(313) 434-3673

Mellinger's, Inc.
2310 W. South Range Road
North Lima, OH 44452
(800) 321-7444
www.mellingers.com

Miller Nurseries, Inc.
5060 West Lake Road
Canadaigua, NY 14424
(800) 828-9630
www.millernurseries.com

Nourse Farms, Inc.
RFD, Box 485
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.
Highway 54 West
Louisiana, MO 63353-0010
(800) 325-4180

Swedberg Nurseries
Highway 210 West
Battle Lake, MN 56515
(218) 864-5526

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended,
nor is criticism implied of similar products not mentioned.

Publications from Kansas State University are available on the World Wide Web at: <http://www.oznet.ksu.edu>

Contents of this publication may be freely reproduced for educational purposes. All other rights reserved. In each case, credit
Sorkel Kadir, Strawberries, Kansas State University, March 2003.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF-598

March 2003

It is the policy of Kansas State University Agricultural Experiment Station and Cooperative Extension Service that all persons shall have equal opportunity and access to its educational programs, services, activities, and materials without regard to race, color, religion, national origin, sex, age or disability. Kansas State University is an equal opportunity organization. Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, as amended. Kansas State University, County Extension Councils, Extension Districts, and United States Department of Agriculture Cooperating, Marc A. Johnson, Director.