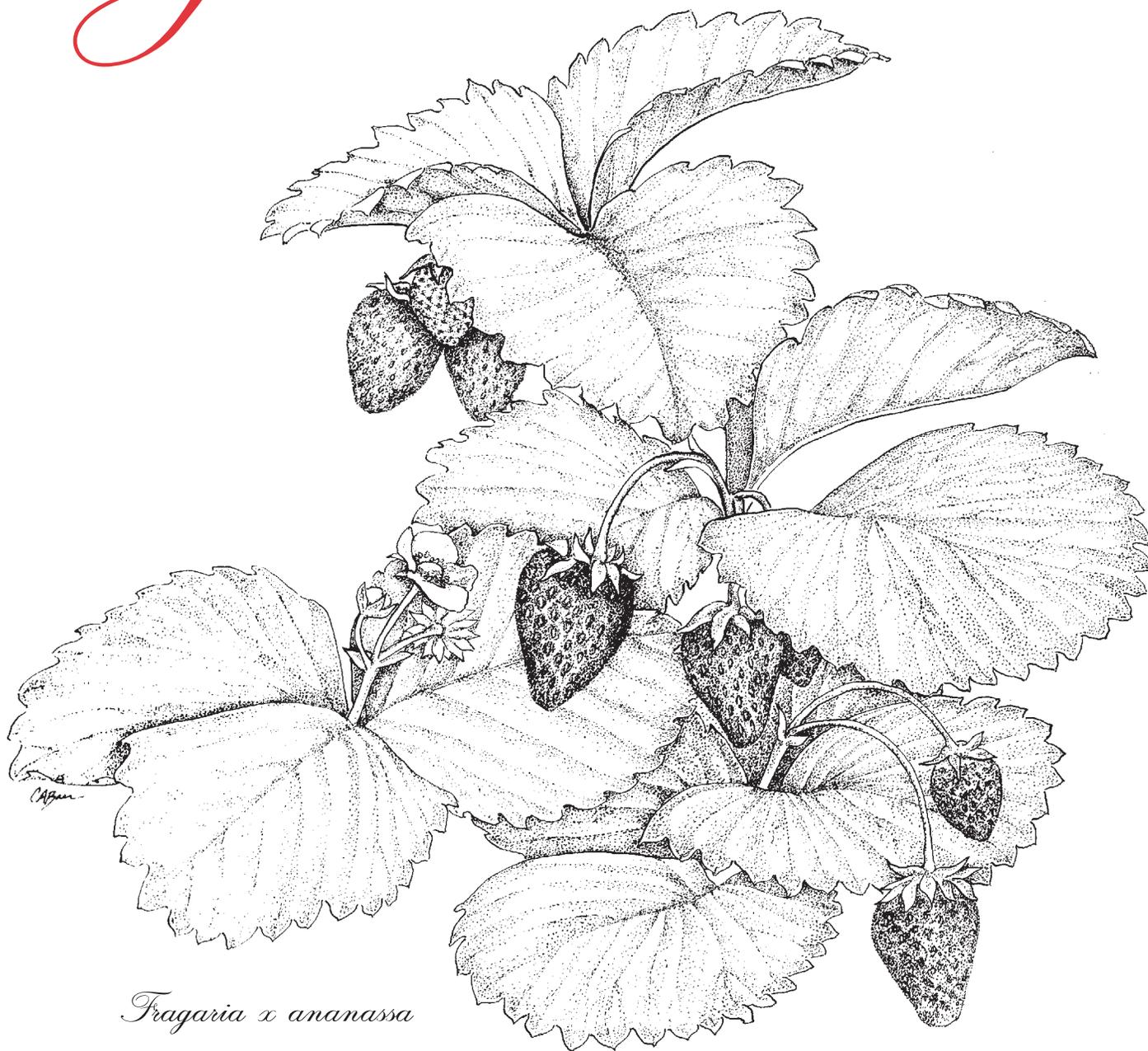


GROWING STRAWBERRIES IN WISCONSIN



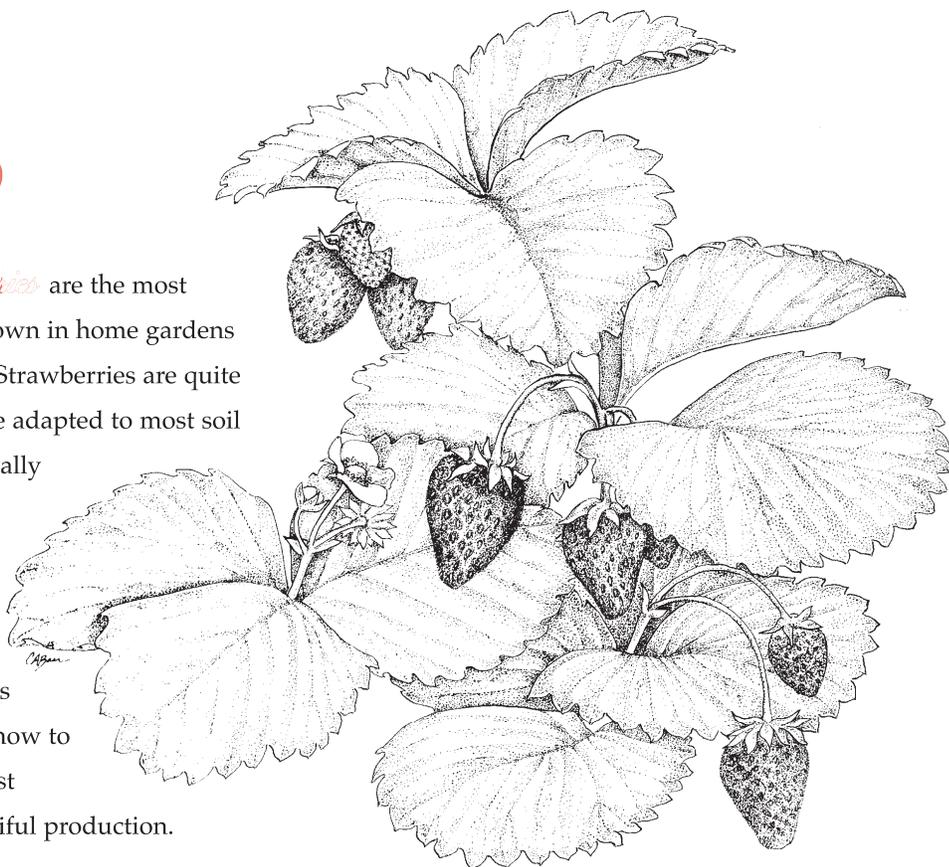
Fragaria x ananassa

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*S*trawberries are the most popular small fruit grown in home gardens throughout the state. Strawberries are quite easy to grow. They are adapted to most soil types and do not typically require an elaborate spray program. One plant can yield 1 to 1½ quarts of fruit if cared for properly. This publication describes how to plant, tend, and harvest strawberries for bountiful production.



THE STRAWBERRY PLANT

The strawberry is an herbaceous perennial. The perennial portion of the plant is the crown, which is a shortened stem. The crown produces roots, leaves, runners (stolons), branch crowns, and flowers. As the crown grows it elongates upward, and thus tends to “grow out” of the soil. New roots are formed progressively higher on the crown. Strawberry plants are shallow rooted with 50 to 90% of the root volume in the top 6 inches of soil. Be careful to not disturb the roots when cultivating and to keep the soil in the root zone from drying out.

Strawberry plants spread by means of runners (stolons). Stolons are initiated in response to day length. At the second node of the stolon, leaves

and roots are initiated, forming a daughter plant. Once the daughter plant has rooted, the stolon can be cut and the new plant will continue to thrive. Rooting usually takes 2 to 3 weeks.

Branch crowns are also formed from axillary buds on the main crown. Unlike daughter plants, branch crowns do not form their own roots, but they are otherwise identical to the main crown axis and daughter plants. A branch crown produces leaves and flowers independently of the main crown. As more branch crowns are produced, the crown becomes crowded, inefficient, and unproductive. This is one factor that determines when a strawberry planting must be replaced.

GROWTH AND FRUITING HABIT

Junebearing cultivars

The most common type of strawberries in Wisconsin are Junebearing. These plants bear one large crop of fruit each year after the first year in mid-June to early July, depending on location in the state. Plantings of Junebearing strawberries will be productive for 3 to 6 years if given proper care.

Everbearing cultivars

These plants bear a small early summer crop and may fruit one or more additional times until the first heavy freeze. Everbearing cultivars require different planting systems and more attention than Junebearing cultivars. You can expect fruit from mid- to late summer the year of planting. Plantings of everbearing strawberries should be replaced every other year.

Day-neutral cultivars

Day-neutral cultivars produce fruit and runners continuously during the growing season if cool temperatures and sufficient moisture prevail. These plants require full sun to produce a crop just like other strawberry types. Day-neutral cultivars can be allowed to start setting fruit in July the year of planting. Currently available day-neutral cultivars are not as cold hardy as the hardiest Junebearers and everbearers. Plantings of day-neutral strawberries should be replaced each year.

CULTIVAR SELECTION

To help ensure success with your berries it is important to select a cultivar (cultivated variety) suited to your particular needs and growing conditions. Various cultivars are good for freezing, fresh use, or both. You will get the most

FIGURE 1. Relative percentage of roots growing in the top 12 inches of soil.

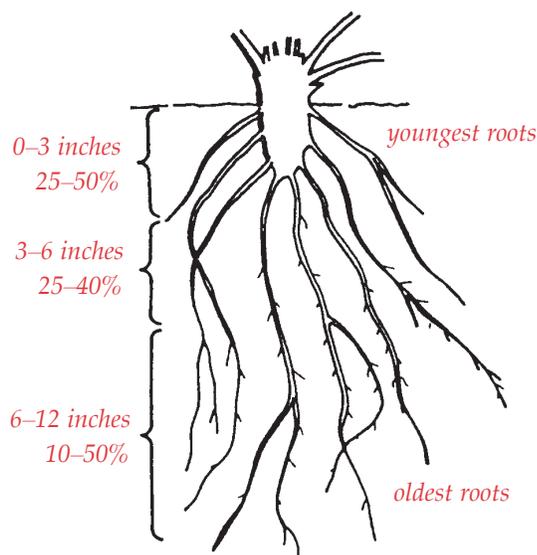
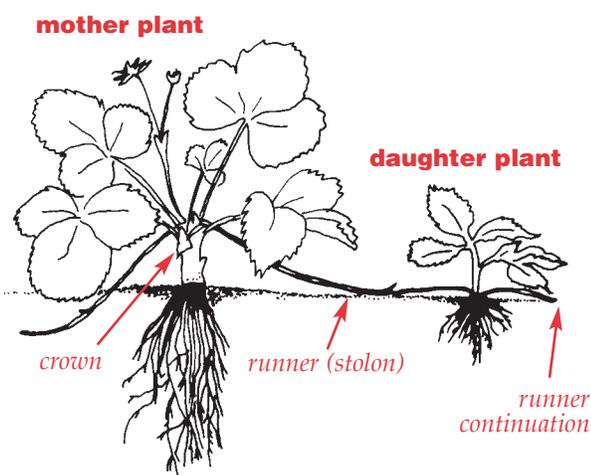


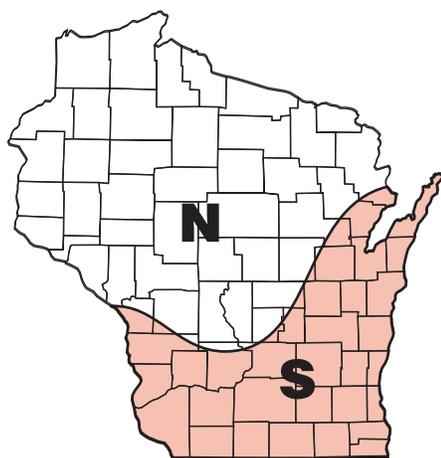
FIGURE 2. Strawberry plant with rooted daughter plant.



berries in any one picking season from Junebearers. Everbearing and day-neutral cultivars produce a smaller but more constant supply of berries for fresh eating and desserts throughout most of the growing season. Cultivars also vary in the degree of disease resistance or tolerance, cold hardiness, yield, and ripening season.

The following cultivars are grouped in order of ripening. The letters N and S indicate the region (northern and southern, respectively) the cultivar is best suited for.

FIGURE 3. Northern and southern winterhardiness designations for Wisconsin.



Junebearing cultivars

Early season

Annapolis (N&S) Fruit is attractive, large, medium red, and firm, but somewhat bland. For fresh use. Quite productive cultivar. Good resistance to red stele.

Crimson King (N) Fruit is large but somewhat soft and marginal in quality. Good for fresh use or processing. Vigorous and productive cultivar. Shows good tolerance to leaf scorch and leaf spot. Resistant to several races of red stele. Very hardy.

Earliglow (S) Fruit is firm and has excellent flavor. Fair for freezing. Moderately productive cultivar. Resistant to root diseases, moderately resistant to leaf diseases, and tolerant of botrytis.

Lester (S) Attractive, large berries are firm and have very good flavor. For fresh use or freezing. High vigor and plant production. Resistant to red stele and leather rot, and has a high tolerance for gray mold.

Early midseason

Honeoye (N&S) Top commercial cultivar in Wisconsin. Large, attractive fruit is good for fresh use and excellent for freezing. Highly productive cultivar. Tolerant of leaf powdery mildew and botrytis gray mold, but susceptible to red stele and angular leaf spot. Very hardy.

Raritan (S) An older cultivar requiring a little extra care due to lower vigor and less disease resistance. The excellent quality, flavorful fruit is glossy, bright red, and medium-large. Very easy to harvest. Use fresh; not for freezing.

Redchief (S) Medium-large berries are firm, glossy, and deep red with good flavor and consistency. For fresh use or processing. Resistant to mildew, red stele, and leaf scorch. Tolerant to Verticillium wilt.

Midseason

Cavendish (N&S) Dark red fruit is firm and very large. Flavor is slightly superior to Annapolis. For fresh use. Very high yield potential. Resistant to red stele and tolerant of botrytis.

Glooscap (N&S) Large fruit is dark, glossy red and has good flavor. For fresh use or processing. Plant is very productive and vigorous. Produces many runners. Resistant to leaf scorch and leaf spot, but susceptible to soilborne diseases.

Kent (N&S) Berries are firm, large, and glossy; milder in flavor and lighter in color than Honeoye. Excellent for all uses. Plant is high yielding and vigorous, but produces few runners.

Late midseason

Jewel (S, for trial N) Very attractive, medium-red, glossy fruit has excellent flavor. For fresh use or freezing. High yield potential. Good tolerance to botrytis gray mold and post-harvest fruit rots.

Mira (for trial N&S) New from Nova Scotia. Large, blocky-conical fruit is a bright medium to light red in color and has a mild flavor. Resistant to most foliar diseases and most races of red stele. Good runner production.

Mesabi (for trial N&S) New from University of Minnesota and USDA. Glossy, bright red fruit is large and very firm. Fruit has very good flavor. Vigorous plants may have limited runner production. Hardy.

Seneca (N&S) Attractive fruit is very large and firm, but has only average flavor. For fresh use or freezing. Vigorous plant growth. Average disease tolerance.

Late season

Lateglow (S, for trial N) Very large, symmetrical, pale fruit has excellent flavor and adequate firmness. For fresh use or freezing. Excellent vigor and disease tolerance.

Sparkle (N&S) High-quality, flavorful berry. Excellent for freezing. Late berries tend to be small and soft. Susceptible to virus disease but tolerant to red stele. Very hardy.

Winona (S, for trial N) A new cultivar from the University of Minnesota and USDA. Attractive, very large, glossy scarlet fruit is firm with good texture and quality. Resistant to most leaf diseases and several root diseases. Vigorous plants have good runner production.

Everbearing cultivars

Fort Laramie (N) Medium-sized, soft fruit is dark red and sweet. Plants are vigorous and winter hardy. Dense, leathery foliage is somewhat resistant to leaf spot.

Ogallala (N) Medium-sized fruit is dark red and somewhat soft but highly flavored. Good for freezing. Plants are hardy, vigorous, and productive. Resistant to leaf spot and tolerant of drought.

Ozark Beauty (N&S) Large, moderately firm fruit is necked and glossy and has a mild flavor. For fresh use or freezing. Plants are productive, vigorous, and produce runners freely. Resistant to leaf spot and leaf scorch.

Day-neutral cultivars

Day-neutral cultivars will need to be replanted each year as the plants will not survive most Wisconsin winters.

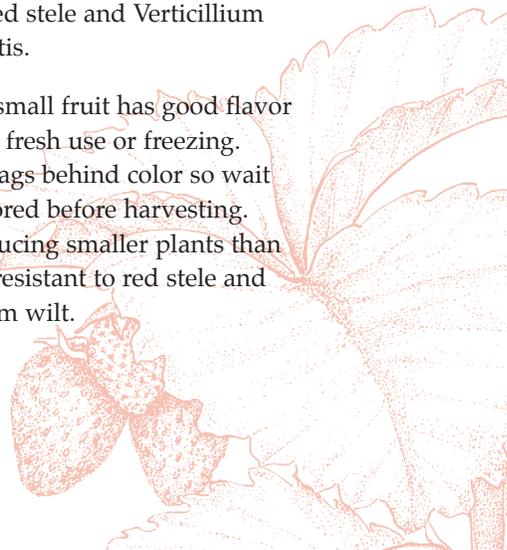
Fern (N&S) Good quality, medium-large fruit is red and conical. For fresh use. Good repeat bloom. Tolerant to leaf spot and susceptible to red stele, leaf scorch, and Verticillium wilt.

Selva (N&S) Very large, conical fruit is medium red and should be allowed to fully ripen on the plant for full flavor. Vigorous, productive plants.

Seascape (N&S) Large, conical fruit is medium firm with dark red skin and flesh. Very good flavor. For fresh use. Resistant to Verticillium wilt and leaf scorch, susceptible to leaf spot.

Tribute (N&S) Firm fruit has good flavor but lacks intense red coloring. For fresh use or freezing. Quite vigorous, producing medium-sized plants. Resistant to red stele and Verticillium wilt; tolerant of botrytis.

Tristar (N&S) Firm, small fruit has good flavor and intense color. For fresh use or freezing. Flavor development lags behind color so wait until fruit is fully colored before harvesting. Moderate vigor, producing smaller plants than Tribute. Moderately resistant to red stele and resistant to Verticillium wilt.



Plant source

Avoid the temptation to start new plantings from an existing planting. These plants may harbor diseases and insects that are not readily apparent. Purchase plants from a reliable nursery to be sure they are true to name, vigorous, healthy, and disease free. Disease-free plants grow better, produce more fruit, and live longer. But remember, although these plants start out disease free, they are not immune to diseases. You will still need to take precautions to avoid infecting the planting with viruses and other diseases that will weaken the plants. Many local and mail-order nurseries sell high-quality strawberry plants.

Plant numbers

Fifty plants should produce enough fresh fruit for a family of four. Extra plants will provide berries for home freezing, jellies, and jams.

SITE AND SOIL REQUIREMENTS

Choose a convenient location in full sun. Strawberries grown in shade are less productive. Avoid low spots where water often stands. Such spots have poor soil drainage and may be frost pockets where cold air collects on frosty nights.

You can grow strawberries successfully on many different kinds of soil. A sandy loam is ideal, offering good drainage with adequate water-holding capacity. Avoid poorly drained clay soils.

Fertilization

Preplant fertilizer needs will depend on the present fertility of the soil. To determine initial soil fertility, you should have the soil tested. A soil test will tell you how much lime, organic matter, and fertilizer your soil may need. Most soils benefit from a preplant application of organic matter. For more information on fertility see Extension publication *Fertilizing Small Fruits in the Home Garden* (A2307).

Site preparation

Site preparation should begin at least one year before planting. This is the best time to control perennial weeds since removing them after planting is extremely difficult.

In the spring before planting, work the soil so that it is loose to a depth of 6 to 8 inches. Add any lime or fertilizer recommended by the soil test report. Avoid planting strawberries in the same space where they grew previously. Rotate garden spots with other crops. Some crops harbor diseases that strawberries are susceptible to. If possible, avoid rotating strawberries into areas where the following crops were grown: raspberries, blueberries, tomatoes, potatoes, peppers, eggplants, and vining crops such as cucumber and watermelon.

PLANTING

Protect plants

After receiving plants from a nursery, do not allow them to become too warm. Be sure to keep the roots moist. If the plants arrive before they can be planted, you have two storage options: heeling in (temporary planting) and refrigeration.

To heel in plants, remove them from the shipping bags immediately on arrival. Using a spade, dig a V-shaped trench 6 to 8 inches deep in a cool location. Lay the strawberry plants 2 inches apart along one side of the trench, perpendicular to the trench length. Fill the trench with soil and then water the plants thoroughly. You can keep plants this way for several weeks.

If you need to keep plants in refrigerated storage, leave them in the shipping bags. Plants should be kept relatively dry until planting. Moisture from the plants themselves will provide sufficient humidity within the bags to keep them alive and yet prevent rotting. If plants appear unusually dry, wrap a damp paper towel around the roots. Plants can be kept in the refrigerator for up to 6 weeks. *Don't store strawberry plants with fruit such as apples or pears.*

FIGURE 4. Technique for planting strawberries.



When to plant

Strawberry plants should be planted in early spring as soon as the soil can be thoroughly worked. Properly stored plants may be planted as late as mid-June if soil moisture is good and irrigation is available. Strawberries planted late will have inferior yield the first season compared to stock planted early.

Setting plants

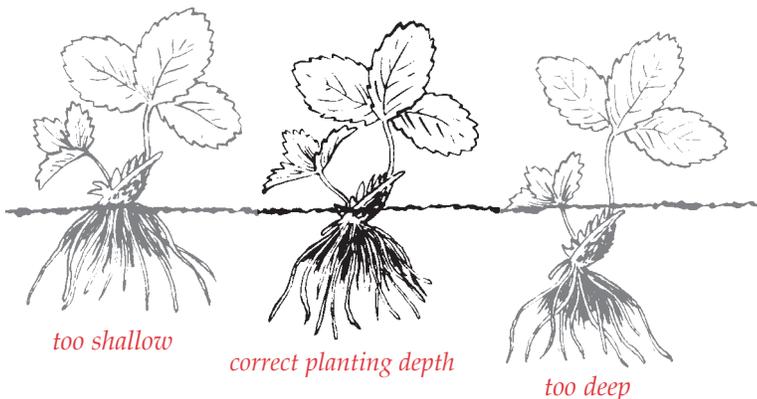
Just before planting, remove dry and old leaves from the crown and any attached runner remains. Leave two or three fairly well-developed leaves.

Using a trowel or spade, open a hole in the soil deep enough for the roots to hang straight. Spread out the roots for good soil contact. Place the plants so that only the roots and base of the crown will be covered with soil. Press soil firmly to establish contact with the roots and to eliminate air pockets.

Plant spacing and training

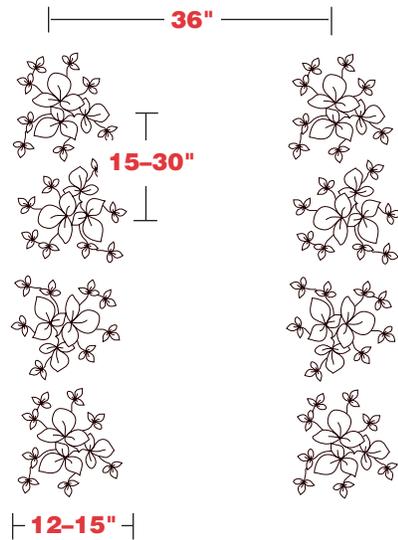
Proper plant spacing and training will maximize fruit production and reduce some pest problems. The goal of all strawberry planting systems is to optimize plant density. Too many or too few plants will reduce fruit yield. Most fruit are produced along row edges.

FIGURE 5. Proper planting depth.



The two basic methods of handling runner plants (new plants growing from the parent plants) are the matted row system and the hill system. Many variations are possible within these two basic systems. You can vary between-row spacing, within-row plant spacing, runner plant density, and row width (width you allow plants to fill in a row) for maximum production or to suit your particular requirements.

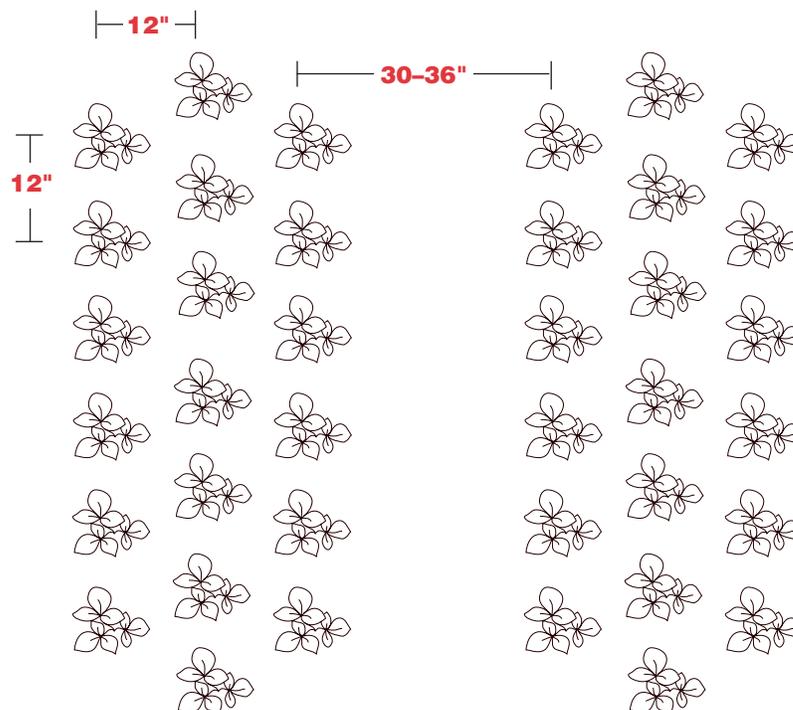
FIGURE 6. Matted row system (for Junebearing cultivars).



Matted row system. This system requires the least amount of labor and is best suited for Junebearing cultivars. With this system, runner plants are allowed to root at random within the row until they form a solid mat of a certain width. To maximize yields, limit the row width to 12 to 15 inches and maintain between-row spacing at about 36 inches. A rotary tiller can be used to maintain row widths. Within-row plant spacing for vigorous cultivars such as Honeoye and Sparkle should be 24 to 30 inches. Cultivars such as Kent may be planted 14 to 24 inches apart within rows.

Hill system. This system offers maximum production from a small space and is ideal for everbearing and day-neutral cultivars. Plant beds contain three rows spaced 12 inches apart; plants within the rows are spaced 12 inches apart. Stagger the middle row as shown in the diagram below. Leave 30 to 36 inches between each three-row bed. Cut off all runners as soon as they are visible. Continue to remove runners for the life of the planting to encourage large crowns, larger berries, and higher yields on the original plant.

FIGURE 7. Hill system (for everbearing and day-neutral cultivars).



CARE OF PLANTS

General care

Irrigation. Water is a key ingredient to successful strawberry growing. Depending on soil type, strawberries require about 1 inch of water from irrigation or rainfall every week during the growing season. Since most of the roots are near the soil surface, frequent irrigations of lesser amounts are best. Irrigation must continue after harvesting Junebearing strawberries. If the weather turns hot and dry during harvest, daily watering will help produce good fruit size and will maintain berry firmness.

Cultivation. Begin to cultivate within a few days after planting to keep the soil loose and to prevent weed growth. Continue cultivating throughout the growing season to kill the weeds and to keep the soil in good condition. Hoeing and hand weeding will be necessary to remove the weeds growing between the plants. Remember that about 50% of a strawberry plant's roots are in the top 3 inches of soil and 90% are in the top 6 inches. Shallow cultivation will limit root damage.

Weed control. Weeds compete directly with strawberry plants for light, water, and nutrients. They also interfere with insect and disease control. If you allow weeds to flower and set seeds, weed problems will worsen each year. Therefore, weeds must be controlled at all times. By cultivating the soil with a sharp hoe while at the same time removing weeds, you will greatly benefit the planting.

The use of herbicides (weed-killing chemicals) is not recommended for small strawberry plantings. Cultivation, mulching, or hoeing provide good weed control.

A summer mulch will help control weeds. Wait to apply the mulch until after the runner plants have rooted. Two types of mulch are available for weed control in strawberry plantings: organic and synthetic. Organic mulches are satisfactory

for all strawberry planting systems while synthetic mulches are better suited for the hill system.

Organic mulches include straw, sawdust, shredded bark, crushed corn cobs, and chopped hay. In addition to controlling weeds, organic mulches also hold moisture, keep berries clean, add organic matter to the soil and maintain a cooler, more even root temperature (especially important for everbearers and day-neutrals). When applying mulch, spread it no deeper than 3 inches over the soil surface.

Organic mulch may reduce the amount of nitrogen available to plants, so you should spread supplemental fertilizer over the mulch at the rate of $\frac{1}{4}$ cup of ammonium nitrate (33-0-0) per bushel of mulch. Don't disturb mulch after applying nitrogen.

Black plastic is a typical synthetic mulch. It is more appropriate for everbearing and day-neutral cultivars. Lay down black plastic at planting. Cut a small cross-shaped slit for each plant. Until plants produce a good canopy the black plastic may overheat the soil, which will slow plant growth and fruit production. To prevent overheating, spread a light straw mulch over the black plastic until the plants grow larger and cover most of the plastic.

Winter mulch. Strawberries are not sufficiently hardy to tolerate all winter weather conditions. Damage to the crown can be expected if the temperature drops below 18°F. Applying a good loose mulch will protect the plants against cold. Cover plant rows with clean (free of weed seed) marsh hay, sudangrass, coarse wheat or rye straw, or other suitable material when the ground has frozen about $\frac{1}{2}$ -inch deep, generally when the temperature drops to 20°F (mid- to late November). Apply enough to provide a settled mulch 2 to 4 inches deep.

Tree leaves make poor winter mulch. When wetted, they tend to mat and may smother strawberry plants underneath. Oat straw is also unsuitable because it often contains many weed seeds and breaks down too quickly.



FIGURE 8. Plants covered with mulch for winter protection.

Care during the first year

Blossom removal. On Junebearing cultivars, pinch out all blossom clusters the first year. This practice allows production of a large, vigorous plant and healthy runners instead of fruit. Fruit production will be greater the second year if flowers are removed the first year.

On everbearers and day-neutrals, remove all blossoms for the first 6 to 8 weeks after planting. If flowers are not removed during this establishment period, the plants become stunted, reducing later yields. After plants are established, allow all flowers to develop into fruit. If plants are kept for a second year, allow all flowers to develop to take advantage of the long fruiting season unique to these types.

Fertilization of Junebearing cultivars. For strong runner plants, apply nitrogen when plants begin to form runners, about mid-June. Applications of 1 pound (2 cups) of ammonium nitrate per 100 feet of row should be sufficient. Brush off any fertilizer that falls on the leaves. Water plants after fertilizing to dissolve fertilizer and wash it into the soil.

Strawberry plants start forming blossom buds for next year's crop beginning in late August. They need to have adequate fertility available at that time to produce many flower buds. Therefore, apply nitrogen a second time over the row in early to mid-August at 1½ times the earlier rate.

For more detailed fertilization suggestions, refer to Extension publication *Fertilizing Small Fruits in the Home Garden* (A2307).

Tissue testing is another method used to analyze nutritional requirements. For more information, contact your county Extension office.

Fertilization of everbearing and day-neutral cultivars. These two cultivar types require a different fertilization regime from Junebearing strawberries. Generally day-neutral cultivars need the most fertilizer because of almost constant fruiting. Everbearing cultivars differ widely in ability to produce multiple crops. Therefore, for everbearing and day-neutral types, fertilize every month they're in flower or are fruiting. Apply 1 to 2 pounds (2 to 4 cups) of ammonium nitrate per 100 feet of row. In cooler areas of Wisconsin during the summer, some day-neutrals may require fertilization every month from June through September. Spread the fertilizer in a ring or band at least 3 inches away from the plant.

Care after the first year

Mulch removal. Remove mulch in the spring as soon as new growth appears from the crown. Wait until the average nighttime low remains above 20°F. Once you've removed the mulch, you'll need to protect plants on frosty nights.

Frost control. Early spring frosts are a hazard for strawberries. If the mulch is still in the planting, it can be raked back over the plants for the night. Or cover the plants with a tarp or spunbonded polyester row cover. The goal is to retain heat from the soil under the tarp. As the strawberry plants and flowers develop, they become increasingly vulnerable to frosts. Once the flowers are visible, they will be damaged if temperatures fall below 28°F.

Cultivar selection can also help to avoid frost problems. Lateglow, Seneca, and Sparkle usually bloom late in the season and escape frost. Everbearing or day-neutral cultivars quickly produce new flower clusters if the first flowers are injured.

Fertilization. Do not fertilize Junebearers early in the spring before harvest. Fertilizer increases vegetative vigor of the plants and may reduce yield and cause soft berries. One possible exception to “no spring fertilization” is when strawberries are grown on a light sandy soil and plants appear deficient due to rapid leaching of nutrients in late fall and early spring or if some winter injury has occurred. See the section on renovation for fertilizer recommendations.

Renovating matted row plantings

(Junebearing strawberries). For continued production in succeeding years, you must begin renovating Junebearing strawberry plantings immediately after harvest. To renovate, follow these steps:

- 1. Remove weeds.** Keep weeds out of the planting by cultivation and hand weeding. To help maintain a weed-free planting, a summer mulch can be placed in the aisles between rows. Be sure to leave the row free of mulch so new runner plants can fill in to restore proper plant row width.
- 2. Mow the foliage.** If leaf diseases are evident they may be lessened by removing the foliage with a lawn mower. Set mower height at a point where the leaves are cut off while not damaging the crown.
- 3. Narrow the rows.** Strawberries spread by sending out runners. To maintain aisles between rows, plants must be removed between the rows. A row width of 12 to 15 inches is optimum. A rotary tiller, sharp hoe, or shovel can be used to keep the rows narrow and cultivate between the rows. Cultivation also incorporates any organic mulch materials left over from winter.
- 4. Fertilize.** Apply nitrogen fertilizer at the rate of $\frac{1}{2}$ to $\frac{3}{4}$ pound actual nitrogen per 100 feet of row. This would be about 6 pounds of 10-10-10 fertilizer, 3 pounds of ammonium sulfate (21-0-0), or 2 pounds ammonium nitrate (33-0-0).
- 5. Irrigate.** Continue watering after harvest to keep the planting healthy. Flower buds for the next year’s crop are formed after harvest, so keeping the planting vigorous during this period is critical for next year’s crop. Strawberries should receive at least 1 inch of water per week.

6. Fertilize again. Apply additional nitrogen fertilizer in mid-August to help flower bud formation. About 3 pounds of 10-10-10 fertilizer per 100 feet of row, or $1\frac{1}{2}$ pounds ammonium sulfate or 1 pound ammonium nitrate should be adequate.

Renovating hill system plantings

(everbearing and day-neutral cultivars). Set new everbearing plants every other year and day-neutrals annually using nursery-grown plants. As described earlier, prepare the site before each planting. Keep the area weed free between plantings by cultivation and hand weeding.

HARVEST AND HANDLING

Harvesting

Berries should be picked as often as every other day to maintain quality. Do not allow overripe berries to remain on the plants. Overripe berries invite insect and disease problems and some cultivars develop off-flavors when overripe.

To pick strawberries, cradle the fruit in your hand, pinch the stem between the thumb and forefinger, and pull with a twisting motion. The caps should be picked along with the fruit. Pick all of the ripe berries, both the large and small fruit. Place the fruit into shallow containers no more than 3 inches deep. Deeper containers will lead to bruising. Quart and pint containers are typically used.

Storing fruit

Ripe strawberries are very perishable. For maximum storage life, the fruit must be cooled immediately after harvest. If you have a large quantity of fruit to cool, spread it out in the refrigerator. After the berries have cooled, the containers can be placed in vented plastic bags. The higher humidity will keep the fruit firmer in storage. Fruit may be stored up to 4 days if refrigerated promptly. Do not wash berries before storage as washing leads to more fruit rots. However, be sure to wash fruit in running water before eating or processing.

INSECT PESTS

Although there are several insect and mite pests of strawberry, generally damage is relatively minimal. However, in some locations or during some years they can cause serious damage if not properly managed. The best approach to managing strawberry insects involves being able to recognize important pests and their damage, and knowing a little about their life cycles and best methods for control. Check the planting weekly throughout the growing season for symptoms of unusual plant growth or signs of specific pest activity. If you find pests that you don't recognize, have them identified so that you can choose the best control options. Ideally, you will use insecticides only when needed, when pest pressures warrant attention and non-chemical methods are not available.

A second approach to managing strawberry insects is the use of preventive insecticides. This option is acceptable where there has been a known history of significant pest pressures. Standard times for applying preventive insecticides are just before bloom, just after bloom, and after harvest and renovation.

If it is necessary to use both an insecticide and a fungicide, in many cases these products can be mixed together and sprayed at the same time. However, in some cases there may be pesticide incompatibility; carefully read the labels of both products before attempting unfamiliar mixtures.

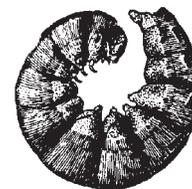
For specific insecticide recommendations, consult *Strawberry Pest Management for Home Gardeners* (A2127). This publication is revised as needed. Because pesticide information frequently changes, you should refer to the most recent version of the publication and to the label directions on the container.

Aphids

Several different kinds of aphids feed on strawberries. Most are small, greenish, soft-bodied insects which may or may not have wings. Aphids begin to feed soon after birth by sucking plant juices, thus reducing plant vigor and yield. More important, aphids spread certain virus diseases and, therefore, should be controlled throughout the season. Aphids are usually more abundant early in the season.

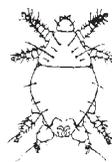


Cutworms



Cutworms can cause severe damage by cutting off plants at or below ground level, as well as by feeding on foliage and fruit. The worms are stout, smooth, greasy looking, and usually curl up when disturbed. Cutworms feed on plants at night and hide near the plants in the soil during the day. They are usually a problem in grassy or weedy plantings or if sod areas are spring plowed and planted to strawberries. Close observation with a flashlight at night may be necessary to confirm cutworm activity. Cutworms can be controlled with several insecticides. In addition to sprayable formulations, granular baits, with an incorporated feeding attractant, are also available for cutworm control.

Cyclamen mite



The cyclamen mite is nearly impossible to see with the unaided eye, but the damage it causes is quite noticeable—plants become very stunted, older leaves are cupped and new leaves are extremely small, wrinkled, and noticeably off-color. Heavy infestations will result in small, off-color, and leathery fruit. The mites generally feed in the crown area and are not abundantly found on

exposed leaves or fruit except when the populations are very high. Commercial growers should refer to Extension publication *Strawberry and Raspberry Pest Management in Wisconsin* (A1934) for recommendations on chemical control. No effective pesticides are available to home gardeners. The most appropriate approach for home gardeners is to destroy the infested planting, carefully clean up all the plant residues, and replant the following year with uninfested plants.

Always start new plantings with clean stock. Do not use daughter plants from mother plants suspected to be infested, because mites readily crawl from plant to plant. Young plants can appear healthy but still be infested.

Flea beetles



These small ($\frac{1}{16}$ inch) blue-black metallic beetles readily jump when disturbed. Flea beetles feed on leaves, flowers, and young fruit. Damaged leaves are riddled with small holes. These insects are usually not a severe problem in weed-free strawberries or strawberries isolated from weedy adjacent areas.

Leafhoppers

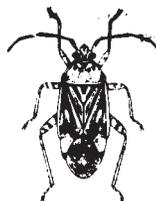


Many species of leafhoppers infest strawberries, but the potato leafhopper causes the most damage. The potato leafhopper is wedge-shaped, light green in color, about $\frac{1}{8}$ inch long and the adults quickly fly when disturbed. The young nymph is lighter in color and lacks wings. You can readily identify it by its habit of moving sideways. Both adults and nymphs feed on the underside of leaves sucking plant juices. They also inject a toxic saliva into the plant which causes cell breakdown. As a result, leaves become curled and stunted.

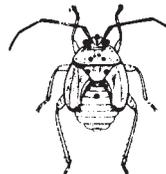
The potato leafhopper attacks many types of plants. It frequently becomes more of a problem

in strawberries after surrounding vegetation has been stressed or damaged. For example, the mowing of an adjacent alfalfa field or roadside right-of-way can force leafhoppers to seek food in managed plantings such as strawberry. Similarly, as vegetation dries in mid to late summer, leafhoppers will be attracted to irrigated or otherwise more healthy plants. The most severe damage from leafhoppers may appear during the establishment year.

Plant bugs



Adult



Nymph

Plant bugs, or lygus bugs, cause stunted berries with a concentration of seeds at the tip. Damaged berries are called "cat-face" berries.

Plant bugs are the most important insect problem of strawberries grown in Wisconsin. They suck plant sap and inject a toxin which breaks down tissue. Adult plant bugs are about $\frac{1}{4}$ inch long, somewhat flattened and bronze in color with yellow and black markings. They appear very early in spring and are present all season. Relatively few plant bugs can cause quite a lot of damage. If plant bugs have been a problem, apply an approved insecticide just before the start of the blossom period. A second application may be necessary toward the end of bloom.

Sap beetles or picnic beetles



These small, elongate or oval-shaped beetles are usually black with orange markings on the back. They readily attack damaged ripe fruit or overripe fruit and can be found tunneling in the berries during harvest.

During heavy infestations, sap beetles even attack healthy berries, especially those touching the soil. The problem is usually more severe in summer, and everbearing and day-neutral culti-

vars may be more heavily attacked than the earlier Junebearing cultivars. The beetles are strongly attracted to areas where plant fluids are fermenting or souring. Avoid placing compost piles near the garden, and remove all types of overripe or damaged fruit and vegetables. Pick berries before they become too ripe. You can trap sap beetles in cans (1-quart size) baited with a mixture prepared of one cake yeast, 2 quarts water, and 5 quarts dark syrup. Place containers around the edge of the strawberry planting, concentrating in areas where trees border closely.

Snails and slugs

Snails and slugs are neither insects nor the larval stages of insects. Snails are grayish in color, wormlike, and slimy with varying colored shells on their backs. Slugs do not have shells, are usually mottled with shades of gray and may reach 2 inches in length. Both feed at night eating large irregular areas out of berries and foliage and leaving a glistening trail of slime. During the day they hide in damp refuse or under leaves or mulch. For control, apply a slug bait along the alley ways.



Spider mites



Although more than one species may attack strawberries, the twospotted mite is the most common. Spider mites are extremely small, measuring about $\frac{1}{2}$ of an inch. Color varies from pale yellow to red. They feed on the undersides of leaves in a fine network of webbing. Damaged foliage takes on a bronzed appearance and severe infestations will destroy blossom parts.

Spider mites tend to be more of a problem during prolonged periods of warm, dry weather. No specific miticides are available for control in the home garden. However, broad-spectrum insecticides may help. Insecticidal soap also controls spider mites, but it is essential to get good spray

coverage on all leaf surfaces, including the undersides. Commercially available predatory mites are a good biological control if applied early in a spider mite infestation.

Spittlebugs

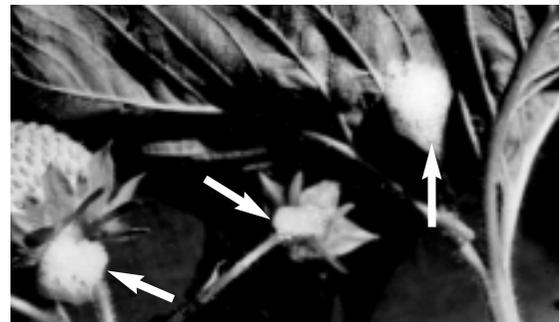


FIGURE 9. Spittle masses.

Immature spittlebugs produce the frothy material (spittle mass) found on strawberries in May and early June. The spittle masses contain small, bright yellow insects sucking out the plant juices. Their feeding weakens growth and stunts the berries. When the flower-bud clusters are attacked there is usually no berry production at all. Adult spittlebugs are very active throughout the summer, but do not cause a great deal of damage. Various insecticides usually provide satisfactory control. Each spittle mass represents only one insect, so a few scattered masses do not justify a spray treatment. Spittlebugs also feed on many types of weeds, and problems may be reduced by keeping the bed and surrounding areas weed free.

Strawberry leafroller

Adult strawberry leafrollers are moths with a wingspread of less than $\frac{1}{2}$ inch, rusty red in color with brown and white markings. The moth lays her eggs near the leaf base. Eggs hatch into small greenish or bronze caterpillars which fold and roll the leaves together while feeding. Heavy feeding causes withering of leaves and fruits. In addition to conventional insecticides, microbial

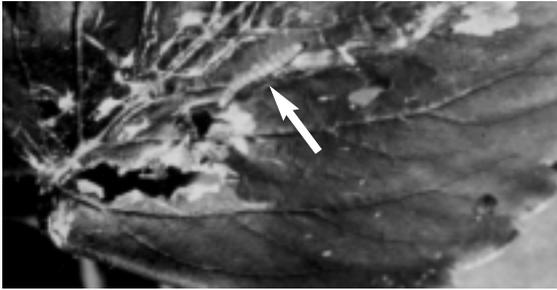


FIGURE 10. Leafroller damage. Note larva on open leaf.

insecticides containing *Bacillus thuringiensis* are effective if applied when the caterpillars are young.

Strawberry root weevil

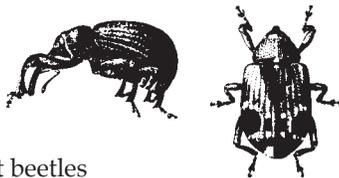


Small brown to black weevils appear from June through late summer. Adult weevils feed on leaves producing small notches on the leaf margins. Damage as a result of adult weevil feeding is minor. However, eggs laid during

the feeding period hatch into small, white, C-shaped grubs which feed on the roots. The grubs completely destroy small rootlets and on occasion feed into the plant crown. Plants wilt and die in early or midsummer. If root weevils have been a problem, cultivate the soil and leave it bare, free from weeds, for one year before a new planting. Adult weevils can be sprayed with insecticides. While no chemical controls are available for larvae, commercially available insect-parasitic nematodes will control them.

Strawberry weevil (clipper)

The strawberry weevil is similar to but smaller than the strawberry root weevil. Adult beetles leave their hibernation sites just before strawberry blossom time and move to



strawberry fields. They puncture flower buds with their mouthparts and then deposit eggs in the punctures. After egg laying, the weevil girdles or clips the bud stems causing the buds to drop off or hang limp, preventing fruit formation. Treat at the first sign of bud damage.

Thrips

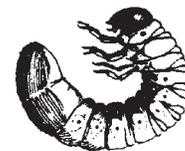
Whitened spots on the fruit surface, golden-brown berry discoloration, or cat-facing all indicate thrips feeding. Feeding on flowers results in low-quality fruit.



Thrips are very slender insects about $\frac{1}{25}$ inch long, usually yellowish, with wings resembling feathers. Generally, populations increase more rapidly during middle or late summer, making everbearing varieties most likely to be seriously affected.

White grubs

White grubs are generally a problem where strawberries are planted following sod or in weedy established strawberries. The grubs are $\frac{3}{4}$ to 1 inch long, white with brown heads and C-shaped bodies. Adults are the common May beetles or June beetles which appear in late spring and early summer. White grubs kill or weaken strawberry plants by feeding on the roots. Damage can occur for 3 years as most species require this much time to complete development. Carefully examine the soil before planting for presence of grubs. If necessary, apply an approved soil insecticide prior to planting. To discourage ongoing infestations, keep the planting and surrounding areas weed free. No insecticides are registered for use on established plantings.



DISEASES

Strawberries are susceptible to many diseases. This section describes the most common diseases in order of importance and suggests practices that will help prevent and control them. The most sensible and practical way to keep strawberry diseases in check is by taking preventive measures.

You can reduce losses due to diseases by (1) using the best cultural practices, (2) selecting adapted and, if possible, resistant cultivars, (3) planting pathogen-free stock, and (4) using the proper fungicides as foliage sprays.

1. Cultural practices. Use the cultural practices that are adapted to your area, as recommended elsewhere in this publication. Two essential practices that aid disease control are crop rotation and frequent renewal of plantings and plant stocks. Other cultural practices that help reduce certain foliage, fruit, and crown disease problems are keeping matted rows within the limits recommended for width and plant density, and winter mulching.

Winter injury is often the cause of plant decline and death. Plant cultivars that are known to be hardy in your area and protect plants with mulch in the winter.

2. Cultivars. Select cultivars adapted to your area. Where possible, purchase cultivars with a high level of disease resistance. Highly resistant plants will not become diseased; tolerant plants may become diseased, but their performance won't be significantly affected. Avoid cultivars that are very susceptible to one or more diseases.

3. Pathogen-free stock. Certain diseases can be introduced into new areas by planting infected stock. Also, other diseases will build up much faster when the plants that are set out are already infected. When buying planting stock, deal with nurseries that sell plants certified to be pathogen-free by their state plant-inspection service.

4. Chemical control. Accurate disease identification and proper timing of fungicide applications are critical for effective disease control. For current recommendations, refer to Extension publication *Strawberry Pest Management for Home Gardeners* (A2127).

Botrytis gray mold

This disease, caused by the fungus *Botrytis cinerea*, is the most common and destructive disease of strawberry fruit.



FIGURE 11. *Botrytis gray mold.*

Symptoms. The infection often starts on blossoms and green fruit, especially on frost-injured flower stalks and caps, or where dead petals stick to developing fruit. Infection can prevent fruit development. Mold may also start where a berry touches the ground, another decayed berry, or a dead leaf. At first there is a light brown, soft spot on the berry. The rot spreads and usually a gray or dusty mold appears, covering the fruit. Early-season infections often show no symptoms until after harvest.

Prevention and control. Damp, muggy weather and dense foliage shading the berries favor gray mold. To help prevent disease, space plants properly, avoid wide rows with high plant densities, control weeds, and time nitrogen fertilizer and irrigation as recommended. Apply nitrogen in summer and fall, not in spring. Use a good layer of mulch to protect berries from soil or decayed plants. Cultivate as little as possible from bloom to harvest. During renovation, remove and destroy plant debris to eliminate overwintering sites for the pathogen. Fungicide applications are more effective at bloom than at harvest. The cultivars Cavendish, Earliglow, Honeoye, Jewel, Lateglow, Lester, and Tribute are highly tolerant of botrytis.

Leaf spot and leaf scorch

These infections, caused by the fungi *Mycosphaerella fragariae* and *Diplocarpon earliana*, are spread by similar means and cause similar types of damage. Therefore, prevention and control measures are largely the same.

Symptoms. Leaf spot appears first as round, purple spots up to ¼ inch in diameter on upper sides of leaves. Later, centers of spots become

tan, gray, or white, with the border remaining purple. Leaf scorch produces small, dark purple spots more irregular in shape than leaf spot. They never develop light-colored centers. Spots may become so numerous that the leaf dries up and looks scorched.

A severe leaf spot or leaf scorch infection kills so many leaves that the whole plant is weakened or killed. Leaf scorch can also damage berry caps, leaf stalks, runners and fruit stalks. Rain, overhead irrigation, and too much nitrogen fertilizer favor disease.

Prevention and control.

1. Renew plantings regularly—after 1 or 2 years' cropping.
2. Use row widths of 12 to 15 inches.
3. Avoid high plant density within rows.
4. Plant resistant or tolerant cultivars. Annapolis, Crimson King, Earliglow, Glooscap, Jewel, Lateglow, Lester, Mira, and Ozark Beauty are tolerant of leaf scorch and leaf spot. Seneca is tolerant of leaf spot; Redchief and Winona are tolerant of leaf scorch.
5. Use fungicides when necessary on susceptible cultivars.



FIGURE 12. Leaf spot produces dark, circular spots that turn white in the center.



FIGURE 13. The irregularly shaped spots caused by leaf scorch are uniformly dark.

Leaf blight

Symptoms. The fungus causes reddish to brown spots with purplish borders. Spots are oval to triangular, generally much larger than those of leaf spot or leaf scorch— $\frac{1}{4}$ to 1 inch across. Spots commonly extend to the margin of a leaf. Leaf blight is most frequently found on mature plants after harvest; runner plants are seldom infected.

Prevention and control. The same chemical controls used for leaf spot and leaf scorch will help control leaf blight. Winona appears to be resistant.

Black root rot

The black root rot complex is a general name for several crown and root problems that produce similar symptoms. It is a limiting factor to growing strawberries in Wisconsin.

Many factors can contribute to black root complex. Among them are various soil fungi and bacteria, nematodes, winter injury, insect injury, dry weather, compacted or heavy soil, too much soluble salt, or high water table. Winter injury and soil fungi appear to be the main causes in Wisconsin.

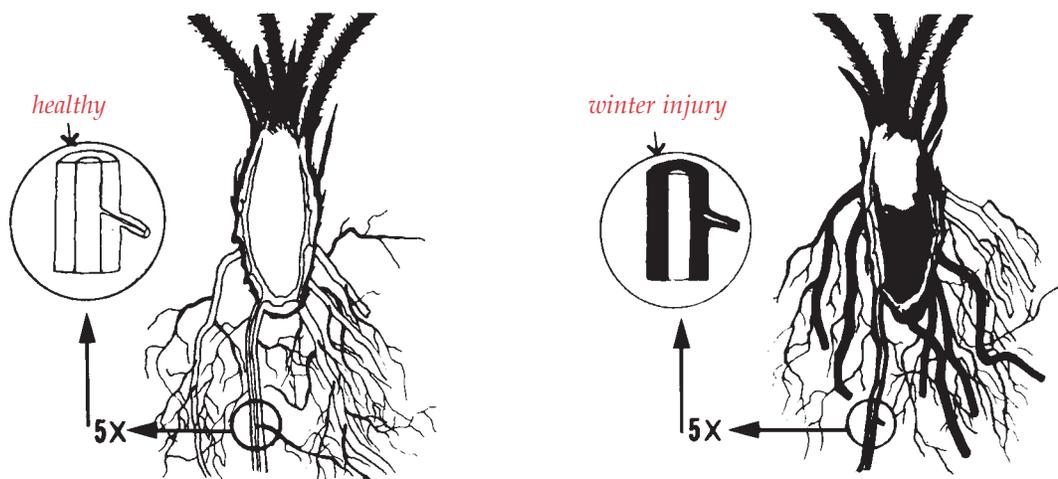
Symptoms. Roots of a plant with black root rot show one or more of the following symptoms:

1. The root system is much smaller than in healthy plants.
2. Main roots have lesions or areas that are darker than the rest of the root.
3. The small feeder roots are either not present or they are dry, brittle, and dark-colored.
4. Part (usually the tips) or all of the main roots may be killed, and a cross-sectional examination shows the dead parts to be dark in color throughout.
5. Cutting the crown area in half vertically reveals discoloration and tissue breakdown.

Prevention and control. Use only plants with healthy looking root systems and light-colored feeder roots. Cut through the crowns of a few representative plants and check for discoloration or breakdown of tissue. Fertilize new plantings adequately to get good-sized, vigorous, producing plants the following year. Follow carefully the directions for applying winter mulch.

Crop rotation and the frequent renewal of plantings and plant stocks also help reduce chances of root and crown rot. Some growers plow under a

FIGURE 14. Cross-sections of a healthy root system (left) and one with winter injury, a likely cause of black root rot (right).



planting after it has been in production for 1 year. They maintain production by setting out new plants each season. Unless plants are quite vigorous during the second production year, it seldom pays to keep a planting for more than three production years. Winona is the only cultivar that appears to have good tolerance to black root rot.

Verticillium wilt

This disease is caused by a soilborne fungus that attacks the roots and vascular systems of strawberries and other plants. The fungus is most active during cool weather.

Symptoms. Outer leaves wilt and dry up at the margins and between the veins; affected leaf tissue turns dark brown. Few, if any, new leaves develop. New roots that grow from the crown often are short and have blackened tips. Severely affected plants collapse and die. Less severely infected plants are unproductive and easily winter-killed. A few plants may recover and produce a normal crop the next year. The disease often appears in mother plants but not in rooted daughter plants. In new plantings, symptoms usually appear when runners begin to form. In established plantings, symptoms appear about the time the fruit begins to ripen.

Prevention and control. Allow at least 2 years after growing tomatoes, peppers, eggplant, potatoes, strawberries, or cane fruit before planting strawberries on the same land. Plant resistant varieties such as Earliglow, Lateglow, Lester, Redchief, Settler, Tribute, or Tristar.

Leather rot

The leather rot fungus (*Phytophthora cactorum*) has caused serious problems in Wisconsin. The fungus is soilborne and occurs naturally in many soils. The disease tends to be sporadic, but is most troublesome when berries are subjected to prolonged wet conditions.

Symptoms. The disease affects both green and ripe berries. On green berries, diseased areas are either dark brown or natural green outlined by

brown edging. On partly colored berries, diseased areas are light brown at the center and shade into purple at the edges. On fully ripe berries, there may be a slight darkening of the diseased area or no change in color. The healthy flesh of a berry that is even slightly infected with leather rot has a bitter taste.

When you cut into a diseased berry, there is no clear line separating diseased and healthy tissue. Instead, the water-conducting vessels leading to each seed are darkened. In the final stages of decay, the fruit becomes tough and leathery, and often the entire berry cluster is brown and dry.

Disease development is favored by a period of several days when nighttime temperatures remain between 55° and 65°F and moisture is present, followed by cloudy days with temperatures between 65° and 80°F. Infection is also favored where there is little or no mulch on the ground, allowing soil particles to be splashed up onto the blossoms and fruit clusters by rain and overhead irrigation.

Prevention and control. Place up to 3 inches of mulch on the ground between rows in the spring to prevent fruit from contacting soil either directly or by splashing water. Registered fungicides will provide adequate protection from this disease. The cultivars Lateglow and Lester are resistant to leather rot.

Red stele

Red stele is caused by the soilborne fungus *Phytophthora fragariae* and invades the root system of strawberry plants.

Symptoms. The plants wilt prior to and during the first part of the fruiting period. The central core (stele) of one or more of the main roots turns reddish-brown and feeder roots are often lacking. To observe this symptom, carefully slice or split the roots lengthwise using a knife or razor blade, or scrape the root lengthwise several times with your thumbnail. The dark red color may extend only partially up several roots, or it may nearly reach the crown area of the plant. However, red

stele seldom invades the crown itself. The outside of the infected roots is usually a normal, yellowish white color, as is the area surrounding the discolored central core. The younger leaves take on a bluish green cast, while the older leaves turn yellow or red.

Heavily infected plants usually die before the end of the fruiting season, while lightly infected plants often recover during warm, summer weather as the rotted roots are replaced with new ones. However, these plants seldom survive the winter, and those that do are stunted and show typical symptoms again the following spring. It is practically impossible to detect and identify infected plants except during a 3-week period preceding and including the first part of the fruiting season.

Prevention and control. Avoid areas that have heavy soil and are poorly drained. Do not keep plantings more than two bearing seasons; set out new plantings where strawberries have not been grown for 3 to 4 years. Purchase stock from nurseries with a good certification program. Once the soil becomes infested, the only control is to use cultivars that are resistant to the disease. Mesabi, Mira, Tribute, Tristar, and Winona are most resistant, followed by Annapolis and Cavendish. Cultivars with some resistance include Earliglow, Lateglow, Lester, Redchief, and Sparkle.

Angular leaf spot

Angular leaf spot, caused by the bacterium *Xanthomonas fragariae*, can cause serious defoliation of strawberry plants. It can also affect flowers and young berries before leaf symptoms become apparent. The disease is favored by cool temperatures and high humidity.

Symptoms. The most common symptoms of this disease are dark green, water-soaked, angular spots on the undersides of leaves. When holding an infected leaf up to a bright light, the spots appear pale green or yellow. The spots later

become visible on the upper surface as reddish or brownish angular spots of variable sizes. When the leaves are wet, bacteria ooze from the tissue as a whitish slime on the surface of the lesions. When the slime dries, it leaves a thin, clear, scaly film.

Prevention and control. Copper fungicides are the only materials that might be effective against the disease. If the disease was present the preceding year, copper sprays should be applied as soon as new growth starts in the spring. Several additional applications at 7- to 14-day intervals may be needed. Never exceed the rate recommended on the product label because excessive copper is toxic to plants. Also, do not spray copper when temperatures are above 80° to 85°F as plants may be injured. No cultivars are resistant, but Honeoye is noticeably susceptible.

Viruses and phytoplasmas

Most strawberry diseases caused by viruses arise from two or more viruses in the same plant (a virus complex). Often, the plants do not show obvious disease symptoms. However, the infection weakens the plant, reducing berry production and quality.

The disease aster yellows was once thought to be a viral infection. It is now known to be caused by a phytoplasma found in plant phloem cells. The pathogen is carried and spread by the feeding of the six-spotted aster leafhoppers. Plant symptoms are much like severe 2,4-D herbicide injury, with yellowing, dwarfing, and cupping of young leaves. Abnormal green, leafy flowers are often produced, resulting in little or no berry production.

A disease called "multiplier" is also caused by a phytoplasma. Affected plants are small and spindly and have many crowns, sometimes as many as a hundred. Leaves are one-third to one-half normal size, leaf stalks are short, and there are only a few short runners.

Prevention and control. Most viruses and phytoplasmas are spread from plant to plant by the feeding of insects, particularly aphids and leafhoppers. To reduce the spread of these diseases, apply a recommended insecticide throughout the first growing season and up until bloom, and then after the fruiting period during the bearing year.

When setting out a new planting, always use plants that are certified to be virus-tested. Virus-tested plants of most cultivars are now available from reliable nurseries.

Nematodes

Nematodes are tiny, threadlike worms that are too small to be seen easily by the unaided eye. Most nematodes in a typical soil are harmless to plants. Those that cause injury to plants by feeding on or invading the root system are called plant parasitic nematodes.

Nematodes are of minor importance on strawberries in Wisconsin, probably due to our cold winters. Occasionally, northern root knot nematodes infect plants in a few restricted areas in a planting. This nematode forms swellings or galls on roots. The galls range in size from a mere speck to $\frac{1}{4}$ inch in diameter and interfere with the normal functioning of the roots.

Root lesion, dagger, and sting nematodes are occasionally found in soils where strawberries are grown, but they seldom cause sufficient injury to the plants to warrant control measures.

PROBLEM SOLVING

Why plants fail to bear

There are many reasons why strawberries don't bear fruit—spring frosts, too much fertilizer, weed competition, or pests. This section describes the most common problems and how to avoid them.

Cold injury. Strawberries are susceptible to winter cold injury. Plant injury begins when the crown temperature (not air temperature) reaches 23°F. The amount of damage increases as the temperature drops below 23°F, with substantial injury or plant death occurring at 4°F. Mulching helps keep the crown temperatures stable. Suitable mulching materials will trap air and maintain loft throughout the winter. In areas where snow cover is deep and reliable, mulching is not necessary for protection. Ice over the mulch reduces loft and conducts heat from the plants. Ice should be avoided.

Spring frosts. Spring frosts pose perhaps the largest risk to successful strawberry production. When air temperatures at canopy height drop below 28°F injury will occur. To avoid damage, protect plants and blossoms when frosts are forecasted. Small plantings can be covered with straw, tarps, or row covers that will trap the heat around the plants. Covers should be put in place shortly after sundown and should remain on the plants only until the air temperature is above freezing in the morning.

Overfertilization. When bearing plantings receive heavy nitrogen applications before harvest, the plants produce vegetative growth at the expense of fruit growth. Strawberries require moderate nitrogen fertilization. Bearing plantings should only receive nitrogen after harvest. Young plantings should be well fertilized to encourage runnering.

Overcrowding. Most strawberries are produced at the row edges. When strawberry patches become a solid mat rather than a collection of rows, yields and fruit quality decline. Don't allow matted beds to be wider than 12 to 15 inches to maximize the linear feet of row edge.

Weeds. Strawberries do not compete well with weeds. Weeds will shade strawberry plants and compete for water and nutrients. Grass weeds are most competitive. Weedy berry patches will produce few fruit of poor quality.

Insects. Clipper weevils can devastate strawberry plantings. If not controlled, clipper weevils will clip the stem of virtually every flower, destroying fruit production.

Poor fruit quality

In some instances strawberry plantings produce fruit, but the fruit are small, poorly colored and of low quality. This section describes several problems that lead to poor fruit quality.

Age. As plantings age yields decline. Strawberry plantings are usually kept to bear fruit between 3 and 5 years. After that the planting should be removed and another crop rotated into that space for a year or two before replanting. Old plantings usually have more weed and insect pests than younger plantings.

Neglected plantings. Fruit quality suffers when plantings are not cared for. The plants need to be cultivated, fertilized, and have pests controlled as described in this bulletin. Reclaiming neglected plantings is usually not effective. It is better to remove the planting and start over.

Poor growing conditions. Patches established in poor sites will produce poor fruit. Wet, shady, or droughty sites will result in poor plant growth and few small fruit. The soil should also be prepared properly before planting. Adding organic matter to soils before planting will improve soil characteristics.

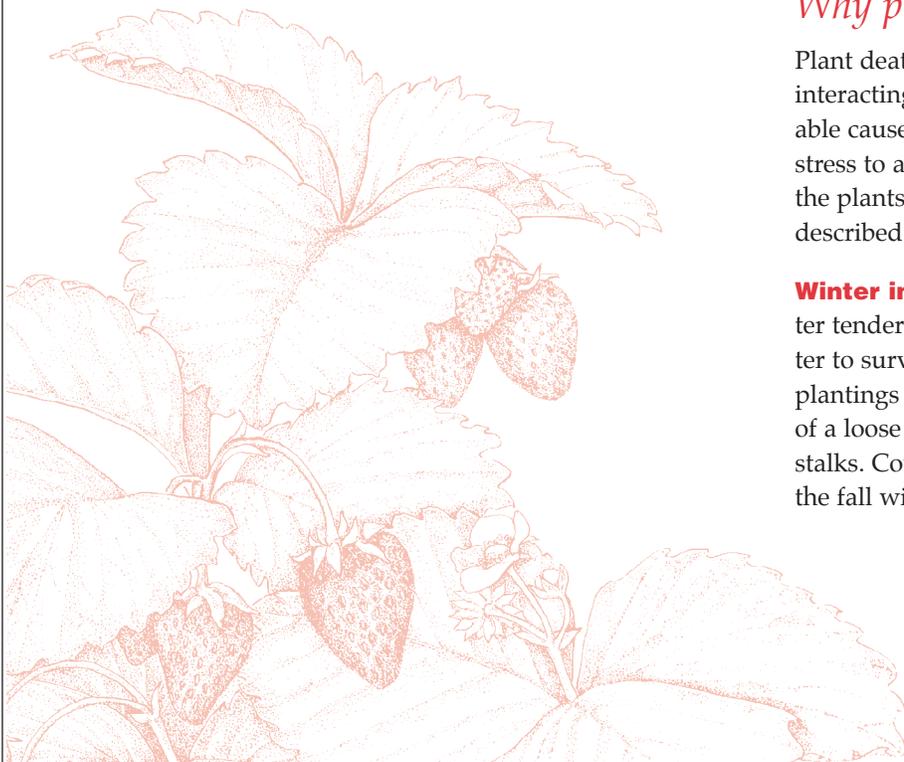
Insect and disease pests. The most common insect pest of strawberries is the tarnished plant bug. Tarnished plant bug injury results in misshapen, seedy fruit. Gray mold and leather rot are the most important disease problems. Plants infected with gray mold will have gray to white fuzzy growth on ripe fruit. Berries with leather rot will have discolored spots and a bitter flavor. See the insect and disease sections for more information on managing these pests.

Inferior cultivars. Inferior cultivars will produce inferior fruit. For the best chance of success plant cultivars recommended in this bulletin, *Home Fruit Cultivars for Northern Wisconsin* (A2488), or *Home Fruit Cultivars for Southern Wisconsin* (A2582).

Why plantings fail

Plant death is usually caused by a number of interacting factors rather than by a single identifiable cause. One injury may provide sufficient stress to allow other problems to eventually kill the plants. Several reasons for plant death are described here.

Winter injury. Strawberry plants are quite winter tender and require protection during the winter to survive and produce fruit. Strawberry plantings are usually covered with 2 to 4 inches of a loose mulch such as straw or chopped corn stalks. Covering plants with mulch too early in the fall will not allow them to harden off suffi-



ciently for winter. Removing the mulch too early in the spring may subject the plants to frosts. On the other hand, removing the mulch too late will reduce yields. Snow can be captured over strawberry plants during the winter by placing snow fencing to the windward side of the plants.

Too much water. Strawberry plants will not tolerate wet feet. Saturated soils do not allow air to reach the roots and they predispose the roots to root diseases such as red stele. Plant strawberries only in well-drained soils. Irrigate prudently so soils don't remain wet.

Drought. Strawberry plants have shallow roots that don't explore a large volume of soil. When soils are allowed to become too dry the plants will die. Weeds will also compete with strawberry plants for moisture when water is in short supply. Light sandy soils are particularly prone to drought. Adding organic matter, controlling weeds, and irrigating will keep soils moist.

Mechanical injury. Physical damage to strawberry plants can be caused by a variety of sources, including lack of care while picking, setting mowers too low at renovation, and deer and other animals browsing. Fencing the berry patch with chicken wire will help keep small animals from the patch. There is little that can be done to keep large animals out of the patch. Use care at renovation to keep from injuring the crowns. If the crowns are damaged, the plants are unlikely to survive.

Insect and disease pests. Severe infestations of insects or diseases can weaken plants making them prone to winter injury or summer droughts. While these pests seldom kill plants outright, they are often contributing factors. Manage insect and disease pests using the practices described earlier in this publication.

RELATED PUBLICATIONS

For home gardeners

Fertilizing Small Fruits in the Home Garden (A2307)

Home Fruit Cultivars for Southern Wisconsin (A2488)

Home Fruit Cultivars for Northern Wisconsin (A2582)

Strawberry Disorders:

- Black Root Rot (A3231)
- Strawberry Gray Mold (A3232)
- Leaf Spot and Leaf Scorch (A3233)

Strawberry Pest Management for Home Gardeners (A2127)

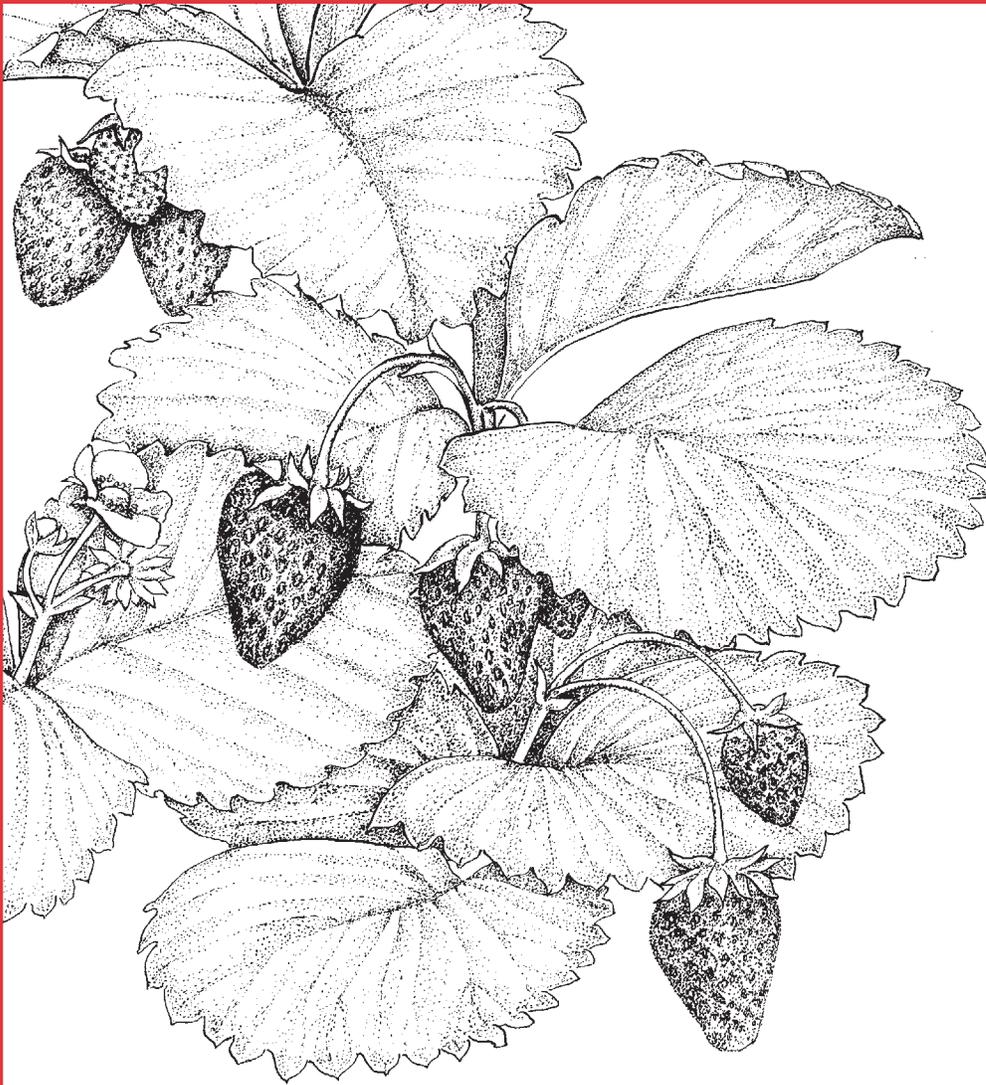
For commercial growers

Compendium of Strawberry Diseases, APS Press, (800) 328-7560

Midwest Small Fruit Pest Management Handbook (Bulletin 861), Ohio State University, (614) 292-1607

Strawberry and Raspberry Pest Management in Wisconsin (A1934)

Strawberry Production Guide for the Northeast, Midwest, and Eastern Canada (NRAES-88), Cornell University, (607) 255-7654



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