

GROWING STRAWBERRIES IN HOME GARDENS

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Figure 1. Two wild varieties of strawberries used for breeding purposes. Photo courtesy of Scott Bauer, USDA, www.forestryimages.org.

Strawberries are easy to grow. They provide the first fruit of the season, and are quick to bear. When harvested fully ripe in the home garden they have excellent flavor. In stores they can be expensive and are often harvested prior to being fully ripe. Strawberries derive their name from the practice of winter mulching with straw to lessen winter soil heaving caused by soil freezing and thawing cycles. Various types of strawberries are available. Each type has specific environmental requirements such as temperature and hours of daylight for good production. With the wide range of climatic zones in Arizona it is important to choose the right type of strawberry for your growing conditions.

The cultivated garden strawberry, *Fragaria x ananassa*, is a cross between two wild strawberries: *Fragaria virginiana* (meadow

strawberry), native throughout much of North America, and *Fragaria chiloensis*, native to the Pacific coast of North and South America. The latter species was brought to France from Chile by Amédée-François Frézier in 1714. This cross was made in France in the 1750's with a strawberry from the Eastern United States and the other from Chile (Figure 1). All types are self-fruitful, needing only one cultivar for pollination and fruit production. <http://www.botgard.ucla.edu/html/botanytextbooks/economicbotany/Fragaria/index.html>

Strawberries grow from crowns, which are short, compressed stems. The crown produces a whorl of leaves, fruiting structures (inflorescences), branch crowns, and runners. (Runners or stolons, are also called "daughter" plants, which can be used to propagate new strawberry plants.) The strawberry fruit is fleshy, with achenes (seeds) on the surface. The fruit is topped by a calyx (green, leafy cap) which might remain on the plant when the fruit is picked.

These plants are very sensitive to crown depth. Thus, proper planting depth is important. The ideal air temperature regime for growing strawberry fruit is a low of 55° F (13° C) and a high of 70° F (21° C). Temperatures outside of this range will result in vegetative growth of leaves and runners (stolons). Flower buds are produced when day lengths are shorter than 12 hours a day.

Regardless of where you live in Arizona strawberries are adaptable, but variety selection is as important as their care (culture). Strawberry plants respond to good care. Proper care begins with close attention to variety selection, correct planting time, soil improvement, fertilization, irrigation, and mulching. Good care results in larger yields of high quality fruit, 25 plants will yield up to 25 pounds of fruit.

SITE SELECTION

Strawberries require direct, full sunlight for best production. However, high summer afternoon temperatures can damage plants in low and mid-elevation desert locations. Many varieties bloom early in spring, so in frost prone areas don't plant them in frost pockets (areas that cold air drains into at night). Strawberry blossoms are susceptible to late spring frosts, which can kill early flowers. This is a serious loss because these early blossoms produce the largest berries. In colder areas, if possible, select a site slightly higher than the surrounding ground with a gentle slope. This allows for cold air drainage, which follows the flow of water, and helps to minimize frost damage. Another method of reducing frost damage is to cover plants with a gardening/landscape fabric or straw mulch. A southern exposure is usually warmer earlier in the spring, thereby hastening the bloom and ripening season. However, in areas where late spring frosts are rather frequent, a northern exposure, which would delay bloom, might be more desirable. Locations next to houses will be warmer from heat generated from the home.

In the mid to lower elevations of Arizona strawberries should be shaded in the afternoon during summer months. This reduces heat

and water stress to the plants and fruit. Establish planting beds where morning sun is received but plants are in the shade during the afternoon to avoid the heat. Plant next to a wall or fence that provides afternoon shade or erect a cover over the bed with a 65 percent shade cloth for best results.

Avoid planting strawberries after eggplant, peppers, potatoes, tomatoes, blackberries, raspberries and strawberries. These crops can cause the soil to be contaminated with verticillium wilt disease, many strawberry varieties are highly susceptible to this disease (for more information on verticillium see Olsen 2011).

Average strawberry plantings can remain productive for three or four fruiting years, but may be productive for up to eight years. When production drops replant in soil that has not been used to grow strawberries or other verticillium wilt susceptible plants.

SOIL PREPARATION

Strawberries grow best in well-drained, sandy loam soils high in organic matter and fertility. Most sandy loam or sandy soils meet this drainage requirements but are low in organic matter. Saline or alkaline soils (above pH 7.5 to 7.8) are not good because strawberries are highly sensitive to salts in soil and irrigation water. It is wise to prepare soil well in advance of planting (6 to 8 weeks). To prepare the bed, water to encourage weed growth followed by removal of these weeds. Incorporate two to four inches of organic matter into the bed to a depth of 12 inches since this is the depth that strawberry roots grow. Good sources of organic matter are bagged steer manure and/or compost that contain decomposed leaves, grass clippings, and similar materials. Avoid animal manures that have not been hot composted unless nothing else is available. They may contain weed seeds and harmful toxic salts.

When preparing the bed add three pounds of ammonium phosphate (16-20-0) per 100 square feet (0.5 pounds of actual nitrogen). Ammonium phosphate will supply needed nitrogen and phosphorous to the new plants. The addition of soil applied sulfur may be desirable if soil pH is above 7.5. Apply at the rate of three to five pounds per 100 square feet. After incorporating all of these materials into the soil, thoroughly water to settle the bed for future planting.

Where soluble salts are a problem, planting on a raised bed (setting the plants halfway up the side of the bed) allows for salts in the soil and water to rise to the peak of the bed above the root zone. Flat beds can be better than raised beds because it is easier to leach (applying large quantities of water during an irrigation) toxic salts below the root zone. Leaching is done by applying three to four times the amount of water normally applied during an irrigation. Leaching may be done every six to eight weeks during the growing season.

Special strawberry beds may be prepared where space is limited or the soil is not optimum for normal plantings. The bed is usually surrounded by wooden boards (landscaping timbers), rocks or other suitable materials. To develop the bed, mix one-half part coarse builder sand, one-fourth part organic matter and one-fourth part topsoil. The beds should be at least ten inches deep for good root development, high water-holding capacity and sufficient internal drainage.

CULTIVARS AND CULTURE

Cultivars (cultivated varieties) of strawberries are classified as three types. They are: 1) June-bearing, producing one spring crop per year;

2) everbearing types, producing fruit twice each year, in the spring and fall; and 3) day-neutral types, which produce when temperatures are below 90° F. (32° C.).

June-bearing types produce about twice as many berries as everbearers. They also produce numerous runners as temperatures warm. June-bearing plants are set in the spring in upper elevations (Northern and Southeastern Arizona) and should not be allowed to fruit the first season. Removal of flowers strengthens the plant and promotes runners, which result in a larger crop with better fruit quality the following spring. June bearing cultivars planted in the fall in the lower elevations (Southern Arizona, Gila and Salt River valleys) are fruited the following spring and summer. Plants are allowed to fruit for one year and are normally replaced the following fall for best results. The summer heat causes too much stress for strawberries and they will probably not produce well.

Everbearing types do well in the northern part of the state but should not be allowed to fruit until the latter part of the first growing season. In the lower elevations everbearing types do not tolerate heat well and will not perform as well as June-bearers. These plants produce few runners. Both day-neutrals and everbearers may be sold as "everbearing" types in retail nurseries.

Day-neutral cultivars will produce when temperatures are below 90° F. (32° C.) and will revert to vegetative growth when temperatures are above 85° F. (29° C.). They produce few runners. These varieties will produce much like everbearing varieties in Arizona. In lower elevations day-neutral cultivars may be grown as annual plants.

June-bearing varieties, which perform well in the lower elevation ranges, and available from local nurseries are, 'Earliglow', 'Honeoye', 'Lateglow', 'Sequoia', 'Camarosa', 'Chandler', 'Tioga', and 'Sweet Charlie'. Everbearing varieties which can be tried are 'Gem', 'Streamliner', and 'Ozark Beauty'. Day-neutral cultivar which perform well are 'Seascape', and 'Tristar'.

In the higher elevations, June-bearing varieties, which may perform well, are 'Honeoye', 'Sequoia', 'Tioga', 'Jewel', 'Sparkle', and 'Robinson'. Everbearing varieties, which have a better success for crops because of potential frost damage, are 'Gem' ('Superfection'), 'Ozark Beauty', 'Fort Laramie', 'Ogallala' and 'Quinault'. Day-neutral varieties which perform well are 'Tribute', 'Seascape', and 'Tristar'.

PLANTING

Best results are obtained with dormant, virus-indexed plants purchased from a reliable nursery or mail order firm. Strawberries can be planted during two different seasons (spring or fall). The time will vary depending on elevation. In areas above 3,000 feet, a spring planting (March 15 to May 15) is suggested, since temperatures are cool and the plants have a better chance for survival. Plant as soon as the soil can be worked. In areas below 3,000 feet, a fall planting (September 15 to November 15) is suggested. This allows for plants to become well established to support a crop of fruit the following spring.

Obtain plants that are dormant and healthy. For all plantings in the lower elevations, obtain plants that have been chilled (also known as "frigo" plants commercially), for best fruit production the following spring.

Be sure to spot-check plants for signs of winter injury, mold, and root rot. Plants showing signs of winter injury (golden orange-colored crowns) are likely to die if the weather turns hot and dry. A heavy mold

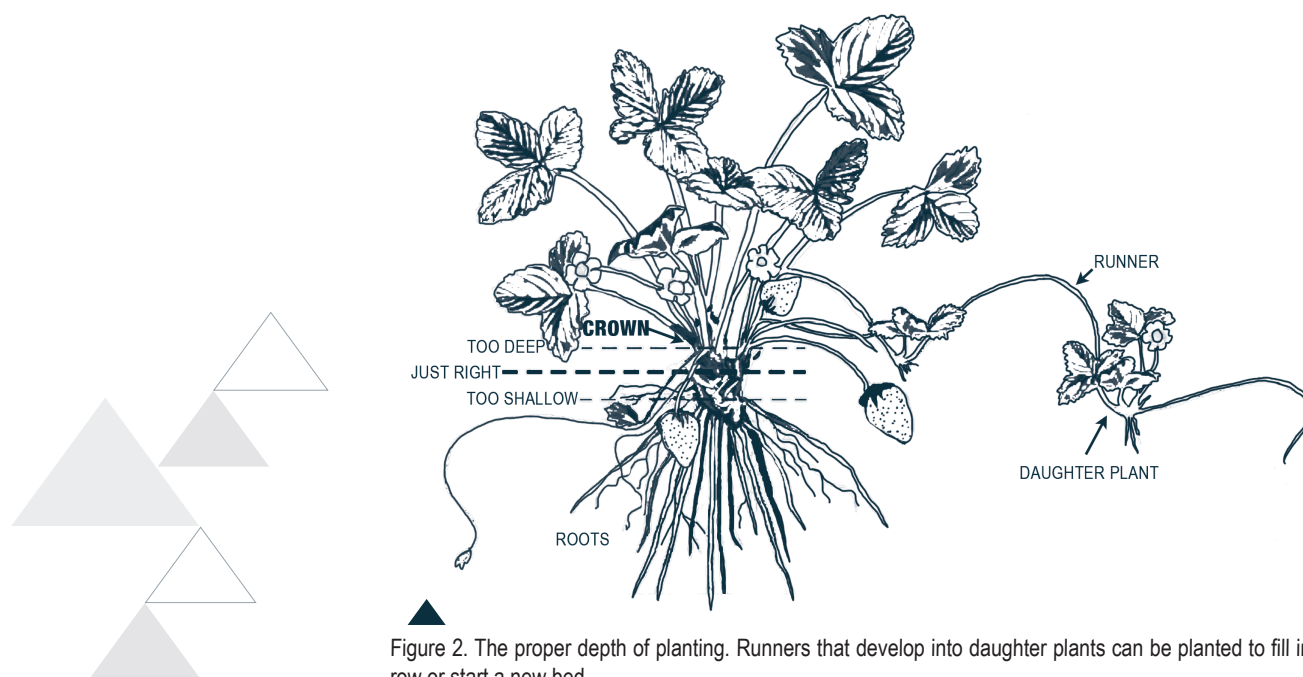


Figure 2. The proper depth of planting. Runners that develop into daughter plants can be planted to fill in a row or start a new bed.

on strawberry roots and crowns is an indication of improper storage. If plants are moldy, discard them. When plants arrive, keep them in the refrigerator until you are ready to plant.

Plants should be spaced 12 inches apart in most planting beds. In areas where plants will be grown for three to four years (higher elevations) and allowed to develop new plants from runners, a wider spacing (24 to 36 inches) is more desirable. Care should be taken to set out new plants at the proper depth. Set plants so crowns (the space between leaves and roots) are level with the surface of the soil where the plants were growing in the nursery (Figure 2). If plants are set too shallow or too deep they could die. Soil should be firmed around the roots so no air spaces are left. Water plants immediately after planting.

In general, strawberry barrels and pyramids have not proven successful in Arizona because they dry out quickly in low and mid-elevation areas. Higher elevations have had better success.

CARE AND CULTURE

Strawberry plants produce runners that make new plants when temperatures are out of the optimum fruit producing range (Figure 2). These new plants may be transplanted to make a new bed or fill in the gaps of an existing bed. These runners may be removed or left to grow. When runners are removed, the mother plants will produce fewer berries but they will be larger. If runners continue to develop into new plants more berries will be produced but they will be smaller. Selective thinning can be conducted to balance out yield and berry size depending on how dense a stand is desired. In row plantings new plants from runners are placed down the row.

When the bed becomes too crowded then renovation (pruning) needs to take place. The process has several steps. Step 1) raise a rotary mower to its highest wheel setting and mow the strawberry plants, after fruit has been harvested in the spring; Step 2) narrow row to 8 to 12 inches with a rototiller or by hand digging; Step 3) remove all

weeds; and Step 4) fertilize with nitrogen. Weed control at this time is important. Weeds may be controlled by hand removal, hoeing, mulching or judicious use of herbicides.

Plastic film or straw mulch, commonly used in strawberry production, which helps keep berries clean and reduces fruit rots, it also promotes earlier harvest and increased yields (Figure 3). Clear plastic film increases soil temperature and promotes more vigorous early growth and earlier yields but does not control weeds. Black plastic film reduces weed growth but does not increase soil temperature as much as clear plastic mulch, although the plastic itself is hotter. Plastic film may be put into place prior to planting or after plants have been established. The disadvantage of applying prior to planting is that wind can whip the plastic and pull the young plants out of the ground. Make sure the plastic film is well anchored around the edges and at each plant. If film is applied after planting wait 2-3 weeks for roots to become well established to minimize plant damage. The soil should be wet at the time of film installation. Straw mulch also works well, providing it does not add weed seeds to the bed or is not blown away.

Irrigation should be frequent because of the shallow root system (12 inches). However, too much water can cause yellowing of leaves because of iron chlorosis. During the fruiting period irrigate every 3-6 days on light soil and every 7-10 days on heavy soil. New plants should receive water almost daily for about a week to lessen the shock of transplanting. Drip irrigation methods are well adapted to strawberry culture. Irrigation water containing more than 640 ppm total salts is hazardous. If water does contain excessive salts, make sure enough water is applied at each irrigation to prevent the accumulation of salts in the root zone. After harvest, the roots should be kept moist if plants are to be retained for another growing season.

Strawberries need additional fertilizer once new growth begins in late winter or early spring and three to four months later after harvest and during renovation. Apply 1½ pounds of ammonium sulfate (21-



Figure 3. Strawberries planted through plastic mulch. Photo courtesy of Howard F. Schwartz, Colorado State University, www.forestryimages.org.



Figure 4. Red stele root rot of strawberry (*Phytophthora fragariae*). Photo courtesy of Scottish Crop Research Institute, www.forestryimages.org.

o-o), or the equivalent, per 100 square feet (0.3 pounds of actual nitrogen), in several applications. Scatter the fertilizer on the ground and wash it off the leaves to prevent salt burn before irrigating. If possible, work fertilizer into the ground prior to the next irrigation. If drip irrigation is used for watering, fertilizer can be injected into the system. If injection is used, reduce the amount of nitrogen applied by ½ to prevent nitrogen burn.

STRAWBERRY PROBLEMS

Chlorosis of leaves is a major problem in Arizona. In the early stages, leaves turn pale green then yellow between the veins. As the condition becomes more severe, leaves become white, then turn brown around

the edges and may die. The cause may be too much water on poorly drained soils that do not allow the roots to mine the soil for iron. Also, high calcium carbonate (lime) content of soils may limit iron uptake. Treating the first condition requires water drainage and change in irrigation scheduling. Lengthen the intervals between watering to allow the soil to dry. The second condition is corrected by adding iron chelate compounds or iron sulfate to the soil or more effectively, in the form of foliar sprays. Add a tablespoon of iron sulfate crystals to one gallon of water and spray on leaves to give temporary control. This treatment must be applied at 14- to 21-day intervals to relieve the problem. In lower valley areas iron chelate such as Sequestrene 138 applied as a soil treatment has been the only satisfactory method of curing iron chlorosis. Follow manufacturer's application directions.

Nematodes are serious pests of strawberries in some areas. On strawberries, these pests do not usually cause the characteristic knots on the roots common to many other plants, although some swelling may be evident. For this reason, a nematode infestation is more difficult to detect. Stunted plants in an area known to be infested with nematodes may indicate that they are the problem. Soil solarization during the summer is the only adequate solution. This is done before planting strawberries. This is a three step process. Step 1) irrigate the area to be pasteurized to the depth of 12 inches; Step 2) rototill or double-dig the area; and Step 3) place clear plastic over the tilled area and seal the edges with soil. Leave the plastic in place for at least six weeks. The heat produced under the plastic will kill or drive nematodes deeper into the soil. This treatment will also reduce weed seed viability and some soil pathogens.

Black-Root disease (*Rhizoctonia solani*) is caused by a fungus that lives in the soil. Plants decline in vigor and productivity and have poor, typically black root systems. The best control is rotation and better cultural practices.

Phytophthora (*Phytophthora* species) root and crown rot (red stele disease) is first seen when leaves and overall growth are stunted (Figure 4). Young leaves may wilt. Leaves and crowns turn reddish to brown in color. Wilted plants eventually collapse and then die. Proper water management is needed to reduce or eliminate this problem. If water puddles for more than six hours then disease spores will be activated and may infect the plants water conducting system. Let soil dry out before watering again. Planting on raised beds will also help by keeping roots and crowns from sitting in water. Replace plants every few years. If Phytophthora becomes severe soil solarization may help. Follow the directions found in the nematode section.

Catfacing or irregular shaped fruit is common on the earliest crop in some years. The cause is improper pollination, often due to low temperatures. Insect feeding may also cause catfacing.

Verticillium wilt caused by a soil-borne fungus, is a problem in some soils, especially in lower and mid-elevation valley areas. As the disease progresses, outer leaves begin to dry up, first at the margins, then between the veins because this disease affects the water conducting tissue. Growth of new leaves is greatly retarded, making plants look flattened and stunted. Plants may wilt and will die under severe attacks of this disease. If Verticillium wilt is suspected, have a plant diagnosed by a laboratory to be sure. Do not replant in soil infected with Verticillium wilt.

Spider mites often build up in large enough numbers on strawberry plants to cause damage. Leaves become dirty and gritty, and a close inspection reveals tiny light colored mites. These very tiny "pests"

suck the plant juices from the leaves. A strong jet of water on the leaves or employing insecticidal soap will usually discourage them, but dusting with a 300 mesh sulfur dust is sometimes needed after harvest. (Sulfur should not be applied when temperatures are over 85° F.) Do not use insecticides to try and control spider mites. They are not insects and insecticidal use will only kill spider mite predators and cause larger populations of this pest.

REFERENCE

eXtension.org. Search hundreds of Cooperative Extension sites.
<https://search.extension.org/>

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Olsen, M. 2011. Verticillium Wilt. University of Arizona, College of Agriculture and Life Sciences Bulletin, AZ1034. Tucson, Arizona.

Further information concerning pests and their control for strawberries is available at: University of California Davis Integrated Pest Management. For information on strawberry pest management go to: <http://www.ipm.ucdavis.edu/PMG/GARDEN/FRUIT/strawberries.html>

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ACKNOWLEDGE

The author wishes to acknowledge the contributions of Robert E. Call in the preparation of the material presented in this publication.

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