

The Blackberry¹

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Introduction

Blackberry (*Rubus* spp.), family Rosaceae (somatic number 21, 28, 35, 42, 56, 63, 70, 77, 84), is a deciduous crop that grows best in temperate climates. Several blackberry species are native to Florida. Wild blackberries are often harvested in Florida; however, they have several limitations, including comparatively small berries, lack of uniformity, low yield, and late maturation. The culture of improved blackberries in Florida is primarily limited to homeowner production, although there is some potential for "U-Pick" and local sales in North Central and North Florida. Blackberry yields in many areas of the country may exceed 6,000 lbs/acre; however, quantitative yield data from Florida are scarce. In Florida, blackberries typically ripen during May and June. They are extremely perishable and as such are very difficult to ship satisfactorily to distant markets. The major blackberry production areas in the United States are the Pacific Northwest, Michigan, and Arkansas.

Blackberry bushes may be erect or trailing with gradations in between. Although most blackberries produce shoots with thorns, many cultivars are thornless. Historically, the cultivars 'Oklawaha',

'Flordagrاند', and 'Brazos' have been recommended for Florida. However, many new blackberry cultivars are available from breeding programs, and they are increasingly appearing in the retail market. Some of the new blackberry cultivars are being tested by the University of Florida and are discussed in more detail below. The most promising new blackberry cultivars are from the University of Arkansas and are denoted by an Indian name. In Florida, they are only adapted to the northern parts of the state. Drake and Clark (2000) reported that 'Arapaho' had a chilling requirement of 400–500 hours of exposure at 3°C, while the chilling requirement of 'Navaho' was 800–900 hours. Warmund and Krumme (2005) ranked the lowest chilling requirement to the highest as follows: 'Kiowa', 'Arapaho', 'Shawnee', 'Navaho', 'Chickasaw', and 'Apache'.

Blackberry and raspberry plants produce an aggregate fruit and are derived from many ovaries from a single flower. The major difference between blackberries and raspberries is that when blackberry fruit are consumed, the receptacle of the inflorescence (known as a torus) is also consumed. By contrast, raspberries—when picked ripe for consumption—have a hollow center since the receptacle remains on the cane. Raspberries are not

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generally recommended for the southeastern United States and are discussed only very briefly here. 'Dorman Red' is the only raspberry cultivar recommended for trial in Florida when grown as a perennial crop; however, berry flavor is poor to fair. 'Heritage' raspberry has been grown as an annual crop during the winter in southern parts of the state after it has received its chilling requirement.

The remainder of this publication will be devoted to blackberries.

Cultivars

'**Apache**' is an erect, thornless blackberry bush released by the University of Arkansas. In Arkansas, it produces higher yields and larger fruit than the other thornless cultivars, 'Arapaho' and 'Navaho'. 'Apache' produces a 10 g berry, which is the largest of the three thornless cultivars. Berries are conical in shape with a glossy black finish. Soluble solids average 10 °Brix, and fruit firmness is acceptable and similar to that of 'Arapaho'. 'Apache' has not been adequately tested in North Florida, although it is expected to do well in areas where 'Arapaho' and 'Navaho' have done well. For additional information, consult Clark and Moore (1999a). 'Apache' is now under trial at the UF NFREC–Quincy.

'**Arapaho**' is an erect, thornless blackberry bush released from the University of Arkansas breeding program (Moore and Clark 1993). It has good fruit quality and ripens before 'Apache' and 'Navaho'. It is moderately vigorous. Symptoms of rosette have not been observed. Yield characteristics in North Florida have been as follows: yield of 1.7 tons/acre, berry weight of 4.5 g, and soluble solids of 10 °Brix. For additional information concerning the performance of 'Arapaho' in North Florida, consult Table 1. In Florida, it is likely only adapted to extreme North Florida. 'Arapaho' is now under trial at the UF NFREC–Quincy.

'**Brazos**' is an erect, thorny blackberry cultivar released by the Texas Agricultural Experiment Station (Lewis 1959). Yields have generally been high in North Florida and South Georgia. The fruit are medium in size. Since fruit are high in acidity, 'Brazos' is mostly used for jams, jellies, and baking. 'Brazos' is self-fruitful and generally ripens from

mid-May to late May. Rosette disease is a serious problem. This disease contributes to productivity loss in 'Brazos' blackberry plants with age.

'**Chester**' is a semi-erect, thornless blackberry that may require trellising. 'Chester' has a wide range of adaptability in the United States, but to our knowledge it has not been tested previously in Florida. 'Chester' reportedly produces a high yield. Berry size is medium large (about 5 g), and flavor is mild. Ripening date is July. 'Chester' is currently under trial in North Florida at the UF NFREC–Quincy.

'**Chickasaw**' was released in 1999 by the University of Arkansas. It is an erect, thorny blackberry bush that is among the highest-yielding cultivars in Arkansas. Berries are long and cylindrical. Berry weight is about 7–10 g, and firmness is rated high. Berries are sweet, averaging about 9–10 °Brix. Quantitative yield data are not available for Florida. 'Chickasaw' has better postharvest keeping quality than 'Shawnee'. For more information, refer to Clark and Moore (1999b).

'**Choctaw**' is an erect, thorny, high-yielding blackberry cultivar from the University of Arkansas. The fruit are medium in size (about 5 g) and moderately sweet in flavor. This cultivar is most noted for early ripening, small seed size, and good flavor. Consult Moore and Clark (1989a) for more information.

'**Flordagrاند**' was released in 1964 by the University of Florida for home and local markets. Flordagrاند is adapted to Central Florida, where it is evergreen in growth habit and requires a pollenizer. 'Flordagrاند' has a trailing growth habit. The berries are oblong in shape, shiny black in color, and average just over 5 g. The berries are tart in favor (high in acidity), and soluble solids average 8 °Brix. It is not often grown any longer. For more information, refer to Shoemaker et al. (1964).

'**Kiowa**' is a large-fruited, erect, thorny cultivar from the University of Arkansas breeding program. A large fruit size (> 10 g) is maintained throughout the season. It has good firmness and flavor. 'Kiowa' averages 10 °Brix. For more information, consult

Moore and Clark (1996). 'Kiowa' is now under trial at the UF NFREC–Quincy.

'**Natchez**' is an erect, thornless blackberry recently released and patented by the University of Arkansas. 'Natchez' has produced very high yields in Arkansas and is expected to supplant or replace 'Arapaho'. Average berry weight is medium to high (5–8 g). Soluble solids average 8.7 °Brix. Berries are very firm and attractive. 'Natchez' has not been tested previously in Florida, although it is currently under trial at the UF NFREC–Quincy. For more information, consult Clark and Moore (2008).

'**Navaho**' is an erect, thornless blackberry cultivar from the University of Arkansas breeding program. Yields in Arkansas are moderate to high. In Florida, yields have been 1.8 tons/acre or slightly higher than that of 'Arapaho' (Table 1). The berries are small to moderate in size (3.5–4 g) and moderately sweet in flavor (9 °Brix). Disadvantages include late ripening and a prolonged ripening period. Consult Moore and Clark (1989b) for more information. 'Navaho' is now under trial at the UF NFREC–Quincy.

'**Oklawaha**' was released by the University of Florida in 1964. It is semi-evergreen to evergreen and has a trailing growth habit. 'Oklawaha' requires trellising. It was released as a pollenizer for 'Flordagrind'. Similarly, 'Oklawaha' is self-unfruitful and requires a pollenizer. Berries are moderate in size. Soluble solids average about 8 °Brix. It is not often grown any longer. Refer to Shoemaker and Westgate (1964) for more information.

'**Ouachita**' is an erect-growing, thornless cultivar released from the University of Arkansas breeding program (Clark and Moore 2005). It is expected to do well where 'Apache', 'Arapaho', and 'Navaho' have performed well. Desirable characteristics of 'Ouachita' include consistent high yields, large fruit size, and good postharvest keeping quality. Fruit averages about 10 °Brix and is larger than that of 'Arapaho' and 'Navaho'; yields are comparable to 'Apache'. For more information, consult Clark and Moore (2005). 'Ouachita' is now under trial at the UF NFREC–Quincy.

'**Prime-Ark**' is a recently (2009) patented cultivar from the University of Arkansas breeding program. This is one of three Arkansas cultivars that fruits on current-season primocanes (denoted by the prefix "Prime"). It is erect and thorny. Yields appear to be more consistent in diverse locations than 'Prime-Jim' or 'Prime-Jan'; however, temperatures above 85°F can reduce fruit set and fruit quality on primocanes. Berries are medium large in size with an average of about 6 g. Soluble solids have been measured at 10–12 °Brix. For more information, consult Ruple et al. (2010).

'**Prime-Jan**' is a primocane-fruiting, erect, thorny cultivar that was released and patented by the University of Arkansas breeding program in 2004. Yield varies with location, and it has not been tested in Florida. There may be a fruit set problem with temperatures exceeding 85°F; therefore, it is not likely well adapted for Florida. Average berry size is 5 g with a range from 3 to 15 g. Soluble solids average 9–10 °Brix. 'Prime-Jan' is only recommended for home garden use due to erratic yields, poor postharvest keeping quality, and shipping potential. For more information, consult Clark et al. (2005).

'**Prime-Jim**' is a primocane-fruiting, thorny, erect cultivar that was released by the University of Arkansas breeding program in 2004. Yield varies with location, and it has not been tested in Florida. There may be a fruit set problem with temperatures exceeding 85°F; therefore, it is not likely well adapted for Florida. Fruit size is about 5 g but varies from 3 to 10 g. Soluble solids average 8 °Brix. 'Prime-Jim' is only recommended for home garden use due to erratic yields, poor postharvest keeping quality, and shipping potential. For more information, consult Clark et al. (2005).

'**Shawnee**' is a 1984 release from the University of Arkansas breeding program. It has a prolonged ripening period during which the fruit retain a large size throughout. This cultivar has largely been replaced by 'Choctaw,' 'Chickasaw,' and 'Kiowa'.

'**Triple Crown**' is a semi-erect, thornless blackberry that may require trellising. 'Triple Crown' is very productive with large, sweet berries. Berries are firm with a good sugar/acid balance. Ripening

date is early July. 'Triple Crown' is grown in central and northern North America. To our knowledge, 'Triple Crown' has not been tested previously in Florida, but it is currently under trial at the UF NFREC–Quincy.

'Tupi' is a thorny, semi-erect blackberry that was developed in Brazil and is the most common commercial blackberry cultivar in Mexico. In low-chilling areas of Mexico, flower bud development is promoted by chemical defoliation and application of gibberellic acid. 'Tupi' produces a large fruit with a good sugar/acid balance. 'Tupi' has not been tested previously in Florida, but is currently under trial at the UF NFREC–Quincy.

Site Selection and Site Preparation

Ideally, a prospective commercial blackberry grower should select a site with good air and water drainage. Low-lying areas should be avoided to minimize the probability of flood injury during periods of excess rainfall and frost injury to flowers and newly developing fruit. Blossoms can be injured by temperatures below 28°F. For the homeowner, site selection is often limited by availability and practicality. The site should be located conveniently to a source of water as the period of fruit ripening is often quite dry in many parts of the state. Hilltops often accord the grower improved air circulation during the growing season and can be a prime location if the soil has not been eroded by previous agricultural use.

Prior to planting, in-row strips about 5 feet wide can be treated with an herbicide such as glyphosate to kill all weeds and vegetation. In-row strips should be thoroughly disked to at least a depth of 1 foot. In some regions of the country, green manure crops are grown on the site and plowed under. Although blackberries do well in most soils, deep, well-drained soils are ideal. Blackberries perform best at a soil pH between 5.5 and 6.5. In general, to increase pH 1 unit, mix 5 lb of dolomitic lime with 100 square feet of soil. To decrease pH 1 unit, mix 1 lb of elemental sulfur with 100 square feet of soil. In addition, components of the irrigation system should be in place to provide water once the blackberries are planted. Drip irrigation, as compared to overhead

irrigation, minimizes subsequent weed control efforts, which can be a substantial portion of the labor involved in cultivating blackberries. Polyethylene mulch or landscape fabric can serve as an excellent means of weed control.

Planting and Spacing

Planting is best performed from December through February. Upon arrival, bare-root plants should be kept moist but not wet. If these plants arrive prior to the anticipated planting date, they can be stored in the refrigerator (in small quantities) or heeled in a trench (in larger quantities) to stay moist. To heel plants in, simply dig a trench and cover the roots with damp soil. During planting, do not allow the blackberry roots to dry out. Cut back the shoots to about 6 inches in length and plant to the same depth they were in the nursery. Spread the roots around the hole, but try to avoid excessive root bending. Remove air pockets by compacting the soil.

Plant spacing is cultivar dependent. In general, erect cultivars and trailing blackberries are spaced from 2 to 4 feet apart and from 3 to 5 feet apart within a row, respectively. The spacing between rows can be 10–15 feet, depending on plant vigor and farm machinery limitations.

Pollination

Blackberry fruit is borne on the current year's growth with usually 10–20 flowers per cluster. Blackberries and raspberries are an aggregate fruit with individual pistils that form drupelets. To obtain a large, well-formed berry, most of the individual pistils in an inflorescence should be pollinated. Drupelets only form around fertilized ovules. Thus, berry size for a given cultivar is dependent on the number of seeds. Inadequate pollination results in smaller or imperfect fruit since not all seeds and drupelets are formed. Blackberries range from completely self-fruitful to completely self-unfruitful. Most erect blackberries (including all the Indian-named Arkansas blackberries) are self-fruitful and do not require a pollinizer. Blackberry flowers produce nectar and pollen that attract bees, which serve as pollinators. Honey derived from blackberry flowers is reported to be light in color with good flavor.

Bloom date for most cultivars is during early March, although 'Oklawaha' and 'Flordagrاند' may bloom as early as mid-February. Bloom date tends to be earlier as one progresses farther south. Frost injury can be a problem in some locations. Open flowers can be injured by a temperature of 30°F or less. Sprinkler irrigation can be employed to reduce the risk of freeze injury.

Propagation

Leafy Stem Cuttings. This is the most feasible method to propagate large quantities of plants. Leafy stem cuttings may be propagated from the apical 4–6 inches of cane when the cane is succulent but still firm. Application of Rootone[®] to the cut stem can also improve rooting efficiency. Cuttings should be placed to a depth of 2 inches in a perlite and peat or peat and sand mixture. The cuttings should be misted, especially in the two- to four-week period before the roots are formed. It is important to promote good water drainage.

Root Cuttings. All blackberries can be propagated by root cuttings. This is the fastest method to produce new plants. Cut roots 1/4– 1/2 inch in diameter into 6-inch pieces. They can be directly planted in the new location, grown as a potted plant, or placed in a plastic bag in a refrigerator. When planted directly in the field, uneven stands often result during the first year. Potted plants can be grown in the nursery for up to one year. When planted in soil, they should be covered with 2–4 inches of soil. Planting is best accomplished during the winter. Substantial quantities of suitable roots can be had by plowing a furrow and severing the roots adjacent to the mother plant.

Suckering. The easiest and most rapid method to propagate blackberry is to utilize the suckers that naturally form from roots. Simply sever the sucker from the point of attachment with the mother plant and move it to its desired location. Removing suckers has minimal or no impact on the mother plant. Genetically thorny blackberry cultivars will remain thorny and genetically thornless blackberry cultivars will remain thornless whether propagated from stem cuttings, root cuttings, or suckers.

Tip Layering. Semi-erect or trailing blackberries can be propagated by tip layering. Tip layering sometimes occurs in nature and is a viable method for the homeowner to propagate relatively few plants. The technique is to bring first-year vegetative shoots into contact with the ground and cover the shoot under approximately 3 inches of soil. A more efficient method of tip layering is to remove the shoot apex to induce lateral branching. Next, during the summer, dig a 3-inch-deep hole that slopes toward the mother plant and vertically away from the plant. Place the terminal end of the shoot in the hole and cover the shoot with three inches of soil. By the fall, the shoots will have produced roots and the plant can be transplanted.

Fertilization

Blackberries do not require much fertilizer in most soils in North Florida. Blackberry roots are located close to the surface, and excess fertilizer can burn leaves or even kill plants. Fertilizer can be applied in an 18-inch ring surrounding a plant, or it can be applied parallel to the row 12–18 inches from the row center. Fertilization with 10-10-10 N-P-K with micronutrients is satisfactory. Do not apply fertilizer at planting in the winter; rather, wait until late spring or summer. Fertilization applied during planting may not only be injurious to the plant, but it may also be wasted since the roots are not yet sufficiently distributed in a row. During the establishment year, fertilize with about 1/4 lb per plant or up to 5 lbs per 100 feet of row. During the second year and thereafter, fertilize in the winter and in the summer (after harvest) with 1/4– 1/2 lb per plant or about 10 lbs per 100 feet of row.

Irrigation

Irrigation is a requirement for consistent blackberry production in North and North Central Florida and is most critical during the establishment year. Irrigation and weed control are the two most important cultural practices during the establishment year. Drip irrigation is preferable to overhead irrigation as drip irrigation conserves water, does not wet blackberry foliage (which can enhance disease), and does not promote excessive weed growth. Drip irrigation can be in the form of biwall tubing or 3/4

inch poly tubing either buried or on the ground surface. In the case of poly tubing, run 1 gallon per hour emitters (spaced 3–5 feet apart) for two to four hours per day. Irrigation frequency can vary from once every two days during a summer drought to not at all from November through March. Soils with a high water-holding capacity require less frequent irrigation than sandy soils. Organic mulches, such as mushroom compost mulch, pine straw, or pine bark, further enhance water conservation.

Training and Pruning

Erect or Semi-erect Blackberries. Blackberry plants are perennial plants that can live for many years. Typically, bare-root blackberry plants are 6–12 inches in length. Container-grown plants are more variable in size and stature. During the establishment year, blackberry plants produce shoots from the buds and perhaps from root suckers adjacent to the crown of the plant. The tendency for a blackberry to produce suckers and expand beyond the crown is cultivar dependent. During the first year, shoots elongate but do not produce berries. They are known as primocanes. For erect or semi-erect blackberries, it is advisable to cut the tip off primocanes after they reach a height of 30–36 inches to promote lateral branching. Especially vigorous canes or plants may benefit from two tippings. For 'Oklawaha' and 'Flordagrاند' or vigorous cultivars such as 'Brazos', tip at a longer cane length. Tipping should be performed as early as possible in the season so as to ensure that the flower bud initiation process is complete prior to the onset of dormancy. Blackberries produce fruit on canes, known as floricanes, that were formed the previous year. Cutting the tip off primocanes to promote lateral branching and enhance flower bud initiation increases yield considerably. After fruiting, floricanes dry up and die. Primocanes bear fruit the following year. It is advisable to prune out and remove all floricanes at the ground or crown level after fruiting. Ideally in a healthy blackberry stand, five to six canes should exist per foot of row, and blackberries can form a solid hedgerow. Recently, primocane-fruiting blackberry cultivars ('Prime-Jim', 'Prime-Jan', and 'Prime-Ark') have been released from the University of Arkansas. They grow like the other erect cultivars; however, the canes that emerge in spring flower in

midsummer and fruit in the fall. Although they have not been tested in Florida, they appear best adapted to cool climates.

Some growers mow the entire planting at a height of about 1 foot after harvest to invigorate blackberry plants. The major reason for mowing is to reduce insect and disease pressure by removing infected canes. It is likely that yield will be reduced the following year since the primocanes are removed with the floricanes. One possibility is to mow every three or four years or mow a percentage of the planting every year so that a yield reduction is less noticeable.

Trailing Blackberries or Dewberries. Trailing blackberries require a trellis. Otherwise, canes (and berries) tend to grow on the ground. Many trellis designs have been used by commercial blackberry growers. End posts should be 7 1/2–8 feet long, buried at least 2 feet deep, and well anchored. Interior posts may be smaller. Post spacing should be about 20 feet apart. Galvanized wire #9–#12 should be stapled loosely to the posts. One may construct a single-wire system with wire about 5 1/2 feet above the ground or a two-wire vertical system with wires 2 1/2 and 5 1/2 feet above the ground. Three-wire systems have also been used. Blackberry canes can be gradually wrapped around the wires, and/or canes can be attached to the wire with string. Alternatively, in the case of a two-wire vertical system, canes can be interwoven between the upper and lower wires. The tips of canes should be pinched off to promote lateral branching, as in the case of erect blackberries. However, with trailing blackberries, canes are generally longer (40–48 inches when they are tipped).

Production and Harvesting

Harvest seasons are cultivar and location dependent. The harvest season of most cultivars lasts about three to four weeks. 'Oklawaha' and 'Flordagrاند' ripen during April and May. 'Brazos' and the Arkansas cultivars generally ripen from mid-May through mid-July. The harvest season can be prolonged substantially by including cultivars with different ripening dates.

Blackberries are generally harvested by hand. Generally, they must be picked once or twice a week during the harvest period. They turn from red to black before they are fully ripe. Blackberries are extremely perishable and must be handled with care. Growers often pick fruit during the early morning or even at night when temperatures are low. Blackberries should be marketed immediately after picking or refrigerated at 32°F–40°F.

Quantitative yield data are very limited for blackberry plants in Florida. 'Flordagrind' and 'Oklawaha' have been reported to produce 3–8 pints per plant or 1.5–4 lbs/plant in Florida (Shoemaker and Westgate 1964; Shoemaker et al. 1964). In Texas, 'Brazos' has produced 6,500–6,800 lbs/acre (Lewis 1959). In Arkansas, the average yield of thorny cultivars ('Chickasaw', 'Choctaw', 'Shawnee', and 'Kiowa') and thornless cultivars ('Apache', 'Arapaho', and 'Navaho') has varied considerably (approximately 4,000–12,000 lbs/acre) depending on location and year.

Yield and berry characteristics of 'Arapaho' and 'Navaho' were evaluated in 1994 in a planting at the UF NFREC–Monticello (Table 1). The treatments were as follows: 1) pine bark mulch, 2) plastic mulch, 3) mushroom compost mulch, and 4) no mulch. Yield varied from 1.1 to 2.0 lbs/bush or 2,483–4,312 lbs/acre for 'Arapaho' and 1.3–2.2 lbs/bush or 2,787–4,704 lbs/acre for 'Navaho'. Thus, yields were on the low end of that reported from Arkansas. Yields were lowest for the pine bark mulch and highest for the plastic mulch treatment for both cultivars. 'Arapaho' berries were larger than 'Navaho.' In addition, 'Navaho' exhibited a reduction in berry size from first to last harvest. 'Arapaho' berries also tended to be sweeter and less acidic than 'Navaho'. Mulch treatment had no or a very slight influence on berry weight, soluble solids, pH, and titratable acidity.

Weed Control

It is extremely difficult to gain control of weed problems in a blackberry planting. Methods to control weeds in blackberry plants include mulching, cultivation, herbicides, and mowing. The yield results of a mulching trial conducted at the UF

NFREC–Monticello were discussed above. The plastic mulch treatment was the most effective in controlling weeds, followed by pine bark. Mushroom compost and bare soil treatments were equally prone to weed problems. Cultivation, whether it be by hoeing or disking, should be very shallow and no more than 2 inches in depth. Blackberry roots are very shallow and easily injured by deeper cultivation. Contact your county Extension agent concerning specific herbicides that can be applied to control weeds in blackberry plants. It is beneficial to mow grass in between blackberry rows to enhance air circulation and minimize the seeding of in-row strips.

Insects

Several insect species attack blackberries, such as the strawberry weevil, the red-necked cane borer, thrips, gall midges, stink bugs, and beetles. Some of these insects are occasional pests of blackberry and seldom require control. Control measures for insects may not be required in some regions. Contact your county Extension agent for current pesticides and rates.

Diseases

Diseases incited by different disease organisms are a common problem in blackberry. All the following diseases are caused by fungi except crown gall, which is caused by a bacterium. Consult your county Extension agent for current pesticides and rates. Sanitation and cultural control methods are described below.

Anthracnose. This disease has a very broad host range. Anthracnose appears as small, purplish lesions on canes. The lesions enlarge, and the center turns a grayish color with purplish margins. The canes may turn dark, crack, and eventually die. Cultural control includes removing and burning all infective canes as well as the floricanes after fruiting.

Leaf Spot. Leaf spot appears on the foliage as dark red spots with a whitish center. It occurs to some extent in all blackberry plants and tends to weaken the plants. Proper sanitation procedures, as mentioned above, should be followed.

Crown Gall. This disease is caused by a soilborne bacterium that results in plant tumors in the crown of the plant. It spreads by entering open wounds. When young, crown galls can resemble a russet potato in appearance, but they eventually turn dark with age. Crown gall reduces stand productivity; once a field is infected, it could stay infected for many years. Do not take cuttings from any plant that shows evidence of crown gall, and remove infected plants. Also be careful to disinfect pruning tools after use on plants where crown gall may be a factor.

Rosette (Double Blossom). Double blossom is a serious fungal disease in the southeastern United States. It infects 'Brazos' and wild blackberry. Some erect thorny cultivars developed in Arkansas are susceptible, although most thornless cultivars are resistant.

Many trailing blackberries also appear to be resistant. Double blossom disease is very distinctive. It starts as an abnormal flowering stage followed by a "witch's broom" stage in which tightly clustered shoots form in bunches. In certain plants, cutting back infected canes to the ground after harvest and burning them seems to prevent serious infection. Fungal spores on the flowers of the infected floricanes infect the buds on the vegetative primocanes. Once the fungus enters the primocane, it becomes systemic, and next-season floricanes show symptoms early in the growing season.

Orange Rust. Orange rust starts out as bright orange masses of spores on the underside of the leaves in the spring. It is systemic and can last from year to year. It is first noticeable on expanding leaves in the spring. The spores are disseminated in early to mid-spring, and they are spread great distances to adjacent canes and plants. Once plant crowns are infected, orange rust becomes systemic, and the entire plant needs to be removed. In the summer, plants appear to outgrow the infection, but that is not the case. The only solution is to remove and burn infected plants.

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Table 1. Yield and berry quality of two thornless blackberry cultivars subjected to pine bark, plastic, or mushroom compost mulch, or no mulch

	Yield per bush (lb) ^{zy}	Yield per acre (lb)	Avg berry wt ^x (g)	Soluble solids (°Brix)	pH	Titrateable acidity
'Arapaho'						
Pine bark mulch	1.14	2483	4.51	10.2	3.50	0.82
Plastic mulch	1.98	4312	4.59	9.4	3.48	0.74
Mushroom compost mulch	1.65	3594	4.53	9.4	3.50	0.88
No mulch	1.39	3027	4.20	10.5	3.49	0.82
'Navaho'						
Pine bark mulch	1.28	2787	3.85	9.1	3.26	1.06
Plastic mulch	2.16	4704	3.82	8.6	3.35	0.96
Mushroom compost mulch	1.56	3398	3.51	8.6	3.29	1.19
No mulch	1.72	3737	3.57	9.4	3.41	1.01
^z Harvest period was from 3 to 22 June for 'Arapaho' and from 16 June to 22 July for 'Navaho'.						
^y Yield was determined on 10 plants of each treatment. Plants were spaced 0.61 and 3.0 m within and between rows, respectively.						
^x Average berry weight from first to last harvest declined from 4.58 to 4.29 g for 'Arapaho' and from 4.34 to 2.31 g for 'Navaho'.						