

Growing Highbush Blueberries in Kentucky

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Blueberries are one of the few fruit crops that are native to North America. They are increasing in popularity and can be grown on selected sites in Kentucky. At present, Kentucky has a small established commercial blueberry market and an excellent potential for local sales, U-pick and home use.

Highbush (northern) *Vaccinium corymbosum* L. blueberries will do best in most parts of the state, while rabbiteye (southern) *V. ashei* Reade blueberries may do well in warm southern locations. Rabbiteye blueberries bloom 1-1.5 weeks earlier than highbush blueberries and consequently are more prone to late spring frost injury. They require an acid soil like highbush blueberries, but will tolerate higher soil pHs, heat and dryer soils better. Harvest is later than that of highbush cultivars. Since research at UK has been limited to highbush blueberries, this publication will deal only with this type. Lowbush (*V. angustifolium*) blueberries that grow wild in Maine are not adapted to Kentucky. Huckleberries *Gaylussacia* spp. have 10 seeds and are often confused with blueberries which have many small seeds.

Blueberry plants, with proper care, will remain productive as long as most fruit trees. Few pests or diseases have been reported on blueberries in Kentucky and yield per acre on mature bushes ranges from 5-11 thousand pounds (6-15 pounds per bush). Yields of 6,000 pounds per acre are considered good, but yields can be considerably higher in some years. Winter injury and spring frost damage are relatively rare on highbush blueberries in Kentucky. Consequently, the crop is rarely lost on good sites. Consider commercial production only if you have access to large amounts of organic mulching material (usually sawdust) and irrigation.

Blueberry soil requirements differ from those of most other temperate fruit crops. They thrive in a highly organic well-drained soil with a pH of 4.5-5.2. Most Kentucky soils do not meet these requirements; however, you can amend most sites to provide an environment suitable for blueberries.

Site Selection and Preparation

Blueberries have the same physical site requirements as other fruit: good air drainage and internal soil drainage. A site with good air drainage will have a higher elevation than much of the surrounding area. This will facilitate movement of heavier



Figure 1. 'Blueray' highbush blueberries ready for harvest. Note that all fruit do not ripen at the same time in the cluster.

colder air away from the planting on cold spring nights. In addition to good internal soil drainage, the soil should not compact easily. Despite what the general public believes, blueberries do not grow well in swamps or bogs, the roots must be above the water level. Soil structure can be improved if you add organic matter and use green manure crops before planting. Mulching blueberry plantings helps to maintain high organic matter.

Most soils can be amended with finely ground sulfur or aluminum sulfate to adjust the pH to the optimum 4.5-5.2. Soil samples from potential sites should be submitted through your county Extension office. Ask for the test for available calcium per acre, as well as standard soil tests. If available calcium is below 2,500 pounds per acre, the site soil can usually be effectively acidified. Table 1 shows the quantity of sulfur or aluminum sulfate needed to adjust soil pH. Sulfur, or aluminum sulfate, should be tilled into the top 2-3 inches of soil at least 60 days before planting. Retest the soil pH 60-90 days after applying sulfur to determine if you need another application. Continue to test the soil for the next several years to make sure that the pH remains in the 4.5 to 5.2 range. On some soils and in instances where the irrigation water pH is high, the soil pH will tend to increase with time.

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Table 1. Amending Soil to Reduce pH.

To lower the pH one full pH unit (e.g. from 5.5 to 4.5), incorporate either finely ground sulfur or aluminum sulfate. Sulfur is usually the least expensive material. Use the water pH value rather than the buffer pH value to determine how much sulfur or aluminum sulfate to incorporate.

Soil Texture	Sulfur lb/100 sq ft ¹	Aluminum Sulfate lb/100 sq ft ¹
Light, Sandy	0.75	4.5
Medium, Sandy Loam	1.50	9.0
Heavy, Clay Loam	2.25	13.5

¹ Since the soil's buffering capacity affects the degree to which a soil is acidified, apply the recommended amount well before planting. Then recheck the pH 60-90 days later.

Cultivar Selection

Cultivars differ as to when they ripen. If they are properly selected a continuous supply of fresh berries will be available throughout the fruiting season. Spring frost hardiness is based on cultivar floral developmental stages. Earlier maturing cultivars bloom earlier than late maturing cultivars and are consequently more prone to frost injury. Blueberries bloom about the same time as strawberries and highbush blossoms will withstand 28°F in full bloom. As a rule, berries will ripen 60-80 days after bloom. Each cultivar will normally supply fresh fruit for a 2-3 week period.

Plant at least two cultivars to assure cross pollination. Group cultivars by ripening dates so that harvest will progress in an orderly fashion. For example, 'Duke', and 'Spartan', are good early season cultivars. 'Ozarkblue', 'Sierra', 'Toro', and 'Bluecrop' are good mid-season cultivars, while 'Nelson', 'Darrow', and 'Elliott' are good late season cultivars.

Desirable fruit characteristics are, large size, light blue color, firm fruit, resistance to cracking, good keeping quality and good aroma and flavor. In addition, the tendency for fruit to remain on the plant rather than drop when ripe and a small dry fruit scar that reduces decay after harvest are desirable. See Table 2 for information on recommended cultivars.

Blueberries are one of the few crops in which the grower gains by purchasing 2-year-old plants that are 18-24 inches high. These may be bare-rooted or potted. Purchase only virus-free or virus tested plants from reputable nurseries, because several easily transmitted blueberry viruses can destroy the planting if they are brought in.

Table 2. Recommended Cultivars in Order of Ripening.

Duke: USDA 1986 release, bush vigorous, berries firm, medium size (55 to 65 berries per cup) with good color, and a small dry scar. Late blooming; very productive; ripens early (the first week of June, in western Kentucky). This variety has not performed as well in the Mammoth Cave and in the South East Kentucky areas.

Spartan: Bush vigorous, erect; fruit large (60 berries per cup), very firm, light blue, highly flavored with a dry scar. Blooms late and has some resistance to mummy berry.

Patriot: Bush upright, open-spreading, slow growing and productive; fruit are large (49-60 berries per cup), firm, with good color, good flavor when completely ripe and with a very small dry recessed scar. More tolerant of heavier soils and has some phytophthora root rot resistance.

Bluejay: Michigan release, bush very vigorous, very winter hardy, grows well on heavier soils, medium to large round firm berry (70 berries per cup), excellent flavor, loose clusters. Field resistant to shoestring virus and moderately resistant to mummy berry.

Ozarkblue: is the first release from the Arkansas blueberry breeding program and is a southern highbush variety. Plants are vigorous with upright growth that tolerates late spring frost and warm summers. Fruit is firm, large, (60 berries per cup) and attractive, and is suitable for either fresh market or U-pick. Fruit ripens in mid-season in Eastern Kentucky.

Sierra: USDA 1988 release. Bush vigorous and very productive; fruit is large (about 60 berries per cup), has excellent quality, and can be used for either processing, fresh market, or U-pick. About 80 percent of the fruit ripens from the second through the fourth week of June, in western Kentucky. (For trial)

Bluecrop: A standard midseason excellent tasting cultivar, with nearly all of its fruit ripening before July 1, in western Kentucky. Berry size is large (65 berries per cup) and this variety has performed a little better than most on soils where the pH is slightly higher than recommended in Ohio studies. Field resistant to shoestring and red ringspot virus, moderately resistant to powdery mildew and mummy berry.

Bluegold: USDA 1989 release, plants vigorous, low growing with many branches and very productive. Berries are medium in size (70 berries per cup) and have small dry scars, good color, flavor and firmness. Because of the low growing habit it is necessary to prune to force upright growth and to reduce crop load. Bushes are moderately productive, with 75 percent of the fruit ripening between the second and fourth weeks of June in western Kentucky

Toro: USDA/New Jersey Experiment Station release, 1987. Plants are vigorous, upright and productive with very large fruit (50 berries per cup), which ripens from the second week of June through the first week in July with 'Bluecrop', in western Kentucky. The fruit is firm, has excellent quality, a small dry scar and can be used for either processing, fresh market, or U-pick.

Nelson: USDA 1989 release, bush vigorous, and productive; berries similar to those of 'Spartan' in size (large...60 berries per cup), with good firmness, color, flavor and a small dry scar. A good cultivar for commercial packing and U-pick. Fruit ripens late (from second week of June through the second week in July, in western Kentucky).

Brigitta: A very productive late ripening Australian variety; the plant is upright; fruit are very attractive, very large (55-60 berries per cup), firm, sweet and have an excellent shelf life. (For trial)

Darrow: Bush erect, vigorous, productive; fruit cluster medium size; berries are very large (57 berries per cup), light blue, firm, tart until completely ripe. They have an excellent flavor when fully ripe.

Elliott: Michigan release; bush is vigorous, winter hardy and a heavy consistent producer. Berries are firm, light blue, medium sized (75 berries per cup) with a good mild flavor. One of the latest ripening cultivars. Berries store well, but are not fully ripe when they first turn blue and need to remain on the plant to develop sugars.



Figure 2. 'Spartan' highbush blueberry.



Figure 3. 'Bluejay' highbush blueberry.

Planting

Plant blueberries in early spring before growth starts or in late fall after frost. A north-south row orientation is preferred when possible so sunlight is more uniformly distributed. Plant bushes in rows far enough apart so that tractors or trucks can be driven between rows for mulching. Recommended planting distances are 10-14 feet between rows and 4-6 feet within rows. See Table 3. Do not plant vigorous cultivars, like 'Ozarkblue' closer than 5 feet apart in the row. At these spacings, plants will eventually form a hedgerow. Blueberry plants are purchased as either dormant bare root plants or as potted plants. Make planting holes several inches larger and deeper than the root system. Recent research at the University of Illinois, Urbana-Champaign has showed that blueberry plants set in deeper narrower holes produce more fruit. It is thought that plants with a deeper root system experience less drought stress. Holes can be dug using a tractor mounted auger or by hand. Plants that grew in holes that were 18 in. in diameter and 24 in. deep produced better than those that were grown in holes 24 in. in diameter and 15 in deep. We recommend using a sub-soiler or ripper to mark off the rows the fall before planting when the soil is dry. Sub-soiling helps loosen the soil and will improve internal drainage. On many heavier soils in Kentucky blueberries should be planted on a slightly raised bed (4-6 in.). This will improve drainage during wet winter months.

Table 3. Relationship between plant spacing and number of plants per acre.

Plant spacing (ft)	Plants per acre
4 x 10	1,089
4 x 12	907
4 x 14	777
5 x 10	871
5 x 12	726
5 x 14	622
6 x 10	726
6 x 12	605
6 x 14	518

Blueberries grow best on soil having a higher organic matter content than most Kentucky soils. To improve growth, mix one gallon of wet peat moss with the soil in the bottom of the hole prior to planting. One 6 cu ft bale of peat is enough for 45 plants. **Sawdust, hay or compost should not be substituted for peat moss because as these materials decompose they may stunt or kill the plants.**

Blueberries should be planted at the same depth as they grew in the nursery with roots well spread out and soil packed firmly around the roots. Broken or injured roots should be cut off of bare rooted plants before planting. Water plants thoroughly to settle the soil around the roots after planting.

Fertilization and Nutrition

Do not put fertilizer in the hole at planting since blueberries are very sensitive to fertilizer burn. Rather, adjust soil fertility based on the soil test before planting. Then sidedress at bloom and six weeks later with 0.1 lb of ammonium sulfate per plant each time. Ammonium sulfate also helps maintain an acid pH. In subsequent years, use the same timing and increase the amount of fertilizer by 0.1 lb each year until you are applying 0.3 lb. of ammonium sulfate per bush per application.

Kentucky research indicates that when nitrogen is applied as sulfur coated urea, blueberry plants yield more than when ammonium sulfate is used as the nitrogen source. Sulfur-coated urea is not as acidic as ammonium sulfate, so if it is used, check and adjust the soil pH more often. Sulfur-coated urea is more expensive than sulfur.

On sites with heavier soils and where the pH is more difficult to maintain plants can be fertilized using Osmocote Plus 15-9-12 at the rate of 2 oz per plant per month from March 1 through August 1. This material contains six trace elements and magnesium and is more expensive than the previously mentioned products. However, it will provide a more complete and continuous supply of nutrients, in situations where the mulch or a higher pH tie up nutrients that would otherwise be available to the plants.

Add additional phosphorus and potassium at the same time if soil tests indicate a need. Be careful to apply fertilizer completely around each bush, since little lateral transport of nutrients occurs from one side of the bush to the other. Thus, fertilizer applied to one side of the bush will only fertilize that side. If you use wood chips or sawdust for mulching, plants may need additional nitrogen at a rate of 0.1 lb of ammonium sulfate per plant for the first few years.

Nutritional Deficiencies—Nitrogen deficiency is characterized by uniform yellowing of the entire leaf surface. Leaves then redden and die. Symptoms are evident on older leaves first and the entire plant is stunted. This can be corrected by applying nitrogen to the soil. For rapid symptom correction a foliar spray of urea at 4-6 lb of actual N per acre can be used.

Iron deficiency or chlorosis is a very common deficiency in Kentucky. It is first exhibited by younger leaves and spreads to the entire shoot. Yellowing occurs between veins while veins stay green. Leaves may turn completely yellow, or in severe cases, reddish brown. Blueberry plants are not able to remove iron at a high soil pH. Iron is much more available at a lower soil pH. To correct iron deficiency apply an iron chelate to the soil or to the leaves. The iron chelate molecule is able to be taken up by the plant at a higher pH. The more permanent and less expensive solution is to lower the soil pH with sulfur, however this takes time.

Manganese toxicity can occur when soil pH is too low or too much acidifying material has been used. Symptoms are similar to those of iron deficiency. A foliar analysis may be needed to determine the problem.

Pollination

The blueberry flower's shape makes pollination by honeybees difficult. Bumblebees with their longer tongues tend to be more effective pollinators. They fly in colder, windier weather than honeybees, but their populations fluctuate too much from year to year to be dependable. Therefore growers must rely on honeybees and twice as many hives of bees per acre are needed as for other fruit crops, ie. 2 hives/acre.

Blueberry fruit normally contain up to 65 seeds. Some studies have shown that fruit with more seeds tend to be larger. Thus, reduced pollination may cause fewer and smaller fruit. In addition, cross pollination with a different cultivar generally increases fruit size slightly. **For proper pollination, no cultivar should be separated by more than 2 rows from a cultivar with a similar bloom or fruit maturity period.** Producing a good crop of blueberries, generally requires that 80% of the blossoms be pollinated.

Blueberries are not a good source of pollen, so honeybees prefer to work dandelions. Since bees tend to continue working the flower source that they begin working on, move the bees into the field after blueberry blossoms have begun opening, but before 25% open bloom. If bees are moved in after 25% bloom, reduced set will result, because pistils only remain receptive for 5-8 days. A rule of thumb developed in Michigan indicates that when temperatures are in the 70s and 80s°F, pollination will be adequate if you see 4-8 bees per bush.

Mulching

After planting, mulch blueberries with an organic mulch like sawdust, wood chips, pine needles, ground corn cobs or straw. Mulch may heat while it decomposes, so keep a 3-inch circle around the plant base free from mulch to prevent cambium damage. Mulch to a depth of 4-6 inches, and re-apply when it rots to a depth of 3-4 inches. Remulching will be necessary every year or two. Blueberry roots grow at the soil/mulch interface and if the mulch decomposes too much and is not replaced the roots will be exposed.

Mulch is commonly applied as a 3-4 foot wide band down the row. Producing plants are generally mulched following harvest to avoid removing blossoms and fruit during the mulching operation. Mulch increases organic matter, conserves moisture, protects shallow roots from heat and helps control weeds. Mulching moderates soil temperature fluctuations and substantially increases the growth of young plants. Unfortunately, mulch may also harbor rodents in winter. There are several preemergent and postemergent herbicides that are cleared for use on blueberries. Use a preemergent herbicide early in the spring to control germinating weed seed and a post emergent material to kill existing weeds. Consult ID-94, Midwest Commercial Small Fruit and Grape Spray Guide for current weed control materials and rates. Supplement mulching and herbicide applications with hand weeding for complete weed control.



Figure 4. Well mulched planting.

Irrigation

Blueberry roots do not have root hairs, and consequently absorb soil moisture very inefficiently. Keep soil damp, but not wet. Mature blueberries require the equivalent of 1-2 inches of rainfall every 10 days during the growing season. Insufficient moisture will reduce fruit bud formation for next year's crop.

Trickle irrigation is highly effective for growing blueberries. When trickle irrigation is used, be sure to monitor soil moisture with a tensiometer or other device to avoid over watering the plants. Blueberries can be grown without irrigation, but tests in Kentucky show that irrigation more than doubles yields. Thus, blueberry production should not be attempted on a commercial scale without irrigation. During ripening drought conditions may affect fruit flavor and reduce fruit size. Irrigate plants during dry periods so that moisture does not become limiting. Irrigation is particularly important the first year if it is dry to insure plant survival.

Leaf Scorch—Edges of leaves turn brown and roll inward. A variety of conditions can cause scorch, but in blueberries, it is frequently caused by insufficient moisture in the root zone.



Figure 5. Trickle irrigation works well on blueberries.

Pruning

Regular annual pruning is necessary to help establish plants and to develop vigorous plants that produce consistent crops of large early maturing berries. Canes that are larger than one inch in diameter at the ground use more of their energy to produce leaves at the expense of fruit production. Thus, younger vigorous canes are more efficient in fruit production. In addition, bushes with a high proportion of large canes have more internal shading and these shaded areas become net users of energy rather than producers. Pruning is also necessary to remove dead and diseased canes which if left in the field can serve as sources for additional infections.

Pruning may be done from February to bud break in the spring. Avoid pruning after bud break because many buds and flowers are rubbed off in the process. Pruning during bloom will retard bush vegetative growth.

To prune highbush blueberries correctly it is important to know the plant's flowering and fruiting characteristics. Flower buds are formed in leaf axils on the top portions of current season's growth during late summer and early fall. These will bloom and produce fruit the following summer. Each flower bud has 5-8 flowers, and six of these will usually produce fruit. Since 150 to 300 fruit equal a pound, 25 to 50 flower buds are left for each pound of fruit. The highest quality and largest berries are borne on the most vigorous wood on canes less than 1 inch in diameter at their base.

At planting, remove from $\frac{1}{3}$ to $\frac{1}{2}$ of the top of the plant to improve plant survival. Leave thicker shoots and remove all spindly wood. The only additional pruning you'll need to do the first 3 years is removing diseased or damaged limbs. Blossoms should be rubbed off the first two years. If blossoms are left on bushes the first two years in the field, plants will make little growth or be dwarfed and future yields will be reduced. Blossoms are easily removed by moving a gloved hand quickly along the limb during bloom. After the third growing season, prune the bush to an open vase shape and remove excess shoots at ground level. Leave the most vigorous largest diameter canes.

On a mature bush, begin by removing any diseased or injured wood. If two canes are rubbing against each other, remove one of the canes. Remove some of the old, least vigorous canes at ground level or cut these back to young vigorous shoots so that the bush never has canes more than 5 or 6 years old. When canes are removed, cut them as close to the ground as possible. This will eliminate stubs that decay and become a source of disease. Weak, brushy or twiggy wood, low limbs and limbs extending into the open vase should also be removed. Short branched canes that are shaded should be removed as these produce fruit that ripens late. Flower buds on thick shoots tend to open later in the spring than those on twiggy wood and are less prone to frost injury. Spreading cultivars require more pruning of low drooping branches, while erect cultivars will need more thinning in the bush center.

Up to 20% of the wood in a bush can be removed without decreasing yields. However, the number of berries will be decreased, while individual berry size is increased. If too many blossoms and fruit are left, a large crop of small berries that ripen over a long period of time will result. An ideal bush has 2-3 canes of each age up to 6 years old. Each year 2 of the oldest canes would be removed and 2 new canes allowed to develop. A mature bush should have about 20 good canes. If the cultivar has small berries, berry size may be increased by tipping the fruiting wood. Most growers don't let bushes get higher than 6 feet.



Figure 6. Blueberry flower buds are borne terminally on shoots.



Figure 7. Each flower bud contains 5-8 flowers.



Figure 8. Neglected unpruned plants that need to be rejuvenated through pruning. Note the large number of old canes and a lack of young vigorous canes.



Figure 9. Highbush blueberry following pruning. Oldest large diameter canes have been removed and vigorous one-year-old growth with large flower buds have been left. Note the large number and range in cane age arising from the ground.

Harvesting and Postharvest Handling

Highbush blueberry harvest in Kentucky begins in early June (western Kentucky) to mid-June (central and eastern Kentucky) and finishes in early August. Fruit do not ripen evenly throughout the cluster and should be picked at least once a week. Only fully mature fruit should be harvested since immature fruit are quite acidic and of poor quality.

Immature fruit have a reddish tinge, while ripe fruit are a uniform blue. Fruit do not develop their full flavor when they first become blue, but require 1 to 2 days to develop full flavor. Fruit size will continue to increase up to 35 percent after berries turn blue as water moves into the fruit. Blueberries, unlike some other small fruit, can remain on the plant for up to 10 days after ripening without a loss in size. Fruit sugar content can be as high as 15 percent when fully ripe. Fruit flavor and sugar content will not improve after harvest. Thus, the best tasting fruit are obtained if the berries are allowed to ripen fully on the plant, however the storage life is considerably shorter when berries are fully ripe. Most commercial operations consider it necessary to pick the field once per week.

Blueberry pickers should be instructed to pick all the ripe berries on the bush before proceeding to the next bush and to pick only well ripened fruit. Immature fruit should be left for subsequent harvests. Blueberries should be rolled from the cluster with the thumb into the palm of the hand. Fruit should be handled carefully and as little as possible to avoid rubbing off the bloom (the light waxy finish on the skin) and to reduce bruising that leads to decay. Harvest only when berries are dry. Hands should be placed beneath the clusters to insure that berries are not dropped. Pickers should not overfill their hands during harvest and should avoid squeezing the fruit. Cull fruit and plant debris should be kept out of the harvest containers and left in the field.

Quality control begins in the field and careful supervision of the harvest crew is very important. Pickers should be supervised and if berries are being harvested directly into pint cups one or two pints should be examined randomly in each flat. Pour the pint container into a shallow pan and examine the fruit. More rigid quality control is needed if more than six to eight percent of the fruit are of poor quality to avoid buyer complaints. It should be stressed with the workers that blueberries are eaten fresh, often without washing and that proper hand washing and sanitary procedures are required at all times.

Berries may be picked into pails or into the pint boxes in which they will be marketed. Use a shoulder or belt fastener when possible to hold the container so that both hands can be

used for harvesting. Round the box and cover it with plastic or cellophane which may be fastened with a rubber band or tape. Pulp and plastic clamshell containers are now being used extensively in many markets. Ten to 15 pickers are needed per acre for hand harvesting. If picking is good a good picker may harvest 20, 12-pt flats per day.

Following harvest blueberries should not be allowed to remain in the sun. The dark fruit heat up rapidly.

At this point decay is the primary source of berry loss. Anthracnose, gray mold and alternaria diseases are the three most common fruit decay organisms. Decay is more of a problem with fruit harvested late in the season where a large percentage of fruit are overripe.

The easiest, most effective means of retaining blueberry quality following harvest is to use refrigeration. Low temperatures slow ripening and substantially reduce decay. Blueberries keep best at 32°F and 85% relative humidity. Freshly harvested blueberries will keep for 2 weeks at 32°F, but for only 2 days at 70°F.

In Kentucky, U-pick is one of the most desirable ways to market blueberries. Customers drive to the farm, choose and harvest their fruit and often furnish their own containers. In rural areas many people are not use to eating blueberries. Consequently, better U-pick locations are near urban areas. When planning U-pick plantings, put driveways or cross walks across rows every 200 to 300 feet. Illinois data indicates that it takes roughly 450 customers to harvest an acre of blueberries and that the average customer picks 11.7 lb of berries.



Figure 10. Twelve pint blueberry flat.

Blueberry Diseases

Phytophthora root rot

Symptoms

The very fine absorbing roots turn brown to black and the larger diameter roots may also become discolored. In severely infected bushes, the entire root system may be darkened. Above ground, symptoms include chlorosis and reddening of leaves, small leaves, defoliation, stunting, branch dieback, stem and whole plant death.

Disease cycle

The fungus causing this disease is a water mold and is most active in poorly drained parts of the field and in heavy clay soils. It will survive for a long time in the soil.

Disease management

- *Site selection and water management.* Avoid heavy soils and high water tables. Grow blueberries on raised beds, if possible. Manage irrigation to avoid long periods of saturated soil.
- *Fungicides.* The soil applied fungicide mefenoxam can be applied if *Phytophthora root rot* develops. It can be applied twice per year. See the Kentucky Commercial Small Fruit and Grape Spray Guide, ID-94 for specific information.
- *Resistant varieties.* There are no resistant varieties, but Patriot and Bluecrop may tolerate infection better than others.

Mummyberry

Symptoms

Young shoots and leaves wilt, turn brown, and die, giving an appearance of frost damage. Tissue at the base of flower clusters may appear water-soaked or brown. As harvest approaches, berries that develop from infected blossoms become tan or cream-colored, shrivel into hard mummies, and shatter easily off the bushes.

Disease cycle

The fungus causing this disease, growing on fruits infected the previous year, produces spores to infect new shoots and blossoms. Disease pressure is greatest when wet weather prevails between green tip and bloom.

Disease management

Mummyberry disease is not present in all blueberry plantings, but where it has been, control measures will be needed.

- *Sanitation.* Rake or lightly till the soil beneath the bushes just prior to bud break to disturb production of the mummyberry fungus spores.
- *Fungicides.* The critical time for preventing shoot infections is between bud break and bloom, so fungicide sprays may be needed if the weather is wet then. The fungicides benomyl plus captan are registered for applications from green tip until early petal fall for shoot blight fruit infection prevention. Currently benomyl is no longer being manufactured or sold, however growers may use up their supply of this product. Fungicide use strategies will depend on early spring wetness and how much disease was present the previous year.

- *Resistant varieties.* Blueberry varieties most resistant to mummyberry include Bluejay, Burlington, Darrow, Duke, Elliott, Lateblue, Northblue and Northsky. Bluecrop, Coville, Herbert, Jersey, Rancocas, and Spartan are less resistant, and Berkeley, Bluegold, Bluehaven, Blueray, Bluetta, Collins, Earliblue, Northland, Rubel, Sierra and Weymouth are most susceptible.

Botrytis blossom and twig blight

Symptoms

Blossoms and young shoots die and turn brown from infections by the *Botrytis* fungus. On leaves and shoots, a dusty gray mass of fungus spores are produced on diseased tissue following wet or foggy weather.

Disease cycle

The *Botrytis* fungus can be found growing on dead tissues of many different types of plants during wet weather. This disease is favored by moist weather during the pre-bloom and bloom period, and by application of high rates of nitrogen fertilizer, which makes the shoots more succulent.

Disease management

- *Cultural management.* Reduce nitrogen fertilizer applications.
- *Fungicides.* Blossom and twig blight can be controlled with applications of fungicides from pink bud until petal fall, but are only needed if excessively wet or foggy weather is predicted or occurs during bloom.

Anthraco

Symptoms

The anthracnose fungus causes a decay of the berry resulting in a soft, sunken area near the calyx end of the fruit. Infected fruits may have bright pink spore masses at the blossom end. Prevalent during hot, muggy weather, the disease frequently attacks and rots fruits after harvest. Twigs may also be infected and young girdled stems may die back.

Disease cycle

The causal fungus overwinters in dead or diseased twigs and fruit spurs. Spores are released in the spring and are spread by rain and wind. Blossoms, mature fruit, and succulent tissues may become infected and in turn become sources of spores for continued infection.

Disease management

- *Cultural management.* Harvest fruit frequently. Improve air movement and sunlight penetration with good plant spacing and thinning of branches. Prune out infected shoots.
- *Fungicides.* Refer to the Kentucky Commercial Small Fruit and Grape Spray Guide, ID-94 for specific recommendations.
- *Resistant varieties.* There are no resistant varieties when weather is favorable for disease development.

Phomopsis canker and dieback

Symptoms

New shoots wilt and die back from the tips toward the crown, discoloring pith and wood. Infected individual mature canes may suddenly wilt and die in the summer while nearby canes remain healthy.

Disease cycle

This canker-producing fungus normally attacks injured or weakened plants. Blueberries with winter injury or spring frost damage are especially susceptible.

Disease management

- *Cultural management.* Plants should be maintained in a vigorous condition by using best growing practices. Provide proper soil pH and adequate water throughout the season.
- *Sanitation.* Prune out dead twigs and branches.
- *Fungicides.* There are no effective sprays for blueberry canker diseases.

Fusicoccum canker

Symptoms

When stems become infected by the *Fusicoccum* fungus, small reddish spots appear on the stems, frequently around a leaf scar near the ground. As the canker enlarges, a bull's eye pattern develops. Plant parts above the canker may suddenly wilt and die during warm, dry weather.

Disease cycle

New infections develop from spores produced by the fungus on previously infected stems. The disease appears to be more common in the northern Midwest areas.

Disease management

- *Sanitation.* Prune and burn diseased canes as they appear.
- *Resistant varieties.* Jersey, Earliblue, and Bluecrop are all very susceptible to the disease; Coville, Berkeley, Bluejay, Burlington, and Rubel are moderately susceptible; Rancocas is resistant.

Blueberry shoestring disease

Symptoms

This virus disease can cause dramatic reduction in yields. New stems of infected plants may show an elongated reddish streak while leaves are narrow, wavy, and somewhat sickle-shaped with red banding or a red-purple oak-leaf pattern. Flowers may be red-streaked and berries turn purple prematurely.

Disease management

- *Sanitation.* Remove and destroy infected plants.
- *Exclusion.* Purchase only good quality disease-free virus-indexed plants.
- *Resistant varieties.* The varieties Bluecrop, Bluejay, Darrow, and Northland are resistant, while Burlington, Earliblue, Elliott, Jersey, Rancocas, Rubel, Spartan, and Weymouth are known to be susceptible.

Blueberry stunt

Symptoms

Affected plants are dwarfed, with shortened internodes, excessively branched, low in vigor with small downward cupped leaves which turn yellow along the margins and between the veins. The yellow mottled areas turn red prematurely in late summer. Fruits on affected bushes are small, hard, lack flavor, ripen late, and remain attached to the plants longer than normal.

Disease cycle

This disease is caused by a pathogen called a phytoplasma and is spread from plant to plant via leafhoppers.

Disease management

- *Sanitation.* Remove and destroy infected plants. Take care to not dislodge leafhoppers that could vector the disease; application of insecticide before plant removal might help.
- *Exclusion.* Purchase only high quality disease-free virus-indexed plants.
- *Resistant varieties.* Bluetta, Jersey, and Weymouth are all very susceptible to the disease; Rancocas is resistant.

Chlorosis

Symptoms

Yellowing mainly between the veins of leaves on new shoots usually indicates that high soil pH has caused an iron deficiency problem.

Disease cycle

Chlorosis is not an infectious disease. Blueberries require an acid soil with a pH between 4.5 and 5.2 for best performance. Blueberries suffering iron deficiency are more likely to have chlorosis and canker disease problems because of their weakened state.

Disease management

Adjust soil pH to create an optimally acid soil.



Figure 11. Iron chlorosis on young leaves.

Blueberry Insect Management

Generally, blueberries have only a few insect pests and these pest do not commonly build up to damaging levels. For this reason, preventive insecticide sprays are usually not recommended with small commercial or home plantings. Planting should be monitored at least once per week and management decisions based on the results of monitoring.

Japanese beetle

Japanese beetle adults are attracted to blueberry bushes as well as many other hosts. They skeletonize the leaves and can end up as contaminants in the berries at harvest. The $\frac{1}{2}$ inch beetles are a distinctive green and brown color. There is a row of white tufts along the perimeter of the abdomen near the edge of the wings. Japanese beetle grubs are found in the soil where they feed on the roots of grasses. There is one generation per year.

Clean harvesting to reduce the amount of overripe and damaged fruit will help to discourage beetles from being attracted to the planting. Japanese beetle traps have been shown to be ineffective at reducing beetle numbers, and in some situations have increased the amount of damage near the traps.

Where beetle numbers are high during the mid summer, an insecticide may be needed. Sevin and malathion are labeled for Japanese beetle control on blueberries. Observe all preharvest restrictions with these pesticides.



Figure 12. Japanese beetle feed primarily on leaves, but may feed on fruit towards the end of the season.

Bagworms

Bagworm larvae can be a problem on blueberries in some years. These insects are easy to recognize as they construct a shelter for themselves from silk that they produce and leaves of the plants they feed upon. As the larvae grow, they expand the size of the bag-like shelter. Inside the bag they move around on the plants to feed on leaves and surface of fruits. The females never leave the bag, while the adult males are winged and fly in search of the females. The females deposit their eggs inside the bag where the eggs remain until the following spring. There is a single generation per year.

During the winter, the bags should be removed from the bushes and destroyed. This will eliminate the bagworm eggs and help to break their lifecycle. During the growing season, bagworms can be controlled with sprays containing *Bacillus thuringiensis*, Sevin or malathion. Observe all preharvest restrictions with these pesticides.

Plum curculio

Plum curculio is a late spring pest of blueberries. The adult females feed on and lay eggs into the developing fruits. After hatching, the larvae tunnel in and feed on the berries. Damaged berries will shrivel and fall off prematurely. The adult beetle has a mottled brown and gray color and has a long snout. The $\frac{1}{5}$ inch beetles are active primarily at night and readily drop to the ground if disturbed. There is a single generation per year.

Starting at petal fall and for the next two to three weeks watch for plum curculio and their damage to the berries. Initial damage usually begins when the nighttime low temperatures begin to exceed 60°F. Generally, when plum curculio is a problem, insecticide sprays are needed for control. Malathion can be used for plum curculio control on blueberries. Observe all preharvest restrictions with these pesticides.

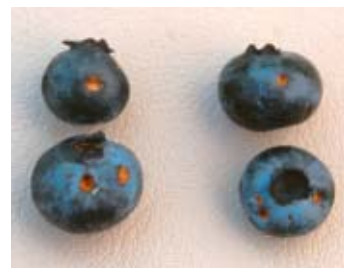


Figure 13. Plum Curculio damaged fruit.

Wildlife Management in Blueberries

A number of wildlife species can be a problem in blueberry plantings. A brief discussion of the most predominant problem species is given below.

Birds

Robins, starlings, grackles, quail and brown thrush are frequently serious pests of blueberries, particularly in small plantings.

Bird control through destructive methods is subject to state and federal laws. (Primarily trapping and poisoning). Visual repellents like hawk-like balloons, balloons with large eyes painted on them, artificial snakes and plastic streamers suspended over bushes have provided some protection. However, birds generally lose their fear of these after a short period of time.

Auditory repellents are more effective than visual repellents. These include devices that make exploding noises and electronic devices that give off bird distress calls at intervals. Exploding devices are not popular with neighbors.

The most effective method of protection is to cover plants with netting. Install it just before berries begin to ripen and remove it when harvest is completed. Some growers will permanently install 8-9 ft tall posts and overhead wires to support netting.

Deer

In areas where there are high deer populations, blueberry plantings have been damaged by browsing on foliage, twigs, buds and fruit. Deer will also damage plants by rubbing the branches with their antlers in the fall.

Mice

Watch for mouse activity around plants in fall and winter. Use poison baits for control. Avoid making excessive applications of fresh mulch.

Rabbits

Rabbits eat fruit buds and one-year-old wood. If rabbits are a problem, use Thiram or another rabbit repellent spray.



Figure 14. Mature planting with overhead support wires for bird netting.



Figure 15. Young planting with bird netting.

More details of these and other wildlife problems can be found in UK's Forestry publications, including assistance, procedures, policies, and regulations (FOR-13), coyotes (FOR-37), chipmunks (FOR-41), rabbits and voles (FOR-43), woodchucks (FOR-44), squirrels (FOR-45), snakes (FOR-46), skunks (FOR-49), white-tailed deer (FOR-57), and birds (FOR-62).