



# Establishment and Maintenance of Blueberries

Blueberries were once a small-scale crop, but they are now grown throughout the world. Highbush blueberries (*Vaccinium corymbosum*) are the primary type of commercially grown blueberry, but southern highbush (*Vaccinium* spp.) and rabbiteye (*V. virgatum*; syn. *V. ashei*) are also widely produced.

Blueberries are grown in Mississippi and throughout the southeastern United States by commercial producers for local and wholesale, fresh and processing markets. Since their commercial production began about a century ago, blueberries have become the most highly valued fruit crop grown in the region.

Blueberry plantings are relatively expensive to establish but can remain productive for a long time. To remain competitive, blueberry growers must have a clear understanding of several key factors and plan carefully when preparing to establish a blueberry planting. Careful consideration of site selection, preplant preparation, plant management, cultivar selection, pest management, harvesting, and marketing is crucial to success.

## Site Selection

### Soils

Site selection is critical to the success of a blueberry planting. Old pasture sites or farmland with a pH below 5.5 may be adapted to blueberry culture. Soil properties, terrain, and climatic factors must be considered when evaluating a site. Conduct soil fertility and irrigation water analyses when choosing a site. Blueberries grow best in well-drained, sandy soils with a pH of 4.5 to 5.5. Plants growing in soils with an improper pH will grow poorly, have nutritional deficiencies, and have higher mortality rates during establishment.

The first step is to contact your local county MSU Extension office for guidance on soil testing. The Mississippi State Soil Testing Lab performs routine and specialized soil tests for a fee. Instructions for how to collect a soil sample are available in MSU Extension [Publication 3858 Soil Testing for the Farmer](#). Soil test results will be returned with recommendations, and Extension agents can help interpret the lab results. Follow soil test recommendations to correct any inadequacies, eliminate hardpans, improve soil structure, and add organic matter to reach acceptable levels for your blueberry crop.

Blueberry plants will perform poorly in areas with large amounts of wood ash, as found where windrows were recently burned on newly cleared land. These areas have high concentrations of minerals and salts, as well as a higher pH. Consider the location of these windrows when laying out the field to reduce problem areas after planting.

Soils with a native pH above 5.5 will be more difficult to adapt for blueberry culture, so consider alternate locations. Soils with low native pH that has been limed for previous crops to achieve an artificially high pH may be lowered by adding sulfur. Incorporate the sulfur into the soil at least 6 months before planting.

Blueberries have a shallow, fibrous root system that grows best in well-drained soil with high organic matter content. These soil conditions increase the vigor and production of blueberry plants. The addition of organic matter, such as pine bark, to the soil at planting will greatly increase the productivity of the blueberry planting. Poorly drained soils will not sustain blueberry plants, but raised planting beds (8 to 12 inches high) can be used in marginally wet areas.

## Terrain and Climatic Considerations

Blueberry cultivars vary in their chilling requirements (hours below 45°F). Consider these requirements when selecting cultivars for specific geographic regions. Generally, cultivars requiring as few as 300 to 400 hours may be grown in south Mississippi, below Hattiesburg, while cultivars having requirements of 500 hours or more may be grown in more northern regions of the state. For more information on chilling hours, see MSU Extension [Publication 3067 Chilling-Hour Requirements of Fruit Crops](#). MSU Extension also has a [web-based application to track chill hours](#) during the dormant season.

Developing flower buds, blooms, and fruit of lower-chill, earlier-ripening rabbiteye and southern highbush blueberry cultivars are susceptible to late-spring freeze injury and frequently require frost protection to prevent crop loss. Low-lying areas are not suitable for blueberry production. Cold air often settles into these areas, and frost damage can occur during bloom and early fruit set, resulting in a reduced crop.

Most rabbiteye cultivars require 300 to 600 chill hours to break dormancy. Until the chilling hour requirement is achieved, an extended period of warm weather will not usually cause floral budbreak. Once the chilling hour requirement has been satisfied, extended periods of warm temperatures will initiate flower bud growth.

## Cold Damage and Mitigation

Susceptibility to cold damage in rabbiteye blueberries, the most common blueberry type in Mississippi, is directly related to the stage of development. As flower development progresses, susceptibility to damage becomes greater. Swollen, unopened flower buds can withstand temperatures as low as 21°F. If bud scales have separated from the stem (abscised) and individual flowers are distinguishable, buds are killed at 25°F. Flowers that are distinctly separated with corollas unexpanded and closed are killed at 28°F. Fully opened flowers are damaged at 29°F, and fruit are severely damaged at 30°F.

Certain cultivars are more cold-tolerant than others. This is primarily determined by the extent of floral development when a killing freeze occurs. Earlier-blooming cultivars are more prone to freeze injury because they will have the greatest number of advanced blooms.

The common method of determining if buds have frost damage is to cut through the bud several hours to a couple of days after a freeze and look for browning that indicates injured tissue. Sometimes the freeze injury is not severe enough to kill the fruit or flower completely but may affect individual parts, such as the pistil, stamen, or seeds, which may result in reduced fruit set or size. Blueberry fruit can develop and mature after a portion of the ovaries are damaged; however, because fruit size is highly correlated with seed number, fruits from damaged flowers are usually smaller.

Freeze damage also causes external scarring on the fruit, which results in reduced quality. The area of the fruit exposed to cold temperatures will desiccate, resulting in a brown necrotic ring around the calyx. Because this tissue is dead or dry, it is more brittle than surrounding tissue and may be the site of splitting during periods of wet weather during harvest. At best, it will cause a discolored ring and possibly some disfigurement of the fruit. At worst, freeze injury can promote secondary fungal infections (i.e., *Botrytis*) that can spread to and destroy healthy blooms.

Freeze protection of blueberry fields is not an exact science. It is difficult to make recommendations about freeze protection because every freeze event is different. Weather conditions, wind, temperature before the freeze, length of freeze period, and plant growth stage are a few factors that affect the success of freeze protection. Ground cover does influence temperature around the plant. A mowed cover crop is warmer than an unmowed cover crop, and clean cultivation is warmer than grass. Packed soil is warmer than loose soil, and wet soil is warmer than dry soil. A good practice is to wet the soil before freezing conditions, which can reduce the need for overhead irrigation in some situations.

Wind machines have been used successfully to protect tender blueberry blooms. Most spring freezes are radiational freezes, where there is no wind and the heat at ground level is lost to the atmosphere. Wind machines are very effective in this type of freeze. A wind machine causes air turbulence that disrupts the inversion layer by intermixing warm and cold air. Often the inversion layer of warm air is 50 to 200 feet above the surface and, if it is within reach, the wind machine will pull it down and mix it with the air in the field. Growers sometimes use helicopters to gain the same effect. The helicopter will find the inversion layer and push the warm air down and mix it with the colder surface air. The air currents mix the air and keep the warm air from escaping back into the atmosphere.

Overhead sprinkling is another effective method of frost protection when flowers are open. However, it is expensive to install and requires a large volume of water. Water volume is critical— $\frac{1}{2}$  to 1 inch of water per hour and at least one sprinkler rotation per minute are needed. Water must be constantly applied because ice is a poor insulator. The protection comes from the constant application of water, which is above 32°F, and the release of heat when the water turns into ice, which keeps the plant tissue at or above 31.5°F. The water must be constantly applied until the air temperature rises above 32°F. If the water is turned off too soon, the entire crop may be lost.

Improper use of this technique can cause more damage than if no overhead sprinkling was used. Follow these rules for overhead frost protection:

- Apply water fast enough to keep ice wet at all times.
- Apply enough water to cover the plant.
- Make sure water coverage is uniform and overlapping.
- Make sure sprinklers are close enough together (the higher the wind speed, the closer they need to be).

While specific conditions may dictate when to stop and start overhead sprinkling, run the system if temperatures less than 28°F are expected for southern highbush and less than 30°F for rabbiteye. If conditions are still (no to little wind) with high humidity, start at 33°F. With conditions of low humidity, start at 36 to 38°F. Continue to run the system until the ice begins to melt and the temperature goes above 40°F. Realistically speaking, the effective temperature range to save a crop is between 24 and 32°F. If conditions are windy, then overhead sprinkling for frost protection will not be as effective.

The most common causes of failure of overhead sprinkling for frost mitigation include poor system design, too-cold temperatures, too-windy conditions, starting the system too late, stopping the system too early, and not providing adequate water.





## Preplant Preparation

Kill perennial weeds the summer before planting by cultivating and using a systemic herbicide. Weed control during the first 2 years after planting is challenging; eliminating perennial weeds before planting greatly reduces future weed problems. Mulching is also highly beneficial to help control weeds. For more detail, see *Selecting, Handling, and Setting Plants* below.

Begin preparing the soil the summer before planting blueberries. Mark the rows off in 12-foot increments (10-foot for southern highbush, if desired) in a north-to-south orientation if possible. Pull a subsoiler down the row to eliminate a hardpan. Till or disk the soil thoroughly to kill weeds and vegetation. Tilling the rows multiple times during the summer will kill several flushes of weed seed germinations. Apply glyphosate or another suitable herbicide on emerging weeds between tillings to help eliminate stubborn perennial weeds.

Before planting in the fall, spread a layer of pine bark 2 to 4 inches deep over the prepared rows, and incorporate it into the soil with a disk or tiller. Do not use fresh sawdust or wood chips because they tie up nitrogen in the soil as they decay. After the bark is incorporated, pull the soil-bark mixture into a wide, 6- to 10-inch-high raised row with a row-making implement. This raised bed will concentrate the soil mixture into the bed for the newly planted blueberry bushes and provide superior drainage, which will protect the plant roots if any low, wet areas exist in the field.

Before planting, make sure there is an abundant source of irrigation water on-site with no sodium, low calcium, and favorable levels of other minerals. Irrigation water can come from wells or ponds with proper filtration. See the *Plant Management* section below for more discussion on irrigation after planting.

## Selecting, Handling, and Setting Plants

Purchase healthy plants from a reputable nursery. Consult other growers for recommendations. Blueberry plants for commercial use are usually purchased as 2-year-old plants (plants that have grown through two growing seasons). Blueberry plants are available in containers or as bare-root plants. Buy containerized plants in 1-gallon or larger containers.

Water the plants when they arrive and keep them moist until they are planted. If plants are still in the containers when freezing weather occurs, saturate the root media in the containers before each hard freeze. This will protect the roots from freeze damage.

When planting containerized plants, make sure the plants are not root-bound. If the roots have grown to the edge of the container and begun growing around the perimeter of the root ball, they often continue growing in this pattern and do not grow out into the soil after planting. When planting, break the root ball up with your fingers or use a knife to make multiple vertical slashes. This will reorient the roots and encourage them to grow into the surrounding soil.

If purchasing bare-root plants, make sure the roots are moist when they arrive and do not let them dry out. Blueberry roots are naturally brown on the outside and white on the inside. Plant bare-root plants immediately. If they cannot be planted right away, heel them in (bury the roots in soil) to keep the roots moist until they can be planted. Bare-root plants must be handled properly because the roots are more vulnerable to drying out and the plants have less root volume than containerized plants.

Before planting, prune the plants back, removing about half of the top. This will remove most of the flower buds and balance the top and root of the plant. If conditions are favorable, the plant will produce vigorous vegetative growth the first season and no fruit. This will result in a larger plant in the fall and more fruit the second year. Remove flowers and fruit if any do develop during the first season.

Rabbiteye blueberry plants should be spaced 5 feet apart in rows 12 feet apart. This will require 726 plants per acre. Southern highbush blueberry plants are smaller and grow slower, so they are typically spaced 4 feet apart in rows spaced 10 feet apart. This spacing requires 1,089 plants per acre. Use the following formula to calculate how many plants are needed per acre for other spacings:

# of plants per acre = 43,560 sq ft per acre / (desired plant spacing in feet × desired row spacing in feet)

Plant blueberry bushes during the dormant season, which is November through February in Mississippi. It is generally best to plant before the end of December because this gives the plant more time to establish roots before spring arrives, allowing it to get off to a better start when growth begins.

After the beds are formed, install the irrigation system and set the plants. You can slightly bury the irrigation system to prevent it from being exposed to sunlight, to reduce expansion and contraction due to fluctuating temperatures, and to hide it from chewing animals. Alternatively, lay the irrigation system on the soil surface and bury it in a heavy mulch layer after planting.

Set the plants into the soil in the center of the bed, being careful not to plant too deeply. The root ball should be at the soil surface line. If the soil settles around the stem of the plant 1 to 2 inches deep, or more, it will struggle for a few years and then die. Many blueberry plants have died from being set too deeply at the time of planting.

When the bushes are planted and the irrigation is installed, turn on the irrigation system and make sure it is working uniformly across the entire field. When the irrigation system is working properly and the bushes are set correctly, apply a layer of mulch over the planting bed.

Mulching with organic materials, such as pine bark, pine needles, leaves, or hay is very beneficial. Mulch helps control weeds and helps keep soil cool, loose, and uniformly moist. Mulch should be 4 to 6 inches deep and cover a 4-foot band centered on the plant row. Replenish the mulch as it deteriorates. Deteriorating mulch adds organic matter to the soil and creates a favorable environment for root growth, but it can cause root exposure if not replenished.

## Plant Management

### Plant Nutrition

Fertilizer is usually applied to blueberries in the spring when growth begins and again immediately after harvest. The exception to this is when the fertilizer is injected into the irrigation system, in which case it is done on a weekly basis during the growing season (except during harvest).

Blueberry plants are very sensitive to readily soluble fertilizers, and excessive amounts can cause plant injury or death. Higher than recommended rates can cause brown, necrotic margins or pale-yellow chlorosis of leaves and low vigor, particularly where too little water is applied.

Do not concentrate fertilizer in a small area around plants, but rather broadcast or apply as a band several inches from the base. Do not use nitrate forms of fertilizer. Ammonium sulfate is the most often-used nitrogen source. Avoid ammonium nitrate and other nitrate-containing fertilizers because nitrate ions are very damaging to blueberries. Blueberries also respond well to fertilizers containing urea and diammonium phosphate, and to slow-release nitrogen fertilizers. Urea nitrogen and organic forms, such

as cottonseed meal, convert to ammonium, making them acceptable nitrogen fertilizer sources. Ammonium sulfate has an acidic reaction with the soil. However, continual use of ammonium sulfate may reduce the soil pH below the desired range of 4.5 to 5.5. Urea nitrogen is less acid-forming than ammonium sulfate. If the soil pH is below 5, the urea form of nitrogen is preferred. If the pH is above 5, ammonium sulfate can be used.

Mature plants (6 years old or 6 feet tall) should be at the peak fertilizer rate. If applying fertilizer with a spreader, try to place most of the material in the row area to reduce weed growth and maximize fertilizer use by the blueberry plant. As a general recommendation, apply 30 pounds per acre of actual nitrogen in the spring as a complete fertilizer (e.g., 214 pounds of 14-8-8 per acre or 300 pounds of 10-10-10 per acre), plus 30 pounds of actual nitrogen per acre after harvest as urea (66 pounds per acre) or ammonium sulfate (142 pounds per acre). If growth is excessive (more than 12 to 14 inches of new growth per year), reduce the amount of nitrogen to 30 pounds per acre per year.

**Table 1** gives a program for fertilizing blueberries at various stages of maturity.

**Table 1. Blueberry fertilization with 10-10-10, 14-8-8, ammonium sulfate, or urea.**

Age of plant in field	Amount of fertilizer per plant per application*			
	10-10-10 (spring)	14-8-8 (spring)	Ammonium sulfate (summer)	Urea (summer)
2nd year or 2 feet tall	2.0 oz	1.7 oz	1.2 oz	.56 oz
3rd year or 3 feet tall	3.0 oz	2.6 oz	1.8 oz	.85 oz
4th year or 4 feet tall	4.0 oz	3.4 oz	2.3 oz	1.1 oz
5th year or 5 feet tall	5.5 oz	4.3 oz	2.9 oz	1.5 oz
6th year and older	7.0 oz	5.7 oz	3.9 oz	2.0 oz

\*Evenly placed in a circle 18 inches in diameter centered on the plant.

### Liquid Fertilizer

Fertilizer may be applied in liquid form through the irrigation system (fertigation) rather than surface applying dry granular material.

There are some advantages to fertigation:

- The fertilizer is more efficiently used.
- It may be applied weekly in small amounts so that it is more available when the plant needs it.
- The application cost is considerably less.
- The nutrients more quickly reach the root zone in a soluble form.

There are also some disadvantages:

- Irregular growth and damage to plants is possible if the irrigation system is not working properly.
- Specialized equipment must be added to the irrigation system.
- Soluble fertilizer is more expensive than granular fertilizer.

The irrigation system must be functioning properly, and all plants must receive the same amount of water. If water distribution is erratic, some plants may not get enough fertilizer while others get too much. On sloping ground, use pressure-compensating emitters to ensure that plants in the low areas do not receive more water than those on higher ground. Consult an irrigation expert if needed.

Regulate water pressure so it is within the boundaries of the emitters, and make sure the flow rate through the pressure regulators is adequate to supply the area being irrigated. It is important to have a backflow valve in the main irrigation line—this is a legal requirement in many cases. This will prevent fertilizer solution from being sucked back into the well, community water system, or other water source in the event of a power failure.

After applying liquid fertilizer, follow up with a proper and regular watering program. Proper irrigation will allow the fertilizer to stay in solution until the plant has taken it up. If the fertilizer solution dries in the soil, the fertilizer within the solution becomes more concentrated and can become toxic if additional water is not applied. Regular watering between fertilizer applications helps wash the solution deeper into the root zone and encourages a larger, deeper, healthier root system.

Since liquid fertilizer is more efficiently placed and is more readily available throughout the growing season, it is easy to force more growth than is needed. Most fruit is borne on the last 8 to 10 inches of the previous year's growth. More than 12 to 14 inches of growth is excessive. During the first 4 or 5 years, rapid growth is desired. However, if the plant grows too rapidly during the early years, it may become tall and leggy with only a small amount of fruiting wood.

**Table 2. Amount of liquid nitrogen for blueberry fertilization.**

Age of plant	Pounds of actual N/acre annually	Pounds of actual N/acre/week (25 applications)	Total soluble fertilizer (lb/acre/week)					
			% nitrogen in fertilizer					
			10%	15%	20%	25%	30%	35%
1 year	10	.4	4	2.7	2	1.6	1.4	1.2
2 years	20	.8	8	5.3	4	3.2	2.7	2.3
3 years	30	1.2	12	8.0	6	4.8	4.0	3.4
4 years	40	1.6	16	10.7	8	6.4	5.3	4.6
5 years and up	50	2.0	20	13.3	10	8.0	6.7	5.7

### Irrigation

Mature blueberry plants require 1 to 2 inches of water per week for optimum plant performance. Upland soils in the Gulf States region are well drained but have low water-holding capacity. Short periods without rain can severely stress blueberry plants. Applying water through irrigation is essential to maintaining good plant health. Add organic matter to the planting bed at the time of planting and apply surface mulch to help maintain a uniformly moist soil in the root zone.

The rapid decrease in soil moisture during dry periods on nonirrigated plantings increases the concentration of fertilizer nutrients in the soil solution, which may damage plants. Irrigation lowers the concentration of nutrients in the soil solution and reduces the risk of fertilizer damage.

Apply liquid fertilizer to blueberries by incorporating it into the watering program once per week. Run irrigation water for 1 hour to fill the irrigation system and moisten the soil at the root zone. Then introduce the recommended amount of fertilizer solution into the irrigation water for 1 or 2 hours, followed by fresh water for 1 hour. This method will allow the system to fill with water and moisten the ground, apply the fertilizer, flush salts from the system, and wash the nutrients into the root zone.

An injector pump is the easiest and most reliable method for introducing fertilizer into the system. Most pumps will inject a certain amount of solution per hour. If you know this ratio, it is easy to apply a recommended amount of fertilizer with the system.

Fertilizer rates are based on the age of the plants. **Table 2** indicates the total annual nitrogen recommended for blueberries in the first 5 years after establishment. The nitrogen rate is broken down into a weekly application rate, which will allow 25 applications beginning in early March and ending in late August. Discontinue fertilizer applications during harvest and resume after harvest. Stopping the fertilization program in August will allow most of the fertilizer in the soil to be used by the plant before it enters dormancy.

The most efficient method of irrigation is a drip (trickle) system. Use a water source from a well, pond, or lake. If using water from a lake or pond, you must use a filtration system to prevent debris from plugging the drip emitters. In-line swimming pool filters that use a sand medium have given excellent results. Filter well water if it contains sand or grit that could plug the system.

A drip system operates on low water pressure and consists of polyethylene tubing laid down the row, buried in the soil or under the mulch, with emitters formed into the tubing or plugged into it at specific intervals. A calculated amount of water is discharged on the soil surface beneath each plant. Water requirements increase as plants increase in size and age, but also during the growing season, with higher demand when the crop is present on the bush and during hot, dry



conditions. The drip system operates under low pressure and requires less water for a given area than an overhead system, thereby increasing the efficiency of the pump. Contact an irrigation specialist for advice on setting up an irrigation system.

## Pruning

Compared to other fruit crops, blueberries require little pruning during the first few years of establishment. Pruning consists mainly of removing the lower twiggy growth, dead or damaged shoots, and weaker growth. To stop excessive upward growth and to encourage branching, remove the tops of vigorous shoots that emerge. Maintain the base of the plants by removing all shoots growing outside a 12-inch crown within the row. The objective is to keep the plants properly shaped and of a size that fits a particular harvesting method. If the fruit will be mechanically harvested, the plants should be narrow at the base with excess suckers removed.

Prune blueberry plants immediately after harvest but no later than the first of August. The plant must have time after pruning to produce new wood and have it mature enough to develop fruit buds for the next spring's crop. The earlier in the summer pruning is done, the more time the plant has to produce wood and set fruit buds.

The primary reason for pruning blueberries is to control and maintain the size of the plant and to encourage wood renewal. Studies have shown that reducing fruiting buds does not result in an appreciable increase in the size of the remaining fruit. This means that the goal should be to maximize the amount of fruiting wood while maintaining a plant size that conforms to a particular harvesting method. As plants begin to get out of bounds, shear (prune) them to reduce their size and encourage new growth and fruiting wood. To accommodate further growth, shear plants to about 10 to 12 inches shorter than their ideal size. Depending on the vigor and rate of growth, this pruning may not be necessary every year.

Beginning the fifth or sixth year, as the plants become mature, remove older wood within the plant as it loses vigor. This encourages new growth within the plant and directs the plant's energies into more vigorous canes. Selective cane removal involves removing one to three of the oldest canes each year. This cut should be made low in the plant or as close to the ground as practical. The objective is to remove 10 to 20 percent of the wood annually, so the plant is renewed in 5 to 7 years. This pruning is often done after harvest following the shearing operation, but it may be done during the winter when the workload is reduced and the structure of the plant is more easily visible.

Plants allowed to grow with little or no pruning will eventually become overgrown, and the fruiting wood will become concentrated in the top of the plant, out of reach of hand or mechanical harvesters. Prune these plants to reduce the size of the plant and encourage fruiting wood lower in the plant. In most cases, the best pruning method for these plants is a rejuvenation prune, which involves cutting the plants to about 12 to 24 inches tall and allowing them to reestablish themselves with new wood (**Figure 1**). As this new wood grows, you may need to tip the new sprouts to encourage

branching. This procedure seems drastic, but the plant will grow back with more vigor and will produce more fruit than in its overgrown state.

Plants that have been pruned regularly for several years may have restricted fruiting wood; these plants also can benefit from a rejuvenation prune. Since the plant is being reduced drastically in size, it will not produce the fruit quantity of a mature bush the following year. But it will regrow quickly and be back into production the second year. For this reason, do not prune all bushes in one year. Growers sometimes take advantage of a year when the crop is lost to a freeze to prune heavily in April or May and allow renewal growth during the summer.

## Propagation

It is possible to propagate blueberries, but commercial plantings should start with purchased nursery-grown plants. While propagation is less expensive, there are several downsides to this method. It is only appropriate when a specific cultivar or plant is unavailable in the nursery trade. *As a reminder, it is illegal to propagate patented cultivars even for your own use.*

Blueberries usually are propagated from softwood or hardwood cuttings selected from healthy, disease-free mother plants. Propagation beds need to be well-drained and under a shade cloth (40 to 70 percent shade) and have adequate ventilation. Avoid excessive wind movement that may interfere with mist coverage.

A propagation medium that retains moisture well but allows aeration is necessary. Media containing various propagation mixtures of coarse sand, ground pine bark, perlite, sawdust, and peat moss have proven satisfactory. A good rooting medium recipe is a mixture of coarse sand, ground pine bark, and peat moss (1:1:1) or perlite and peat moss (1:1).



**Figure 1.** A renovation cut after harvest can help rejuvenate an old, unproductive blueberry bush. E. T. Stafne

The mist system should keep the media uniformly moist but not soggy. You should be able to squeeze only a few drops of water from a handful of media. An intermittent-mist system will keep the humidity around the cutting near 100 percent to prevent wilting and keep the medium moist. Starting with a porous medium that holds moisture well, adjust the mist intervals to maintain turgid (not wilted) leaves and high humidity. Use frequent (every 2 to 10 minutes), short (2 to 10 seconds) misting intervals.

Take softwood cuttings (4 to 5 inches long) in late spring from the tips of the current season's growth on the upper part of the mother plant. Collect these when stems have developed woody tissue but are still somewhat flexible and terminal leaves are half-grown to almost mature. Cuttings taken too early (terminal leaves very succulent and stems very flexible) wilt readily. Cuttings taken too late (mature leaves and second flush of growth initiated) root poorly. Rooting usually is more successful when you get cuttings from the first flush of spring growth. However, you can collect cuttings from growth flushes occurring later in the growing season.

Use sharp, clean pruning shears or knives disinfected in a solution of one part household bleach to five parts water to make cuts. Remove lower leaves, leaving two or three terminal leaves. Don't allow cuttings to dry; keep them moist and cool after collection. Place cuttings in the propagation bed, under mist, as soon as possible at a depth of one-half to two-thirds their length.

Take hardwood cuttings during the dormant season after sufficient chilling has occurred, usually late January through February. Collect strong, healthy shoots (called "whips"; usually 12 to 36 inches long) that grew the previous summer. Divide these "whips" into sections 5 to 6 inches long with a sharp knife or a bench saw with a fine blade. If the terminal of the shoot contains flower buds, remove the flower buds or discard the tip.

Insert cuttings into the propagation medium at a depth of one-half to two-thirds their length with one shoot bud exposed. Keep the propagation beds moist, but be careful not to use too much water. You can water hardwood cuttings with a sprinkler until they leaf out, then mist-water them while in leaf but not yet rooted.

After cuttings are rooted, apply a dilute complete liquid fertilizer weekly. Plants can remain in the propagation bed until winter, when you should transplant them into pots or nursery beds and hold them for 1 year. The plants should be large enough for field planting the next winter.

## *Cultivar Selection*

Both rabbiteye and southern highbush types of blueberries can be grown in Mississippi. The rabbiteyes are native to the region and are generally more vigorous, more productive, and easier to grow than other types of blueberries. Currently, rabbiteye blueberries are grown on about 90 to 95 percent of Mississippi's blueberry acreage.

Rabbiteye blueberry cultivars ripen from mid-May or early June to late July in much of Mississippi. They grow well on acidic soils (pH 4.5 to 5.5) with relatively low organic matter (1 to 2 percent) and on soil types ranging from sands to loams to sandy clay loams.

Conversely, southern highbush blueberries require more well-drained soils with high organic matter content (3 percent or greater) or soils that have been amended with pine bark. Southern highbush cultivars ripen earlier than rabbiteyes (late April through late May in south Mississippi), and although they are riskier to grow, they provide growers with lucrative prices for earlier-season, fresh-market blueberries.

The main advantage to growing rabbiteye blueberries is that, with good management practices, rabbiteye bushes grow vigorously and are long-lived. Well-managed plantings yield as much as 6,000 to 10,000 pounds of berries per acre. With some exceptions, the fruit of rabbiteye blueberries is firmer than that of southern highbush blueberries and have a very good shelf life. These qualities also make them quite suitable for mechanical harvesting.

Blueberry cultivars of both types vary in their degrees of self-fertility, and it is generally necessary to plant two or more cultivars having similar bloom periods to assure good cross-pollination, higher fruit set, and earlier berry ripening. To improve cross-pollination and optimize fruit set, plant a minimum of two cultivars with similar chilling requirements and bloom periods in an alternating row pattern in each field (A-B-A-B or B-A-A-B-A-A-B or A-B-B-A-A-B-B-A). Establishing and promoting native bee populations requires additional effort and expense. You may want to rent domestic honeybees or bumblebees to achieve optimum pollination and fruit set.

In Mississippi, the ripening period of the early-maturing rabbiteye blueberry cultivars is later than that of most southern highbush blueberry cultivars, but it is still sufficiently early to allow participation in the more profitable fresh market, which currently extends from early to mid-May to early July. Commercial rabbiteye blueberry growers primarily grow the early-ripening rabbiteye cultivars to compete for premium prices. As northern highbush blueberries enter the market from states like New Jersey and Michigan, fresh rabbiteye blueberry prices fall, and the late crop is sold to the less profitable process market. Exceptions might include niche local-fresh markets, organically grown, or pick-your-own.

Production of southern highbush blueberries in Mississippi is for the early fresh market, and acreage is still limited. Since southern highbush blueberry cultivars vary in adaptation, vigor, and longevity, and site requirements differ significantly from that of the rabbiteye blueberry, successful production has been challenging in Mississippi.

Universities and USDA-ARS have conducted research defining and refining production practices required to grow southern highbush blueberries in the southeastern United States. As growers continue to adjust their management practices, more educated answers will emerge regarding southern highbush blueberry cultivar performance in Mississippi growing conditions.

Early to mid-season southern highbush cultivars offer growers the greatest opportunity to participate in the earliest fresh berry markets, which are the most lucrative. Mid- to late-season cultivars ripen along with the early rabbiteye cultivars and compete with the more productive, easier to manage rabbiteye cultivars. Thus, the advantage of being



among the earliest berries to market diminishes. However, because of their excellent fruit qualities, these later-ripening southern highbush cultivars may be suitable for some local fresh markets, pick-your-own operations, and home gardens.

Southern highbush blueberries give Mississippi blueberry growers enhanced opportunities to participate in the lucrative early fresh blueberry market. Southern highbush cultivars result from crosses between the northern highbush blueberry (which in comparison has a shorter bloom-to-ripening interval than rabbiteyes) and native wild southern species to transfer traits that provide greater adaptation to southern growing conditions.

Southern highbush blueberries are generally less vigorous and more difficult to grow, so they have different establishment requirements than rabbiteye blueberries. Cultivar longevity with good management practices may be 10 or more years before pest problems, soil organic matter depletion, and other issues result in declining plant health and mortality. Keep in mind that replanting southern highbush plants will likely be necessary as bushes decline.

Blooms of southern highbush cultivars are generally more self-fertile than rabbiteye blueberries, but cultivars having similar chilling requirements and bloom periods should be interplanted to achieve optimum pollination and fruit set and earlier harvest. Southern highbush cultivars generally having a winter chilling requirement of 400 hours or more are best adapted to Mississippi's climate. Those having lower requirements bloom very early and are susceptible to late-spring freeze injury. These types are more viable closer to the Gulf Coast. Cultivars having greater chilling requirements (500 to 600 hours) have a reduced possibility of late-spring frost injury but may have growth and production problems in areas that do not receive enough chilling.

### Rabbiteye Blueberry Cultivars

**Note:** Performance information for several newer blueberry cultivars in Mississippi is limited. Information on their performance was obtained from regional blueberry production trials from other universities in the southern region. The following rabbiteye blueberry cultivars are listed in approximate increasing levels of chilling requirement.

**Prince**—Chilling requirement, 300 to 400 hours. Normally blooms 3 to 5 days before Climax. In south Mississippi, ripens late May to early June. The plant is very productive, displays vigorous growth, and has a spreading growth habit. The fruit are medium size and have good color, firmness, flavor, and a dry picking scar. Rainfall during ripening may result in physiological splitting. Due to the early bloom period, Prince should be grown only in the coastal region and may require frost protection to prevent injury from late-spring freezes. Released by USDA-ARS in 2008; public.

**Savory**—Chilling requirement, 300 to 400 hours. Blooms with Climax. In south Mississippi, ripens late May to early June. Savory plants are productive and have a vigorous, upright growth habit. Savory produces large, light-blue berries with good scar, firmness, and flavor. Savory is susceptible to fungal diseases including *Gleosporium* leaf-spot and powdery mildew, which can be controlled with

fungicides. Savory may require winter pruning to prevent overcropping. Because of the early bloom period, Savory should be grown only in the coastal region and may require frost protection to prevent injury from late-spring freezes. Released by University of Florida (UFL) in 2003; patented.

**Brightwell**—Chilling requirement, 350 to 400 hours. In south Mississippi, ripens early June to early July. Plants are productive, vigorous, and upright. Berries are medium to large size with small, dry stem scars and good color, firmness, and flavor. Mature fruit are susceptible to physiological splitting under wet conditions. Brightwell is subject to over-cropping and reduced return blooms if the bushes are not given good postharvest care and management. *Septoria* and *Gleosporium* leaf spot diseases can be a problem on some sites, and postharvest fungicide applications may be necessary to aid in leaf retention. Jointly released by the University of Georgia (UGA) and USDA-ARS in 1983; public.

**Climax**—Chilling requirement, 400 to 450 hours. In south Mississippi, ripens late May to early June. Climax blooms and small fruit may require frost protection to prevent injury from late-spring freezes. Plants are productive, upright, and open. Berries of Climax are small to medium size with good color, good flavor, and small, dry scars. Fruit firmness is excellent. Climax has a poor cropping history due to late-spring freeze damage and poor leafing. As a result, popularity is declining among many growers. Released jointly by UGA and USDA-ARS in 1974; public.

**Krewer**—Chilling requirement, 400-450 hours. Very large fruit with high yield potential. Good plant vigor. Somewhat susceptible to splitting. Fruit scar good. Complementary cultivar to Titan. Released by UGA in 2014; patented.

**Austin**—Chilling requirement, 450 to 500 hours. Blooms 5 to 7 days after Climax. In south Mississippi, ripens early to mid-June. Plants are very productive, moderately vigorous, and have an upright growth habit. Berries are medium to large with good color, stem scar, and flavor. Fruit firmness is less than Climax. Austin produces large seed, which is sometimes considered objectionable. Released by UGA and USDA-ARS in 1996; public.

**Alapaha**—Chilling requirement, 450 to 550 hours. Blooms 7 to 10 days after Climax. In south Mississippi, ripens late May to early June, about the same time as Climax. Plants of Alapaha are productive, vigorous, and upright with narrow crowns. Berries are medium size and have good color, firmness, and flavor and small, dry scars. In some conditions, fruit size has been smaller than expected. Alapaha is a potential replacement for Climax. Released jointly by UGA and USDA-ARS in 2001; patented.

**Vernon**—Chilling requirement, 500 to 550 hours. Blooms 7 to 10 days after Climax. In south Mississippi, ripens with Climax and Premier. Vernon plants are productive, vigorous, and moderately spreading. Berries are large and have very good color, firmness, and flavor and a dry picking scar. Vernon is a potential replacement for Climax or Premier. Released jointly by UGA and USDA-ARS in 2004; patented.



**Premier**—Chilling requirement, 500 to 550 hours. In south Mississippi, ripens late May to early June with or before Climax. Premier plants are productive and vigorous and have an upright growth habit. Berries are medium to large with good color, stem scar, and flavor. Berries left hanging too long become too soft for the fresh market. Young canes may be too limber for heavy fruit loads, and some pruning is required. Fruit set on Premier is often less than expected due to malformed flowers, which may result in greater susceptibility to frost injury and insect feeding. Premier has been reported to tolerate soils with a higher pH than other rabbiteye blueberry cultivars. Considered susceptible to Septoria leaf spot. Released jointly by North Carolina State University (NCSU) and USDA-ARS in 1978; public.

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**Titan**—Chilling requirement, 500 to 550 hours. Plants are vigorous and upright and have narrow crowns. Flowering occurs in mid- to late March. It is a highly productive bush. Berries tend to be very large with good color and a medium dry scar; they are firm and flavorful. Fruit is subject to rain-induced splitting. Ripening time is mid-June to early July. Effective pollinizer cultivars include Premier, Brightwell, and Vernon. Released by UGA in 2010; patented.

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**Montgomery**—Chilling requirement, 550 hours. In south Mississippi, ripens late May to mid-June, overlapping with Premier. Plants are very productive, moderately vigorous, and have a semi-upright growth habit. Berry size is medium to large. Berries have very good color, picking scar, fruit firmness, and flavor. Released by NCSU in 1997; public.

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**Onslow**—Chilling requirement, 500 to 600 hours. Ripens about the same time as Powderblue. Plants are productive, vigorous, and have an upright growth habit. Onslow has fairly broad soil adaptation and can tolerate soils having a somewhat higher pH than many other rabbiteye cultivars. Berries are large with medium-blue color, dry picking scars, very good firmness, and aromatic flavor when fully ripe. Fruit may be either hand or mechanically harvested, are resistant to cracking, and have good postharvest fruit quality. Blooms of Onslow are self-fertile, but pollination may enhance size and quality. Onslow is recommended for commercial production, pick-your-own, and local markets. Released by NCSU in 2001; patented.

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**Bluesfest**—Chilling requirement, 500 to 600 hours. Ripens late June to early July, over a period of about 3 weeks. Plants are moderately vigorous and spreading and have adequate cane renewal. The bush may sucker under heavy mulching. Flowering is roughly the same time as Powderblue. Productivity of the bush is medium to high. Berries are medium to large, exceptionally light blue, very firm, and have very good flavor when fully ripe. They have relatively small picking scars. Berries should remain on the plant at least 7 days after turning light blue to obtain optimum sugar content. Effective pollinizer cultivars are Brightwell, Tifblue, Ochlockonee, and DeSoto. Released by USDA-ARS in 2014; public.

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**Yadkin**—Chilling requirement, 500 to 600 hours. Ripens late June to late July. Plants are moderately vigorous, productive, and have a semi-upright growth habit. Berries are medium

size, medium to dark blue, and have excellent picking scar, firmness, and flavor. Fruit can be hand or mechanically harvested, are resistant to cracking, and have good postharvest quality. Blooms are self-fertile. Due to relatively dark blue fruit color, Yadkin is mainly recommended for homeowners rather than commercial production. Released by NCSU in 1997; public.

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**Powderblue**—Chilling requirement, 550 to 600 hours. In south Mississippi, ripens late June to late July. Plants are productive and have an upright, spreading growth habit. Berries are medium size with a very light blue color; small, dry stem scars; and average firmness and flavor. Fruit are less susceptible to cracking and hang on the bush better than Tifblue. Appearance, quality, and season are similar enough to Tifblue that the two can be harvested together and used as pollinizers for each other. Other suggested pollinizers include Brightwell, Columbus, Ira, and Ochlockonee. Released jointly by NCSU and USDA-ARS in 1978; public.

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**Columbus**—Chilling requirement, 600 hours. Blooms and ripens just ahead of Tifblue. Plants are very productive, vigorous, and have a semi-upright to upright growth habit. Berries are large with excellent color and average picking scar. Berry firmness is about the same as Premier. Due to the large berry size, fruit should only be hand harvested. Berries are resistant to rain-related cracking and have a good shelf life. Released by NCSU in 2002; patented.

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**Ira**—Chilling requirement, 600 hours. Blooms several days after Tifblue. In south Mississippi, ripening occurs mid-June to July. Blooms are relatively self-fertile. Plants are productive, vigorous, have an upright growth habit, and can tolerate higher-pH soils. In North Carolina, Ira has been outstanding for cropping over a wide range of environments. Berries are medium size and medium blue color; they have an excellent picking scar, good firmness, and aromatic flavor. Ira may be hand or machine harvested. Berries are resistant to fruit cracking during wet periods and have a good postharvest shelf life. Released by NCSU in 1997; public.

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**DeSoto**—Chilling requirement, 600 to 650 hours. In south Mississippi, ripens mid-July to mid-August. Plants perform best on well-drained soils, are productive and moderately vigorous, and have a moderately upright growth habit. Berries are medium size and have very good color, picking scars, firmness, and flavor. Berries can be hand or mechanically harvested, are resistant to cracking, and have good postharvest quality. DeSoto can be grown commercially for local fresh or pick-your-own markets. Released by USDA-ARS in 2004; public.

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**Tifblue**—Chilling requirement 600 to 700 hours. Blooms in mid- to late March in south Mississippi and ripens late June to July. Tifblue plants are productive and have a vigorous, upright growth habit. Fruit are small to medium with good color, picking scar, firmness, and flavor. Cane numbers can be excessive, and frequent pruning may be required to prepare Tifblue plants for mechanical harvesting. Tifblue was once the favored cultivar for the commercial rabbiteye industry because of its high yields and vigorous growth. However, newer, early-ripening cultivars with larger, high-

quality fruit that don't split during wet weather have replaced it as a commercial cultivar. It is susceptible to stem blight. Tifblue still remains the standard to which other cultivars are compared, so references to Tifblue are common in literature and grower discussions. Released by UGA and USDA-ARS in 1955; public.

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**Ochlockonee**—Chilling requirement, 650 to 700 hours. In south Mississippi, blooms with Tifblue and ripens early to late July (about 5 to 7 days after Tifblue). Plants are very productive and vigorous with an upright growth habit. Berries are medium to large and have good color; small, dry picking scars; good firmness; and good flavor. Fruit can be hand or mechanically harvested, are resistant to cracking, and have good postharvest quality. Ochlockonee can be grown commercially and for pick-your-own and local fresh markets. Released jointly by UGA and USDA-ARS in 2002; patented.

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### Southern Highbush Cultivars

**Emerald**—Chilling requirement, 200 to 300 hours. Berries are large to very large and moderately firm. Emerald berries maintain good size throughout the harvest season if bushes are well cross-pollinated and crop is not excessive. Berry color is medium to dark blue. Berry shape is wider than tall. Emerald is a vigorous, upright-spreading bush. Spring leaf development is good. Flower bud production is medium to heavy and has high yield potential. Susceptible to rust, moderately tolerant of bacterial leaf scorch, and resistant to stem blight. Fruit clusters are tight and do not ripen uniformly, making it more difficult to hand-pick. Harvest season can be long. Needs cross-pollination with another cultivar with similar chilling requirement. Released from UFL in 1999; public.

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**Jewel**—Chilling requirement, 250 hours. Blooms extremely early in the spring. Fruit size medium to large with excellent stem scar and firmness. Flavor is good, slightly tart. Berry color is medium blue. Moderately vigorous, upright, high yielding, with a spreading bush habit. Produces large numbers of flower buds, but still develops leaves well in the spring. Highly susceptible to rust. Likely needs a good freeze protection system. Cross-pollination with other cultivars is suggested. Released by UFL in 1998; public.

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**Farthing**—Chilling requirement, 300 hours. Vigorous, compact growth habit and many branches. Flowers abundantly with heavy crop loads. Has a protracted harvest season. Berry size usually medium but can be larger if crops are light. Berry firmness is exceptional with a crisp texture. Scar and flavor are good. Berry color is darker than most. Stem end of berry may remain red or purple when plants are carrying heavy crops or in tunnel production. Farthing is moderately tolerant of bacterial leaf scorch. Can be successfully harvested using machines under commercial production. Released by the UFL in 2007; patented.

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**Santa Fe**—Chilling requirement, about 350 hours. Blooms sufficiently early to require frost protection. Ripens early to late May. Plants are productive, vigorous, and have an upright growth habit. Berries are blue to dark blue and medium to large. Excellent scar, firmness, and flavor. Somewhat

difficult to propagate; best results are obtained with very soft softwood cuttings. Released by UFL in 1999; public.

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**Suziblue**—Chilling requirement, 400 hours. Flowers and ripens early. Grows vigorously with a semi-spreading growth habit. Large, firm, sweet berries. Plants are high yielding. Tight clusters may limit early harvesting with machine. Released by UGA in 2009; patented.

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**Windsor**—Chilling requirement, 400 hours. Blooms in early March in south Mississippi; frost protection may be required. Ripens in early to late April to early May. Plants are very productive and have excellent vigor with a semi-spreading growth habit. Very large fruit with good color, firmness, and flavor. Picking scar size may vary on younger plants, but older plants have medium picking scars. Berry skins may tear upon picking; morning harvesting can help prevent this. Good resistance to leaf spot diseases but only fair to moderate root rot and stem blight resistance. Not self-fertile; plant in alternate rows with other southern highbush blueberry cultivars having similar bloom periods, such as Star, Santa Fe, and Rebel. Released by UFL in 2000; patented.

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**Gumbo**—Chilling requirement, about 400 hours. Plants are productive, vigorous, and have an upright growth habit. Flowering occurs about 1 week after Santa Fe (mid- to late March). Berries are medium size with good color, firmness, and flavor and small picking scars. Fruit ripens in late May. Released by USDA-ARS in 2018; patented.

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**Palmetto**—Chilling requirement, 400 to 450 hours. Blooms early March and ripens early to late May in south Mississippi. Plants are productive, vigorous, and have an open, spreading growth habit with narrow crowns. Berries are small to medium size with medium color, good scar and firmness, and mild flavor. Released jointly by UGA and USDA-ARS in 2003; patented.

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**Pearl**—Chilling requirement, about 450 hours. Plants grow in an upright and spreading habit with narrow crowns. Flowering occurs mid- to late March. Moderately productive. Berries are very large and light blue with a small, dry picking scar; excellent firmness and flavor. Very attractive, firm berry that presents in clusters for easy harvest. Berries ripen late May to early June. Effective pollinizer cultivars include Dixieblue, Santa Fe, Star, and Rebel. Released by USDA-ARS in 2012; public.

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**Star**—Chilling requirement, 400 to 500 hours. Blooms sufficiently early to require frost protection. In south Mississippi, ripens late April to mid-May. Plants are productive, moderately vigorous, and have an upright-spreading growth habit. Berries are large to very large with good color, flavor, and medium firmness. Berries may exhibit physiological splitting in wet weather. Susceptible to Septoria leaf spot and moderately susceptible to bacterial leaf scorch, but resistant to stem blight. Star should only be grown in the coastal region. Released by UFL in 1996; public.

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**Southern Belle**—Chilling requirement, 400 to 500 hours. Blooms later than Star, but frost protection should be

available in case of spring freezes. Productive, moderately vigorous, intermediate growth habit; produce numerous canes, forming a dense, wide bush. Berries are medium blue and large to very large with very good scar, firmness, and flavor. Susceptible to *Phytophthora* root rot; grow only on well-drained sites. Released by UFL in 2002; patented.

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**Rebel**—Chilling requirement, 400 to 500 hours. In south Mississippi, blooms and ripens 3 to 4 days before Star. Frost protection is recommended. Plants are productive and vigorous; spreading growth habit with medium crown. Highly susceptible to bacterial leaf scorch. Berries are large and medium to light blue. Small, dry picking scars and good firmness, but relatively bland flavor. Some stemming may occur at harvest. Released by UGA in 2006; patented.

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**O'Neal**—Chilling requirement, 400 to 500 hours. Ripens late April to mid- to late May in south Mississippi. Plants are moderately vigorous but only moderately productive and have a semi-upright growth habit. Berry size and color is medium with good picking scar, firmness, and flavor. Moderately susceptible to bacterial leaf scorch, susceptible to stem blight, but resistant to stem canker. Begins blooming early and has an extended bloom period, making it a desirable pollinizer for other southern highbush cultivars; it is recommended primarily for this purpose throughout Mississippi. Released by NCSU in 1987; public.

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**Camellia**—Chilling requirement, 450 to 500 hours. Ripens early to mid-May in south Mississippi. Plants are vigorous with strong cane growth and open, upright growth habit with narrow crowns. Berries are large and have good firmness, picking scar, and flavor. Released by UGA in 2005; patented.

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**Gupton**—Chilling requirement, 500 hours. Blooms and ripens about 7 to 10 days after Star in south Mississippi (early to late May). Bloom period usually sufficiently late to avoid late-spring freeze injury. Plants are productive and vigorous; have an open, upright growth habit with narrow crowns; and have good longevity. Berries are medium to large and light blue; have small, dry stem scars; and have very good firmness and flavor. Berries are resistant to physiological cracking and have good postharvest quality. Plant with other early- to midseason-blooming southern highbush cultivars to achieve good pollination and fruit set. Released by USDA-ARS in 2005; public.

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**Dixieblue**—Chilling requirement, 500 hours. Ripens about 10 days after Star in south Mississippi. Plants are productive and moderately vigorous; have an upright, spreading growth habit with narrow crowns; and have good longevity. Berry size is medium to large with a relatively unique flat shape and good color, picking scar, firmness, and flavor. Mature berries show few signs of cracking during wet weather. Very good postharvest fruit quality. Released by USDA-ARS in 2005; public.

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**New Hanover**—Chilling requirement, 500 to 600 hours. Ripens early to mid-May in south Mississippi. Plants are very productive and vigorous and have a semi-upright growth habit. Berries are large to very large and have very good color, firmness, and flavor and average picking scars. Fruit should

be hand harvested. Very good postharvest fruit quality. Blooms are highly self-fertile, reducing the need for pollinizer cultivars. Released by NCSU in 2007; patented.

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**Legacy**—Chilling requirement, 500 to 600 hours. Fruit are medium to large, moderately firm, and have good stem scar and flavor. Bush is upright and productive. Blooms early and produces large yields over a long harvest period. Suitable for mechanical harvest. Has some resistance to mummy berry but is susceptible to stem blight. Released by USDA-ARS (New Jersey) in 1993; public.

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**Bladen**—Chilling requirement, 600 hours. Ripens in south Mississippi in mid-May, several days before O'Neal. Bushes are upright and moderately vigorous with a moderately spreading canopy. Berries are small to medium with good color, picking scar, firmness, and flavor. Berries are resistant to cracking in wet weather and may be suitable for mechanical harvest. Small fruit size may limit the speed of hand picking. Recommended for central to northern Mississippi. Released by NCSU in 1998; public.

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**Carteret**—Chilling requirement, 500 to 700 hours. Ripens early to late May in south Mississippi. Plants are very productive and vigorous, have an upright growth habit, and have broad soil adaptation. Berries are small to medium with excellent color, picking scar, and flavor. Good postharvest fruit quality. Firmness is sufficient for machine harvest for the fresh market if berries are not allowed to get overripe. Highly self-fertile, reducing the need for pollinizers. Released by NCSU in 2007; patented.

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**Pamlico**—Chilling requirement, 600 to 800 hours. Ripens early to late May in south Mississippi. Plants are productive and vigorous with a semi-upright growth habit. Good resistance to stem blight. Berries are small with good color, picking scar, firmness, flavor, and postharvest quality. Berries may be hand or machine harvested. Blooms are highly self-fertile, reducing the need for pollinizer cultivars. Released by NCSU in 2003; patented.

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**Lenoir**—Chilling requirement, 600 to 800 hours. Ripens mid-May to early June in south Mississippi. Plants are productive and vigorous and have a semi-upright growth habit. Berries are medium size with medium blue color and have a very good picking scar, firmness, and flavor. Berries are suitable for both hand and mechanical harvest and have very good postharvest quality. Lenoir is not self-fertile and requires interplantings of other relatively late-blooming southern highbush cultivars to achieve optimum pollination and fruit set. Released by NCSU in 2003; patented.

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**Ozarkblue**—Chilling requirement, 800 to 1,000 hours. Best suited for north Mississippi. Fruit quality including stem scar, color, firmness, and flavor are high. Fruit are large with moderate yields and a long harvest period. Ozarkblue is late-blooming so may avoid some frost injury. Plants are semi-upright and vigorous. Heavy crop loads can lead to long, spindly canes. Reportedly drought resistant. Some susceptibility to *Botryosphaeria* stem blight (dieback). Released by University of Arkansas in 1996; public.

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**Note:** While the listed cultivars have been shown to work in some areas of Mississippi, not all have been extensively tested around the state. There are likely other cultivars that will perform sufficiently in Mississippi. Several recent southern highbush releases from the University of Florida with higher chilling requirements (Indigocrisp, Keecrisp, Magnus, Optimus, Patrecia, Sweetcrisp, and Wayne) have not been fully tested but may have potential in south Mississippi. Similarly, some releases from the University of Georgia (Georgia Dawn, Miss Alice Mae, Miss Jackie, Miss Lilly, and Southern Splendour) may have potential in south Mississippi. Pay close attention to chill hour data and align that with the growing location when choosing a cultivar. Many cultivars can be grown successfully, but there are differences, sometimes substantial, between those grown for large-scale commercial production done via hand harvest and machine harvest and those for pick-your-own or local sales. Consult with your local county Extension agent for more specific recommendations.

## Integrated Pest Management

Integrated pest management (IPM) includes using good cultural management methods, such as cultivar selection, accurate identification of insects/diseases, and biological and chemical management methods. Scouting for pests in the field and appropriate use of pheromone traps is an essential part of IPM. To fully implement IPM principles, you must know the primary pests that attack the crop, understand their life cycles, and make decisions based on economic impacts. Sometimes the best option is to do nothing.

The following section covers the major diseases and insect pests that impact blueberries in Mississippi. For complete information on how to implement an

effective IPM program, see the most recent edition of the [Southeast Regional Blueberry Integrated Management Guide](#) or consult your local Extension agent.

## Disease Management

### Common Diseases

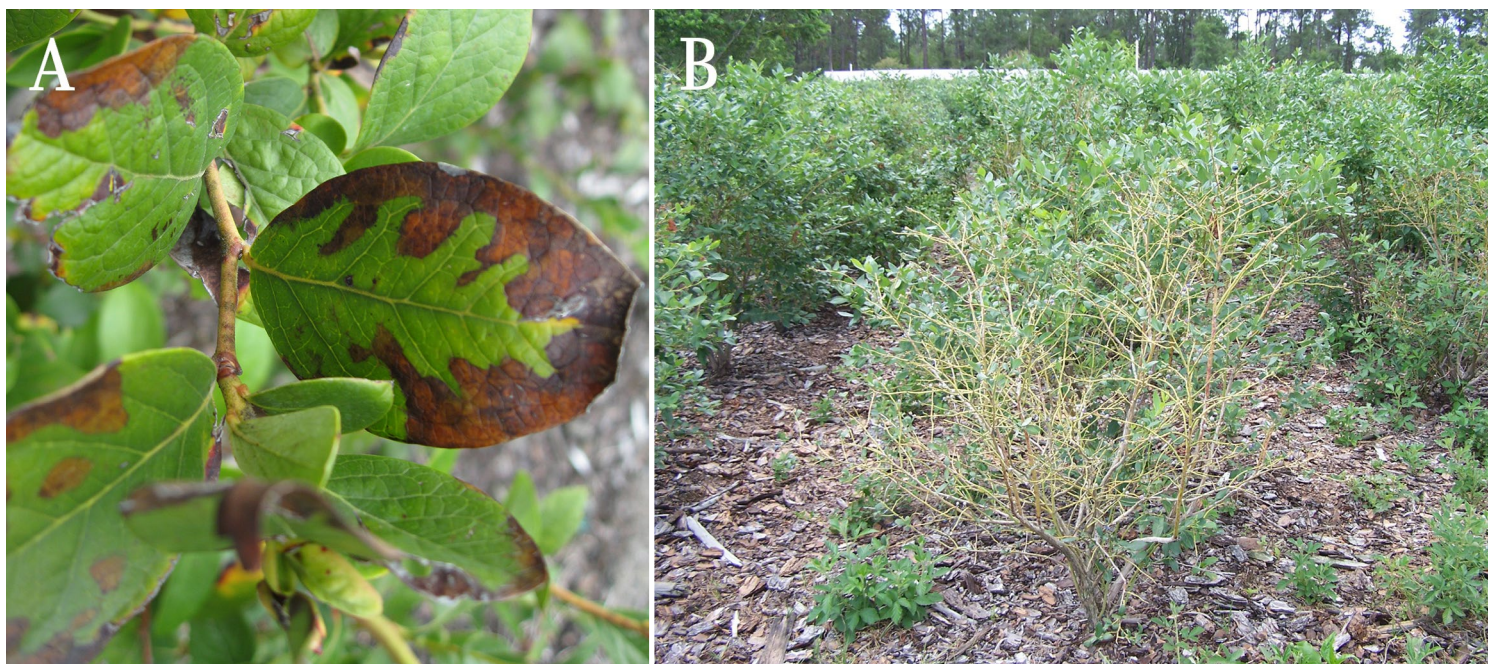
#### Anthracnose Fruit Rot (Ripe Rot) (*Colletotrichum acutatum* and *C. gloeosporioides*)

This fungal disease is one of the most economically important diseases of blueberries. While symptoms can include blossom blight, shoot tip blight, and leaf spots, the most common and damaging symptom is fruit rot. Fruit are susceptible to infection at all stages, including during bloom. Infected berries may shrivel on plants but may remain symptomless until they ripen; symptoms can even appear after harvest, when the blossom-end of berries may become soft and sunken. Under favorable environmental conditions, fungal growth may be visible on berries as salmon-colored masses.

The fungus overwinters in infected bud scales, twigs, and fruit pedicels. During fruiting, splashing water from rains or overhead irrigation promotes the spread of spores from overwintering sites or infected fruits. Tissue wetness is required for infection, so losses will be more severe following prolonged periods of warm, wet weather during bloom and before harvest. Susceptibility varies among species and cultivars. To manage ripe rot, apply appropriate fungicides beginning at bloom and continuing through cover sprays on susceptible cultivars. Harvest fruit often and as it ripens, and use rapid post-harvest cooling to inhibit post-harvest rot.

#### Bacterial Leaf Scorch (*Xylella fastidiosa*)

This disease is caused by a bacterium. It can affect both southern highbush and rabbiteye blueberries, but it is much more problematic in southern highbush blueberries. Cultivars also vary greatly in their susceptibility to this disease. Symptoms of bacterial leaf scorch include a marginal leaf scorch that may be present throughout the plant or only a few branches, defoliation (leaf drop), yellowing of stems, and eventually plant death (**Figure 2**). The



**Figure 2.** Symptoms of bacterial leaf scorch in blueberry plants include leaf scorching (A) and stem yellowing (B). P. Brannen, University of Georgia



pathogen is transmitted by various xylem-feeding insects (e.g., sharpshooters). There are no chemical management methods for the pathogen. Use of resistant/tolerant cultivars is critical to effective management in areas with a high likelihood of infection. Remove and destroy infected plants as soon as possible. Do not take cuttings from infected plants. Managing potential insect vectors may help delay disease spread.

#### **Botryosphaeria Stem Blight and Stem Canker (*Botryosphaeria dothidea* and *B. cortices*)**

Symptoms of *Botryosphaeria* stem blight typically begin on one or more branches as a yellowing and reddening or drying of the leaves followed by rapid wilting and eventual death of the entire plant. Flagging, in which affected leaves remain attached to a dead branch, is common. Wood of infected stems also has a light brown discoloration extending down the stem. The stem blight fungus largely infects plants through wounds that may be caused by mechanical injury from equipment, including mechanical harvesters, from pruning wounds, by cold injury, or by other pathogens.

Symptoms of *Botryosphaeria* stem canker begin as small, red lesions on tender stems that develop slowly into larger cankers that may girdle and kill stems (**Figure 3**). Symptoms of stem canker can vary depending on cultivar and blueberry type. The stem canker fungus infects only the current season's growth. Fungicides are typically not effective in managing these diseases. Plant resistant cultivars where these diseases, particularly stem blight, are a problem. Some southern highbush cultivars are classified as being resistant to stem blight and stem canker and others determined to be susceptible; however, many are unknown. Remove and destroy infected branches and stems 6 to 8 inches below diseased wood. If necessary, remove and destroy entire plants. Pruning dead or diseased tissue can be done at any time; however, pruning in the winter may help to reduce disease development since pruning creates wounds that may serve as entry points for the pathogen. Try to avoid wounding plants with farm equipment.



**Figure 3.** Small, red lesions develop on tender stems of blueberry plants infected with the *Botryosphaeria* stem canker pathogen. G. Holmes, Strawberry Center, Cal Poly San Luis Obispo, Bugwood.org

#### **Botrytis Blight and Fruit Rot (*Botrytis cinerea*)**

*Botrytis* blight, sometimes called gray mold, is a fungal disease. The biggest losses occur when flowers are infected, but leaves, twigs, and fruit may also be infected. This disease can be a major problem when rainy weather occurs during bloom. Freezing temperatures that damage susceptible tissues, especially blooms, may predispose damaged tissues to infection. Infected tissues generally turn brown and die. Disease symptoms may be confused with freeze damage. However, if *Botrytis* is present, fuzzy fungal growth will commonly be visible on infected plant tissues. Fruit rot can occur after berries are harvested (during storage). Cultural practices that increase air circulation through the plant canopy and promote drying can help reduce disease development. Removing dead tissues and plant debris from plants and plantings can also help reduce disease. It may be necessary to apply labeled fungicides during bloom, particularly when freezing temperatures have occurred, or during fruit development to prevent fruit infection and rot.

#### **Exobasidium Fruit and Leaf Spot (*Exobasidium maculosum*)**

This disease is caused by a fungus that infects leaves, fruits, and shoots. On leaves, light green, circular spots develop on the upper surface of leaves, and white fungal mats opposite these spots develop on the lower surface of leaves. Over time, these spots will become brown and necrotic. On fruits, light green, circular spots develop and remain green even when berries ripen (**Figure 4**). The pathogen may also cause cankers on young shoots that lead to girdling of the shoot. *Exobasidium* leaf spot appears to be most prevalent in fields with poor airflow and high humidity, often near riparian areas or ponds.



**Figure 4.** Fruits affected by *Exobasidium* fruit spot develop light green, circular spots that remain green—even when berries ripen. P. Brannen, University of Georgia

Fields that are surrounded by trees, have a prevalence of morning fog/dew, and are in low spots are most susceptible. Exobasidium can cause significant losses because diseased fruit are not marketable, and it can be very difficult to separate diseased fruit from healthy fruit in sorting lines because the diseased area is heavier and settles on that side. Late-season leaf flushes do not develop infections. Disease is most severe in the interior of the plant canopy, so pruning to improve air circulation and sunlight penetration into the canopy may help reduce disease. While there may be some host tolerance or resistance to the disease, resistance has not yet been investigated. Fungicides applied during late dormancy may have the greatest efficacy in managing this disease, but follow-up applications during the growing season may also be needed.

#### **Mummy Berry (*Monilinia vaccinii-corymbosi*)**

Mummy berry is one of the most potentially devastating blueberry diseases. Symptoms of this fungal disease include shoot blight, flower cluster blight, and fruit mummification. Infected fruits typically remain symptomless on the outside but become pinkish to white, shriveled, and hard as they ripen (**Figure 5**). Mummified fruit eventually drop to the ground and serve as a source of pathogen inoculum for the following season. A 1-inch layer of fresh mulch can cover mummified fruit under the plants and prevent the mushroom that is produced from reaching the surface and subsequently releasing spores into the air. Mechanical harvesters can carry mummified berries to new sites. Thoroughly clean harvesters that have been in mummy berry-infested fields before moving them into new fields. Apply fungicides from green tip or first bloom (whichever occurs first) and throughout bloom development to manage mummy berry.



**Figure 5.** Blueberry fruits with mummy berry disease become pinkish to white, shriveled, and hard as they ripen. *University of Georgia Plant Pathology, University of Georgia, Bugwood.org*

#### **Phytophthora Root Rot (*Phytophthora cinnamomi*)**

Blueberries do not tolerate poorly drained soils, making them susceptible to this disease. Rabbiteye cultivars are less susceptible than southern highbush cultivars. The pathogen is present in the soil and attacks small roots; from there, it can infect main roots and, finally, the crown of the plant. Symptoms are initially seen on aboveground plant parts as leaf yellowing or reddening followed by defoliation, stunting, lack of new growth, and eventually plant death. Discoloration, lesions, and rot develop on roots. Site selection and site preparation are the most important factors in managing this disease. Do not plant in areas that have poorly drained soils. Plant on raised beds to improve drainage. Avoid overwatering. Some fungicides may provide relief but do not substitute for proper site selection.

#### **Septoria Leaf Spot (*Septoria albopunctata*)**

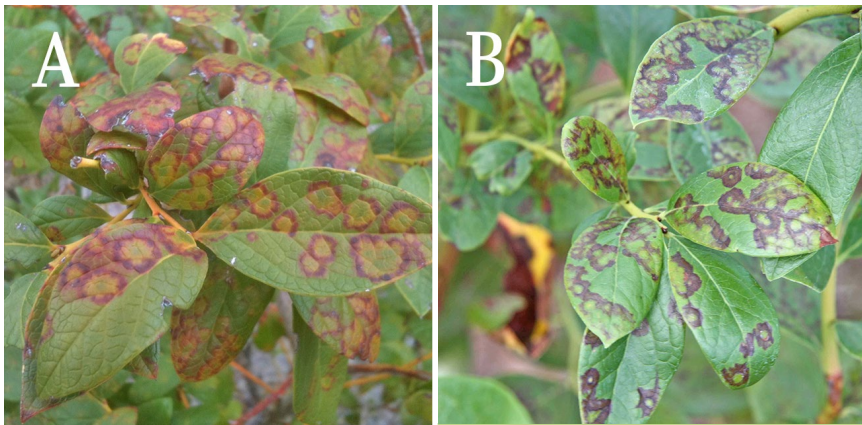
This disease is caused by a fungus that overwinters in leaf debris and infected stems. When the pathogen is present and environmental conditions are favorable, small, grayish-white lesions (spots) with purple borders develop on leaves. Similar lesions may also develop on stems. Leaf spots develop in early May and then can increase rapidly throughout the growing season. The fungus overwinters in leaf debris and infected stems. Cultivars vary in their susceptibility to this disease.

#### **Viruses**

Virus infections in blueberries have been identified in some regions but have not been widespread in Mississippi. Some of the identified viruses within the southeast region include blueberry latent virus, blueberry mosaic associated virus, blueberry necrotic ring blotch virus (BNRBV), and blueberry red ringspot (BRRV). (**Figures 6 and 7**). Symptoms vary depending on the virus but may include necrotic or red ring spots with green centers on leaves and stems and a mosaic/mottle (bright yellow/green to pink/red) on leaves. Some virus infections do not produce symptoms. There is no cure once a plant contracts a virus. Virus management in plants will vary greatly depending on the specific virus.

To date, most viruses found in southeastern blueberry production are relatively benign. For example, BRRV does not cause major issues in blueberries and does not spread readily from plant to plant, and BNRBV, a non-systemic virus that is commonly observed on specific southern





**Figure 6.** Ringspot symptoms of blueberry red ringspot virus (A) and blueberry necrotic ring blotch virus (B) on blueberry leaves. (A) P. Brannen, University of Georgia; (B) P. Harmon, University of Florida IFAS



**Figure 7.** A mosaic on leaves is common in blueberry plants infected with blueberry mosaic associated virus. N. Gauthier, University of Kentucky

highbush cultivars, can cause substantial yield losses in one year due to defoliation but may not be observed the following year. You don't necessarily have to take action if these viruses develop, but it is important to prevent introducing them into new areas. Some viruses introduced from other regions may require the immediate destruction of infected plants. If you observe virus symptoms in blueberry plantings, immediately contact your local county Extension agent or specialist. In general, to avoid introducing viruses into a new or existing planting, only purchase plants that have been inspected for viruses.

#### Other Foliar Diseases

Other foliar diseases not described in this publication, such as *Alternaria* leaf spot, leaf rust, and powdery mildew, may also occur. Make preventive fungicide applications for leaf spot diseases to maintain plant health and productivity. Leaf rust and powdery mildew are usually not problematic; however, outbreaks may occur from time to time that require management. While not as immediately impactful as fruit diseases, severe infections of leaf diseases can lead to reduced plant productivity via loss of leaf photosynthesis.

#### After Harvest

While the focus of disease management during the season is geared toward successful crop production, blueberry plants continue to be susceptible to some diseases after harvest. Fungicide applications may be needed during this time to manage various foliar, dieback, and root rot diseases to keep the plants in good condition going into the next season. The number of fungicide applications needed depends on disease pressure, weather conditions, and cultural practices.

#### Other Considerations for Disease Management

Scout fields frequently for the presence of diseases and obtain an accurate diagnosis for each disease in the field. Some cultural management methods may be effective for some diseases but not others. Some fungicides may be more effective against certain diseases than others. When using fungicides, good spray coverage is important. Water-sensitive spray cards are very helpful in determining spray coverage at various times throughout the season. Make sure you use enough water at each application to completely cover the foliage. This will usually range from 50 to 100 gallons per acre depending on plant size. Adjust spray volume as the season progresses to ensure adequate coverage throughout the plant.

Growers applying fungicides and implementing a fungicide spray program for disease management should practice fungicide rotation. This practice, based on the Fungicide Resistance Action Committee (FRAC) groupings of each fungicide, helps prevent resistance issues and ensure the longevity of these disease management tools. See the latest edition of the [Southeast Regional Blueberry Integrated Management Guide](#) for more information on fungicide efficacy and rotation. When using fungicides, be sure to completely read and follow the label. The label is the law. Also, make sure the products are labeled for use in Mississippi. See MSU Extension [Publication 3155 Pesticide Label Databases](#) for additional information regarding pesticide registrations.

## Insect Control

This guide can help blueberry producers in Mississippi and neighboring states develop integrated controls for insect pests on their farms. Please be aware that, although fungicides can be used during bloom, insecticides should not be applied during bloom unless there is a strong need to do so. In rare cases where insecticides must be applied during bloom, use only products that have minimal impact on pollinators. Because native bee species are key pollinators of blueberries, the adverse effects of insecticides on pollinator populations may not be felt right away and may take several years to manifest. Growers who routinely apply insecticides during bloom, even at night, will kill bees, which can cause a gradual decline in native pollinator populations. Fortunately, few insect pests require control during bloom, and insecticides that have low impact on pollinators are available for use against these pests.

### Common Insect Pests

#### Azalea Caterpillar (*Datana major*)

This pest can defoliate bushes in a short amount of time but is often not noticed until the damage has already occurred. There are generally one to two generations per year from July through October. They are easy to control when they are small. Apply appropriate insecticides if infestations are large enough to create economic damage or defoliation.

#### Bagworms (*Thyridopteryx ephemeraeformis*)

Remove any small, brown bagworm cases from plant stems and leaves, and destroy the bags promptly. Severe outbreaks of this pest usually become evident later in the season as mature, heavily skeletonized leaves begin turning brown. Widespread infestations may require insecticide applications.

#### Blueberry Bud Weevils (*Anthonomus musculus*)

Blueberry bud weevils (also called cranberry weevils) usually emerge in May and feed on leaf buds during the summer and fall. The only known natural enemy of the blueberry bud weevil is a tiny parasitic wasp, which keeps weevils from becoming a severe pest of rabbiteye and southern highbush blueberries. However, recent farm surveys have identified a higher than expected number of weevils in Mississippi fields. These small beetles commonly leave their winter hosts (wild blueberry bushes) and enter fields when blueberry buds swell in late February and early March. Adults are dark reddish-brown, one-eighth of an inch long, with heads shaped into a long, curved snout. Adults bite deeply into leaf buds, often preventing them from opening. Adult weevil injury to leaf buds will cause abnormally dwarfed foliage on bushes as well

as small, irregular holes within necrotic lesions along the midrib. Often, weevil leaf damage is masked by feeding damage from other pests such as leafrollers and leafeaters. Female weevils lay their eggs in unopened flowers as soon as petals form. Eggs hatch within 3 to 9 days, and the legless grubs that emerge begin to eat flower parts. Larvae feeding within the buds cause the infested blossoms to turn purple, wither, and drop to the ground, where weevil grubs will eventually pupate. Collect weevils from blueberry plants with a sweep net or by shaking the foliage onto a white ground cloth. If supplementary chemical control is needed, apply a short-residual, pre-bloom insecticide about a week before buds open. Pre-bloom sprays intended for blueberry gall midges and flower thrips will also control blueberry bud weevils.

#### Blueberry Gall Midges (*Dasineura oxycoccana*)

Blueberry gall midges are tiny, mosquito-like flies about one-twelfth of an inch long. Immature larvae (maggots) feed on blueberry plants' floral and leaf buds. For most rabbiteye cultivars, vegetative feeding causes little damage (**Figure 8**). However, some rabbiteye cultivars are highly susceptible to both flower and vegetative bud injury. Blueberry gall midge occurs sporadically but can cause 20 to 80 percent flower bud/fruit loss. Begin a pre-bloom insecticide spray program for blueberry gall midges only after the pest has become active on the farm or in nearby fields. Gall midges lay eggs on warm, late-winter days, usually after a heavy rainfall. Apply labeled insecticides for gall midge control when flower buds reach stages 1 and 2 (i.e., swelling buds are starting to show signs of scale separation; as early as late January to early February in Mississippi). Repeat pre-bloom sprays during warm spells. Cease spraying when bloom begins and bees are actively foraging in the field. A second, newly discovered leaf-feeding midge, the blueberry tip midge (*Dasineura oxycoccana*), may attack flower buds during late bloom; no control measures currently exist for this pest, but their attacks on blueberry flower buds occur only rarely.



**Figure 8.** Leaf damage caused by blueberry gall midge. E. T. Stafne



### **Blueberry Stem Borer (*Oberea myops*)**

Blueberry (azalea) stem borers are longhorn beetles that also attack rhododendrons and azaleas. This pest is active in May and June and can best be controlled by removing infested (damaged) canes that are often brown and wilted with small holes. Cut stems well below the brown, hollowed-out section, where the stem is still green and not hollow. Promptly destroy each wilted cane because they probably contain larvae. This ensures larvae do not migrate into crowns and kill plants. This pest poses more risk to very young blueberry plants (younger than 4 years old).

### **Cherry Fruitworm (*Grapholita packardii*)**

Cherry fruitworm is a sporadically occurring caterpillar pest that feeds inside developing berries. During years of unusually high populations, cherry fruitworms can potentially cause rejected sales due to contamination. This is because mature caterpillars, which are only about one-fourth of an inch long but a conspicuous pink color, will emerge from harvested berries and wander about where they are easily observed. Cherry fruitworms may be difficult to detect because larvae make a small hole in the berry and feed on it without many visual symptoms. Although caterpillars usually damage more than one berry, they move from berry to berry at points where berries are touching, leaving little outward sign of feeding activity. Look for berries that turn blue prematurely or berries that appear to be stuck together as an indication that this pest may be present. Use pheromone traps to monitor for flight activity of male cherry fruitworm moths to help determine the timing and need for insecticide sprays. Cherry fruitworm flight activity often begins before that of cranberry fruitworm. Place and begin running pheromone traps during early- to mid-bloom. Timing of insecticides can be critically important in eliminating this pest.

### **Cranberry Fruitworm (*Acrobasis vaccinii*)**

These fruit-feeding caterpillars can web together and eat six to eight berries in a cluster. Scout fields for cranberry fruitworms by checking for infested berry clusters twice a week from full bloom until 4 weeks after petal fall. Examine fruit clusters for pin-sized holes in berries, with frass and webbing. Infested fruit will prematurely turn blue and stand out among surrounding healthy, green fruit. Break berries open to look for larvae and feeding damage. Pheromone traps are also available for cranberry fruitworms (the traps are the same as for cherry fruitworms, but the lure is different). Early-blooming cultivars such

as Climax are often infested first. Remove and destroy all infested berry clusters within bushes. Do not put infested berries on the ground near the bush because that is where the larvae complete their life cycle.

### **Fire Ants (*Solenopsis invicta*)**

Fire ants can cause problems in blueberry fields, especially in pick-your-own operations due to increased liability and a reduction in return business. They can also interfere with equipment operation and maintenance duties. For these reasons, it is important to control this pest. For more details, see MSU Extension Publication 2494 Control Fire Ants in Commercial Fruits, Nuts, and Vegetables.

### **Flower Thrips (*Frankliniella* spp.)**

Flower thrips are tiny insects that can destroy the reproductive parts of flowers, rendering blooms incapable of setting fruit, even after bee pollination. Begin sampling flower clusters for thrips when buds are swelling and scales are separating, as well as when corollas start opening. Place flower bud clusters in sealed plastic bags and incubate them in a warm room or on a windowsill. Fewer than two thrips per individual bloom will probably not cause economic injury. However, six thrips per bloom can destroy whole flowers or impede pollination. If you find thrips in blooms, begin sampling two to three times per week. Take a minimum of five bags of bloom clusters per field. You can also use sticky cards or white, light blue, or yellow flagging tape to monitor flower thrips as they attract and capture the thrips. If you find two or more thrips per individual bloom or the density of thrips on traps rapidly increases, apply a registered insecticide no later than 5 days pre-bloom.

### **Leaf-Footed Bugs/Stink Bugs (*Leptoglossus phyllopus*/*Chinavia hilaris* and other species)**

Leaf-footed bugs and stink bugs can damage larger green and ripe fruits (**Figure 9**). They also can raise their brood within fruiting clusters. Immature bugs (nymphs) resemble smaller adults, except that they are often more brightly colored with orange or red markings. Nymphs are wingless, although wing pads are visible. Apply insecticides as needed once they are identified.



**Figure 9.** A leaf-footed bug on a blueberry stem. These insects can cause significant injury to fruit. E. T. Stafne



### Green June Beetles and Others (*Cotinis nitida* and other species)

May and June beetles can be abundant in some areas. Control nocturnal May and June beetles more effectively with evening insecticide applications. Some species of green June beetles forage during daylight hours and are better controlled during this time.

### Spotted-Wing Drosophila (SWD) (*Drosophila suzukii*)

Spotted-wing drosophila is a relatively new, nonnative pest of blueberries that can cause significant damage and loss of sales if not controlled. This pest results in leaky berries, fruit rots, fruit drops, and maggot-contaminated produce. Monitor weekly using traps (**Figure 10**). Begin implementing management programs when berries are full green. Traps can consist of an apple cider vinegar or yeast-sugar mixture bait. Commercial baits are also available. It takes at least one trap per 5-acre block around the field borders and center of field to adequately monitor this pest. Some cultural techniques may help reduce the incidence of SWD, including sanitation, frequent harvesting, and removing culls from nearby packing sheds and fields. These measures may help but are not likely to be enough for adequate control, so chemical control is necessary in most cases. Apply reduced-risk pesticides according to label rates, and rotate chemical classes to prevent resistance build-up in the insect population. Effective control of SWD requires making insecticide applications during the harvest season. Pay careful attention to preharvest intervals and manage harvest schedules, choice of insecticides, and spray schedules appropriately. Populations of SWD generally become problematic



**Figure 10.** A simple trap with sugar and vinegar can help monitor populations of spotted-wing drosophila (SWD) but will not act as a control measure.  
*E. T. Stafne*

in mid- to late June, primarily affecting mid- to late-season rabbiteye cultivars. Because of the low tolerance wholesale buyers and consumers have for maggot-infested berries, failure to adequately control SWD can result in rejection of berries and loss of future markets.

## Abiotic Disorders

Abiotic problems are not always easy to diagnose because such problems may appear to be caused by a disease or insect. While not all abiotic issues are easily diagnosable, some of the more common ones are readily known.

### Cold Injury

One of the most recognizable issues is cold injury. Low temperatures during or after bloom can cause damage on flowers (**Figure 11**) or developing fruit (**Figure 12**). Fruit scarring on the blossom end is most common. While this may not make the fruit inedible, it can cause it to



**Figure 11.** Cold damage to blueberry blooms. These flowers are now susceptible to Botrytis infection that could spread to fruit later in the spring.  
*E. T. Stafne*



**Figure 12.** Cold injury often is seen on the blossom end of developing blueberry fruit. The scarred tissue will make this fruit unmarketable.  
*E. T. Stafne*



be unmarketable. Cold injury to flowers turns them brown, which may look like they have been infected with a disease. The damage does often lead to further infection by diseases (especially Botrytis) later, but the initial symptoms are from cold injury.

### Iron Deficiency

Another common abiotic disorder is iron deficiency. Iron deficiency symptoms are first seen as interveinal chlorosis (yellowing) in young leaves while the veins remain green. This can occur when the soil pH is greater than 5.3 to 5.5, when the soil has an excess of lime or phosphorus, during waterlogged conditions, or during drought conditions when high-pH water is used for irrigation. To correct the problem, adjust soil pH to a more appropriate level and apply ferrous sulfates and iron chelates as needed.

### Other Conditions

Waterlogging, drought stress, and herbicide injury share common symptoms such as wilting, leaf chlorosis, and marginal leaf burn. Pay close attention to conditions that may have led to these symptoms (rainfall, recent herbicide applications, etc.), and document progression of the problem. Commonly used herbicides such as glyphosate can cause serious plant damage (**Figure 13**) from which the plant may never recover. It is extremely important to choose the best herbicide for the task and apply it at the proper rates. However, some problems can be corrected if identified early enough.



**Figure 13.** Blueberry bushes are susceptible to damage from systemic, nonselective herbicides. The bush will have a difficult time recovering from this injury. *E. T. Stafne*

## Weed Control

Weed control during the first 2 years is one of the most difficult and critically important parts of establishing a blueberry planting. Weeds compete with blueberry plants for water, nutrients, and sunlight. Weeds also decrease harvesting efficiency and interfere with maintenance operations. Effective weed control begins 6 to 12 months before planting by using a combination of herbicides and cultivation. Make sure planting rows are thoroughly prepared and weed-free at planting time.

Maintain a 4-foot-wide weed-free strip, centered on the plant row, throughout the life of the blueberry planting. Establish sod between the rows and maintain it by mowing. Some native grasses are better choices than bahiagrass or Bermudagrass, which grow much faster and require more maintenance.

Several herbicides are labeled for use in blueberry production. Always follow label instructions carefully when using any herbicide. Preemergence herbicides act by forming a protective layer on bare soil that prevents seedling emergence. They are not effective if applied over organic mulches or heavy leaf litter. Postemergence herbicides control weeds that have emerged and are actively growing. Most blueberry growers apply postemergence herbicides to the weed-free zone, using a shielded sprayer, to prevent the herbicide from getting on the blueberry plants. Currently, the most commonly used herbicide is glufosinate ammonium. For the most up-to-date information, see the latest edition of the [Southeast Regional Blueberry Integrated Management Guide](#).

## Wildlife Control

Two of the most common animal pests are deer and birds. Others, such as feral hogs, rabbits, and coyotes, can occasionally cause problems in certain situations. While there is no perfect solution to eliminating these pests, deterrents are the most effective for managing them. Rarely does a single deterrent work, so use multiple methods to rid the area of these pests. For deer, electric fencing around the entire area may be necessary. When coupled with legal depredation harvesting, the damage from deer can be greatly reduced.

Birds are a far more difficult pest to stop. The sheer numbers can be overwhelming, and they can reduce crops in a short time. Use multiple strategies to mitigate losses. Many bird species are federally protected, so killing them is not an option. However, harassing and frightening them is legal. There are different methods to accomplish this, including chemical sprays (methyl anthranilate), noise repellents, laser targeting, falconry, and netting.

Cost of implementation is commonly the deciding factor. Fencing and netting are expensive but most effective. Consider all options carefully and choose those that make the most economic sense.

## Plant Removal

Once a planting has outlived its usefulness, remove it. Unmanaged blueberry plantings act as insect and disease reservoirs that can negatively impact nearby bushes. For recommendations on removal, contact your local county Extension office.

## Harvest and Post-Harvest Management

Rabbiteye blueberries in southern Mississippi normally begin ripening in mid-May and continue into late July. They continue to ripen into mid-August in northern Mississippi. Southern highbush cultivars begin ripening in mid-April and are usually finished by early June. Blueberry fruit will continue to ripen for several days after turning blue.

Maximum flavor and size are achieved 5 to 7 days after the fruit turns blue. This is the best time to pick for home use or pick-your-own operations. Fresh fruit that will be packed and shipped needs to be picked before the fruit reaches its natural peak in the field. If commercial fruit harvest is delayed until it has reached its peak, it will be too soft to handle, and the shelf life will be considerably shortened.

Harvest blueberry fruit every 5 to 7 days; depending on cultivar, three to five pickings may be necessary to complete the harvest. In order to reduce field heat, harvest fruit in the early morning, late afternoon, or at night. To reduce postharvest fruit rots, delay picking until after dew has evaporated. Some drying of dew-moistened fruit may be done in an air conditioned, low-humidity room. Excessive rainfall can cause ripe berries to split. If heavy rains delay harvest, the overripe fruit will need to be sold to the processing market. Once the overripe fruit is out of the field, resume picking for the fresh market.

Where available, hand harvesting is used for fresh-market berries. Roll ripe berries from the bush by hand and place them into gallon buckets. Some grading of hand-picked fruit is necessary, but be careful not to handle it any more than necessary during picking, sorting, and packing. Handling removes the “bloom,” or surface wax, which gives the fruit its characteristic frosty blue color. Excessive handling can cause bruising and spread organisms that cause decay. Remind workers that they are handling a food product that is eaten fresh and often not washed. Clean hands and sanitary personal habits are required at all times. Provide portable toilets and hand-washing stations with soap and single-use towels for pickers.

Blueberries can be mechanically harvested with a catch frame or over-the-row harvester. Because mechanical harvesting collects more debris and unacceptable fruit during the harvest operation, grading is necessary. A common blueberry grading line consists of a blower unit (removes leaves, small twigs, and debris), a tilt belt (removes clusters and soft, misshapen berries), a color sorter (removes red and green fruit), and a sorting table on which a conveyor moves the fruit along for visual inspection and hand removal of the remaining undesirable berries. A greater percentage of mechanically harvested berries will go to the processing market, and mechanically harvested fresh-market berries have a shorter shelf life than hand-picked berries.

Storage life of blueberries is quite good if you handle them properly. Store and transport blueberries at 32 to 35°F and 85 to 90 percent relative humidity. Blueberries that are stored and handled properly should have 2 weeks of storage and shelf life measured from the day of harvest.

## Fruit Cooling

Blueberries harvested at warm field temperatures are very perishable, and quality rapidly deteriorates. To ensure optimum shelf life and overall quality, cool fruit within 4 hours of harvest or sooner. This requires frequent trips to the processing facility or a refrigerated storage unit.

Blueberries continue to respire and produce heat after harvest. At a temperature of 80°F, blueberries produce heat due to respiration; unless this heat is removed by cooling, it can cause a considerable rise in temperature. Cooling lowers the respiration rate, slowing the ripening process and the inevitable decline in quality. The respiration rate of blueberries at 80°F is nearly 20 times the rate at 40°F. In other words, blueberries held at 40°F have nearly 20 times the shelf life of those held at 80°F. Softening is the most obvious physiological damage from overripening. The industry standard is to achieve a fruit temperature of 38°F within 6 hours of harvest. The optimum temperature that will ensure the longest shelf life is just above freezing, 33 or 34°F.

A pallet of packaged blueberries, initially at 80°F, allowed to remain for an hour in a cooler without forced-air ventilation may appear to have cooled. However, only the packages on the outside will cool appreciably in that length of time. Temperature measurements taken inside containers near the center of pallets, standing in still air at 44°F, will show a temperature increase during the first hour of cooling. In still air, the average cooling rate of pallets of blueberries is slow because heat is transferred from the interior only by conduction. Packaging material and air gaps between containers act as insulation, slowing the movement of heat. Pallets of hot blueberries allowed to stand in a cooler without forced-air ventilation for several hours before shipment will not be cooled uniformly. Transport refrigeration provides little to no additional cooling.

It is common for packers to install equipment inside the cooler to force the cold air through the containers, greatly increasing the cooling rate. Blueberries cooled with forced air reach the desired uniform storage temperature significantly faster than those in still air. Blueberries in the center of the pallets of 80°F blueberries require more than 36 hours to cool to below 50°F. Depending on the circumstances, the rate of cooling with forced air may be 16 to 20 times faster than still air. If you have already made a considerable investment in refrigeration equipment, an additional nominal investment in one or more forced-air cooling fans can dramatically reduce the time required to cool blueberries satisfactorily.

## Food Safety

Blueberries, like many other berries, fruits, and vegetables, have been implicated in a few foodborne illness outbreaks. Most foodborne outbreaks associated with berries have been associated with hepatitis A (harvest workers), *Salmonella*, *E. coli* 0157:H7, and *E. coli* 0126. Other microorganisms



associated with outbreaks in berries (not necessarily blueberries) are norovirus, *Cyclospora*, and *Listeria monocytogenes*. Chemical (pesticide residues) and physical (metal, etc.) hazards can be mitigated by using existing controls like integrated pest management and good agricultural (and handling) practices (GAPs).

GAPs are voluntary practices that can lower the risk of contamination with foodborne pathogens and other hazards. Farms (including packing and related activities) are audited by private entities and the USDA. Buyers sometimes require these practices in order to market the product. Generally, larger buyers have stricter food-safety certification requirements (third-party audits). However, the FDA developed regulations under the Food Safety Modernization Act to oversee the safety of fresh fruits and vegetables, including blueberries. The Produce Safety Rule (PSR 21CFR112) established standards for fruits and vegetables that are consumed fresh. The rule, with some exemptions, requires that farmers attend or have someone attend a PSR course and keep certain records at minimum. Farmers must identify potential sources of contamination related to agricultural water quality; employee health and hygiene; animals; biological soil amendments of animal origin; and equipment, tools, and buildings. They must develop mitigation practices and document them through monitoring, corrective actions, and records. Producers who have GAPs in place may already be in compliance with some or most of the PSR requirements. However, the PSR requires specific training and recordkeeping practices. For more information, contact your local county Extension office.

## Marketing

Blueberry markets are dynamic and can change rapidly from year to year. Price, volume, and quality requirements vary across market channels, so choose a market outlet based on the scale of your operation and overall farm goals. Market channels can be classified into direct marketing channels and non-direct or wholesale markets.



## Direct Marketing

Direct sales markets are the best option in terms of price return because they eliminate the need for an intermediary or broker. Farmers can charge retail prices and capture a larger share of the food dollar paid by consumers. However, this may not be the best option for moving larger volumes of product, unless it is part of a marketing strategy that includes multiple market channels. Some potential direct-marketing channels for blueberries include these:

- pick-your-own (U-pick) operations
- farmers markets
- farm or roadside stands
- CSAs (consumer supported agriculture) or produce subscription boxes
- direct sales to restaurants and institutions (schools, hotels, etc.)
- online sales

Local options, such as pick-your-own, roadside stands, subscription sales, and farmers markets, can provide excellent outlets for direct fruit sales that are less subject to outside price influences. Another option is to sell blueberries directly to restaurants and institutions without an intermediary or broker. To do this, it is important to develop relationships with chefs. Start by making an appointment with the chef or owner to tell them about the product and provide samples. When working with restaurants, you must ensure consistent quality and reliable deliveries.

Direct marketing requires management, capital, planning, and advertising to be successful. It is important to have a marketing plan and develop a strong social media presence (Facebook, Twitter, Instagram, etc.) to increase awareness of your farm and inform consumers about products. Remember that, with direct marketing, the owner-operator must attract the customers. When marketing directly to consumers, sharing your farm's story is important for building strong relationships with buyers and fostering consumer loyalty.

There are pros and cons to any kind of marketing channel. Pros for direct marketing:

- lower transportation costs
- lower product specification requirements
- lower post-harvest handling costs
- selling an “experience”
- setting your own prices
- receiving payment at the time of sale

Cons to direct marketing:

- liability (e.g., accidents involving customers at U-pick operations)
- matching volume to number of customers reachable through direct market channels
- facilities and location setting (e.g., proximity to customer base)
- nearby competition from other farms
- direct contact with customers
- sales labor needed, which may require additional employees

In addition, it may be difficult to attract customers if you don't have a variety of products. Often, neighboring farmers will agree to sell products jointly to increase product variety. Another potential con is that it may be difficult to find a market for unsold produce. An option for this situation is to sell value-added blueberry-based products with a longer shelf-life (jams and jellies) under the Mississippi cottage food law.

Depending on the operational scale, e-commerce (online/internet sales) may be a viable option. Consumers can preorder or buy products from an online storefront to pick up at the farm or have delivered. Some platforms allow producers to manage sales through multiple market outlets and/or CSA subscriptions.

### Wholesale or Non-direct Marketing

In wholesale or non-direct marketing, you sell your product to someone who then sells it to the consumer. This type of marketing can include terminal markets, cooperatives, packing sheds, grocery stores, distributors, processors, restaurants, and produce brokers. It requires high-quality, uniform produce that meets the requirements of the buyer, including specific container sizes, volume quantities, and defined delivery times.

While non-direct markets may provide lower prices, it can be a more convenient way to sell fruit in larger quantities. Pros to selling fruit in this manner:

- less risk
- larger potential market
- concentrated sales
- larger volumes
- quick sales involving less time
- readily available market information

Cons to non-direct marketing:

- lower flexibility in how the crop is sold
- need for high-quality, uniform produce and containers (additional post-harvest handling, washing, sorting, grading, and packing)
- risk of delayed payment or product rejection
- price and demand fluctuations

Wholesale markets often have additional requirements, such as refrigerated transportation, GAP certification, or liability insurance, all of which result in additional costs.

It is critically important to understand what the buyer wants and needs. The ultimate mantra for a blueberry grower should be, "If you can't sell it, don't grow it!" Before starting a new operation or scaling up an existing operation, it is important to identify and secure a market for the fruit. Growers have different talents, abilities, and resources; match your type of marketing with your specific traits. Since the blueberry market can change, it is smart to consider more than one type of marketing.

Remember that you can use a combination of marketing channels, including various direct sales outlets and/or wholesale to reduce marketing risk. Prioritize channels based on economic importance (share of sales and profitability), farm objectives and preferences, and buyers' preferences and requirements. For example, if wholesale is your primary market, then the best quality fruit can go wholesale and the rest can be sold at a farm stand or farmers market or used for processing.

### Prices

Prices are an important aspect of marketing. Selecting the right price is key for the profitability of a blueberry farming operation. Before setting a price for the fruit, you must know the cost to produce it. A good price should cover all costs and provide a profit. Budgets are a good tool for tracking the cost of producing and marketing a crop. Stay updated on prices in the overall market to use as a benchmark.

Typically, in Mississippi, the best prices are obtained from early-harvested fruit (late April to early June) when there is less regional and global competition. When selling through non-direct or wholesale markets, prices will be lower than retail prices. The [USDA Marketing Service Specialty Crops terminal market report](#) is a good reference for wholesale prices.







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