# Establishment and Maintenance of Blueberries

MISSISSIPPI STATE UNIVERSITY EXTENSION

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.

The most effective methods for enhancing blueberry production and profitability have come from research by progressive farmers, the U.S. Department of Agriculture's Agricultural Research Service, universities, and private companies.

In 2008, the southeastern U.S. blueberry industry had approximately 23,800 acres of production, with a market value of $72.8 million. Blueberry plantings are relatively expensive to establish but generally remain productive for a long period of time.

Blueberry growers who wish to remain competitive should have a clear understanding of several key factors and plan carefully when preparing to establish a blueberry planting. Consideration must be given to site selection, variety selection, pest control, water availability and quality, harvesting, and marketing. This publication discusses these and other factors.

## Establishment

### *Site Selection: Soils*

Site selection is critical to the success of a blueberry planting. As a general rule, blueberries grow best on nonagricultural land that has been recently cleared. Old pasture sites or old 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. Soil fertility and irrigation water analyses should be conducted 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 (often showing up as yellow leaves), and have higher mortality during establishment.

Follow soil test recommendations to correct any inadequacies, eliminate hardpans, improve soil structure, and add organic matter to reach acceptable levels for your particular blueberry crop. Blueberry plants will perform poorly in areas having 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, and a high pH. The location of these windrows should be considered when laying out the field to reduce problem areas after planting.

Soils with a native pH above 5.5 will be hard to adapt for blueberry culture and should be avoided. Soils with low native pH that has been limed to achieve an artificially high pH may be lowered by adding sulfur. The sulfur should be incorporated into the soil at least 6 months before planting.

Blueberries have a shallow, fibrous root system that grows best in a well-drained soil with high organic matter content because this increases 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.

### *Site Selection: Terrain and Climatic Considerations*

Rabbiteye blueberry cultivars vary in their chilling requirements (hours below 45 °F), and these requirements must be consid-

ered when selecting cultivars for specific geographic regions. Generally, cultivars with as few as 300 to 400 hours may be grown in south Mississippi, below Hattiesburg, with frost protection, while cultivars having requirements of 500 hours or more may be grown throughout the state.

Developing flower buds, blooms, and fruit of lower-chill, earlier-ripening rabbiteye 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. The soil is often poorly drained in these areas, and blueberries will not grow well in excessively wet areas. Marginally wet areas can be adapted for blueberry production by using raised planting beds (8 to 12 inches high).

Perennial weeds should be killed the summer before planting by cultivating and using a systemic herbicide. Weed control the first 2 years after planting is challenging, and eliminating the perennial weeds before planting greatly reduces future weed problems

### *Site Selection: Water Availability*

An abundant source of irrigation water with no sodium, low calcium, and favorable levels of other minerals should be readily available on-site. Irrigation water can be obtained from wells or ponds with proper filtration.

## Variety 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 95 percent of the Mississippi blueberry acreage.

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

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

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.

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; as a result, rabbiteye blueberries are more suitable for mechanical harvest, and most cultivars have a very good shelf life.

The flowers of most cultivars are self-sterile and require interplantings of pollinizer cultivars. To improve cross-pollination and optimize fruit set, a minimum of two cultivars with similar chilling requirements and bloom periods should be planted 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). Additional effort and expense may be required to establish and promote native bee populations. It may be necessary to rent domestic honeybees or bumblebees to achieve optimum pollination and fruit set.

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

Southern highbush blueberries may 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. The breeding objectives include transferring traits from wild species to provide greater adaptation of the northern highbush 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. Since southern highbush plantings in Mississippi are limited, cultivar longevity has not yet been well established. However, with good management practices, an orchard life of 10 to 15 years may be realistic before pest problems and soil organic matter depletion result in declining plant health and mortality.

Blooms of southern highbush cultivars are generally more self-fertile than rabbiteye blueberries. Still,

many cultivars require interplantings with other cultivars having similar chilling requirements and bloom periods to achieve optimum pollination and fruit set, and earlier harvest. Southern highbush cultivars, best adapted to Mississippi, generally have a winter chilling requirement of 400 hours or more. Those having lower requirements bloom very early and are susceptible to late spring freeze injury. Cultivars having greater chilling requirements (500 to 600 hours) have a reduced possibility of late spring frost injury.

### *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 the University of Georgia, University of Florida, and North Carolina State University. The authors offer their acknowledgement and appreciation. The following rabbiteye blueberry cultivars are listed in approximate chilling requirement and ripening order.

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 and vigorous, 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 release.

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 UFL in 2003; patented.

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, flavor, and small dry scars. In some conditions, fruit size has been smaller than expected. Alapaha is considered to be 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, flavor, and a dry picking scar. Vernon is considered to be 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, vigorous, and have an upright growth habit. Berries are medium to large size 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. Released jointly by NCSU and USDA-ARS in 1978; 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.

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; 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 size 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.

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 UGA and USDA-ARS in 1983; public.

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, medium blue color, 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; patented.

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.

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 blueberry 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 enhanced size and quality. Onslow is recommended for commercial production, pick-your-own, and local markets. Released by NCSU in 2001; patented.

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 size 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 variety for the commercial rabbiteye industry because of its high yields and vigorous growth. However, newer, early-ripening varieties with larger, high-quality fruit that don't split during wet weather have replaced it as a commercial variety. Tifblue still remains the standard to which other varieties are compared, so references to Tifblue are common in literature and grower discussions. Released by UGA and USDA-ARS in 1955.

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. Characteristics including appearance, quality, and season are sufficiently similar to Tifblue that the two can be harvested together and used as pollinizers for each other. Other suggested pollinizers include Brightwell, Columbus, Ira, and Oclockonee. Released jointly by NCSU and USDA-ARS in 1978; public.

Yadkin—Chilling requirement, 500 to 600 hours. Ripens in Mississippi 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 color, 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; patented.

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 size 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.

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. Fruit can be hand or mechanicalhy 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.

### *Southern Highbush Blueberry Cultivars*

Production of southern highbush blueberries in Mississippi for the early fresh market is relatively new, and acreage is 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 limited.

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 adjust their management practices, more educated answers are found to the questions on 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.

### *Early- to Mid-season Southern Highbush Cultivars For Trial Plantings in Mississippi*

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. Star is susceptible to Septoroia leaf spot. Star should only be grown in the coastal region. Released by UFL in 1996; patented.

Windsor—Chilling requirement, 400 hours. Windsor blooms in early March in south Mississippi, and frost protection may be required. Ripens early to late April to early May. Windsor plants are very productive and have excellent vigor with a semi-spreading growth habit. Fruit are very large with good color, firmness, and flavor. The size of picking scars may vary on younger plants, but older plants have medium picking scars. Occasionally, berry skins may tear upon picking, but harvesting in the morning can help prevent this. Windsor has good resistance to leaf spot diseases but only fair to moderate root rot and stem blight resistance. Windsor is not self-fertile and should be planted 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.

Santa Fe—Chilling requirement, about 350 hours. Blooms sufficiently early to require frost protection. Ripens in early to late May. Plants are productive, vigorous, and have an upright growth habit. Berries are blue to dark blue and medium to large size. They have excellent scar, firmness, and flavor. Santa Fe is somewhat difficult to propagate; best results are obtained with very soft softwood cuttings. Released by UFL in 1999; patented.

Southern Belle—Chilling requirement, 400 to 500 hours. Blooms later than Star, but frost protection should be available to avoid spring freezes. Plants are productive, moderately vigorous, have an intermediate growth habit, and produce numerous canes forming a dense, wide bush. Berries are medium blue color and large to very large with very good scar, firmness, and flavor. Southern Belle is susceptible to Phytophthora root rot and should be grown only on well-drained sites. Released by UFL in 2002; patented.

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

Palmetto—Chilling requirement, 400 to 450 hours. Blooms early March in south Mississippi and ripens early to late May. 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.

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

Dixieblue—Chilling requirement, 500 hours. Ripens about 10 days after Star in south Mississippi. Plants are productive, moderately vigorous, have an upright, spreading growth habit with narrow crowns, and have shown 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 and have very good postharvest fruit quality. Released by USDA-ARS in 2005; public.

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

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

### *Mid- to Late-season Southern Highbush Blueberry Cultivars for Trial in Mississippi*

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. The small fruit size may limit the speed of hand picking. Recommended for mid- to northern Mississippi. Released by NCSU in 1998; public.

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. Has good resistance to stem blight. Berries are small with good color, picking scar, firmness, and flavor, and good postharvest fruit quality. Berries may be either hand or machine harvested. Blooms are highly self-fertile, reducing the need for pollinizer cultivars. Released by NCSU in 2003; patented.

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. One of O'Neal's most favorable features is that it 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.

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 fairly broad soil adaptation. Berries are small to medium with excellent color, picking scar, and flavor. They have good postharvest fruit quality. Firmness is sufficient for machine harvest for the fresh market if berries are not allowed to get overripe. Carteret is highly self-fertile, reducing the need for pollinizers. Released by NCSU in 2007; patented.

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 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.

## Pre-plant Activities

Begin preparing the soil the summer before the blueberries are planted. Mark the rows off in 12-foot increments (10 for southern highbush) in a north-to-south orientation. Pull a subsoiler down the row to eliminate a hardpan, if it exists. The soil should be tilled or disked thoroughly to kill weeds and vegetation. Tilling the rows multiple times during the summer will kill several flushes of weed seed germinations. Applications of glyphosate on emerging weeds, between tillings, will 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 sawdust or wood chips to incorporate into the beds because they tie up the 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 plants and provide superior drainage, which will protect the plant roots if any low, wet areas exist in the field.

After the beds are formed, the irrigation may be installed and the plants set. The irrigation may be slightly buried into the bed to prevent it from being exposed to sunlight and from expansion and contraction from fluctuating temperatures. If heavy mulch is applied after planting, the irrigation may be laid on the soil surface and buried in the mulch.

**Table 1. Rabbiteye and Southern Highbush Blueberry varieties**

| Rabbiteye Blueberry Cultivars | | | | |
|---|---|---|---|---|
| **Cultivar** | **Chilling requirement (hours)** | **Ripen Date (South MS)** | **Productivity** | **Vigor** |
| Alapaha | 450–550 | late May to early June | VG | G |
| Austin | 450–500 | early to late June | VG | M |
| Brightwell | 350–400 | early June to early July | VG | G |
| Climax | 400–450 | late May to early June | VG | G |
| Columbus | 600 | late June to mid-July | VG | G |
| DeSoto | 600–650 | mid-July to mid-August | G | M |
| Ira | 600 | mid-June to July | VG | G |
| Montgomery | 550 | late May to mid-June | VG | M |
| Ocklocknee | 650–700 | early to late July | VG | G |
| Onslow | 500–600 | late June to late July | G | G |
| Powderblue | 550–600 | late June to late July | G | G |
| Premier | 500–550 | late May to early June | VG | G |
| Prince | 300–400 | mid-May to early June | VG | G |
| Savory | 300–400 | late May to early June | G | G |
| Tifblue | 600–700 | late June to July | G | G |
| Vernon | 500–550 | early to late June | G | G |
| Yadkin | 500–600 | late June to late July | G | G |
| **Southern Highbush Blueberry Cultivars** | | | | |
| **Cultivar** | **Chilling requirement (hours)** | **Ripen Date (South MS)** | **Productivity** | **Vigor** |
| Bladen | 600 | mid-May | G | M |
| Camellia | 450–500 | early to mid-May | G | G |
| Carteret | 500–700 | early to late May | G | G |
| Gupton | 500 | early to late May | G | G |
| Lenoir | 600–800 | mid-May to early June | G | G |
| New Hanover | 500–600 | early to mid-May | G | G |
| O'Neal | 400–500 | late April to mid-late May | F | G |
| Palmetto | 400–450 | early to late May | G | G |
| Palmico | 600–800 | early to late May | G | G |
| Rebel | 400–500 | late April to mid-May | G | G |
| Santa Fe | 350 | early to late May | G | G |
| Southern Belle | 400–500 | later than Star | G | G |
| Star | 400–500 | late April to mid-May | G | M |
| Windsor | 400 | early to late April and early May | G | G |

### *Selecting, Handling, and Setting Plants*

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

Water the plants when you get them, 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 have begun growing around the perimeter of the rootball, they often continue growing in this pattern and do not grow out into the soil after planting. When planting, break the rootball up with your fingers or use a knife to make a couple of vertical slashes. This will reorient the roots and encourage them to grow into the surrounding soil in the planting hole.

If purchasing bare-root plants, make sure they 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 you cannot plant them right away, heel them in to keep the roots moist until they can be planted. Bare-root plants must be handled properly because the roots are more vulnerable 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 bring the top and root of the plant into better equilibrium. If conditions are right, 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.

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.

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

Set the plants into the soil in the center of the bed, 5 feet apart (4 feet for southern highbush), being careful not to plant too deeply. The rootball should be just below the soil surface approximately one-fourth to one-half of an inch. If the soil is allowed to settle 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 deep at the time of planting.

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

## Management

### *Fertilization*

Fertilizer is usually applied to blueberries in the spring when growth begins and 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 leaf 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. Do not use nitrate forms of fertilizer. Ammonium sulfate is the most often-used nitrogen source. Ammonium nitrate and other nitrate-containing fertilizers should be avoided because nitrate ions are very damaging to blueberries. Blueberries also respond well to fertilizers containing urea and diammonium phosphate, and to slow-release type 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. 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. There are several urea-ammonium sulfate blends with diammonium phosphate on the market today.

Mature plants (6 years old or 6 feet tall) should be at the peak fertilization rate. If fertilizer is being applied with a spreader, try to place most of the material in the row area to reduce weed growth and maximize utilization of fertilizer by the blueberry plant. As a general recommendation, apply 30 pounds per acre of actual nitrogen in the spring as a complete fertilizer (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 18 inches of new growth per year), reduce the amount of nitrogen to 30 pounds per year.

**Table 2** gives a program for fertilizing blueberries at various stages of maturity.

### *Liquid Fertilization*

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

There are some advantages to fertigation: fertilizer is more efficiently used, it may be applied weekly in small amounts so that it is more available when the plant needs it, application cost is considerably less, and nutrients more quickly reach the root zone in a soluble form.

There are also some disadvantages: irregular growth and possible damage to plants if the irrigation system is not working properly, specialized equipment must be added to the irrigation system, and soluble fertilizer is relatively more expensive than granular fertilizer.

It is important that the irrigation system functions properly and all plants 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, it is necessary to use pressure-compensating emitters to ensure that plants in the low areas do not receive more water than those on the higher ground.

Water pressure needs to be regulated so it is within the boundaries of the emitters, and the flow rate through the pressure regulators should be adequate to supply the area being irrigated. It is important to have a backflow value in the main irrigation line. 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.

Follow up with a proper and regular watering program after liquid fertilizer is applied. Proper irriga-

**Table 2. 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) | Am. 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.

tion 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 should be considered 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. Some tipping of the upright branches may be necessary to produce the branching needed for maximum fruit production. Pruning should not be done after July 30 because fruiting buds are set on new growth produced in late summer.

Liquid fertilizer should be applied to blueberries by incorporating it into the watering program once per week. Irrigation water should be allowed to run for 1 hour to fill the irrigation system and moisten the soil at the root zone. The recommended amount of fertilizer solution should then be introduced into the irrigation water for 1 or 2 hours, and then fresh water applied for 1 hour. This method will allow the system to fill with water and moisten the ground, allow the fertilizer to be applied, flush the system of salts, 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. By knowing 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 3** 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. Fertilizer applications should be discontinued during harvest and resumed 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.

### *Irrigation*

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 stress blueberry plants severely. Applying water through irrigation is essential to maintain good plant health. Adding organic matter to the planting bed at the time of planting and applying surface mulch will help maintain a uniformly moist soil in the root zone.

**Table 3. Amount of liquid nitrogen for blueberry fertilization**

| Age of plant | Pounds of actual N/acre annually | Pounds of actual N/acre/week (25 appl.) | Total soluble fertilizer (lbs/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 |

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.

The most efficient method of irrigation is a drip or trickle system. A water source from a well, pond, or lake may be used. If using water from a lake or pond, a filtration system must be used to prevent debris from plugging the drip emitters. Excellent results have been obtained with in-line swimming pool filters that use a sand medium. Well water may need to be filtered if it contains sand or grit that could plug the system.

The trickle system operates on low water pressure and consists of polyethylene tubing laid down the row, buried in the soil or under the mulch layer, 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. The recommended rate is 12 to 16 gallons of water per plant per week, which should be applied in split applications. Water requirements increase as plants increase in size and age. This system operates under low pressure and requires less water for a given area than an overhead system, thereby increasing the efficiency of the pump.

### *Frost and Freeze Protection*

Most rabbiteye varieties require 400 to 600 chill hours (hours below 45 °F) to break dormancy. Until the cold 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.

Susceptibility to cold damage in rabbiteye blueberries 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. Buds in which bud scales have abscised and individual flowers are distinguishable 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 varieties seem to be more cold tolerant than others. This is primarily because of the extent of floral development achieved when a killing freeze occurs. Earlier blooming varieties are more prone to freeze injury because they will have the greatest number of advanced blooms.

The common method of determining if buds have been frost damaged is to cut through the bud several hours 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 a reduction of 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 seed-damaged flowers are usually smaller.

Freeze damage is also the cause of outward 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 that can spread to and destroy healthy blooms.

Freeze protection of blueberry fields is not an exact science. The difficulty in making recommendations about freeze protection is that every freeze event is different. Weather conditions, wind, temperature before the freeze, length of freeze period, and the stage of growth of the plant are a few factors that affect the efficacy of freeze protection.

Wind machines have been used successfully to protect tender blueberry blooms. Most devastating 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. However, it is somewhat expensive to install and requires a large volume of water. Water volume is critical—½ to 1 inch of water per hour and at least one sprinkler rotation per minute. Water must be constantly applied because ice is a poor insulator. The protection comes from the constant application of liquid 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.

### *Weed Control*

Weed control during the first 2 years is one of the most difficult parts of establishing a blueberry planting. Weeds compete with blueberry plants for water, nutri-

ents, 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 herbicide and cultivation. Planting rows should be thoroughly prepared and weed free at the time of planting.

A 4-foot-wide weed-free strip should be maintained, centered on the plant row, throughout the life of the blueberry planting. Sod should be established in the middles between the rows and maintained by mowing. Centipede grass, carpet grass, or some native grasses are better choices than bahiagrass or Bermudagrass, which grow much faster and require more maintenance.

Mulching is very beneficial in controlling weeds during the first few years of the planting. It also benefits the plant by keeping the soil cool, loose, and uniformly moist in the root zone. Several herbicides are labeled for use in blueberry production. Always follow label instructions carefully when using any herbicide. Preemergent 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. Postemergent herbicides control weeds that have emerged and are actively growing. Most blueberry growers apply postemergent herbicides to the weed-free zone, using a shielded sprayer, to prevent the herbicide from getting on the blueberry plants. The safest and most commonly used is glufosinate ammonium.

### *Mulching*

Mulching with organic materials, such as pine bark, pine needles, leaves, hay, or other organic materials, 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.

### *Pruning*

Before planting, prune plants by removing approximately half of the top, including all weak and horizontally growing shoots. Additional pruning is not needed during the first growing season.

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 any 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. Plant dimensions should accommodate the harvester.

Blueberry plants should be pruned immediately after harvest but no later than the first week of August. The plant must have time after the pruning to produce and mature new wood and 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. Pruning after the first week of August does not allow the plant enough time to develop fruit for next year's crop.

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 you should maximize the amount of fruiting wood while maintaining a plant size that conforms to your harvesting method. As plants begin to get out of bounds, they should be sheared to reduce their size and encourage new growth and fruiting wood. To accommodate further growth, the plant should be sheared to about 10 to 12 inches shorter than its ideal size. This shearing should be done immediately after harvest and no later than the first week of August. 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, older wood within the plant should be removed 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 percent to 20 percent of the wood annually so the plant is renewed in 5 to 7 years. This pruning can be done anytime. It is often done after harvest following the shearing operation but may be done during the winter when the workload is less and the structure of the plant is more easily seen.

Plants that are 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. These plants will need to be pruned 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. As this new wood grows it may be necessary to tip the new sprouts to encourage branching.

This procedure will seem drastic at first, 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 a number of years can become restricted in the amount of fruiting wood and also can benefit from this type of pruning method. 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, you may not want to prune all of your 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.

## Disease Control and Suggested Blueberry Fungicide Spray Schedule

### *Mummy Berry*

If Mummy Berry has been detected on your farm, early fungicide sprays are required to prevent the problem from increasing and to reduce losses. The best management strategy for mummy berry is to put a 1-inch layer of fresh mulch under the plants. The infected mummified fruit from the previous season will be covered up, and the little mushroom that is produced will not release the spores into the air. The other cultural method to prevent the movement of mummy berry is to AVOID bringing in mechanical harvesters that have been in mummy berry-infested fields. The harvester probably cannot be completely cleaned of mummified berries, and the disease can be introduced into your field.

Indar™ has traditionally been used by most growers as the first fungicide applied in the early spring. This fungicide has a Section 18 emergency exemption use in Mississippi and may not be labeled in your state. Check with your chemical dealer for this information. The active ingredient is FENBUCONAZOLE, and it is in the triazole class of chemistry (FRAC code 3). The first application should be made when leaves are about one-fourth of an inch long. Two applications 10 to 14 days apart are recommended.

Following the two Indar™ applications, use Abound™. The active ingredient in Abound™ is AZOXYSTROBIN, and it is in the strobilurin class of chemistry (FRAC code 11). Make one application of Abound™ 10 to 14 days after the last Indar™ application. At this point, you will have made three fungicide treatments for Mummy Berry, which should get you past the stage when the fungus is infectious in the field.

### *Botrytis Blight*

If there is a late freeze or even cold weather during bloom time, check the flowers and young fruit for the presence of Botrytis blight. If Botrytis is present, there will be a gray-green, fuzzy growth on the plant tissues. Botrytis will usually cause losses early in the growing season, but a lot of rainy weather during the spring may also lead to Botrytis problems. It is not recommended to treat preventively for this disease. Treat only if there is a frost that damages blooms or if there has been a significant cold spell.

There are two options for good Botrytis blight control. One of these is Elevate™. The active ingredient is FENHEXAMID, and it is in the chemistry group hydroxyanilides (FRAC code 17). The other fungicide is Captan™, a fungicide in the multi-site mode of action chemistry group (FRAC code M). Captan will be most effective if applied as a preventive spray.

### *Botryosphaeria Stem Canker and Stem Blight*

Fungicides are generally not the best management tool for this disease. You will see individual branches on bushes begin to turn brown and die. This disease is usually associated with injuries to the branches, such as freeze damage or some type of mechanical injury from string trimmers, mowers, or mechanical harvesters. You will need to get a lab to verify if the Botryosphaeria fungus is in your field. The only fungicide labeled for this disease is Abound™. The best management practice is to prune out any affected limbs and destroy them. The disease is very slow moving, and individual plants will die off very slowly.

### *Blueberry Foliar Diseases*

The rest of the growing season, you will be concerned about several blueberry foliar diseases, including septoria leaf spot, alternaria leaf spot, leaf rust, and powdery mildew. These diseases should be treated for preventively, even if they are not prevalent in your field.

During fruiting and even through harvest, the fungicide Pristine™ is a good choice to prevent all of the above diseases. Pristine™ has two active ingredients, PYRACLOSTROBIN (FRAC code 11) and BOSCALID (FRAC code 7). Make one application of Pristine™, and then wait and scout your field for the presence of any foliar diseases. Do not make more than one application unless leaf symptoms begin to develop. This fungicide can be applied up to the day of harvest and can be sprayed during harvest time.

DO NOT rotate Pristine™ with Abound™ or Cabrio™ because the three have similar chemistries. You can make two sequential applications of Pristine™ with a minimum of 14 days between sprays if a disease is present and forecasts call for rain.

### *After Harvest*

Following harvest, fungicides still need to be applied to prevent fungal foliar diseases from remaining on the plants and surviving until the next spring. After harvest, Bravo Weather Stik™ is a good broad-spectrum preventive fungicide. Bravo™ has a Section 24c local needs label in Mississippi. You may want to check with your local supplier to make sure it is labeled in your state.

The active ingredient in Bravo™ is CHLOROTHALONIL, and it is a multi-site mode of action fungicide (FRAC code M). Bravo™ applications can be made at 14-day intervals after harvest is complete. DO NOT combine Bravo™ with any other pesticide or surfactant because phytotoxicity may result. The number of applications is determined by disease pressure and weather conditions. You may make two or three at most, but you may be able to get away with just one if disease pressure is light or not present.

### *Other Considerations*

Always scout fields frequently for the presence of diseases. Obtain an accurate diagnosis for each disease in the field.

Some fungicides other than the ones suggested here may be better management options, depending on the particular disease and the incidence and severity of that disease. See **Table 4** for more information.

Make sure applications are made in enough water to completely cover the foliage. This will usually range from 100 to 200 gallons per acre depending on plant size. The early-season and late-season sprays are essential to maintaining good plant health, and some of the mid-season sprays may not be necessary, depending on your situation.

**Table 4. Fungicides labeled for blueberry diseases**

| Fungicide/ (FRAC Code[y]) | Diseases Controlled | Rate (product/acre) | PHI[z] | Comments |
|---|---|---|---|---|
| Abound™ (11) | botryosphaeria canker<br>mummy berry<br>alternaria<br>phomopsis<br>anthracnose<br>septoria<br>powdery mildew | 6.2–15.4 oz/acre | 0 days | Limit two applications in sequence before alternating with a fungicide with a different mode of action. Do not make more than three applications per crop year. Begin application before disease development and continue on a 7- to 14-day schedule. |
| Aliette™ (U) | phytophthora<br>anthracnose<br>alternaria<br>phomopsis | 5 lb/acre | 12 hours | Begin foliar spray in spring at pink bud stage and continue on a 14- to 21-day interval. Do not mix with copper-containing compounds because phytotoxicity may occur. Limit four applications per year. |
| Cabrio™ (11) | alternaria<br>anthracnose<br>leaf spot and blotch<br>phomopsis<br>powdery mildew<br>rust | 14 oz/acre | 0 days | Maximum of four applications per season<br>Limit two applications in sequence. |
| Pristine™ (7 + 11) | alternaria<br>anthracnose<br>leaf spot and blotch<br>phomopsis<br>powdery mildew<br>rust | 18.5–23 oz/acre | 0 days | Maximum of four applications per season. |
| Captan™ (M) | botrytis<br>berry rot<br>mummy berry | 3.125 lb/acre | 0 days | Apply a minimum of 5 gallons of water per acre. Begin program when buds swell and earliest buds have loose scales. Repeat at 7-day intervals through bloom period. |
| Coppers (M) | bacterial canker | various formulations; consult specific label | 0 days | Consult specific label for use instructions. Most copper-containing fungicides are Organic Materials Review Institute (OMRI) approved. |
| Elevate™ (17) | botrytis<br>bud and flower blight | 1.5 lb/acre | 0 days | Begin application at 10 percent bloom; continue through harvest. Do not apply more than 6 pounds per acre per season. |

**Table 4. Fungicides labeled for blueberry diseases**

| Fungicide/ (FRAC Code[Y]) | Diseases Controlled | Rate (product/acre) | PHI[Z] | Comments |
|---|---|---|---|---|
| Indar™ (3) | mummy berry<br>alternaria<br>septoria<br>phomopsis<br>rust | 6 fl oz/acre | 30 days | Apply up to three applications on 10- to 14-day intervals. Use with surfactant Latron. First application should be when leaves are one-fourth of an inch long. |
| Orbit™ Bumper™ (3) | mummy berry<br>alternaria<br>septoria<br>phomopsis<br>rust | 6 fl oz/acre | 30 days | Apply up to three applications on 10- to 14-day intervals. Use with surfactant Latron. First application should be when leaves are one-fourth of an inch long. |
| Switch™ (9 + 12) | mummy berry<br>anthracnose<br>alternaria<br>phomopsis<br>botrytis | 11–14 oz/acre | 0 days | First application during early bloom. Continue at 7- to 10-day intervals. Do not make more than two sequential applications. Limit 56 ounces per acre per year. |
| Bravo Weather Stik™ (M) | mummy berry<br>anthracnose<br>rust (after harvest only)<br>septoria (after harvest only) | 3–4 pt/acre | 42 days | For use early in the season for suppression of mummy berry and after harvest to minimize influence of foliar diseases on spring growth. |
| Prophyt™ (SAR) | alternaria<br>septoria<br>pythium<br>phythophthora | 4 pt/acre | 0 days | Apply on foliage as a preventive spray. Product builds immune mechanisms in plants. |
| Serenade™ (M) | mummy berry<br>botrytis | 2–6 qt/acre | 0 days | Use as a preventive spray. May be tank mixed with other products for improved efficacy. |

[Y]FRAC (Fungicide Resistance Action Committee) http://www.frac.info/frac/index.htm. Products with similar letter designations should not be used in rotation or in tank mixes together. For example, Abound™, Cabrio™, and Pristine™ should not be used in rotation because they are in the same FRAC group.
[Z]PHI (Pre-Harvest Interval). This is the time from the application of the fungicide until harvest can be resumed.

## Insect Pest Management

This guide can help blueberry producers in Mississippi and neighboring states to develop integrated controls for insect pests on their farms. Many of the commercial products listed are registered under Section 18 or 24c of the amended Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), so they may no longer be current or may not always be labeled for use during future blueberry seasons in Mississippi.

**Table 5** shows the insecticide products and formulations that can be used to control the more problematic pests of cultivated blueberries. The table is updated for the 2008–2009 blueberry-growing seasons; it is important to contact your county Extension agent to obtain the latest status of pest control products in your state or region.

Trade names and brand names are products that can be legally applied to U.S. blueberry crops in 2009 and do not constitute endorsements of one product over others that are also suitably effective. Please be aware that although fungicides can be used during bloom, insecticides cannot be used anytime during bloom, day or night. Thus, spraying insecticides or their mixture with other pesticides is prohibited during bloom. There is one insecticide that may be used during bloom for emergency flower thrips control only: SpinTor. SpinTor is proven safe when certain precautions are observed (see **Table 5** for more detail).

## Table 5. Insecticide products and formulations to control blueberry pests

**STAGE OF PLANT GROWTH WHEN PEST CONTROL MIGHT BE NEEDED**
**Late Dormant → Pre-bloom (December to late February)**

**Blueberry gall midges** are delicate mosquito-like flies about one-twelfths of an inch in length. Immature larvae or maggots feed on a blueberry plant's floral and leaf buds. For most rabbiteye-blueberry cultivars, vegetative feeding causes little damage. However, some rabbiteye cultivars are highly susceptible to both flower and vegetative bud injury. Blueberry gall midge occurs sporadically, but when present can cause 20 percent to 80 percent flower bud/fruit loss. It is strongly recommended that farmers begin a pre-bloom insecticide spray program for blueberry gall midge only after the pest has become active on the farm or in nearby fields. Gall midge lay eggs on warm, late winter days, usually after a heavy rainfall. Apply legal 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 February 7–14 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 (blueberry tip midge) 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.

**Flower thrips** are tiny insects that can destroy the reproductive parts of flowers, rendering blooms incapable of setting fruit, even after superb bee pollination. SpinTor™ spray kills adult and immature thrips even after it dries within 4 hours; thereafter SpinTor™ is harmless to bees, yet remains deadly to flower thrips. It is important that SpinTor™ remain dry on plants and no heavy dew or rain occurs the morning after the SpinTor™ cover spray. SpinTor for thrips control must be used in conjunction with a thrips-monitoring program. It cannot be used preventively for thrips control. Precise timing of SpinTor™ with a thrips outbreak is crucial for excellent pest management and a successful harvest (see insect management section of this publication for more information). Begin sampling flower clusters for thrips when buds are swelling and scales 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 is probably insignificant to induce economic injury. However, six thrips per bloom can certainly destroy whole flowers or impede pollination. If thrips are found in blooms, begin sampling two to three times per week. Take a minimum of five bags of bloom clusters per field. Sticky cards or white, light blue, or yellow flagging tape can also be used as convenient methods for monitoring flower thrips. If two or more thrips per individual bloom are found or the density of thrips on traps rapidly increases, apply a registered insecticide no later than 5 days pre-bloom. However, Malathion™ is appropriate from 4 days to 1 day before bloom. This product, or any others like it, should never be applied anytime during bloom. Direct contact or exposure to residuals can repel, sicken, and kill bee pollinators. 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 potent insecticides during bloom, even at night, will kill male bees. This practice will result in more and more male bees and fewer and fewer female bees. The loss of female bees could eventually cause the extinction of a farm's native bee population.

**Blueberry bud weevils**, or adult cranberry weevils, usually emerge in May and feed on leaf buds during the summer and fall. The only known natural enemy of the cranberry 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 huckleberries) 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 leaftiers. 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. Adult cranberry weevils may be collected from blueberry plants with a sweep net or by shaking the foliage onto a white ground cloth. If supplementary chemical control is needed, a short-residual pre-bloom insecticide should be applied about a week before buds open. Pre-bloom sprays intended for blueberry gall midge and flower thrips will also control blueberry bud weevils.

| Insect Pests | Registered Products | Application Rate (per acre, unless otherwise stated) | Integrated Pest Management Comments |
|---|---|---|---|
| gall midges (pre-bloom spray only) | DiazinonAG500™ °(IRAC Group 1) | 1 pt | Do not apply within 5 days of bloom. Gall midges also have natural enemies (tiny parasitic wasps) that can be 100 percent effective at killing midge larvae. Care must be taken not to poison these beneficial wasps inadvertently. |
| flower thrips (pre-bloom with insecticides listed or a single emergency bloom application with spintor™ only, see bloom section) | Malathion 5EC™ (1) | 2.8–3.2 pt | Malathion™ may be applied at flower bud stage 1. Do not apply Malathion™ within 24 hours of bloom. |
| | Imidan™ 70WP (1) | 1.33 lb | Optimal pH for tank mix should be about 5.5. Alkaline water will neutralize Imidan, making it ineffective as an insecticide; adding a buffering or acidification agent to the tank mix may boost efficacy. |
| | SpinTor™ 2SC (5) | 4–8 oz | Apply SpinTor just before bloom. One emergency spray of SpinTor™ can be applied during bloom when flower thrip densities surge to levels that a crop's failure is imminent. SpinTor™ can be applied only at night and must remain dry on plants the next morning so it will remain benign to flower-visiting bees. SpinTor should not be applied the evening before a rain or heavy morning dew is forecast. Flower thrip control will be successful only if growers periodically monitor populations throughout bloom. A fixed spraying program is ineffective and cannot be used anytime during bloom. |
| bud weevils | | | |

## Table 5. Insecticide products and formulations to control blueberry pests

| STAGE OF PLANT GROWTH WHEN PEST CONTROL MIGHT BE NEEDED | | | |
|---|---|---|---|
| **Bloom (Bees active–late February to April)** | | | |
| **Cranberry fruitworms** are fruit-feeding caterpillars that can web together and eat six to eight berries in clusters. Scout fields for cranberry fruitworms, checking for infested berry clusters twice a week from full bloom until 4 weeks after petal fall. Examine fruit clusters for tiny pin-sized holes in berries, with frass and webbing. Infested fruit will prematurely turn blue, thus standing out among surrounding healthy green fruit. Break berries open to look for larvae and feeding damage. Early blooming cultivars such as Climax are often infested first. Remove and destroy all infested berry clusters within bushes. Be sure to inform personnel not to put infested berries on the ground because it is here that larvae will complete their lifecycle. | | | |
| Emergency cover spray for flower thrips | SpinTor™ 2SC (5) | 6 oz | Thrips are periodic blueberry pests. Use SpinTor™ only in an emergency when thrip populations explode during peak rabbiteye blueberry bloom in late March. In such a case, make only an evening application of SpinTor™, and only if no rain or heavy dew is expected the next morning. |
| **Post-bloom or Pre-harvest (April to late May)** | | | |
| **Cranberry fruitworms** and **cherry fruitworms**–Review field histories and scout fields for fruitworms to determine if spraying is needed. If spraying is required, spray at least twice at 7- to 14-day intervals, starting as soon as blooming has ceased and bees have left the field. Try to target infestations in the first or second berries within a cluster so that sprays can give effective control of younger caterpillars. Beginning with early-fruiting cultivars, check for fruitworms twice a week from full bloom until 4 weeks after petal fall. Examine fruit clusters for tiny pin-sized holes in berries, along with frass and premature ripening and shriveling in small, immature fruits. Break berries open to look for larvae and damage. | | | |
| cranberry fruitworms | Malathion™ 5EC (1) | 2.8–3.2 pt | Malathion™ provides good fruitworm control. Spray fruitworms with an approved product when one bush in five has infested fruit clusters. |
| cherry fruitworms | Imidan™ 70WP [24 (c) label] (1) | 1.33 lb | |
| | Sevin™ 80WSP (1) | 1.875–2.5 lb | Confirm™ and Bt products have better efficacy when ingested by smaller caterpillars. Therefore, applications during start of an infestation are preferable. Confirm™ and Bt products will not harm beneficial insects. |
| | tebufenozide (Confirm™ 2F) (18) | 16 fl oz | |
| | Bt products (e.g. Dipel™, Biobit™, Xentari™) (11) | See label for specific application rates | |
| **Pre-harvest to Harvest (May to July)** | | | |
| beetles<br>May beetles<br>June beetles<br>Flea beetles<br>Click beetles<br>grasshoppers<br>katydids | Sevin™ 80S (1) | 1.25–2.5 lb | May and June beetles can be abundant enough to require multiple applications. Do not apply more than 12.5 pounds of Sevin™ 80 S or Sevin™ 80 WSP per acre per crop. Repeat applications as necessary, up to five times, but not more than every 7 days. Nocturnal May and June beetles are controlled more effectively when applications are made in the evening. Some species of green June beetles forage during daylight hours and are better controlled during this time. |
| | Malathion™, Diazinon™, and Imidan™ may also be used (1) | Check labels for recommended rates | |
| leaf-footed bugs<br>stink bugs | | | Leaf-footed bugs and stink bugs can damage larger green and ripe fruits. They also can raise their brood within fruiting clusters. Immature bugs (or 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. |

## Table 5. Insecticide products and formulations to control blueberry pests

**STAGE OF PLANT GROWTH WHEN PEST CONTROL MIGHT BE NEEDED**
**Postharvest (late May to November)**

| Insect Pests | Registered Products | Application Rate (per acre, unless otherwise stated) | Integrated Pest Management Comments |
|---|---|---|---|
| **Blueberry (azalea) stem borers** (*Oberea myops*) 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). | | | |
| yellownecked caterpillars | Malathion™ 57EC (1) | 1.5 pt | Foliage-feeding caterpillars become more difficult to control as they mature. |
| azalea caterpillars | Sevin™ 80S (1) | 1.9 lb | |
| leaftier caterpillars | Imidan™ 70WP (1) | 1.33 lb | Optimal pH for tank mix should be about 5.5. Alkaline water will neutralize Imidan, making it ineffective as an insecticide. You may have to add a buffering or acidification agent to your tank mix. |
| leafroller caterpillars | *Bacillus thuringiensis* Bt (Dipel™ ES) (11) | 1–4 pt | Bt products are effective microbial insecticides for foliage-feeding caterpillars. Bt products are much more effective when applied to small, young caterpillars. Highly recommended for both organic and conventional agriculture. Please verify that a specific Bt product is OMRI approved (i.e., Certified Organic). |
| | Confirm™ 2F (18) | 16 fl oz | Confirm and Bt products are highly effective against small, early-stage caterpillars. |
| **Early Dormancy → Late Dormancy (December to February)** | | | |
| **Bagworms**–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. | | | |
| scales | Superior Oil 70-second | 2 gal/100 gal water/acre or 2 fl oz/1 gal water | Apply oil on dormant or delayed dormant plants. To avoid chemical burns on leaves and buds, do not apply oil when temperatures are going to be greater than 85 °F or less than 40 °F within 24 hours. |
| gall midges | Diazinon™ AG500 (1) | 1 pt | Do not apply Diazinon™ within 5 days of bloom, as residual insecticide may kill or repel bees. |
| flower thrips | Malathion™ 5EC (1) | 2.8–3.2 pt | Apply Malathion™ for gall midges at stage 1 bud development. Do not apply Malathion™ within 24 hours of bloom. Please note that chemical odors can keep bees from pollinating the crop for 24 to 48 hours. |
| | SpinTor™ 2SC (5) | 4–8 oz | Use SpinTor™ near bloom. It should be applied just before bloom. |

**Table 5. Insecticide products and formulations to control blueberry pests**

| Insect Pests | Registered Products | Application Rate (per acre, unless otherwise stated) | Integrated Pest Management Comments |
|---|---|---|---|
| **FIRE ANT CONTROL RECOMMENDATIONS (Throughout Season)** | | | |
| imported fire ants | Pyriproxyfen Esteem™ Ant Bait (7) | 1.5–2 lb **or** 2–4 tbsp per mound | Use Esteem Ant Bait in spring and again in autumn. Do not make other imported fire ant treatments for 7 to 10 days. |
| | Methoprene Extinguish™ Professional Fire Ant Bait 0.5% (7) | 1–1.5 lb **or** 3–5 tbsp/ 1000 sq ft **or** 3–5 tbsp/ mound | Do not apply Extinguish™ on hot days or too soon before rainfall. For heavy infestations, Extinguish™ may need to be reapplied every 10 to 12 weeks after the first treatment. |
| | Do not use AMDRO™ or any AMDRO™-based bait in blueberry fields | | Please note: Extinguish baits with methoprene that also have hydramethylnon (AMDRO) in their formulation are not labeled for use on crops. Amdro in any form is not labeled for use on blueberries. |
| | Malathion™ 57EC (1) | 1 pt | Malathion™ cover sprays applied to plants 1 day before harvest is an effective treatment for temporarily ridding plants of ants. |
| | Diazinon™ AG500 (1) | 1 pt/100 gal | Gently apply 1 gallon of drench in a 6-inch radius around each fire ant mound. |

Ant baits based on IGRs (insect growth regulators) are slow-acting and ineffective when used as curative treatments to "clean up" active infestations. IGR-based ant baits stop larval growth and worker ant production, thus leading to a colony's gradual extinction. Ant baits work best when soil is moist but not saturated with water, and when ants are actively foraging on warm, sunny days. Avoid applying ant baits when you expect conditions to become cool, overcast, rainy, or very hot. In the first year of ant control, two applications in spring or two applications in autumn may be required to reduce colony density. Without disturbing ants, pour a circle of insecticide around each mound. The circle should be about 2 to 4 feet outside the mound. Do not place bait directly on top of the mound.

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[a]IRAC (Insecticide Resistance Action Committee) groups are classes of insecticide products with similar modes of action (ways of killing a pest). Those products with the same IRAC group number (shown in brackets) should not be used in rotation or in tank mixes together. For example, Malathion™, Sevin™, and Imidan™ should not be used in rotation due to being in the same IRAC group (Group 1). Please refer to the IRAC Web site at http://www.irac-online.org.

## Propagation

Blueberries usually are propagated from softwood or hardwood cuttings selected from healthy, disease-free mother plants. Cuttings are placed in a propagation bed in a medium that holds moisture well but allows adequate aeration.

Take **softwood cuttings** (4 to 5 inches long) in late spring from the tips of the current season's growth. 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, stems very flexible) wilt readily. Cuttings taken too late (mature leaves, 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.

Take cuttings from the upper part of the mother plant. Use sharp, clean pruning shears or knives disinfected in a solution of 1 part household bleach to 5 parts water. 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.

**Hardwood cuttings** are taken during the dormant season after sufficient chilling has occurred, usually late January through February. Collect strong, healthy shoots, or "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.

Propagation beds need to be well-drained and under a shade cloth (40 percent to 70 percent shade), and have adequate ventilation. Avoid excessive wind movement that may interfere with mist control.

A **propagation medium** retains moisture well but allows aeration as 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).

The **mist system** should keep the media uniformly moist but not soggy. If only a few drops of water can be squeezed from a handful of media, the amount of moisture is probably correct. An intermittent-mist system is needed to 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 (non-wilted) leaves and high humidity. Frequent (every 2 to 10 minutes), short (2 to 10 seconds) misting intervals are recommended.

## Harvest and Post Harvest

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 varieties begin ripening 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 shortened considerably.

Blueberry fruit should be harvested every 5 to 7 days, and depending on variety, three to five pickings may be necessary to complete the harvest. In order to reduce field heat, fruit should be harvested in the early morning hours, late afternoon, or at night. To reduce postharvest fruit rots, delay picking until after the dew has evaporated. Some drying of dew-moistened fruit may be done in an air conditioned, low-humidity room.

Excessive rainfall can cause splitting of ripe berries. 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 into your 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 spreading of organisms that cause decay. Workers should be reminded 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. Portable toilets and hand-washing stations with soap and single use towels must be provided for pickers.

Blueberries can be mechanically harvested with a catch frame or over-the-row harvester. Because mechanical harvesting removes 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 conveyer 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. Blueberries should be stored and transported at temperatures of 32 °F to 35 °F and 85 percent 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.

## Cooling

Blueberries harvested at warm field temperatures are very perishable, and quality rapidly deteriorates. To ensure optimum shelf life and overall quality, fruit should be cooled within 4 hours of harvest or sooner if possible. 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, and 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 visible physiological damage resulting 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 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. Blueberries in the center of the pallets of 80 °F blueberries require more than 36 hours to cool to below 50 °F. Therefore, pallets of hot blueberries allowed to stand in a cooler without forced ventilation for several hours before shipment will not be cooled uniformly. Transport refrigeration provides little to no additional 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. 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. Depending on the circumstances, the rate of cooling may be 16 to 20 times faster. In situations where a considerable investment has already been made 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.

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