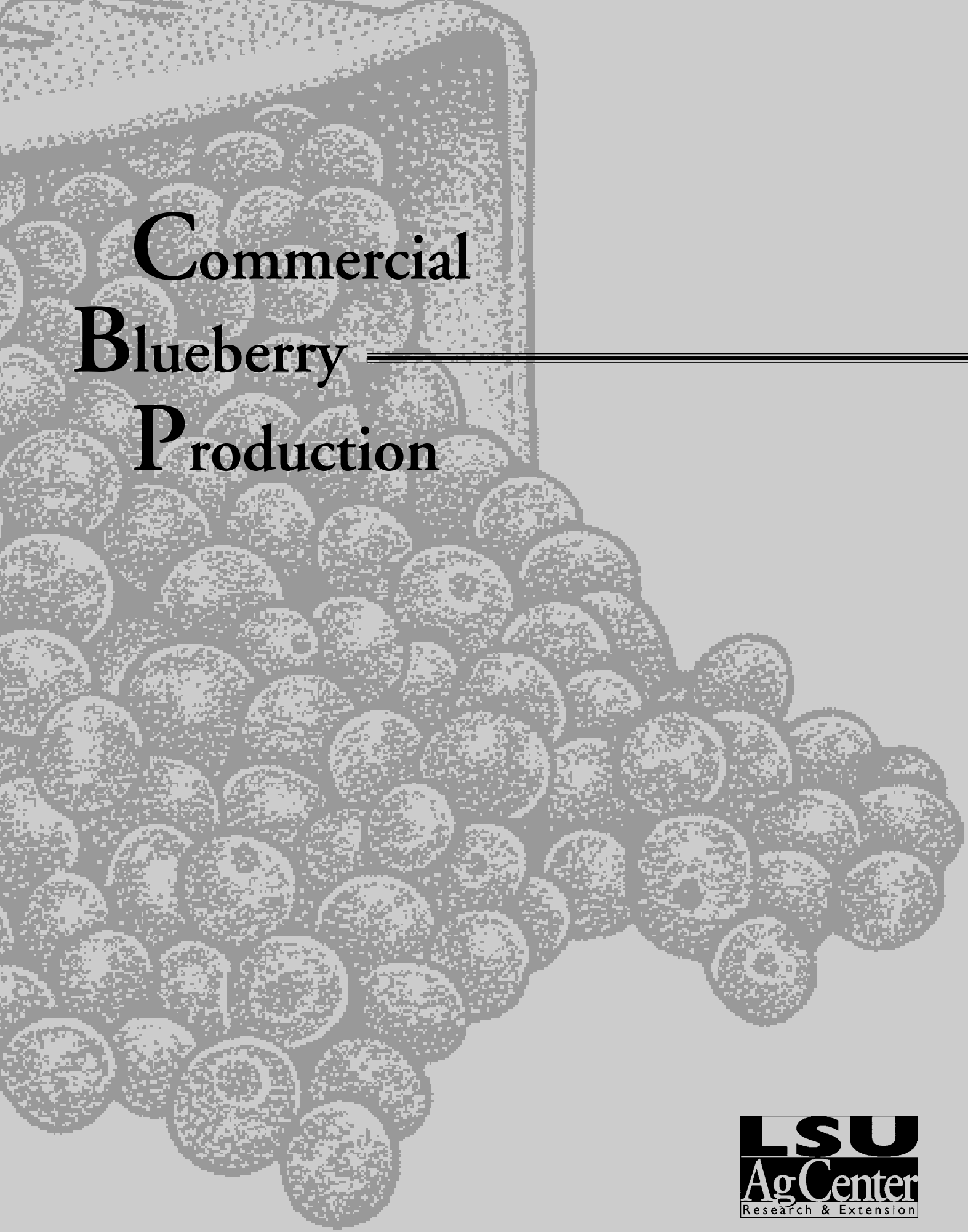
Commercial Blueberry Production



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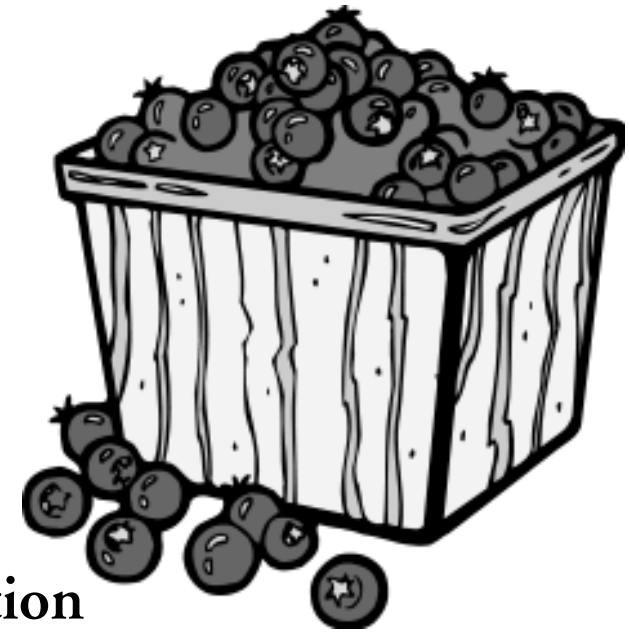

Commercial Blueberry Production

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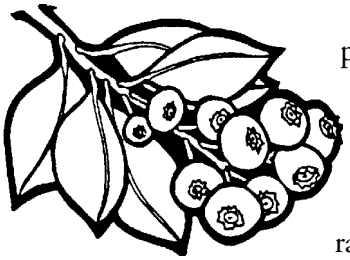
Introduction and History



Commercial blueberry production in Louisiana had its beginning more than 40 years ago with the introduction of improved varieties of rabbiteye blueberry (*Vaccinium ashei*). Since then, acreage has increased steadily.

Commercial blueberry production has been a viable industry throughout the United States for 50 years. Several blueberry species are native to this country. The high bush (*Vaccinium corymbosum*) and low bush (*V. Angustifolium*) species are adapted to the northern climates.

Rabbiteye blueberries are native to the southeastern United States, growing from the eastern sections of Texas to the Atlantic coasts of Virginia and Florida. The rabbiteye blueberry is not to be confused with the "huckleberry" (*Gaylussacia* genus). The two are distinguished from each other by their numbers and types of seed. The huckleberry has 10 large bony seeds, and the rabbiteye has numerous small seeds.

New hybrid cultivars of blueberries are being developed by geneticists who incorporate the higher fruit quality and shorter ripening period of the "Tetraploid" northern high bush blueberries with the Diploid and Hexaploid blueberries indigenous to the South. These newer cultivars, which ripen earlier than rabbiteye blueberries, can extend the marketing season and take advantage of premium prices before the eastern blueberries are available on the market. The "Tetraploid" cultivars (also known as "southern" or "low-chill" high bush) will increase in importance as more varieties are developed.

The rabbiteye species is the primary type grown commercially throughout the Southeast. It's important mainly because it grows on locations with more upland soil types than does the high bush blueberry. Also, the rabbiteye blueberry is not as sensitive to soil acidity and is far more heat- and drought-resistant than is the high bush blueberry.

Potential for Commercial Blueberries

Commercial blueberry potential in Louisiana can be measured in terms of how well you select a site, choose cultivars and plan for cultural practices. Production costs in Louisiana compare favorably with costs in other areas with commercial plantings. Marketing strategies and labor needs are two most important ingredients necessary for success.

A complete marketing program cannot be adequately outlined within the scope of this publication. Yet, marketing should be the one aspect of commercial blueberry production on which a grower spends the most time. Small one- to three-acre plantings can often be marketed as a pick-your-own (PYO) crop. But, PYO success in a given area is directly related to population and number of competing producers. Larger acreages need a more sophisticated marketing strategy pivoted on a reliable labor pool.

Although mechanical harvesting is available, most blueberries are harvested by hand. Mechanical harvesting is very expensive, and large acreage is needed to support this expense. Mechanically harvested blueberries can be sold on the fresh market only after they are cleaned and sorted. This requires a well-adjusted machine, a successful operator, proper timing of harvest and suitable cultivars. Not all the blueberries on a plant can be harvested on a single date because not all fruit ripens together. In the future, determinant ripening cultivars and improved technology may minimize this problem.

Exporting fresh blueberries to other states before the eastern varieties ripen has the most potential. The first blueberries from early cultivars are picked about May 15 in North Carolina, June 15 in New Jersey and June 10 in south Louisiana. Rabbiteye blueberries are late ripeners, with Louisiana's first week of production usually in early June in south Louisiana and mid June in north Louisiana. This time frame overlaps the second half of the North Carolina high bush harvest, but precedes the larger New Jersey harvest, opening an excellent marketing window for early June. Eventually, a May shipping season might be possible in Louisiana as earlier ripening rabbiteye

cultivars and disease-resistant high bush cultivars are developed.

Grower marketing cooperatives such as the Miss-Lou Co-op offer excellent opportunities for producers to consolidate their marketing and purchasing of supplies for a more cost-effective operation. The Miss Lou Co-op has, since its beginning, been an excellent marketing tool for Mississippi and Louisiana producers. All producers should consider joining.

Budget Considerations

Costs and expenses of establishing and managing blueberry acreage vary, depending on existing resources and levels of expertise of individual producers. The initial investment can be large if land, labor and machinery are purchased and charged to the cost-return ledger. Yet, many potential producers may already be involved in other phases of agriculture and have available land and resources that make the initial four years before the first paying crop less costly. The inputs for establishing and maintaining a blueberry planting follow. The total cost for the first year is about $3,000 per acre plus land cost. Most of this goes for purchasing plants, installing an irrigation system, mulch, peat moss and labor. Maintenance costs in years two through four are about $500-$1,000 per acre per year.

Inputs per acre required to establish a blueberry farm.

First Year

Land
Plants (604 plants per acre)
Irrigation installation
Plow land, once, 0.5 hour (tractor, plow and driver)
Disk harrow, twice, 0.3 hour each (tractor, disk and driver)
Lay off rows, once, 0.5 hour (tractor and driver)
Open furrows, twice, 0.3 hour each (tractor and driver)
Apply peat moss, once, 2.0 hours (tractor, trailer and driver)
Fertilize, 5 times
Set blueberry plants, 5.0 hours (tractor, trailer and driver)
Mulch beds, 5.0 hours (tractor, trailer and driver)
Irrigation electricity

Second and Third Years

Fertilize 5 times
Spray 5 times, 0.5 hour each (tractor, sprayer and driver) (herbicides and fungicides as recommended)
Mowing, 10 times, 0.4 hours each (tractor, mower and driver)
Pruning and hoeing (20 hours)
Irrigation electricity
Interest on establishment and pre-harvest costs
Harvesting and marketing
Picking labor
Labor benefits
Containers
Market preparation (including marketing and advertising)
Transportation
Supervision

Site Selection

Site selection should be based on several factors.

Market Considerations

It is critical to choose a site close to a large population if PYO is the primary means of marketing. Such a site should be located on a major thoroughfare, if possible, with the planting visible from the road. Market proximity is not as critical when the primary market is the wholesaler, but a reliable labor pool should be available.

Climatic Conditions

The rabbiteye blueberry is deciduous and requires a given amount of exposure to cold weather to satisfy chilling requirements and to induce flowering. The chilling requirement of rabbiteye blueberries (200-600 hrs.) is below that of high bush (650-800 hrs.). With inadequate chilling, both vegetative and flower buds grow unevenly. Flowers from such buds

will not set fruit. Therefore, do not plant rabbiteye blueberries along the coastal areas of Louisiana where chilling is commonly insufficient.

Topography

Avoid frost pockets by selecting elevated sites with open areas surrounding the planting. "Freeze-outs" are possible, particularly in north Louisiana during early spring when blueberries are in bloom. Open, well-ventilated areas also create a better environment for disease control. Avoid low areas where floodwaters may inundate a blueberry planting.

Soils

Blueberries have specific soil requirements and cannot be grown commercially on a wide variety of soils.

Blueberries require an acid, well-drained soil. Soil pH should be in the range of 4.2-5.5. Advice and counseling on soil testing can be obtained from your county agent. See section on soil testing.

pH

Good production in some soils with pH up to 6.0 may be possible, but nutritional problems such as iron deficiency may occur at high pH levels. Conversely, blueberries begin to lose production efficiency because of nutrient toxicities by manganese and aluminum, or potential nutrient deficiencies of calcium, magnesium, copper, boron and molybdenum at soil pH levels below 4.2. The higher pH soils can be adjusted to 5.5 by adding powdered sulfur. Lower pH soils can be raised by adding fine limestone. Both amendments need to be applied six months to one year before planting. Base rates on soil tests. Certain cultural practices may lower the soil pH. Adding peat moss at planting and using ammonium forms of nitrogen during the growing season will help lower pH.

Adjust soils with a pH above 6.0 to pH 5.4. Determining the amount of sulfur to add to obtain a specific pH level in the soil is not an exact science, and the application can be overdone. Sandy soils can be slightly acid in the top 6 inches because of previous nitrogen fertilization but still have an alkaline reaction in the subsurface depths. Such soils require pH adjustment for successful blueberry production, but an adjustment may be difficult and too costly.

Avoid sites where brush and timber have been burned. The basic minerals of ash will raise the soil pH above the range for best plant growth. Avoid recently limed land unless the lime was applied to raise the soil pH into the favorable range for blueberries. A soil test showing more than 900 pounds of available calcium per acre indicates that the soil was recently limed, and production problems may occur.

Soil Texture

Soil texture refers to the relative proportions of sand, silt and clay in a given soil. Soils are referred to as sands, loams or clays based on the proportions of each. Blueberry plants grow best in loam or sandy loam soils. The fine fibrous root system of the blueberry plant requires open, porous soils. These roots cannot penetrate compact, heavy clay soils. Blueberry plants grow best in soils containing large proportions of sand. Blueberries will grow in clay soils which have been amended with high levels of acid peat, but root growth is restricted.

Soil Organic Matter

Numerous reports refer to the importance of soil organic matter for blueberry production. Soils with potential for blueberry production in most southern states are usually low in organic matter. Mix peat with the soil at planting to overcome this deficiency. Milled pine bark will work about as well as peat and may be substituted.

Soil Depth and Horizon

When selecting a site, consider depth and horizon of potential soils. Soil horizons are layers of soil nearly parallel to the soil surface with distinct soil properties such as color, depth, organic matter content, pH and texture. Soils are classified according to their horizons and properties of these horizons. The surface horizon of an ideal soil for blueberry production contains 4 to 8 inches of a darker sandy loam and organic matter. This is the "A" horizon.

The next horizon of ideal blueberry soil is pale and lower in clay and organic matter content from eluviation (solubilization and leaching) of these materials. This is the "E" horizon. Areas in planted

fields where bushes die, or grow slowly, are often traced to the lack of an "E" horizon because blueberry plants do not grow as well in low organic matter clay soil as they do in sandier, more eluviated soils.

A third soil horizon desirable for blueberry production should occur from 24 to 40 inches below the soil surface. This "B" horizon is often characterized by a concentration of silicate clay that has moved down from the "A" and "E" horizons. The "B" horizon is desirable in soils used for blueberry production because it increases the soil's water retention.

Deep sands and other soils of low fertility and low water-holding capacity are marginally adapted for blueberry production. But, they can be used if properly fertilized and treated with organic matter and if an ample supply of good quality irrigation water is available. Generally, sands deeper than 60 inches are too dry for good blueberry production during extended low rainfall periods.

Soil Drainage

Adequate soil drainage is essential. Land is too wet for blueberries if the water table does not drain to a depth of 24 inches or more below the soil surface within 24 hours after a heavy rain. Gray clay in the subsurface horizons and closer than 24 inches below the soil surface indicates a potential problem with the water table. Red or yellow subsoils are preferred. The red color, like iron rust, means that the subsoil is well aerated and has no problem with excess water.

General Soils Areas in Louisiana

The general soil areas are shown in Figure 1. They are (1) coastal marshlands, (2) recent alluvium, (3) coastal prairies, (4) flatwoods, (5) loessial hills and Mississippi terraces and (6) coastal plain.

Coastal marshlands soils are generally unsuitable for commercial blueberry culture. These soils, although highly organic, are generally wetlands subject to inundation.

Mississippi alluvium soils are represented by three soil types. The Commerce soils are on the low natural levees that represent the highest elevation of flood plain. The Sharkey soils occupy level areas and depressions of the back swamps at low elevation. Mhoon soils are in the broad, level areas lying between the Commerce and Sharkey soils. Of these three soil types, only the Commerce soils have limited potential for commercial blueberries because of their more acceptable aeration and oxidation. But, these soils are not generally recommended for commercial blueberries.

Alluvium soils of the Red and Ouachita rivers. The major soil series of these young alluvial soils are Norwood, Yahola, Moreland and Perry. Norwood and Yahola soils occupy low natural levees at the highest elevations of the flood plain. The Perry soil is in flats and depressions of the back swamp areas. Moreland soils typically occur between the level levees and back swamps. The friable Norwood and Yahola soils are aerated and oxidized, well-drained and generally suitable for blueberry culture. Moreland and Perry soils are clayey throughout and poorly oxidized and are not good blueberry soils. The pH of the Red River soils is generally in the high range (6-7) and should be monitored closely before considering commercial blueberries. The pH of these soils is not easily altered permanently. They may not be acceptable for blueberries.

Coastal prairie soils are the Crowley soils and Midland soils. Associated with the soils of the coastal prairies is the Acadia soil that occupies the forested slopes along stream channels that cross the prairies. Of these three, only the Acadia soil is suitable for commercial blueberries. The Acadia soil has a friable silt loam surface layer with a weak, granular structure and mottled gray, brown and red clay subsoil that is firm when moist. Both the Crowley and Midland soil series have poorly drained upper strata with gray silt clay subsoil that restricts vertical drainage. They are not suitable for blueberries.

Flatwoods soils are flat and nearly level areas of poorly drained and somewhat poorly drained forested soils. The largest areas of flatwoods soils are in southwestern and southeastern Louisiana. In the southwest, the dominant soils are in the Caddo and Acadia series that occur on the level and nearly level ridges, and the Beauregard and Acadia series that occur on side slopes. Other than the Acadia series, they are considered marginal for blueberries.

Figure 1. General Soils of Louisiana

Gently Sloping to Hilly Coastal Plain - Shubuta, Ruston, Bowie, Lucy, Troup, Kirvin, Nacogdoches, Susquehanna, Ora, Sawyer, Boswell, etc., with Cahaba, Prentiss, Stough

Loessial Hills and Mississippi Terraces - Olivier, Loring, Memphis, Providence, Lexington, Calhoun, Jeanerette, etc., with Cascilla, Waverly, Collins

Flatwoods Areas - Caddo, Beauregard, Acadia, Frost, Calhoun, Zachary, Wrightsville, etc., with Bibb, Waverly

Coastal Prairies - Crowley, Midland, with Beaumont, Bernard, Acadia

Mississippi River Alluvial Soils - Sharkey, Mhoon, Commerce, Tunica, etc., with Cypremort, Dundee, Baldwin, Iberia, Jeanerette

Alluvial Soils of the Red and Ouachita Rivers - Moreland, Norwood, Yahola, Perry, Portland, etc., with Gallion, Hebert, Pulaski

Coastal Marshlands - Marsh Peats, Mucks, Clays and Harris, with Swamp Peats, Mucks and Clays

The northeast Flatwoods includes the somewhat poorly drained Olivier soil on level and nearly level ridges that lie a few inches above the poorly drained Calhoun and Frost soils with Zachary soils in flat depression along drainways. These soils have rather friable surface layers overlying a firm fragipan layer. Poor vertical drainage makes these marginal for blueberries.

Loessial hills and Mississippi terrace are represented by Memphis soils on level and sloping ridges and steeper side slopes, the Loring on gently sloping ridges and side slopes, the Olivier on nearly level and gently sloping ridges and on seepy foot slopes, and Calhoun on level tops of ridges, on flats and in depressions. All of these soils are silty throughout. They have friable silt loam surface layers and friable to firm silt clay loam subsoils. The Memphis soil is well drained and of all these series is most suited for blueberries, followed by the Loring series which is, at best, marginal.

Coastal plain soils occur in the area of predominately pine-forested slopes and hills located mainly in the northern half of the state. The major soil series of the coastal plain area are separated into three groups on the basis of soil permeability: permeable subsoils, moderately permeable subsoils and slowly permeable subsoils.

In the permeable subsoil coastal plain soils are the Ruston, Lucy, Troup and Bowie series, all of which have sands or sandy loam subsoils best suited for blueberries. Moderately permeable subsoils of the coastal plain soils are represented by the Nacogdoches, Shubuta and Ora series. Only the Ora series, because of the fragipan subsurface, is marginal for blueberries. The Nacogdoches are considered good blueberry soils with ironstone commonly occurring in the subsoil or throughout the soil profile.

The slowly permeable subsoil coastal plain soils group includes three soil series: Boswell, Susquehanna and Sawyer. These soils can be suitable for blueberry culture, depending on depth of topsoil and quality of subsoil. The deeper surface layers of sandy loam are best. These soils are generally underlaid with acid clays. The deeper the surface soils are separated from the poorly drained subsoil, the more suitable these soils are for commercial blueberries.

Soil Testing

Soil testing of a prospective blueberry site should begin one year before planting. Such tests determine nutrient content of the top 6 inches of soil, pH and calcium levels and determine the potential manganese and aluminum toxicity to blueberry plants. They also indicate the fertilizer requirements of that soil for nitrogen, phosphorus, potassium, calcium, magnesium, sulfur and micronutrients necessary to support vigorous plant growth. Subsurface samples should be taken to determine the pH and carbonates level. This indicates the presence or absence of native lime in these lower depths.

Collect both surface (2 inches to 4 inches) and subsurface (8 inches to 10 inches) samples from random locations in a prospective site. All individual samples can then be combined to form a composite sample. It is important to keep subsurface and surface samples separate. Your county agent's office has sampling instructions.

Site Preparation and Planting

Site preparation should begin one year before transplanting. It consists of land clearing and leveling, design, preplant weed control, subsoiling, cultivation and bed preparation.

If the selected site is wooded, clearing should be done well before planting. If trees and brush are bulldozed, do not burn them on the planting site. Wood ash leaves a chemical residue that can raise the pH for long periods. Remove trees and brush before burning.

On flatwood soils or other poorly drained soils, correct surface drainage problems. Leveling to fill low spots should be done carefully so you don't remove excessive topsoil.

Ditch digging, bed construction and other operations that mix soil horizons may affect soil pH adversely. Problems should not be severe if the soil pH is suitable, but high pH spots created by mixing soils should be treated with sulfur before planting.

Orchard Planting Design: The irrigation system is an integral part of the planting design and must be considered in this phase. If the site has a significant slope, then contouring of rows may be

necessary. The greater the slope, the greater the potential for erosion. Row spacing should be on 12-foot centers with plants spaced 3 feet to 6 feet within the row. A 12-feet x 6-feet spacing, the spacing most commonly used, will result in a plant density of 605 plants per acre.

The standard spacing for blueberries is 6 feet between plants and 12 feet between rows with 605 plants per acre. A closer spacing of 5 feet in the row is recommended for mechanical harvesting. Regardless of spacing used, the row eventually becomes a solid hedge.

Preplant Weed Control: Treat sites that have troublesome perennial weeds, such as bermuda and bahia, well before planting. Eradication of most weeds can be accomplished with a broadcast application of a nonselective herbicide such as Roundup. If there is the potential for soil erosion, or if the field is already in a desirable sod, weed control strips at each row location may be advisable. Carefully mark rows to ensure proper herbicide placement. This will allow an erosion control sod to remain between rows.

Soil Preparation: Any necessary adjustments to soil pH can be lowered by discing in powdered sulfur. There are practical limitations as to how low the pH can be adjusted. On soils naturally high in pH, the pH tends to return to its original levels as the effects of the sulfur wear off. Blueberries should not be planted on such soils. Sulfur is used effectively on soils that are naturally at 5.5 pH or lower and on soils that were acid in their native conditions but previously limed.

The pH adjustment with sulfur should begin six months before planting. If the pH is 5.4 or lower, do not adjust. Otherwise the amount of sulfur to be added is one pound per 100 square feet (500 pounds per acre) for every pH point above 5.4. Treat the entire site without regard to row location. Cultivate the field at least twice at seven- to 10-day intervals. This allows any remaining plant debris to dry out.

After cultivation, the site should be subsoiled at row locations. This promotes deep root penetration of blueberry plants. On heavier clayey soils, cultivate in organic matter such as pine bark into the plant row to improve soil structure. Cultivate sufficiently to develop a well pulverized, finely textured soil. Rows should be bedded on sites with poor surface drainage or with slopes of more than 6 percent. Using a turning plow, construct beds 4 to 10 inches high, flattened or slightly crowned.

Planting

If the soil is well tilled, planting will be simple. Poorly prepared sites will make planting difficult. Prepare the planting holes early to allow for moisture equalization of the soil and peat amendments. Make holes 18 inches to 24 inches in diameter and depth. A hand-dug hole may be practical for small plantings, but for large plantings use a tractor-mounted, power-off, auger-type digger. If an auger is used, score the sides of the hole with a shovel or sharp shooter. Scratches welded onto the auger will prevent glazing or compaction of the walls of the planting hole. Glazing of the walls of a planting hole will cause the hole to hold water much like a well. This can damage young plants.

Studies have shown that peat moss is beneficial to the survival and growth of blueberries. Because of the expense of peat moss, combinations of peat and finely ground pine bark or pine bark alone may be substituted. Use 1/3 cubic foot of peat moss per planting hole to form a 50:50 soil: organic mixture.

Mix soil with the peat in the hole. Other soil amendments, except nitrogen, may be added at this time. Such amendments are based on soil tests. Before planting, allow the soil and peat mixture to moisten either through rainfall or irrigation. To avoid drying, do not open the holes until just before planting.

Containerized plant handling. Do not allow containerized plants to dry out before planting. They can be planted any time, but late fall or early spring is optimal. Thoroughly break up the root ball at the time of planting. Be sure roots are spread into the freshly reopened planting hole. Breaking the rootball results in two to three times the growth in the first season when compared to plants with non-broken rootballs. Set plants slightly deeper than they were grown in the container. After replacing the soil and peat mixture, tamp the area lightly to fill all of the air pockets.

Bare root plant handling. The root system must remain moist until planted. Bare root plants should be planted only during the dormant season. Keep the root system covered with wet hay or peat moss at all times. Set plants at the same depth they

grew in the nursery. As soon as the bare-rooted plant is planted, prune the plant back 25 percent to 30 percent.

Other factors. The irrigation system must be ready to use as soon as plants are placed in the ground. Water all plants immediately after planting. Plantings have failed when allowed to stand dry while the irrigation system was being installed.

Young plants are poor competitors with weeds. The area at the base of the plant must be kept weed free.

Water Source and Quality

Before establishing a commercial planting of blueberries, obtain an ample supply of high quality water. Water quality can be determined through a lab analysis. This analysis will measure pH, electrical conductivity, cations (calcium, magnesium and sodium) and anions (carbonates, bicarbonates, sulfate and chloride).

Water pH. This indicator measures the general mineral content of the water. Water pH levels usually range from nearly 4.0 to 8.0 or higher. Below pH 7, the water is acid; above, the water is considered alkaline. A pH of 7 is neutral. Water with pH levels around 8.5 or higher usually contains an excess of bicarbonates which causes rapid increases in pH of acid, sandy soils. Waters with acid pH levels contain lower quantities of salts and are best for irrigating blueberry plants. Alkaline water generally contains too high a level of salts for blueberries.

Soluble salts. Dissolved salts are dissociated into electrically charged cations and anions. The common cations include calcium (Ca), magnesium (Mg), sodium (Na) and potassium (K). The anions include bicarbonate (HCO_3) carbonate (CO_3), chloride (Cl) and sulfate (SO_4).

Terms used by laboratories in reporting the levels of total dissolved salts (TDS) or cation and anions are: PPM - (1 part of salt per million parts of water or 1 milligram of salt per kilogram of solution). Also, the content may be expressed as milligram per liter of solution which is the same as ppm. Grains per gallon (gpg) may be used if 1 gpg is equal to 17 ppm. Some laboratories may report milliequivalents per liter (me/1). One milliequivalent is the equivalent weight of the element or compound in grams per liter (1000 cc) of solution. For example, the equivalent of Ca = atomic weight divided by valance or 40/2 = 20: therefore, 1 meg of Ca/l is equal to 20 ppm.

Electrical conductivity (EC). It is common practice for the salinity of water to be measured and reported as electrical conductivity (EC) in millisiemens or milliohoms per centimeter (ms/cm or mmho/cm). In converting ms/cm to ppm, multiply by 640; thus 1.5 ms/cm x 640 = 960 ppm.

Sodium absorption ratio (SAR). Water containing high HCO_3 or CO_3 tends to increase the soil pH. High sodium on soils containing clay can result in very poor soil structure. The soil runs together and is almost impervious to water. Some laboratories report the Sodium Absorption Ratio (SAR), which indicates the relative activity of Na as it reacts with clay. The SAR is determined by the following equation.

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

Cations are expressed as meg / 1

In most of Louisiana, a producer must be concerned with both the Na and TDS (total dissolved salts) in irrigation water. The suggested values in Table 1 are used to interpret the LSU samples.

Continued use of even low to medium levels of TDS or Na in irrigation water can result in a salt buildup that can become high enough to affect crop growth and yield adversely. A farmer should test his well for TDS and Na, and, if medium levels of either are detected, he should check his soils annually to determine accumulation in the soil.

The following example may be helpful in determining how much TDS and Na will be added per acre foot of water.

An acre foot of water weighs 2.72 million pounds. Therefore:

TDS ppm in water x 2.72 = TDS ppm per acre foot of water.

Na ppm in water x 2.72 = Na ppm per acre foot of water.

The factor for an acre inch of water is 2.72/12 - 0.227.

Table 1. Estimated guidelines for interpreting laboratory data on water suitability for blueberry production.

Water constituents[1]	No problem	Increasing problem	Severe problem
Salinity[1]	less than		more than
Ec, dS/m (mmho/cm)	0.25	0.25 to 1.5	1.5
ppm	160	160 to 960	960
SAR	less than		more than
water	1.0	1.0 to 3.0	3.0
Bicarbonates[2]	less than		more than
meg/liter	1.5	1.5 to 2.5	2.5
ppm	92	92 to 153	153
Chlorides	less than		more than
meg/liter	4.0	4.0 to10	10
ppm	142	142 to 355	355
Boron	less than		more than
(ppm or ug/g)	0.75	0.75 to 1.2	1.2

[1]Assumes that rainfall and extra water applied through normal irrigation will supply crop needs plus about 15 percent extra for salinity control.
[2] Table estimates may need to be even lower because of the bicarbonate effect on pH of acid, sandy soils.

Irrigation

Irrigation will increase blueberry yields and berry size. It is very beneficial during the fruiting period, especially just before and during harvest. Irrigation should be available with the first planting or transplanting. It will eliminate plant loss caused by dry soils. Irrigation gives plants a good start and enhances an earlier and larger harvest. Irrigation requires large volumes of water and is a major capital investment.

Water Requirements

Rainfall in Louisiana will normally average about one-half to one inch per week during the berry fruiting period. In full production, blueberries require 1.0 to 1.75 inches of water rainfall and irrigation water per week or 0.14 to 0.25 inches per day. A design rate of 1.75 inches per week (7 days) is recommended for sprinkler irrigation. A design rate of 6 gallons per tree per day is recommended for drip irrigation. Do not keep the root zone saturated all the time. Irrigate each area about twice per week to avoid a waterlogged soil. At each irrigation, provide enough water for a 3-1/2 day supply.

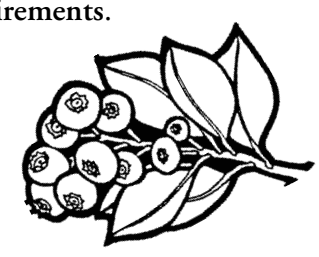
Sprinkler Irrigation Systems

To determine the flow rate in gallons per minute of water needed to sprinkle irrigate, use this equation:

$$GPM = \frac{27{,}154 \times I \times A}{60 \times D \times H}$$

Where A = Acres irrigated
I = Inches of water applied
H = Hours of operation per day
D = Days of operation to apply "I" to "A"
60 = Minutes per hour
27,154 = gallons per acre-inch
GPM = Gallons per minute

The pump must be able to deliver the water flow rates (GPM) needed (see example 1 through 3 or other desired rate) at about 60 PSI (pounds per square inch) for most systems. **The exact GPM and PSI** are determined **by designing for a particular orchard and irrigation requirements**.



Example 1: Sprinkler Irrigation Systems
A = 1.0 acre, I = 1.75 inches, D = 7 days,
H = 12 hours

$$GPM_1 = \frac{27{,}154 \times 1.75 \times 1.0 = 9.4\ GPM}{60 \times 7 \times 12}$$

GPM_1, required for 1 acre: 9.4
GPM_5, required for 5 acres: 47.0
GPM_{10}, required for 10 acres: 94.0
GPM_{15}, required for 15 acres: 141.0

This system will provide a design rate of 1.75 inches per acre every seven days operating 12 hours per day. A maximum of 3.50 inches can be applied every seven days in this example by pumping 24 hours per day instead of 12 hours per day. On the other hand, if 1.75 inches are adequate, then the flow rates required can be reduced by operating the system more hours per day and still apply the same amount of water. See example 2.

Example 2: Sprinkler Irrigation Systems (Recommended)
A = 1.0 acre, I = 1.75 inches, D = 7 days,
H = 18 hours

$$GPM_1 = \frac{27{,}154 \times 1.75 \times 1.0 = 6.3\ GPM}{60 \times 7 \times 18}$$

GPM_1, required for 1 acre: 6.3
GPM_5, required for 5 acres: 31.5
GPM_{10}, required for 10 acres: 63.0
GPM_{15}, required for 15 acres: 94.3

This system will provide a design rate of 1.75 inches per acre every seven days operating 18 hours per day. Its maximum capability is 2.4 inches per acre every seven days operating 24 hours per day.

Example 3: Sprinkler Irrigation Systems (Minimum)
A = 1.0 acre, I = 1.0 inches, D = 7 days,
H = 18 hours

$$GPM_1 = \frac{27{,}154 \times 1.0 \times 1.0 = 3.6\ GPM}{60 \times 7 \times 18}$$

GPM_1, required for 1 acre: 3.6
GPM_5, required for 5 acres: 18.0
GPM_{10}, required for 10 acres: 36.0
GPM_{15}, required for 15 acres: 54.0

This system will provide a design rate of 1.0 inches per acre every seven days operating 18 hours per day. Its maximum capability is 1.3 inches per acre every seven days operating 24 hours per day.

Drip Irrigation Systems

The design rate for blueberries is based on 6 GPM per bush per day. Using 605 bushes per acre (6 feet x 12 feet spacing) requires 3,630 gallons per day per acre (6 x 605 = 3,630). The design pumping time is 18 hours per day. To pump 3,630 gallons in 18 hours requires a pump rate of 202 gallons per hour or 3.36 GPM. From ponds or lakes, the minimum amount of water storage recommended is 1.5 acre-feet for each acre irrigated.

Operated for 18 hours per day, this system applies 6 gallons per bush to 605 bushes. If operated 24 hours per day, it can apply 8 gallons per bush to 605 bushes. Thus, this system can apply a maximum of 8 gallons per bush per 24 hours at a flow rate of 3.36 GPM per acre. Two acres would be the same except at a flow rate of 6.72 GPM per 2 acres. Five acres would have the same capabilities at 16.8 GPM.

Table 2. Number of blueberries per acre* and GPM per acre to apply 6 gallons per bush operating 18 hours per day.

Spacing between rows	Spacing within row			
	5'	6'	8'	
10'	871 4.84 GPM/AC	726 4.03GPM/AC	545 3.03 GPM/AC	
12'	726 4.03 GPM/AC	605 3.36 GPM/AC	454 2.52 GPM/AC	
14'	622 3.46 GPM/AC	519 2.88 GPM/AC	389 2.16 GPM/AC	

*One acre = 43,560 square feet

For newly planted bushes, use an average of about 0.25 gallon per day per bush; for half-grown bushes use about 3 gallons per day per bush; for full-grown bushes, use about 6 gallons per day per bush. Sample the root zone for excess wetness or excess dryness. Based on the soil moisture sample, adjust the quantity of water applied per day as needed.

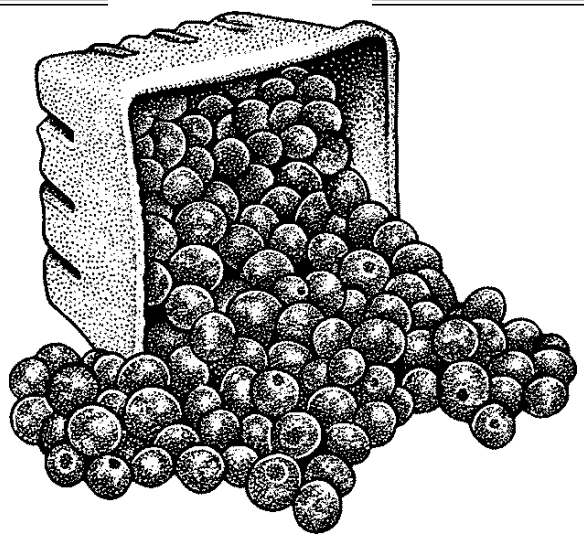
Lateral lines are usually about 5/8 inch to 3/4 inch in diameter. They are special material plastic liner (not regular polyethylene, P.E. pipe). Normally they are 1,000 feet or less in length. The lateral is usually placed on the soil surface near the base of the bushes and lengthwise the row. Emitters are installed on lateral drip lines according to bush spacing. Usually one emitter is used per bush. Its flow rate is usually 0.5, 1.0, 1.5 or 2.0 gallons per hour (GPH). For grown bushes, one emitter every other bush should be adequate if the system is designed and operated properly. To reduce emitter costs, use a row tubing with holes about every 12 inches to 24 inches. This should work well for producing bushes, but it wastes some water on newly set plants.

Major materials for a blueberry sprinkler irrigation system with a 6 feet by 12 feet spacing.

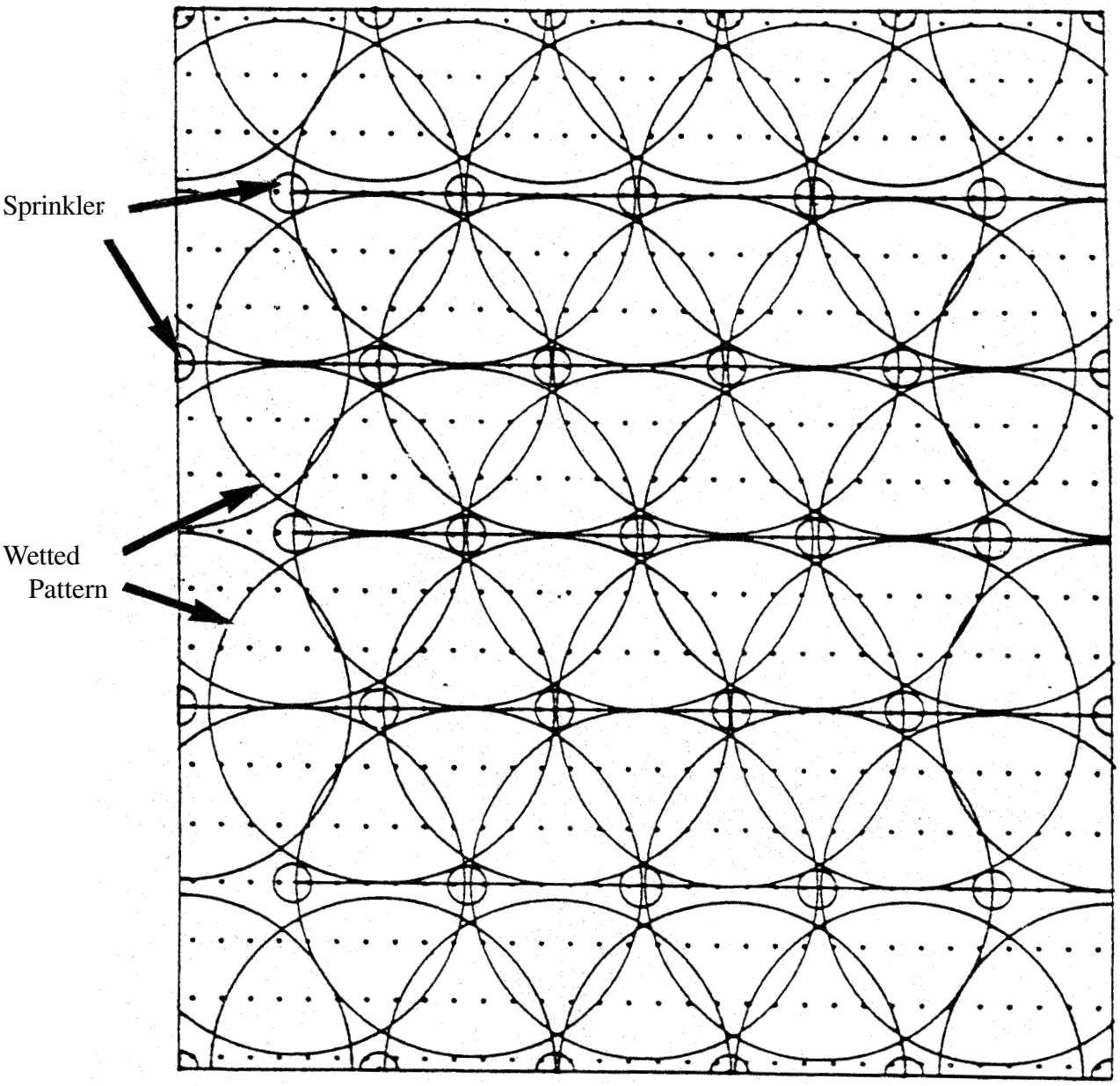
Item number	Item name	Number required (Approximate)				Cost
		1 Acre	5 Acres	10 Acres	15 Acres	
1.	Rainbird Impact Sprinkler Model P3-PJ-07, 7/64 inch nozzle, ½ inch male thread, 25 PSI operating pressure	4	20	40	60	
2.	Rainbird Impact Sprinkler Model P3-PJ-10, 5/32 inch nozzle, ½ inch male thread, 25 PSI operating pressure	35	175	350	525	
3.	Quick cut off valve 1/4 inch female threads	39	195	390	585	
4.	PVC Adaptor, pipe to PVC, male thread by female socket, ½	39	195	390	585	
5.	Riser pipe, ½ inch, plain ends, 8 feet long	39	195	390	585	
6.	Stake, treated wood, 8 feet long, riser support	39	195	390	585	
7.	Reducing tree, PVC, 3/4 x 3/4 x ½ socket	32	160	320	480	
8.	Reducing ell, 90 degrees PVC, 3/4 x ½ socket	7	35	70	105	
9.	PVC pipe, Schedule 40, 3/4 inch, lateral line	1,500	7,500	15,000	22,500	
10.	Water Source, GPM	6.3	31.5	63.0	94.3	
	Approximate PSI required	50	50	60	60	

Major Materials for a blueberry drip irrigation system with a 6 feet by 12 feet spacing

Item number	Item name	Number required (Approximate)				Cost
		1 Acre	5 Acres	10 Acres	15 Acres	
1.	Water source, GPM	3.36	16.8	33.6	50.4	
	Approximate PSI required	25	30	35	40	
2.	Cut off valve, No.:	1	1	1	1	
	Sizes:	3/4"	1"	1 ½"	2"	
3.	Water Meter No.:	1	1	1	1	
	Size:	5/8"	1"	1 ½"	1 ½"	
4.	Check Valve, No.:	1	1	1	1	
	Size:	3/4"	1"	1 ½"	2"	
5.	Pressure Regulator	1	3	3	3	
6.	Pressure Gauge	1	3	3	3	
7.	Chemical Injector	1	1	1	1	
8.	Filter	1	1	1	1	
9.	Water Treatment Unit	1	1	1	1	
10.	PVC, Supply Pipe	100	300	750	1,000	
11.	PVC, Tees	2	5	10	15	
12.	One GPH Emitters, NO.:	605	3,025	6,050	9,075	
13.	Lateral Line, feet:	3,630	18,150	36,300	54,450	
14.	End Plugs, Caps	24	60	120	180	
15.	Lateral, Tees	24	45	90	135	
16.	Valve	3	3	3	3	

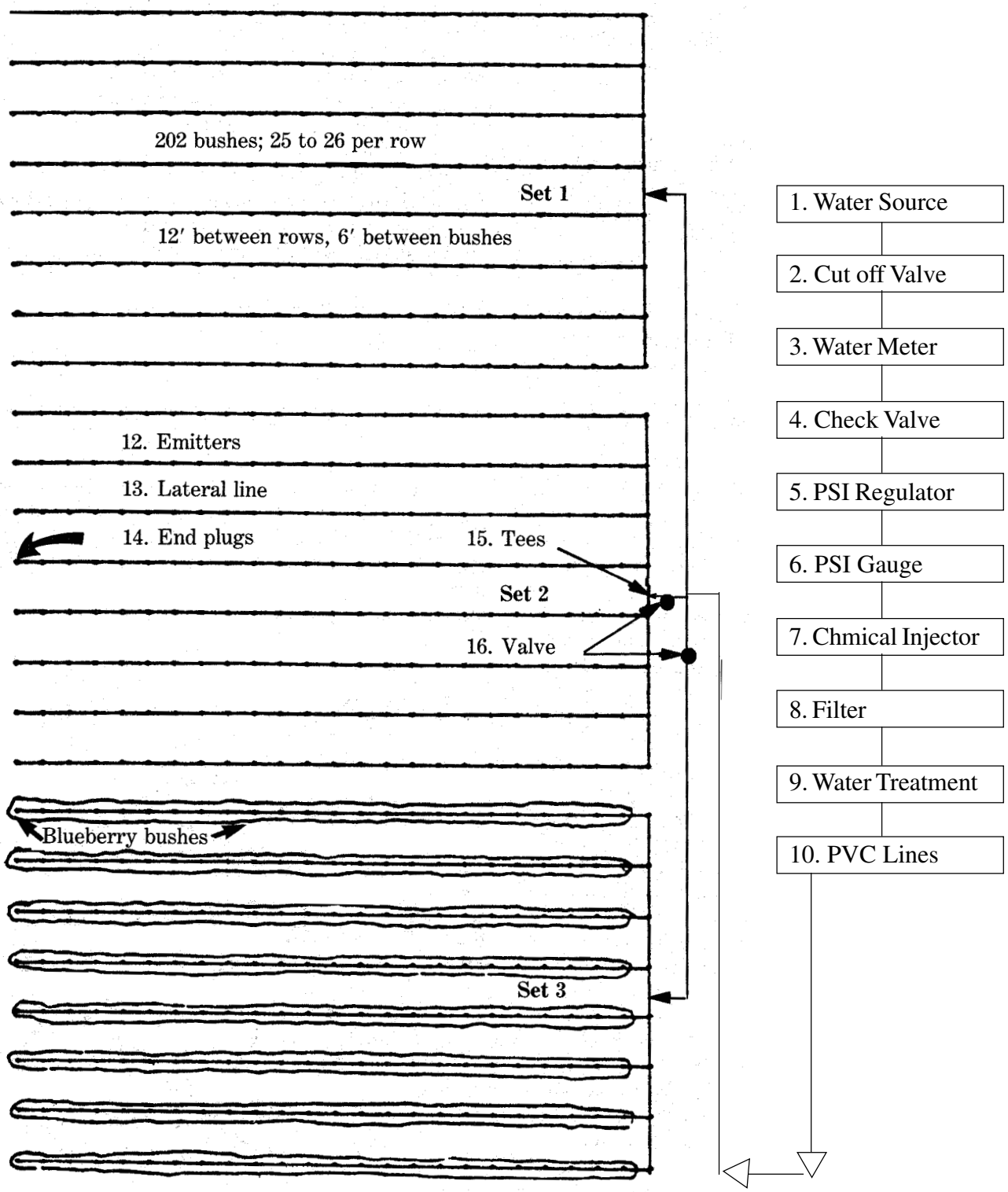


One-acre Sprinkler Irrigation System



Specification: One acre, 192 inches x 228 inches (1.005 Acre). Each row 192 feet long, 32 plants spaced 6 feet apart. Rows are spaced approximately 36 inches apart from a triangular pattern. There are 12 "sets." Each set consists of three full circle sprinklers or up to six part circle sprinklers or a combination thereof.

One-acre Drip Irrigation System



Irrigating with Marginal Quality Water

Regardless of the irrigation method or rate, blueberry plants irrigated with marginal quality water will grow and produce poorly. But, if plants are already established on a site with marginal quality water, some of the harmful effect of salinity can be reduced by modifying the recommended irrigation practices.

First, increase the irrigation rates at least 50 percent. Second, fertilizer rates must be reduced and no fertilizer applied until 3 inches to 4 inches of rain have occurred since the last application. This allows salts from both the irrigation water and the previous fertilizer applications to leach out. Avoid fertilizing during dry summer months.

If young plants are drip irrigated on light textured soils, use only one emitter per plant. Salts from the water concentrate at the perimeter of the wetting pattern. With a single emitter per plant, this highly concentrated salt zone moves away from the main root mass. With an emitter on each side of the plant, the salt zone concentrates at the center of the root zone, and salt burn can occur. In heavier soils, this phenomenon is less pronounced because of a wider wetting pattern and greater buffer capacity.

Research at Overton, Texas, indicates that when marginal quality water is used, better plant growth was obtained with low volume spray emitters than with drip emitters. A heavy application of sawdust mulch also reduced salt damage. Better plant growth was obtained in a clay loam than in a sandy loam when marginal quality water was used.

Weed Control

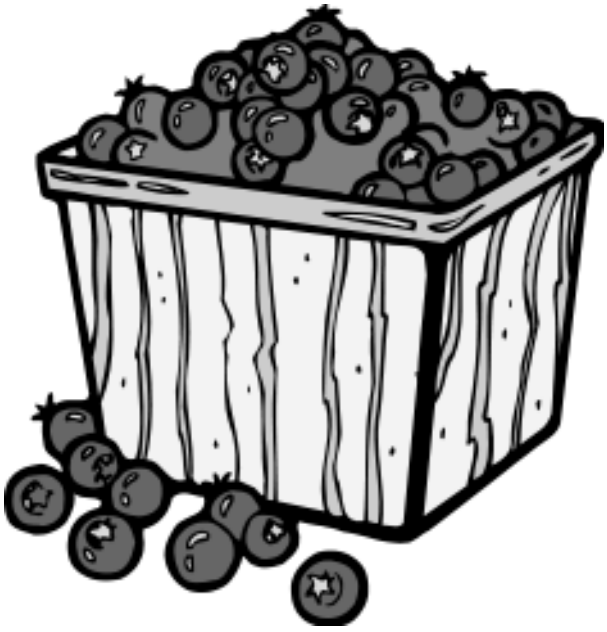
Effective weed control is probably the most neglected aspect of commercial blueberry production. Most beginning producers fail to appreciate the negative impact that weeds have on blueberry plants, particularly in early years.

Blueberry plants compete poorly for water and nutrients. Good weed control has to be an integral part of a blueberry management plan. Blueberry plants have a shallow, delicate root system. Irreparable damage may occur by allowing troublesome weeds to survive around blueberries even briefly.

Weeds may be controlled with either mechanical or chemical management systems. Mechanical means are by far the least cost-effective compared to chemical systems. Mechanical weed control ranges from hand hoeing to shallow cultivation with a rotary tiller or cultivator. Mechanical control is temporary, since it removes only established weeds and does not prevent re-establishment as do pre-emergence herbicides.

Chemical weed control is the most efficient way to control weeds around blueberries. Two types of herbicides should be used, post-emergence and pre-emergence. Post-emergence herbicides are applied to the foliage of competing vegetation. Pre-emergence herbicides are applied to the soil surface to prevent weed seed germination or emergence. They are most effective when applied to a clean, weed-free soil surface. Herbicides are often more effective when used in combination to kill a broader spectrum of weeds. Most herbicides work only on specific weeds. No single herbicide is effective on all weeds.

Weeds should be controlled around blueberries in a band about 3 feet wide. Practice herbicide rotation, and use post-emergence following pre-emergence application to control escaping weeds in the herbicide band. Sod can be maintained in the middles and controlled by mowing.



Blueberry Weed Control

Table 3.

Rate/Acre Active Ingredient	Rate of Formulated Material for 1 Acre Broadcast	Time to Apply	Weeds controlled	Remarks
oryzalin. 2-0-4.0 lbs	Surflan 4AS 2.0-4.0 qts	Pre-emergence	Annual grasses and broadleaf weeds	DO NOT apply to established plants until soil has settled. Apply before annual weeds emerge
diuron 1.2 to 1.6 lbs	Karmex 80W 1.5 - 2.0 lbs	Pre-emergence	Annual weeds	Use only under plants established in the field for 1 year. Repeat treatment in fall after harvest. DO NOT use in soils with less than 2% organic matter.
simazine Spring Fall 2.0 + 2.0 lbs 2.0 + 2.0 lbs 2.0 + 2.0 lbs 2.0 + 2.0 lbs 2.0 + 2.0 lbs	Princep 80W 2.5 + 2.5 lbs Princep 90 DG 2.2 + 2.2 lbs Princep 4G 50.0 + 50.0 lbs Princep 4L 2.0 + 2.0 qts Sim-trol 4L 2.0 + 2.0 qts	Pre-emergence	Annual grasses and broadleaf weeds	Use a different herbicide in the spring to control a broader weed spectrum. DO NOT use on gravelly, sandy or loamy sand soils. DO NOT apply when fruit is present.
terbacil 0. 5 - 1.0 lb	Sinbar 80W 0.6 - 1.2 lbs	Pre-emergence	Annual weeds	USE only under plants established for 1 year. Apply in spring or after harvest in the fall before weeds emerge but are less than 2 inches tall. Avoid contact of foliage and fruit with spray or mist.
norflurazon 2.0-4.0 lbs	Solicam 80 DF 2.5-5.0 lbs	Pre-emergence	Annual grasses, some broadleaf weeds, perennial weeds	Apply fall or early spring before weeds emerge. DO NOT apply on newly established planting until soil has settled. Apply once a year.
napropamide 4.0 lbs 4.0 lbs	Devrinol 50WP 8.0 lbs Devrinol 10G 40.0 lbs	Pre-emergence	Annual weeds	Apply to weed-free soil or fall before annual weeds emerge. May be used on newly planted and established plants until soil has settled. Devrinol must be irrigated in with sufficient water to wet soil 2 inches to 4 inches within 24 hours of treatment.

Table 3. Continued

Rate/Acre Active Ingredient	Rate of Formulated Material for 1 Acre Broadcast	Time to to Apply	Weeds controlled	Remarks
paraquat[1] 0.5 lb	Paraquat + Plus Wetting Agent 2 lbs/gal 1.0 qt Gramoxone 2 lbs/gal 1.0 qt	Post-emergence	Annual weeds	Apply as a directed with 32 oz. nonionic surfactant/100 gals. of spray solution. Apply as a coarse spray to avoid new shoots. *Avoid drift contact with young shoots, or severe injury will occur.
fluazifop 0.5 lb 0.25 lb	Fusilade 4E 1pt Fusilade 2000 1 qt	Post-emergence	Annual weeds	Apply to NON-BEARING bushes that will not be harvested within 1 year. Direct spray. DO NOT contact blueberry foliage. Always use a crop oil concentrate or a non-ionic surfactant. Broadleaf weeds and nutsedge will not be controlled with Fusilade.
sethoxydim 0.28-0.47 lb	Poast 1.5-2.5 pts	Post-emergence	Annual weeds	Apply to NON-BEARING bushes not harvested in 1 year. Direct spray. Use flat nozzle tips. Always use a nonphytotoxic oil concentrate. Broadleaf weeds and nutsedge will not be controlled.

[1]Paraquat should be applied in a minimum of 40 gals./A. Paraquat's effectiveness may be reduced if pond water is used.

Plant Nutrition*

Blueberry plants require 13 mineral elements for normal growth. The three used in largest quantities and most frequently needing replacement in soils are nitrogen, phosphorus and potassium. Calcium, magnesium and sulfur are considered secondary nutrients. They are used by the plant in large amounts but usually require only periodic replacement in soils. The micronutrients of boron, iron, molybdenum, copper, manganese, zinc and chlorine are used in small amounts. Most soils contain sufficient micronutrients, so they are added only if abnormal plant response (familiar symptoms) or a soil or leaf analysis indicates a deficiency. Some nutrients, such as boron, copper, manganese and sodium, can be toxic in high concentrations.

Foliar Nutrient Deficiency Symptoms

Nitrogen. Nitrogen deficiency is observed by reduced growth, followed by older bottom leaves turning yellow-green. In more severe nitrogen deficiencies, the entire plant appears yellow-green. As the deficiency progresses, new leaves turn red. Very small necrotic (dead) spots on the leaves may also be seen. Older leaves drop, and new leaves are considerably smaller than healthy leaves. Young leaves will have a distinct pink color and turn pale green when growth ceases. Symptoms of nitrogen deficiency are most common in late summer and can be easily confused with water stress.

Phosphorus. Deficiencies in phosphorus are not as distinct as for other elements. Older leaves may be dark purple-green. Young leaves are smaller and have a purple cast. This coloration may be difficult to see except in bright sunlight. It is different from the reddening produced by a lack of nitrogen or moisture.

Potassium. Potassium deficiency is indicated by some interveinal chlorosis (yellow between veins) at the tips of young leaves. Older leaves show the most distinct symptoms. They have scorched or dead spots on the leaf edges. The necrotic spotting may spread over the whole leaf. Advanced potassium deficiencies result in severe marginal scorching. As scorching proceeds, the affected area curls upward.

Magnesium. Deficiencies in magnesium are common in blueberries. Interveinal leaf margins, most common on older bottom leaves, turn a distinct red. Interveinal marginal chlorosis may precede this red discoloration. The green areas that remain on leaf veins have a distinct Christmas tree or V-shaped appearance. Leaves may cup inward. Old leaves eventually drop off and leave long, bare stem sections. Symptoms are most prevalent in late summer or on sandy soils.

Calcium. Calcium deficiency symptoms are not easily recognizable. Young leaves and, to a lesser extent, older leaves may show marginal yellowing and scorching. Terminal leaves may have slight yellow-green blotches.

Sulfur. Symptoms of sulfur deficiency are similar to nitrogen deficiency except that the general yellowing of the leaves is lighter and occurs on younger leaves first. An almost completely bleached or white-pink appearance on the entire leaf may be apparent on new growth. Older leaves usually remain green. Sulfur deficiencies are most common in deep acid sandy soils.

Boron. Shoot die-back is the most common symptom in boron-deficient blueberries. Terminal leaves are small, frequently misshapen and may be bluish. Slight yellowing or yellow spotting along leaf margins may be present.

Iron. Symptoms appear first on young leaves as an interveinal chlorosis. Veins and subveins stand out distinctly like a green net over the entire leaf. The yellowing may progress over the entire plant. Plants on soils with a pH higher than 5.5, excessive lime or phosphorus or waterlogged conditions are the most likely to become iron deficient.

Zinc. Like iron, zinc deficiencies include interveinal yellowing of younger leaves. It is distinct from iron in that leaves are small and the distance between leaves is shortened. Symptoms usually appear in the first part of the growing season and become less distinct in summer and fall.

***Reprinted in part from: Patton, K., Texas Blueberry Handbook, 1987 production and marketing. Texas Agr. Extension Service/Texas Agr. Experiment Station, Texas A&M University, College Station, Texas.**

Other nutrients. Manganese, copper and molybdenum are usually not a problem unless the soil pH goes below 4.0. Then manganese can become toxic. Deficiency of copper or molybdenum could also occur. Plant symptoms for these elements are unclear.

Other common nutritionally related symptoms. Any type of plant stress that ultimately damages the root system, such as water stress, herbicide damages, too much fertilizer, poor quality water or soil pH less than 4.0, causes a multitude of plant symptoms. Mild salt or fertilizer injury is indicated by brown leaf spots, particularly around leaf margins and on younger leaves. These appear one to five days after the fertilizer has been dissolved by rain or irrigation. Severe salt injury causes leaf drop and plant death. Low pH and salt damage also cause severe yellowing or bleaching of new leaves, tip die-back, small leaves, purple or red discoloration, and poor to no growth.

Plant symptom diagnosis. Once leaf symptoms occur, the deficiency or toxicity is already severe enough to reduce growth and fruit production. It is best to correct the nutritional problems before the symptoms occur. Use leaf and soil analyses for this purpose. Frequently, deficiencies of more than one element at a time may occur. This causes compound plant symptoms and makes it difficult to diagnose element deficiencies correctly in the field. Plant leaf analysis also helps in this situation. The ultimate test of any diagnosis is the plant's recovery when treated with the deficient element in question.

Leaf analysis. Analysis of leaves for nutrient content can be useful in determining a fertilization program. In general, leaf analysis is needed only every three years. If a nutritional problem exists more frequently, analysis may be required until the problem is corrected.

To obtain meaningful results, pick leaves for analysis from fruiting shoots during the last week of harvest. Select the youngest full-sized (recently matured) leaves, generally the third to sixth from the tip of the shoot. Take five to seven leaves from each of 10 to 15 bushes for each sample. Select bushes at random over the entire sample area. If possible, avoid dusty samples. For micro-element analysis, don't take leaves sprayed with chemicals or nutrients.

Foliar nutrient levels for blueberries are in Table 4. If a value for any particular element is in the deficiency zone, modification may be necessary. For micronutrient deficiencies, consider foliar sprays suggested in Table 5.

Table 4. Foliar nutrient levels of rabbiteye blueberries.

Element	Deficiency below	Sufficient range minimum	Toxicity maximum	level
Nitrogen (N)	1.2%	1.4%	1.8%	
Phosphorus (P)	0.09%	0.10%	0.20%	
Potassium (K)	0.35%	0.40%	0.60%	
Calcium (Ca)	0.10%	0.20%	0.40%	
Magnesium (Mg)	0.08%	0.15%	0.25%	
Sulfur (S)	0.10%	0.125%	0.20%	
Manganese (Mn)	23 ppm	50 ppm	350 ppm	500 ppm
Iron (Fe)	60 ppm	60 ppm	200 ppm	
Zinc (Zn)	8 ppm	8 ppm	30 ppm	
Copper (Cu)	5 ppm	5 ppm	20 ppm	100 ppm
Boron (B)	20 ppm	30 ppm	70 ppm	200 ppm

Table 5. Foliar sprays for correction of micronutrient deficiencies in blueberries.

Nutrient	Material	Rate/100 gal.	Timing
B (Boron)	Solubar	1.5 lbs. product	Any time leaves are present.
Fe (Iron)	Iron chelate	Follow label instructions	Apply to leaves when symptoms appear.
Mn (Manganese)	Manganese chelate	Follow label instructions	Any time leaves are present.
Zn (Zinc)	Zinc chelate	1-2 lbs. product	1 to 3 times during growing season.
Cu (Copper)	Copper sulfate	1 lb. product	Any time leaves are present.
Mo (Molybdenum)	Sodium molybdate	1/4- 1/2 lb. product/acre	Any time leaves are present.

Fertilization Program

Nitrogen. The demand for nitrogen by blueberries is relatively minor compared with its use by other crops. Nevertheless, nitrogen is the most important element needed for blueberries. Sandy soils used for growing blueberries are essentially void of nitrogen. Nitrogen applied in the spring is quickly leached out by heavy rains.

Because blueberries are sensitive to fertilizer burn, apply nitrogen only in several small applications during the peak growing seasons of spring and fall. Avoid a single heavy application of nitrogen in the spring. Do not make the last nitrogen application until sufficient rains have leached the previously accumulated salts from the soil.

In addition to avoiding fertilizer injury by making only frequent small applications of nitrogen, it is critical that fertilizer of any sort never be applied in a concentrated area at the base of the plant. Serious root damage and possible plant death will occur. Instead, uniformly sprinkle fertilizers around the outer base of the plant, extending at least one foot past the spread of the branches. Wait at least one to two months before fertilizing newly set plants.

Blueberries are not only sensitive to the amount of nitrogen fertilizer but also to the type of nitrogen. Blueberries respond best to ammonium types of nitrogen fertilizer. Avoid fertilizer containing nitrate nitrogen. Urea nitrogen and organic forms of nitrogen (cottonseed meal) convert to ammonium, making them acceptable nitrogen fertilizer sources.

All ammonium fertilizers, especially ammonium sulfate, have an acidic reaction with the soil. Continual use of ammonium sulfate in a sandy soil may reduce the soil pH from 5.5 to 3.5 within one to two years. With drip irrigation, this effect is accentuated in the perimeter of the wetting front. The area next to the emitter may have a pH of 5.0, while the pH of the outer edge of the wetting front where the ammonium sulfate accumulates may be 3.5. 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 soil pH is above 5, ammonium sulfate can be used. The soil pH around the blueberry plant must be measured yearly. Low soil pH (less than 4.0) is one of the most frequent problems in blueberry plantings.

For the first two to three growing seasons, the main objective of fertilizing is to obtain as much growth as possible without fertilizer burn. Once plants begin bearing, excessive vigor is not desirable, and plants do not need to be pushed with high nitrogen rates. The nitrogen fertilizer recommendations for blueberries in Louisiana are in Table 6. Use these rates only if plants are irrigated frequently with good quality water. If you're unable to water at the recommended rate, reduce nitrogen rates by half. Two suggested options are listed with respect to the type of fertilizer blend. If plants show typical nitrogen deficiency symptoms and soil moisture is adequate, more nitrogen may still be needed.

A leaf analysis also helps detect an approaching nitrogen deficiency before it becomes serious enough to cause deficiency symptoms. Don't give an extra large "catch up" dose to small, stunted plants. It will do more harm than good. Excessive growth caused by too much nitrogen also reduces yields. Reduce nitrogen rates if excessive vigor on mature plants occurs. It's important to adjust the fertilizer rate based on overall plant response.

Alternative fertilizer blends other than those suggested in Table 6 may be used as long as the overall rates and an ammonium-nitrogen source are used. Excellent results have been obtained by using slow-release nitrogen sources such as Nitro-form. If a slow-release nitrogen is applied, apply it less frequently.

Phosphorus and potassium. The fertilizer program in Table 6 should provide sufficient phosphorus and potassium in most situations, but take periodic soil tests and leaf analyses to assure that phosphorus and potassium needs are met. Table 7 indicates the appropriate fertilization rates for different soil levels of phosphorus and potassium.

If soil tests and leaf analyses indicate that more phosphorus or potassium is needed, use the mixed blend more frequently in place of just nitrogen. For a phosphorus-only application, use 0-18-0 (superphosphate). For a potassium-only application use 0-0-52 (potassium sulfate) or 0-0-22 (potassium-magnesium-sulfate).

Other nutrients and pH. Magnesium deficiencies frequently occur in blueberries. Use soil tests (less than 50 parts per million) and leaf analyses (less than 0.08 percent) to determine if supplemental magnesium is needed. In soils where there are eight parts of calcium to one part of magnesium, magnesium deficiency may also occur. If the soil pH is less than 4.0, apply a very fine dolomitic limestone (500 pounds per acre) to correct a magnesium deficiency. At soil pH higher than 4.0, apply potassium-magnesium-sulfate or epsom salts in the spring. On mature plants, use 2 ounces per plant. On young plants, use 1 ounce per plant.

For deficiencies of other major elements, check with the Extension Service for recommendations. Correct micronutrient deficiencies when confirmed with a leaf analysis by using foliar application rates.

Table 6. Blueberry fertilizer recommendations.

	Ounces per plant							
	12-12-12				Ammonium sulfate* or 15-5-10 alone			
	March	April	May	September**	March	April	May	September**
Year 1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	2.0	1.0	1.0	1.0	2.0	2.0	1.0	1.0
3	3.0	1.0	1.0	1.0	2.5	2.5	1.0	1.0
4	4.0	2.0	2.0	2.0	3.0	3.0	2.0	2.0
5	5.0	2.0	2.0	2.0	3.5	3.5	3.0	2.0

*Below pH 5, use urea as the nitrogen source. When using urea in place of ammonium sulfate, apply after as much as Table 6 rates.
**Do not make the last fertilizer application until residual salts have been leached from the soil by 3 to 4 inches of rain or by sprinkler irrigation with water low in salts.

Table 7. Supplemental fertilization rate for phosphorus and potassium.

Potassium		Phosphorus	
Soil test (ppm)	Ounces of 0-0-52/plant	Soil test(ppm)	Ounces of 0-18-0/plant
40 very low	5	6 very low	6
90 low	3	12 low	8
150 medium	Table 6 rate	22 medium	Table 6 rate

One of the most critical nutritional problems in blueberries is correction of soil pH. Unless pH is higher than 5.8-6.0, don't add sulfur. Improper sulfur application is a frequent cause of plant death in Louisiana. Sulfur acts like other fertilizer salts and kills the plant. If needed, apply only sulfur rates recommended by the soil testing lab. Never apply concentrated sulfur in the zone at the base of the plant. Instead, broadcast uniformly around the plant extending past the perimeter of the branches. Whenever possible, make all sulfur applications six months to one year before planting.

Soil pH less than 3.5 to 4.0 presents a major problem on some sites with excess sulfur or ammonium sulfate. Lime applications are needed to correct the problem. Normal doses of lime are detrimental to blueberries. Instead, broadcast 1/3 to 1/2 pound per plant of a fine grade lime to the soil zone where the pH is low.

Pruning

First-year pruning. Bare-root plants should be pruned back 25 percent to 30 percent when planted. This will compensate for root loss during digging and transplanting. Container-grown plants need little, if any, pruning at planting, but any broke or damaged canes should be removed. During the first growing season, remove all flowers, particularly on weak plants. Fruit development will be at the expense of vegetative growth. If flowers are left to develop, growth will be delayed proportionately. Remove branches that touch the ground. Cut back long, upright shoots to promote lateral branching.

Heavy fruit production on young blueberry plants will stunt plant growth and delay profitable production.

Second-, third- and fourth-year pruning. Pruning the second through fourth years consists of removing the lower twiggy growth and weaker shoots during the dormant season. Some pruning will be needed after harvest, too. Cut back all tall shoots by one-third so the plants can support the crop the next season without excessive drooping. Remove all dead or damaged shoots.

Pruning mature plants. Once blueberry plants attain the desired size, major pruning should be done immediately after harvest. This allows for summer and fall regrowth. If the new growth is not too vigorous, some flower buds will form. In contrast, winter pruning removes more of the fruiting wood for next year. If pruning is omitted on mature plants, they soon become tall, leggy and congested, resulting in diminished production. The fruiting mantle will be exclusively on top and in the outer canopy. Most of the plant's volume will be occupied by unproductive wood.

Berry size is often reduced and ripening delayed when plants are left unpruned. It is important to prune blueberries to generate more young wood for fruiting. Older stems more than one inch in diameter generally have poor production and should be removed. When a bush develops too many canes (15 to 20), the depth of the fruiting surface is only 6 - 12 inches, whereas if the bush has about 10 canes, the fruiting surface extends several feet into the bush. Fruit size and earliness are increased.

Pruning for mechanical harvesting. Plants to be harvested mechanically should have a base of only 8 inches to14 inches. Wider-based plants will not allow the catch on the harvester to close enough to prevent fruit loss during harvest. Plants should be pruned, beginning at an early age, to develop a narrow base. It's not necessary to remove suckers or canes that grow between plants in the row. These only hasten the development of a complete hedge row.

Mulching

Advantages. Applying an organic mulch 3 inches to 4 inches thick around plants can be an important maintenance procedure for small (less than 1 acre) blueberry plantings. A mulch such as sawdust, pinestraw, straw or hay has many benefits. These include maintenance of soil surface moisture, suppression of weeds, improving soil structure and root growth, moderating soil temperature, erosion reduction and enhanced spreading of a drip emitter wetting pattern. Mulches also tend to reduce potential damage caused by poor quality water. Some benefits of mulch are offset by potential disadvantages, however.

Disadvantages. Mulch can be cost prohibitive for a large acreage. Even if the mulch is free and easily

accessible, spreading cost, unless mechanized with a front end loader and a mechanical spreader, can be several hundred dollars per acre. This may be a yearly cost, because most mulch lasts only a year or two, and repeat applications are needed. Other negative aspects of mulch include the increase in fire ant and mice populations. Both can be difficult to control once a planting is infested.

Some mulches cause more weed problems than they prevent. Hay mulch, for example, may infest a clean field with many unwanted weed seeds. The mulch must be weed free. Most mulches have low nitrogen. Soil microorganisms rob fertilizer and soil nitrogen to decompose the mulch. Nitrogen deficiency on heavily mulched fields can occur. Increase nitrogen rates if a thick, low nitrogen mulch, such as sawdust, is used. If the mulch becomes dry, it may be a fire hazard.

An initial one-time mulch may suffice because benefits from mulch are apparent the first few years of the planting when prevention of water stress and weed competition is most critical. For this purpose, a fresh sawdust mulch is probably the most easily obtainable and trouble free. If mature blueberry plants have ample water during dry summer months, mulching is usually not required.

Cultivar Selection

Blueberry varieties for commercial plantings should be selected on size, firmness, ripening dates and stem scar. In non-PYO plantings, adaptability to mechanical harvest and shipping quality may be important.

Ripening is critical, especially when marketing PYO. Berries ripening over as long a period as possible will attract and hold customers. Early ripening varieties generally command the best prices. These varieties need to be a major portion of the orchard when berries are to be shipped to other areas. Early ripening rabbiteye varieties begin ripening in early June (south Louisiana) and mid June (north Louisiana). Mid-season varieties usually begin ripening in late June and early July. Late season varieties ripen in early to mid July. Most varieties ripen over a three- to four- week period.

The type of stem scar determines, to a large degree, how well a variety can be held and shipped without developing postharvest quality problems. A wet scar variety will bleed and deteriorate rapidly. Dry scar varieties are much more suitable for mechanical harvesting and shipping fresh.

Fruit quality involves several characteristics: size, color and flavor. Large fruit has more sales appeal, particularly for PYO. The larger fruit is easier to harvest and will take fewer to fill a pint. Smaller fruit is well suited for processing markets. Varieties with light-colored fruit with a heavy wax bloom are preferred over dark, shiny fruit. Flavor is a product of the sugar/acid ratio. When the fruit is allowed to reach maximum maturity on the plant with maximum flavor enhancement, most varieties are equal or indistinguishable from one another in terms of flavor.

As with all fruits, for best postharvest quality, cool fruit to near 32 degrees F as soon as possible after harvest. This is imperative for fruit destined for fresh markets.

Pollinators

Cross-pollination is an absolute requirement for rabbiteye blueberries. They will set little fruit if planted in solid blocks. Besides increased fruit set, cross-pollination results in bigger fruit and earlier ripening.

The new southern (or “low chill”) tetraploid high bush blueberries are self-fruitful, but they’ll benefit from cross-pollination by yielding larger, earlier fruit.

The most efficient pollinator of blueberries is the southeast blueberry bee, a solitary native bee. Bumblebees are effective pollinators, too. While less effective, honeybees can be brought into the orchard in sufficient numbers during flowering to ensure good cross-pollination.

Table 8. Blueberry Cultivars

Variety*	Type[1] of cultivar	Pollinating[2] Type	Area La.[3] Recomm.	Ripening[4] Date	Fruit Quality	Market[5] Type	Comments
Avonblue	SH	A	N&S	Early May	Good	PYO & Fresh	Large fruit, adapted to mech. harvest. Flavor mild and acid.
Aliceblue	R	B	N&S	Late May	Good	PYO & Fresh	Large fruit, can be harvested mech. Flavor sweet and aromatic.
Beckyblue*	R	B	N&S	Late May	Excellent Dry Scar	PYO, Fresh & Process	Large fruit, good ornamental, leading cultivar in N. Fla., berry firm & stores well.
Bluegem*	R	B&C	N&S	Early June	Good	Early PYO, Fresh	Bush susceptible to *Phytophthora* c., large fruit, plant in welldrained location on elevated rows, high consistent yielder.
Bonitablue*	R	B&C	N&S	Late May	Excellent	Early PYO, Fresh & Process	Fruit large, berry stores well, firm, no fruit scar, leading variety in Fla.
Brightwell	R	C&D	N&S	Early June	Good Dry Scar	PYO & Fresh	Firm berry with little or no fruit scar, recommended for trial plantings only, fruit large.
Briteblue*	R	D	N&S	Mid June	Fair Dry Scar	PYO & Fresh	Fruit quality fair, berries tend to be stemmy. Not recommended. Fruit large.
Chaucer	R	B	N&S	Late May	Fair	PYO & Process	Fruit tends to tear when picked, leaving scar. Not recommended except as ornamental.
Choice	R	D	N&S	Late June	Good	PYO & Process	Small berry, should be harvested mechanically, best ornamental variety.
Climax*	R	B&C	N&S	Late May	Good Dry Scar	PYO, Fresh Process	Leading pollinating cultivar, can be mech. harvested, large fruit.
Delite*	R	D	N&S	Late June	Fair to Good Dry Scar	Late PYO, Fresh & Process	This cultivar being replaced by newer cultivars, fruit medium.
Floridablue	SH	A	N&S	Late April	V. Good	Early PYO, Fresh	Plants not vigorous, ornamental use primarily, large fruit.
Georgiagem	SH	A	N&S	Early May	Good	Early fresh	Medium fruit, little information available on this cultivar, trial plantings only.

Table 8. Continued

Variety*	Type[1] of cultivar	Pollinating[2] Type	Area La.[3] Recomm.	Ripening[4] Date	Fruit Quality	Market[5] Type	Comments
Powderblue*	R	D	N&S	Late June	V. Good	Late PYO, Fresh & Process	Fruit is attractive, good pollinator for Tifblue, large fruit.
Premier*	R	C&D	N&S	Late May	V. Good Dry Scar	PYO, Fresh & Process	Fruit stores well, will fruit w/o pollinator, but never plant w/o pollinator for best results, large fruit.
Sharpblue*	SH	A	N&S	Late April	Fair to Good	Early PYO, Fresh	Number one Southern highbush planted in Fla. Trial plantings only in La., fruit large.
Southland	R	D	N&S	Late June	Fair Dry Scar	PYO & Process	Being replaced by other commercial cultivars. Ornamental use primarily, medium fruit size.
Sunshine Blue	SH	A	N&S	Early May	Good	Fresh	Ornamental use. Good, vigorous plants, berries firm, store well, trial plantings only, medium fruit.
Tifblue*	R	D	N&S	Mid June	Good Dry Scar	Late PYO, Fresh & Process	The leading variety in the South. High yielding dependable producer, fruit large.
Woodard	R	C	N&S	Early June	Fair to Poor	PYO, Process	Ornamental use good, small plants, being replaced by newer cultivars, large fruit.
Cooper	SH	A	S	Early May	Good	PYO & Fresh	Trial plantings only.
Gulfcrest	SH	A	S	Early May	Good	PYO & Fresh	Trial plantings only.
O'Neal	SH	A	A	Early May	Excellent	PYO & Fresh	Trial plantings only.
Blue Ridge	SH	A	S	Early May	Excellent	PYO & Fresh	Trial plantings only.
Cape Fear	SH	A	S	Mid May	Fair	PYO & Fresh	Trail plantings only.

* Recommended for commercial plantings.

[1] SH – Southern Highbush Cultivar
R– Rabbiteye cultivar

[2] A – Early blooming southern high bush self-pollinating. May be planted alone or with any other cultivar. Best to plant two cultivars for maximum yield.
B – Early blooming Rabbiteyes. Plant early blooming Rabbiteye types together to ensure the best pollination.
C – Mid-season blooming Rabbiteyes. Plant together to ensure the best pollination.
D – Late blooming Rabbiteyes. Plant together to ensure the best pollination.
B, C and D: All require cross pollination. Plant two or more cultivars from the same letter group. Cultivars marked with two letters such as B and C may be planted with A, B or C cultivars.

[3] N – North Louisiana
S – South Louisiana

[4] Ripening dates for south Louisiana.

[5] PYO Pick your own
Fresh – Fresh market, stores well
Process – Short storage

Propagation

Rabbiteye blueberry plants are propagated suckers or off shoots by budding on native rootstock and by rooting softwood or hardwood cuttings.

Softwood cuttings – The most common commercial method of propagating rabbiteye blueberries is placing softwood cuttings under mist in prepared media. Softwood cuttings can be taken throughout the growing season, but highest rooting percentages are obtained from cuttings taken soon after the first flush of growth in the spring. Many cuttings can be taken at this time because most shoots are in the same stage of growth.

Cuttings that are too tender and succulent should be avoided to reduce breakage and wilting. Cuttings that have passed the first period of growth and are beginning to harden are the most desirable. Terminal cuttings 4 inches long with all but two or three leaves removed give good rooting results. Cuttings taken from matured growth require longer to root, and lower percentages of rooting usually are obtained.

Various media are satisfactory for rooting blueberries. Good rooting percentages have been obtained with coarse sand, pine bark, perlite, sawdust and peat. Root development usually is best in media containing 25 percent to 50 percent peat. Peat and perlite (1:1); peat and sand (1:1); peat, bark and sand (1:1:1); peat, sand and sawdust (1:1:1 and 2:1:1) have proved successful in most rooting trials. Less root development is present in a coarse sand medium than in mixtures of sand and peat.

Rooting beds are best under shade (30 percent to 60 percent shade) to reduce desiccation of cuttings by lowering daytime temperature and light intensity. Intermittent mist watering is desirable for rooting softwood cuttings. A system based either on rate of evaporation or time can be used.

Most research indicates that hormones are not beneficial in rooting rabbiteye blueberries.

Hardwood cuttings – Hardwood cuttings are taken during the winter (dormant period) from strong, healthy shoots of the past season's growth. Shoots from which cuttings are taken, called "whips," are commonly 12 to 36 inches long. Whips are usually present on vigorously growing rabbiteye blueberries, but whip formation is stimulated by severe pruning in the dormant season.

Whips are produced commercially by cutting plants back to lengths that are 6 to 12 inches less than they were before the previous season's growth. Hardwood cuttings are collected after sufficient winter chilling has occurred, usually in late January through February, and before bud growth begins. Cuttings (whips) can be collected earlier and stored at 35 to 40 degrees F in moist spagnum moss with adequate ventilation until placed in beds.

Whips are divided into cuttings of the desired length (about 5 inches). Cuttings can be made with a sharp knife or bench saw. Pruning shears usually injure cuttings unless the shears have been adapted for this purpose. A bench saw with a fine blade is used commercially to cut large quantities of whips to the desired length simultaneously.

Open beds under a lath house with media similar to those used with softwood cuttings (peat and sand, 1:1; peat and perlite, 1:1) are satisfactory. Cuttings are inserted into the medium from one-half to two-thirds of their length. The medium should be pressed firmly around the base of the cuttings. Spacing of cuttings usually is 2 x 2 inches.

Propagating beds must be kept moist, but guard against using too much water. The critical time is after the cuttings are in leaf but before rooting has occurred. Mist watering can be used but is not as essential as with softwood cuttings.

Plants can be fertilized weekly after cuttings are rooted and established (usually by May or June). A water-soluble complete fertilizer (1/2 oz. per gal. of water) is used. Plants can be grown in the propagation bed until winter and then transplanted into a nursery or into containers. Good results have been obtained by transplanting rooted hardwood cuttings into 1-gallon containers in late July. Such plants are placed under 50 percent shade and watered frequently for two to three weeks before fertilizing each pot with 1 to 2 oz. of a slow-release fertilizer (Osmocote 14-14-14). Plants then are watered as required. Sufficient growth often is obtained to permit field planting or sale as container plants in winter.

Other propagation methods – Suckers grow from roots a distance of a few inches to several feet from the parent plant. These can be separated from the main root system with fibrous roots intact. Excessive mulching usually increases suckering and promotes a shallower root system that makes separation of rooted suckers from the main plant easier. Suckers should be pruned back heavily, transplanted to a nursery (or potted in a 3- to 5-gallon container) and grown for a year before setting in their permanent location.

Insect Identification and Control

Cranberry Fruitworm (*Acrobasis vaccinii* Riley)

This small worm is a pest of cranberries and many species of wild and cultivated blueberries. The larva at maturity is about 1 inch long. The head is yellow with light brown markings. The body is yellow-green but may have a slight red tinge.

The adult is a small, mostly gray, moth which is seldom seen because it flies at night. The moths emerge from pupae that overwinter in the soil during late March and April. The eggs are laid, for the most part, within the calyx cup of the green berries. The hatching larvae crawl about the fruit and usually enter the berry at the junction of the stem and fruit.

As the larvae develop, they move about from one berry to another within the fruit cluster. Each larva remains concealed within the fruit cluster while feeding. A single larva may destroy three to six berries in a cluster. Infested berries become filled with frass, turn blue prematurely and shrivel. The cluster of berries is usually webbed together, and small pockets of frass may extrude from the entrance holes. The frass appears to clump around the entrance because of the silk webbing. Damaged fruit is sometimes harvested with the good fruit because of the webbing. By mid to late May, larval development is complete, and they leave the berries and fall to the soil. Here they pupate and remain until the next spring. In some cases, a small percentage may emerge and produce a small generation on another host.

Controls for curculio will also control this pest.

Cranberry Rootworm (*Rhabdopterus picipes* Oliver)

This small leaf-feeding beetle can make the foliage look tagged, but the larval feeding on roots can cause yellowing and occasionally kill small plants.

The adult beetles are about 1/4 inch long and shiny brown. They emerge in May through June and feed on the foliage of blueberries, camellias and azaleas. Eggs are laid in the soil about the base of plants. The larva are six-legged, white and c-shaped with a light brown head and are about 1 inch long at maturity. They feed until fall and then hibernate as partly grown larvae. Feeding is completed in the spring with adult emergence in May.

Infested plants are not fruitful. They are pale yellow, and the leaves turn red and fall prematurely in the fall. Occasionally, in extreme cases, the plant may die.

Sevin gives good control of the adults when sprayed late in the afternoon. No control has been found for the larvae in planted fields.

Stem Borer (*Oberea myops*)

This small long-horned beetle attacks and infests wild and cultivated blueberries, azaleas, rhododendron and laurel.

The adults of the stem borer are present during peak growing time. Eggs are inserted under a flap of bark near the terminal of a cane. Usually new growth or shoots are chosen for egg deposition. The larva, on hatching, tunnels upward, killing the terminal. It then reverses direction and bores downward. Two to 10 inches may be tunneled the first year. Small lateral tunnels to the outside are made periodically to remove the excess frass and chewed stem.

In winter, the larvae are inactive. The next spring, feeding resumes and, after several months, reaches the crown. Cold weather again deactivates the larvae. Feeding resumes in the spring of the third year, and the galleries are enlarged. Several canes may be encompassed. Another winter of inactivity follows, and the larvae pupate the following spring and adults emerge to continue the cycle.

The larvae are smooth, legless, elongate worms about 1/8 to 1 1/4 inches long. The head is brown and the legs creamy-white. The adult is light brown, elongate and has long antennae.

Damage may be observed as terminal die-back, cane death or by the mounds of frass at the base of plants during the summer. Remove infested canes when found or during pruning time.

Blueberry Maggot (*Rhagoletis menday* Curran)

Blueberry maggots overwinter in puparia in the soil. As the soil warms in the springs, the adults emerge. After one week, female flies actively seek large green, nearly ripe or ripe berries and deposit one to several eggs under the skin of the fruit. Hatching occurs in five days, the young larvae feeding just under the skin. Large larvae tunnel throughout the fruit. Larvae mature in 18 days and drop to the ground to pupate. Only one generation occurs every year.

Larvae are white or gray-white and maggot-like. The head is pointed, indistinct and very small with black mouth hoods. The body is tapered.

The adult flies are about 3/16 inch long. The characteristic feature is the broad black banding of the wings. The tip of the thorax is white or pale, and the abdomen is striped.

Blueberry Bud Mite (*Acalitus vaccinii* Keifer)

This mite is common on both wild and cultivated blueberries. No variety is immune to attack.

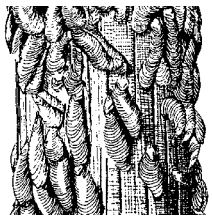
The mite is white, translucent and elongate with four short legs. Its presence is established by looking for injury rather than the mite itself. The mite feeds on the bud scales and on developing leaf and floral parts within the bud. Parts fed on become roughened and warty, usually with red discoloration. Occasionally, small red pimples may occur on the fruit. Persistent feeding by high populations of mites can kill plant tissue and cause failure of buds to expand and produce flowers, thereby reducing fruit yield. Injury occurs shortly after the mites enter the new buds. Critical damage occurs as early as late summer or early fall.

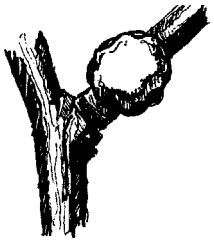
Mites spend most of their life in the buds of blueberry plants. In the spring, the mites migrate from injured tissue to the outer scales of newly forming buds. They crawl under the scales, feed, mate and lay eggs. As the population increases, the mites move to the center of the bud. Feeding, mating, egg laying and populations increase throughout the fall and winter.

Control is obtained by two applications of a miticide made in July and August. Since mites are in the bud scales, sprays must be applied with high pressure (200 psi) to penetrate the buds. Good coverage may require up to 400 gallons per acre, depending on plant size. Pruning of old canes also helps reduce mite populations.

Scales (*Coccids*)

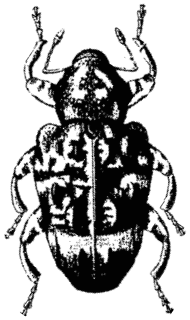
Several species of scales have been reported on blueberries throughout their range. Those that occur in Louisiana are: 1) Japanese wax scale (*Ceroplastes ceriferus* (Fab.) - one generation -approximately 400-3,000 eggs, feeds on stem and fruit, seldom on leaves. 2) Terrapin scale (*Lecanium nigrofasciatum* Pergrande) - one generation a year - bears live young, overwinters as fertile third instar, mature in spring, young settle on foliage, third instar migrates to stems, male develops on leaves, emerges mates with female that overwinters. 3) Oystershell scale (*Lepidosaphes ulmi* Linnaeus - armored scale, multiple generations, 80-100 eggs per generation, infest only stems. Shell covering looks like oyster shell, hence the name. 4) Putnam scale (*Diaspidiotus ancylus* Putnam), multiple generations, primarily on stems under bark scale, well camouflaged. Can be found on fruit and leaves, on fruit as circular gray spots surrounded by red discoloration - harm product salability. 5) Cottony maple scale (*Pulvanaria innumerabilis* Rathvon) - overwinters as young female on stems. Matures in spring. Produces egg sack in early May. Eggs hatch late May or early June. Nymphs settle on underside of foliage. In fall, migrate back to stems. Males develop on leaves, emerge in early fall, mate and die, 6) European fruit Lecanium (*Lecanium corni* Bouche) - overwinter second nymphal instar on branches. Mature early spring. Eggs laid in late April or early May. Hatch in late May or June. Migrate to leaves, develop until fall. Migrate back to stem - one generation.


Oystershell scale


Japanese wax scale

All coccids have piercing, sucking mouthparts. All but wax scale may be unnoticed until populations are very high and some damage has occurred. Those with multiple generations can cause severe problems in one year. Those with single generations are not as damaging. All are easiest to control in the immature stages shortly after emergence from beneath the old female. Most materials are effective on the crawlers. As they mature, they become harder to kill.

Plum Curculio (*Conotrachelus nenuphar* Herbst)



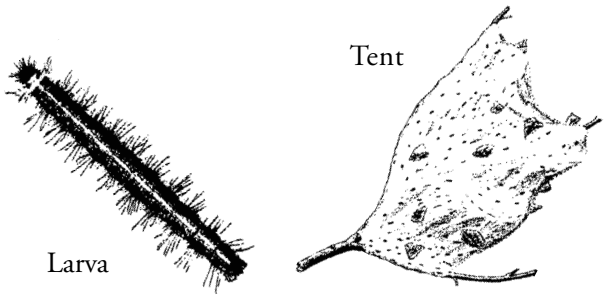
This snout beetle or weevil is primarily a pest of peaches, plums, apples, cherries, other stone fruits and blueberries.

The adult weevil is 1/4 inch long and has a snout. The body surface (forewings) is warty and uneven. The curculio is brown with patches of white or gray. The adults overwinter under trash or in wooded areas adjacent to berry fields. They begin emerging during the end of bloom or at berry set and emerge for four to six weeks. The adults feed on the petals of the blossom and then begin feeding on the green fruit. Eggs are deposited within the green berries in shallow c-shaped feeding scars. Eggs are usually laid singly. Their larvae, upon hatching, feed on the interior of the berry. This causes the berry to stop developing and fall to the ground. The larvae at maturity leave the empty hull and enter the soil to pupate. In about three weeks, the adults emerge. If fruit is present, a second generation develops in the fruit. Although only a single egg is laid per fruit, each female can lay about 140 eggs.

Sprays should be timed at the end of bloom and about seven to 10 days later to get good control of the crculio.

Forest Tent Caterpillar (*Malacosoma disstra* Hbn.)

The caterpillar is an early spring foliage feeder on hard maple, gums, oaks, birch, cherry elm, aspen, willow and blueberries. They don't build webs like the fall webworm or the eastern tent caterpillar, but make a silk-like webbing over the stems and branches which they rest on when not feeding. There is only one generation. Hosts are seldom killed, but repeated defoliation can kill or reduce growth.



Overwintering is in the egg stage on the branches of the host. Emergence occurs about bud break. Initially, the larva is almost black, but at molting pale blue lines on a brownish body with a row of yellow keyhole-shaped spots on a black back become more evident. The larvae move about in large masses on trunks and branches. After five or six weeks of feeding, the mature larva is 2 inches long and begins to spin cocoons in the leaves and bark crevices. The pupae are highly prized by birds as a food source. Those not eaten emerge in about 10 days as light buff-colored adults. The adults live about five days, during which time the crystalline-like egg masses are laid on the branches. Each mass contains from 150 to 300 eggs. The larvae develop in about three weeks, but remain in the egg mass until next spring.

They are easily controlled with most sprays.

Fall Webworm (*Hyphantria curea*)

The adult fall webworm is a medium-sized white moth about 1/2 to 3/4 inch long. There are two races of the fall webworm in Louisiana. Caterpillars of the orange race have orange heads and tubercles (bumps on the body). The black race has a black head and tubercles. Both larvae have long, silky, whitish hairs. At maturity, they are about 1 1/2 inches long.

The fall webworm attacks many deciduous hardwoods and a few species of evergreen trees. In the South, hickory, pecan persimmon, sweet gum and willow are preferred hosts along with blueberries.

The orange race has three generations, the first in April and the last in late October. The black race has four generations, the first in late March and the last in November.

The larvae overwinter and pupate in litter or just below the surface of the soil. The moths are active in spring, summer and early fall. After mating, they lay their eggs in masses on the foliage. The

hatching larvae feed in masses and spin large, loose, irregular webs which cover foliage, branches and stems. As food is needed, the web is enlarged. At maturity, they leave the webs and pupate in litter or the soil.

Defoliation of blueberries can cause crop loss and retard plant growth. Heavy defoliation can cause loss of crop or crop quality next season, too.

Single sprays with Sevin or *Bacillus thuringiensis* will control these insects.

Leaf-footed Plant Bugs (*Leptoglossus phyllopus* L.)

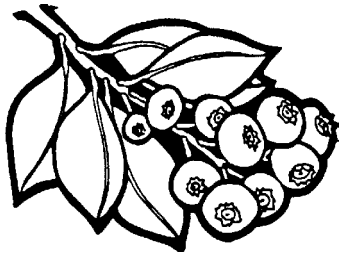
These piercing, sucking insects feed on many fruits and vegetables.

The adult leaf-footed bugs are elongate, about 3/4 inch long, with a stout beak. They are dark brown dorsally with a narrow yellow band across the back and gray ventrally. The hind legs are very distinctive because the lower part of the legs is flattened somewhat leaf-like, thus the name.

The overwintering adults emerge and feed on a variety of hosts. They are attracted to the blueberries just before maturity, usually from mid-May through June. Eggs are deposited on the foliage in May and June. The hatching nymphs are red, have no wings and resemble the adults. Both adults and nymphs suck juices from berries. The feeding injures the cells of the berry. The cells surrounding a feeding puncture fail to turn the color of ripe fruit, and the berries have a mottled appearance. Most injury is caused by mottling of the fruit.

Insecticides used for control for curculio will control this pest also.

These pests are not necessarily found or recorded in Louisiana, but they are among the pests of blueberries. Any pest you find should be brought to your county agent.



1999 Small Fruit Spray Schedule (Blueberries) Commercial Schedule

Time of Application	Rate/Acre	To Control	Remarks
Dormant Spray Oil	Summer of Superior Oil 2-3% actual oil	Scale	Follow manufacturer's directions
Petal Fall and Cover Spray 10-14 days apart	2.0 lbs. Imidan 50WP OR .45 lb Lannate 90WP OR 2-4 pts Lannate L OR 3 lbs Sevin 50WP OR 1 7/8 lbs Sevin 80SP	Worms Weevils Maggots	Don't apply within 3 days of harvest.
Post Harvest	3 qts Thiodan 3EC OR Sunspray ultrafine oil	Mites	Apply after harvest and 6 to 8 weeks apart.

Disease Identification and Control

Once established, blueberry plants are quite hardy and relatively free from disease problems. Blueberries do suffer occasionally from diseases such as mummy berry, anthracnose, *Phytophthora* root rot, and several twig and cane blights.

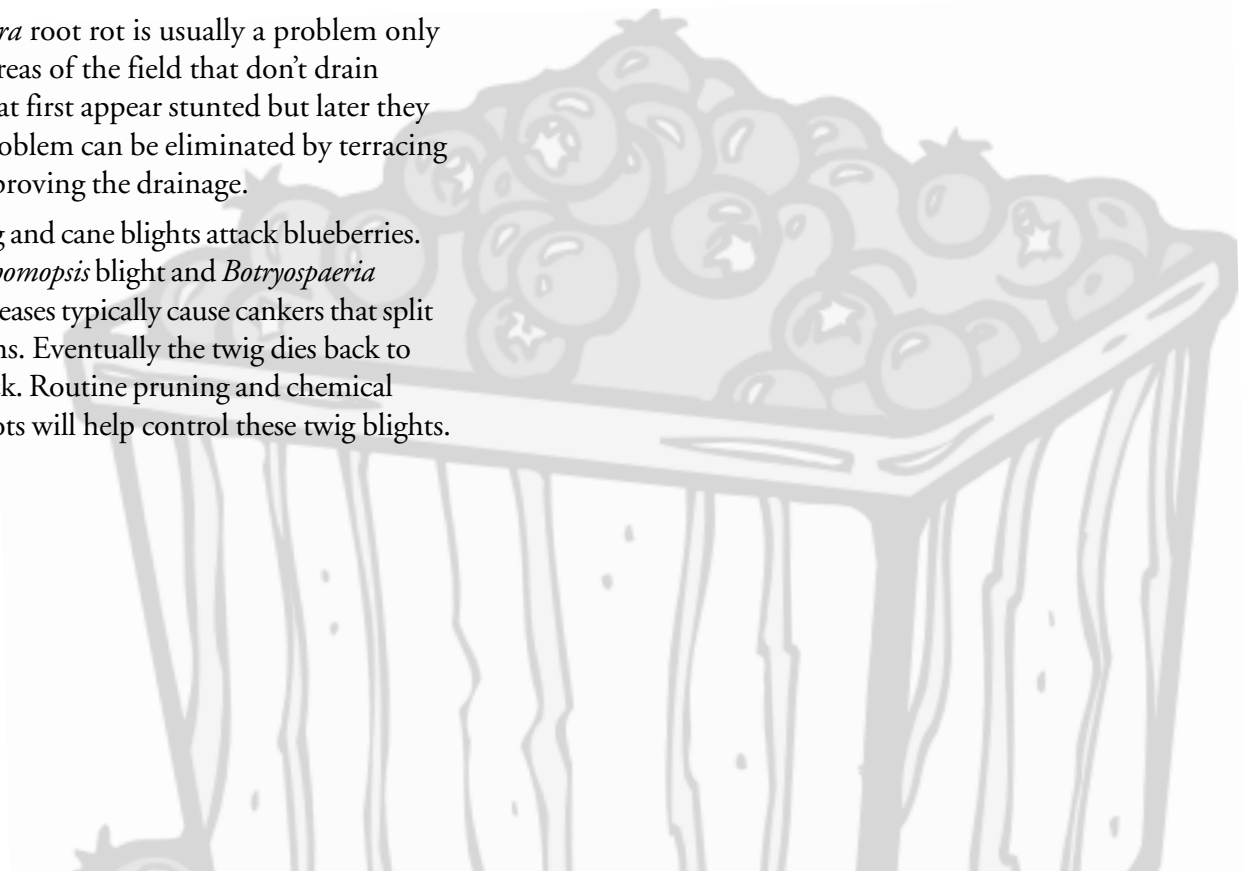
Mummy berry and anthracnose typically are diseases of the fruit, but the causal fungus can also blight newly emerging twigs or blossoms. Mummy berry overwinters on the dried fruit or "mummy," hence the name. Initial infection of twigs and flowers comes from spores produced on these mummies in the spring. More spores are produced on the infected parts that further spread the disease. As the diseased berries approach maturity, they shrivel and fall on the ground where they will overwinter until the next spring.

Anthracnose overwinters on infected twigs. Spores produced in the spring reinfect twigs or fruit. On the fruit the spore masses appear salmon colored.

Both mummy berry and anthracnose can be controlled by cultural and chemical means. Prune and burn damaged twigs. Use recommended herbicides to keep plants free from weeds. Use labeled fungicides such as benlate or captan during the fruiting season. After harvest make additional sprays of the bushes.

Phytophthora root rot is usually a problem only on low sites or areas of the field that don't drain properly. Plants at first appear stunted but later they may die. This problem can be eliminated by terracing the plants or improving the drainage.

Several twig and cane blights attack blueberries. These include *Phomopsis* blight and *Botryospaeria* canker. These diseases typically cause cankers that split or girdle the stems. Eventually the twig dies back to the point of attack. Routine pruning and chemical sprays for fruit rots will help control these twig blights.



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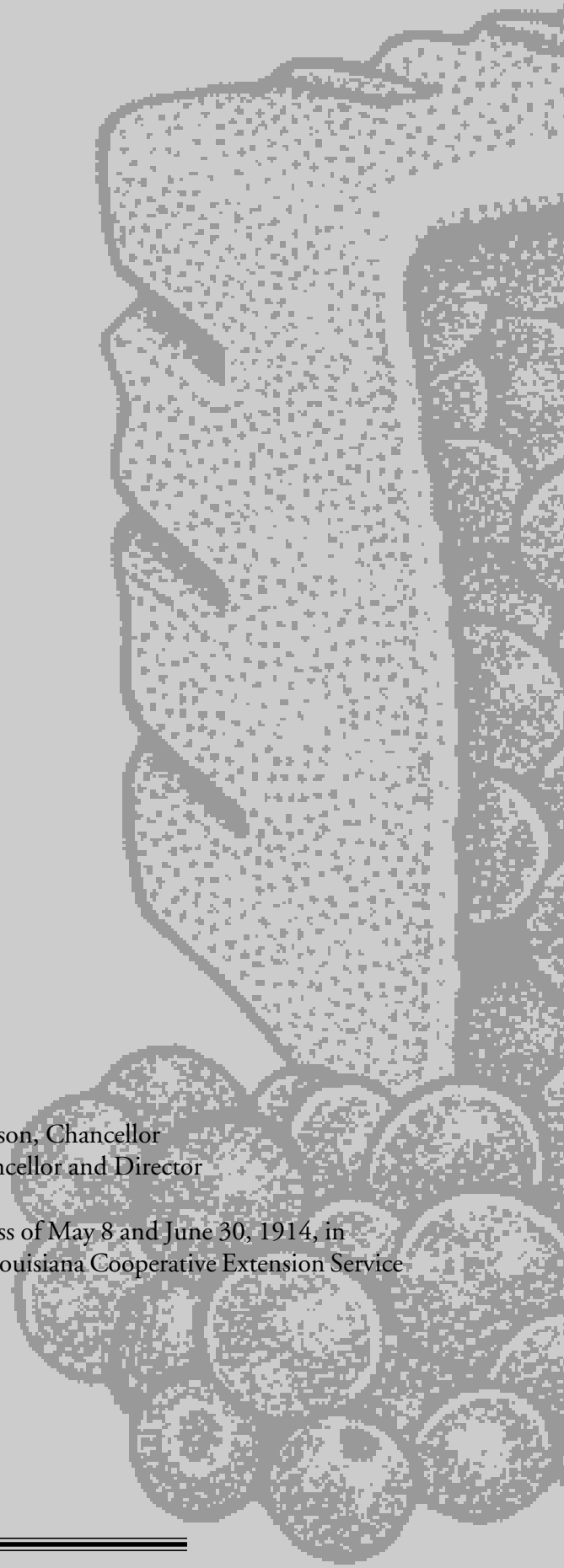

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