SUGGESTIONS FOR ESTABLISHING A BLUEBERRY PLANTING IN WESTERN NORTH CAROLINA1

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Site Selection

a) Well-drained, sandy or loamy soils
b) pH 4.0-5.0 -- high organic matter -- 3% greater
c) Level or rolling land -- elevated area with good air drainage
d) Possibilities for irrigation.

Preparation of Land

a) Soil test: Bring to a medium level of P before planting
b) Eliminate problem weed species with herbicides or cultivation the year before planting.
c) Bark humus or sawdust worked into soil to bring organic matter to 3% or greater if needed in the row (2-4 foot strip) well prepared before planting
d) Set plants 5 feet apart in 9-10 foot rows in late winter or early spring (as soon as the soil can be worked).
e) Sawdust mulch (4-6 inches deep) placed over row immediately after setting plants.
f) Row middles should be in sod (fescue or bluegrass)

	HARVEST SEASON		BERRY	
VARIETIES	BEGINS	ENDS	SIZE	COLOR
*Weymouth	6-15 to 7-1	7-15 to 8-1	small	dark blue

FLAVOR: poor				
*Earliblue	6-15 to 7-1	7-11 to 7-28	medium	med blue
FLAVOR: good				
Spartan	6-21 to 7-6	7-21 to 8-7	large	light blue
FLAVOR: excellent				
Collins	6-22 to 7-7	7-22 to 8-8	med-large	light blue
FLAVOR: good				
Patriot	6-28 to 7-13	7-28 to 8-12	large	med. blue
FLAVOR: excellent				
Bluejay	6-30 to 7-15	7-30 to 8-20	med-large	light blue
FLAVOR: good, mild				
*Blueray	7-3 to 7-19	8-3 to 8-20	large	dark blue
FLAVOR: good				
*Bluecrop	7-7 to 7-23	8-13 to 8-29	med-large	light blue
FLAVOR: good				
*Berkeley	7-7 to 7-23	8-7 to 8-20	large	light blue
FLAVOR: fair, mild				
*Jersey	7-14 to 7-30	8-18 to 9-3	small	light blue
FLAVOR: good				
Coville	7-20 to 8-5	8-20 to 9-5	med-large	med blue
FLAVOR: good, tart				
Elliott	7-30 to 8-15	8-30 to 9-15	med	light blue
FLAVOR: good				

*Varieties that have been grown successfully in the mountain area. The other varieties are suggested for trial planting.

Availability of Plants. Nurseries usually have ample supply of plants priced from 50 cents to $2.00 per plant depending on quantity, variety and size. Two-year-old plants are preferred. Additional plants may be obtained in later years from locally grown cuttings.

Cultivation. Cultivate first year only to control weeds and grass. A 4-6 inch mulch of sawdust or bark helps control weeds and grass. Keep row middles mowed to conserved soil moisture and to keep groundcover under control.

Fertilization. (Caution: Blueberry plants are easily damaged by too much fertilizer.) Acid forming fertilizers that have little limestone filler are desirable. Special azalea or rhododendron fertilizers meet this requirement, but the price maybe prohibitive for more than a few bushes. A standard 12-12-12, 10-10-10 or 8-8-8 can be used if a special blueberry fertilizer is not available. The high analysis fertilizers such as 12-12-12 generally have lower amounts of limestone filler than lower anlaysis fertilizers like 8-8-8. Ammonium nitrate (33.5-0-0) or ammonium sulfate (20.5-0-0) are desirable sources of supplemental nitrogen. If the soil pH is below 5.0, use ammonium nitrate, but use ammonium sulfate for more acid forming effect if the pH is above 5.0. Special attention should be given to leaf yellowing (complete area of young and old leaves) caused by nitrogen deficiency when sawdust or bark was combined with the planting soil. Organisms in the soil deplete the available nitrogen and cause a deficiency for the blueberry plant as the sawdust or bark

decompose.

First Year. Uniformly distribute 16 pounds of nitrogen per acre after the first flush of growth is complete (6-8 weeks after planting) within a band 1 foot on each side of the plant. The 16 pounds of nitrogen are supplied by 133, 160 or 200 pounds, respectively, of 12-12-12, 10-10-10 or 8-8-8. Fertilizer can also be applied by hand around individual bushes. Uniformly distribute 1/2 oz (1 tablespoon) of 12-12-12 within a circle 1 foot from the plant. Use proportionately more 10-10-10 or 8-8-8. Repeat applications using ammonium nitrate or ammonium sulfate every 4-6 weeks until July 1. Extend application intervals during dry periods until rainfall has totaled 4 inches. Use 50 pounds per acre of ammonium nitrate or 80 pounds per acre of ammonium sulfate in a 2 foot band (1 foot on each side of the bush). This rate corresponds to about 1/4 oz (1/2 tablespoon) ammonium nitrate or 3/8 oz (3/4 tablespoon) of ammonium sulfate within the circle 1 foot from the plant.

Second Year. Double the first year rates, but increase the band width to 3 feet or the circle around individual plants to 1 1/2 feet.

Bearing Plants. Apply 300-500 pounds per acre of 12-12-12 or an equivalent amount of 10-10-10 or 8-8-8 in a 3-4 foot band. For individual bushes, apply the equivalent of 1/2 pound (1 cup) of 12-12-12 within a circle 3 feet from the plant. Sidedress with 30 pounds of N (about 100 pounds of ammonium nitrate or 150 pounds of ammonium sulfate) per acre 4-6 weeks later. For individual bushes, this is 2 oz (1/4 cup) of ammonium nitrate or 3 oz (3/8 cup) of ammonium sulfate.

Early Fruiting (places stress on young plants). Plants should not be allowed to fruit the first 2 years. Remove fruiting wood and weak growth during the dormant season.

Insect and Disease Control.
Insects and diseases have not been serious problems; however, check for damage periodically. Wild blueberries are common in western North Carolina; and, therefore, some pest problems may be expected at one time or another.

1For more detailed information, refer to N.C. Extension Circular AG-115, "Commercial Blueberry Production in N.C.".

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BLUEBERRY FREEZE DAMAGE AND PROTECTION MEASURES

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Freeze Prone Sites. Commercial blueberries are generally planted in low areas with high organic-matter content. These sites satisfy the cultural requirements of blueberries for a constant and uniform moisture supply. However, on cold, still nights when radiation frosts occur, heavy cold air from higher surrounding areas "drains" into the low areas causing lower temperatures. Also, the high organic content, especially if the soil is dry, acts as an insulator to restrict heat in the soil from moving up around the plants. The cultural requirement for a uniform soil moisture make selecting higher sites that are less subject to radiation frosts much less practical than with other fruit crops.

Although there is almost no wind during a radiation frost an occasional gentle breeze will occur. Removal of trees and brush from around the field to improve air circulation will allow these breezes to penetrate the field at bush level. The cold air will be displaced or mixed with the warmer air from higher locations and less temperature drop will occur.

Cold Susceptibility. Blueberry blossoms and small berries are considered hardier than the blossoms of most fruits. Temperatures must drop below 28 F for economic losses to occur on highbush blueberry (Vaccinium corymbosum L.). The temperature at which freeze injury begins to occur depends on the stage of development from dormant flower buds through young fruit.

During the winter, dormant flower buds of highbush blueberries will survive temperatures as low as -20 to -30 F while the less hardy rabbiteye (V. Ashei Reade) have survived -10 F but are often damaged below 0 F. As flower bud swell progresses, cold tolerance decreases. By the time individual flowers begin to protrude from the bud, temperatures below 20 F will begin damaging the most exposed flowers. When corollas have reached half of their full length, temperatures below 25 to 26 F will kill the complete flowers. However, at this stage, blossoms on rabbiteye blueberries may receive corolla damage at temperatures as high as 30 F. The corolla withers, but usually remains attached. The withered, unopened corolla prevents bee pollination and otherwise undamaged flowers drop rather than developing into fruit. Corolla damage to unopened highbush flowers that prevents pollination is seldom a problem with highbush blueberries. When the blossoms are open, a temperature of 27 F for more than a few minutes causes damage. Immediately after corolla drop and before the berry begins to swell is the most sensitive stage. A few minutes below 28 F will result in damage. As the berry begins to

enlarge, susceptibility is similar to the critical temperature of 28 F for open blossoms.

Injury Symptoms. Cold damage is not always obvious. Following temperatures well below the critical level, the complete flower or small fruit will develop a water-soaked appearance, shrivel and drop. However, a very brief time at the critical temperature may damage only the pistil. All or a portion of the damaged pistil will develop a brown appearance and prevent pollination and fruit set. Ovules, which develop into the seeds within the berry, can also be damaged without any exterior symptoms. Healthy ovules are plump and white, but become black with cold injury. If a large number of ovules or young seeds are black, the flower or fruit will probably drop. If only a few are damaged, fruit development usually continues, but the fruit will be later ripening and of smaller size than berries with a larger numbers of healthy seeds.

Monitoring Temperature. Reliable and accurate thermometers that register current and minimum temperatures are essential if frost control measures will be used and also to help predict the extent of damage if no protection is provided. Most fields should have at least 3 thermometers placed at bush height in high (warm), low (cold) and average locations in the field. Hygrothermographs that constantly measure temperature and relative humidity placed in a weather shelter at bush height are also very helpful if frost protection measures are available. The plot of temperature and humidity as the night progresses on the hygrothermograph chart aids in making the best possible management decisions. It is much easier to determine the rate of temperature drop and predict the minimum temperature before sunrise from the hygrothermograph chart than from watching the thermometers and plotting

temperature change. Thermometers in warm, cold and average locations in the field should be checked in addition to the hygrothermograph to determine differences across the farm. Relative humidity is usually 100% on radiation frost nights, however, occasionally lower humidity occurs. With sprinkler irrigation for frost control, the system must be started at a higher temperature when humidity is low to compensate for the evaporative cooling that will occur as the first water strikes the bushes. A sling psychrometer that measures wet bulb and dry bulb temperatures is a less expensive method for determining relative humidity than the hygrothermograph, however, unlike the hygrothermograph, there is no constant measurement or permanent record.

Sources of temperature monitoring equipment are listed in Table 1. Commercially manufactured temperature alarms are available or they can be assembled from a refrigeration thermostat and transformer. The thermostat should be set at a temperature high enough to awaken the irrigation manager in time to check field thermometers before the temperature drops below 35 F. Thermometers shielded from the open sky and placed at the height of the upper 1/3 of the bush give air temperature readings that can be related to the temperatures described in this leaflet.

Listening to weather reports is not a reliable method of monitoring current temperatures or determining what the low temperature will be in a blueberry field. Many of the official temperatures reported on radio or television are taken at airport locations. The large paved areas that hold heat and the aircraft mixing of air at airports makes them much warmer than surrounding areas on radiation frost nights. However, you may be able to develop a reasonably reliable adjustment factor for how much colder the blueberry field is than the local reporting station. Blueberry fields will often be as much as 10 to 12 F colder on a

radiation frost night than warmer locations such as airports.

PRACTICES FOR REDUCING FREEZE DAMAGE

Pruning. Flower buds on short, small-diameter shoots will open and become susceptible to freeze damage sooner than flower buds on larger diameter shoots. Pruning to a balance of early blooming and later blooming shoots will help insure a crop. If no frost or freeze occurs, the early blossoms will develop into the early ripening, high priced fruit. If a frost or freeze occurs, there will still be some later fruit for a partial crop.

Avoid Cultivation. Cultivation in late winter and early spring tends to increase freeze damage. Soil temperature on a radiation-frost night will be much warmer than air temperature. If the soil has been cultivated, the surface layer will contain more air and less water. With less water, the surface layer will hold less heat. Also, the increased soil air will cause the surface layer to be a better insulator which will decrease the amount of heat released from deeper in the soil. Bushes will probably stay 1 to 2 F warmer on uncultivated soil than on cultivated soil. To avoid spring cultivation, adequate drainage should be established the previous fall, followed by herbicide application in late winter.

Maintain Soil Moisture. Growers who have hose reel, hose pull, or small portable irrigation systems can benefit from maintaining a moist soil during the period when frosts are possible. By increasing the amount of water in the soil, the soil will absorb more heat during the day and conduct more heat to the surface for plant protection. Maintaining a moist surface on peat and muck soils is especially important. When these soils are dry, they

hold very little heat and a dry surface acts as an excellent insulator to prevent beneficial heat release. Excess water for extended periods must be avoided to prevent flooding or phytophthora root rot damage.

Sprinkler Irrigation. Permanent or solid set irrigation has been the most dependable frost control method. Depending on the design of the system, damage can be prevented when temperatures drop as low as 20 to 23 F. The system commonly used in blueberries is a sprinkler spacing of 60 ft. x 60 ft. with nozzles that supply about 5 to 6 gpm at 55 to 60 psi. This design requires 12 sprinklers/acre. The system is started when the temperature has dropped into a range of 33 to 38 F and the grower expects the temperature to reach a minimum below 28 F before warming begins after sunrise. The temperature to begin sprinkling depends on humidity. If the humidity is near 100% as it usually is on radiation-frost nights in southeastern NC, 33 to 34 F is satisfactory. However, at 40% relative humidity the system should be started at about 37 F to avoid evaporative cooling below 30 F. A psychrometer or hygrometer as previously mentioned is needed to determine relative humidity.

Table 1. Sources of temperature and humidity measuring equipment

Company	Thermometers	Minimum thermographs	Hygro-Alarms	Temperature Psychrometers
Cassco P. O. Box 3508 Montgomery, AL 36193 1-800-633-5888	X			

Cole-Parmer 7425 N. Oak Park Ave. Chicago, IL 60648 1-800-323-4340	X	X	
Forestry Supplies, Inc. 205 W. Rankin St. P. O. Box 8397 Jackson, MS 39204 1-800-647-5368	X	X	X
Omega Engineering, Inc. 1 Omega Dr. Stamford, CT 06907 (203) 359-1660		X	
Science Associates, Inc. 230 Nassau St. Princeton, NJ 08540 (609) 924-4470	X	X	X
Weather Measure Corp. P.O. Box 41257 Sacramento, CA (916) 481-7565	X	X	X

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BLUEBERRY

SYMPTOMS	POSSIBLE CAUSES	CONTROL AND COMMENTS
Plants stunted and discolored	-Soil pH too high	-Blueberries require acid pH; soil test

	-Nutrient deficiency	-Soil test
	-Virus disease (any of several)	-Submit sample for laboratory diagnosis
	-Poor quality water	-Water analysis
Berries turn reddish or tan color as they they ripen and become shriveled and hard; blossoms turn brown and wither; centers of new leaves are black	-Mummy berry (fungal disease)	-Use registered fungicide
Branches die back; cankers may be evident externally; internal discoloration not reddish brown		-Common in spring
Ripening berries soft	-Blueberry maggot	-Use registered insecticide on a regular schedule

BLUEBERRIES FOR THE HOME GARDEN

Blueberries are popular with people and birds. They are attractive fruit-bearing plants that can be used in the landscape or in the garden. They are easy to grow, but usually must be covered with netting to prevent the birds from eating the whole crop. Plants bear more fruit when two or more varieties are grown together.

Site Preparation - Blueberries prefer light, well-drained, acid soils that are high in organic matter. Since most garden don't have these conditions, they must be created. You can add organic matter to your soil by applying peat moss, sawdust, leaf mold, or similar

material before planting.

The pH should be kept between 4.5 and 5.2. If pH is below 4.4, add a cup of ground limestone per plant. To lower the pH from 6.0 on sandy soil, apply 12 lbs of finely ground sulfur per 1000 square foot. To lower pH from 5.5, apply 8 lbs. If you have a loam soil, use 35 lbs at a pH of 6, and 24 lbs at a pH of 5.5.

The plants should be mulched to help maintain a uniform soil moisture content and to control weeds. Use any organic matter source that won't pack. Pine bark, straw, or pine needles are satisfactory. Mulch should be 6 inches deep.

Planting - Spring plantings work best for Delaware. Don't plant blueberries deeper than they were grown in the nursery. Prune off broken limbs or roots before planting.

Varieties - Bluetta, Jersey, Bluecrop, Blueray, and Herbert are some of the better varieties for Delaware. Buy vigorous 2-year-old plants that are free of disease. Rooted or unrooted cuttings can be bought, but they need special care to keep them alive.

Fertilizer - A soil test will indicate what is needed. As a general guide, apply 1/8 cup of 10-5-10 per plant 2 to 3 weeks after transplanting. Spread it evenly in a band 6 to 12 inches from the plant to avoid root damage. Repeat in late June if plants have been watered regularly.

Each year after the initial planting, apply double the rate until the total of two applications reaches 2 cups. This is the maximum rate normally needed.

Watering-Blueberries are shallow-rooted plants that need about 2 inches of water per week during the growing season. Water is

necessary for fruit set, fruit size and plant vigor. Blueberries need water, even after harvest, to set flower buds for next year's crop.

Pruning - The first year, cut back the tips to remove the flower buds. Remove any weak wood. The following year, leave some of the tips uncut to allow some fruit to develop. Again, remove any weak wood. In subsequent years, leave more and more fruit buds until the plants reach 5 to 7 years old. The plants then will be mature and should remain productive for 15 to 20 years. From that point on, each year remove dead wood and diseased wood. Old and unthrifty canes should be cut back to new and vigorous canes, or to within 3 inches of the ground, to encourage new shoots.

Canes that are 5 years or older are less productive and need to be removed. A lack of new, vigorous shoots indicates under-fertilization or overcrowding of old canes. After making major pruning cuts, return later to remove the weakest lateral shoots that develop.

Fall pruning will usually delay blooming in the spring. The normal pruning time is late winter to early spring before the plants break dormancy. For details on pruning, see Bulletin 197, "Pruning in the Home Garden."

Pest Control - Birds love blueberries. Covering the plants with netting before the berries ripen deters birds from eating the fruit and is the only reliable method of control.

Some insect and disease problems may occur, but good fruit can be produced without pesticides. Diseases can be controlled by raking up and removing fallen leaves before April, and then lightly cultivating the soil. Add two inches of fresh mulch to cover the rotten berries before the plants bloom in the spring. However,

don't increase the depth of mulch that was originally applied. Too much mulch will prevent air from reaching the roots and slowly kill the plants. These practices will control the major fruit diseases.

Dormant sprays of liquid lime sulfur can help prevent phomopis blight and blueberry die-back.

Compiled by:
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PRINCIPLES OF PRUNING THE HIGHBUSH BLUEBERRY

Pruning the Highbush Blueberry in Eastern North Carolina

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Effect on Plant Size and Crop Yield. Pruning of a fruit plant reduces its ultimate adult size and the crop yield in at least the following season. To compensate for this loss of bearing area and yield, other factors, largely economic, must be considered in planning a pruning program.

Effect on Fruit Size. By reducing the number of fruit buds (and hence clusters) on the bush, pruning results in an increase in the size of the individual berries. Up to a point, the more severe the pruning, the larger the remaining berries are. Pruning for increased size is a compromise between desired size and yield of fruit.

Effect on Ripening Period. Moderate to heavy pruning tends to shift the ripening period forward so that most of the remaining

fruit ripens together and early. Light pruning results in a longer season of ripening. It may be more profitable in this area to prune fairly heavily, even at the expense of some yield, to realize the earliest possible maturity.

Effect on Plant Growth and Vigor. Pruning results in longer and more vigorous (thicker) shoot growth in the next season. Heavy pruning causes thicker and more leafy shoots than light pruning. The thicker and later-developing shoots tend to produce fewer fruit buds than those which stop growing earlier in the season. Fruit of the blueberry is borne on wood produced in the previous season (one-year-old wood). By pruning you are regulating the fruiting potential of next season's crop. Pruning should be severe enough to invigorate the plant so that sufficient new wood is produced during the following season. You are actually determining the fruiting potential of the crop of two seasons hence by the number and type of cuts you make this winter.

Spacing the Crop on the Bush. By wise selection of canes and lateral shoots on those canes which will bear the crop, the grower can prune to have his fruit well-distributed on the plant. Well-distributed clusters should have enough leaves around them to provide adequate foodstuffs, but not enough to overshade the fruit, or to reduce spray or dust coverage, or to make the clusters hard to reach during harvest.

Bush Life and Productive Life. Blueberry bushes tend to overbear which shortens their lives. By pruning to regulate crop load, the grower can lengthen the life of his bushes and increase the number of commercial crops.

Training Young Plants (1 to 3 or 4 Years of Age).
If vigorous, well-rooted two-year plants are set, they do not need cutting back the first year except to remove fruit buds shortly after planting. Pruning should be moderately heavy in the third year to stimulate strong new growth on selected canes. Do not permit plants younger than three years of age to bear more than a cluster or two of fruit, or the onset of the commercially productive period will be delayed. A large bearing area should be established in the shortest possible time.

Pruning Bearing Plants

1. Make large "shaping cuts" -- Remove all low spreading branches and the oldest canes if they are weak, particularly if in the center of the plant. "Head back" the upright "bull shoots" to the desired height to keep the bush from growing too tall. Essentially, you have then automatically selected the remaining, more upright canes to bear your crop next season and the following season.

2. On the remaining canes, systematically "thin out" the shorter, thinner shoots, leaving enough of the thick shoots to bear the crop and make new growth. Only experience can tell you how many shoots a particular variety of a particular age can carry and still perform well. It is probably better in most instances to prune too lightly than too heavily. Lighter pruning is usually practiced as the plant grows older because it can carry more "wood" successfully due to a larger root system.

3. Finally, some varieties such as Murphy and Scammell should have their fruiting shoots cut back to three to five fruit

buds per shoot. This is done principally to insure adequate fruit size.

Renewal Pruning. When blueberries are about 8 to 10 years old, they are at their productive peak, but renewal growth has reached a minimum, and production will then decline markedly from year to year. Some provision must be made to revitalize the plant to prolong its productive period. Weak or badly diseased canes should be removed entirely. These canes can be identified by generally poor vigor and low fruit bud production. However, in this climate many varieties do not sprout new canes readily from the crown. It may be necessary to either cut the cane back to a strong lateral which is properly located, or to cut the cane severely ("dehorn") back to within two to three feet of the ground. By the latter method, it is hoped that new lateral branches can be forced from below the cut.

Either method may result in a one- to three-year crop reduction, but the plants should then bear several more good crops. However, when rejuvenation becomes necessary, it is well to start considering newer and better varieties to which your acreage may be systematically replanted in the near future.

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