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SPECIALTY CROP PROFILE: BLUEBERRIES FOR THE UPPER PIEDMONT AND MOUNTAIN REGIONS - PART 1

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INTRODUCTION As a small fruit crop, blueberries are a good fit for the diversified small farm and direct marketing operation. Interest in this nutritious and versatile berry is on the increase, as consumers discover its flavor and uses in fresh and home baking recipes. High in anti-oxidants and vitamins, blueberries also have a long post-harvest shelf life as compared to other small fruit, and freeze well for future use, and are well-received in direct market settings (Fig. 1). Additional value-added commercial uses include jams and jellies, and specialty wines.

Fig. 1. Blueberries for sale at local farmers market



Botanically, blueberries are diverse, and the commercial types represent several different species. They are members of the Vacciniaceae, a sub-family of the Ericaceae family that

includes many acid soil adapted plants such as azaleas and rhododendrons. Because of unique soil requirements, blueberries are naturally adapted to well-drained, but nutritionally poor organic sands. In this country important areas of commercial production include southern New Jersey, southwest Michigan, and the Carolina coastal plains. Blueberries can be successfully grown in mineral (clay, loam mix) soils, but the crop can be a special challenge for growers out of the natural adaptation zones, which includes most of the piedmont and mountain areas of Virginia. Careful site and cultivar selection, and proper cultural practices are critical to ensure success.

As with most small fruit crops, blueberries are labor and management intensive, and require considerable initial investment, particularly in plants. A long-term crop that may be in the field for up to twenty years, blueberries require several years to establish, and first harvests will not start until the third or fourth season, with full production reached by years 6-8. On a small scale, fieldwork can be done by hand, or mechanization is available for specific tasks such as fertilizer application, mulching and spraying. During establishment, appropriate fertility, irrigation, weed, insect and disease control are critical. Development of a sound knowledge of the crop and its biology, and the pests and problems affecting it is essential for success.

For the grower that pays attention to cultural details, is patient and has access to a ready market, blueberries represent significant per acre income returns. Mature plantings may yield up to 6000 lbs/acre (or more), assuming good growing conditions and management. With the right marketing strategy and sales, gross can exceed \$5,000/acre, and net returns can be \$3,000/acre or more.

SITE SELECTION AND PREPLANT CONSIDERATIONS

Best sites include gentle slopes that provide both surface water and air drainage. Late spring frosts can damage blueberry blossoms, and a sloped location allows freezing, colder air to drain to lower areas. Though flowers are tolerant to mild frosts, low areas and known cold air pockets should be avoided, especially for early flowering cultivars.

In most cases, the grower has little choice in selection of soil types. Where possible, sites with significant clay content should be avoided, with ideal soils ranging from silt loam to sandy in texture. Sandy soils with low native exchange capacity (or low native fertility) with at least 2-3% organic matter are preferred. As a species, blueberries are intolerant of waterlogged soils, and internal drainage is critical regardless of soil type. Heavy soils with good internal drainage can succeed, but sites in which water stands for extended periods after rainfall should be avoided. Questionable drainage can be improved by planting on raised beds or ridges, or by tile installation.

Of equal importance to soil type is the native soil pH. Blueberries require acidic soils, with an ideal range of 4.5-5.2. Agricultural sulfur can be used to amend or drop the pH. The amount applied is dependent on how much change is needed based on a pH soil test, and the soil type (see table).

Depending on the native pH of the soil, and its buffering capacity (resistance to change), this process can take time. In many cases, it is economically unfeasible to drop pH in soils with high exchange and high base saturation (high pH) levels. In general, soils with a native pH of 6.0 or less can be amended successfully, however the closer to the ideal range, the better. Application of sulfur should be done at least a year ahead of planting, and requires thorough incorporation into the soil profile. Amounts added greater than 400lbs/acre should be split between a fall and spring application. A second soil test should be taken before planting to determine if the target pH was reached. Additional sulfur can be applied just before plants are set. Soils, depending on native pH and buffering capacity, will over time return to original equilibrium status. Thus for the life of the planting, soil pH should be monitored. Keeping the pH reaction downward after planting is accomplished by judicious use of acidifying nitrogen fertilizers and topdressing of sulfur in extreme cases.

Table 1*. Approximate amount of sulfur (pounds/acre) to lower soil pH to 4.5

	Soil type		
Current pH	Sand	Loam	Clay
5.0	175	530	800
5.5	350	1050	1600
6.0	530	1540	2310
6.5	660	2020	3030

* taken from Highbush Blueberry Production Guide, NRAES

Based on a soil test, pre-plant phosphorus and potassium can be broadcast and incorporated with early pH amendments. Both nutrients should be added to build to "moderate" soil levels as indicated in most soil testing formats.

Additional pre-plant activities include site weed assessment and management. The field should be surveyed for perennial weeds that will become more problematic to manage in the future. It is more economical and easier to eradicate weeds using non-selective herbicides prior to planting, than after the plants are set. In general, approved post-plant herbicides for blueberries have poor activity on established deep-rooted perennial weeds. Planting the field to a grain crop such as corn, wheat or soybeans will also help to reduce future soil insect and weed problems. Be careful using herbicides on these crops with carryover potential, such as atrazine. A cover crop, such as rye, vetch or buckwheat can help to build soil tilth. Cover crops should be plowed down at least 3-4 weeks prior to planting to allow for decomposition.

Two final considerations for site selection include proximity to water source for irrigation, or the capacity to develop irrigation, such as drilling a well or digging a pond. Ease of access for pick your own (PYO) customers is also a key concern if you plan to

market in this fashion. The site location should be easily accessible, with an ample parking area near the field.

FIELD LAYOUT AND FINAL PREPARATION

Following cultivation of the site, raised ridges 4-6 in. high and 4 ft. wide should be formed. Ideally rows should be oriented north and south for maximum light exposure. In some poorly drained sites, perpendicular arrangement of rows across slopes may result in pooling of water, and rows should be aligned with the slope. Row spacings of 10-14 feet on center should be made to accommodate equipment and allow for mature plant size. Rows should break every 200 feet with a drive row or cross-walk for U-pick customer convenience.

When available, pre-plant supplemental organic matter additions should be made, either as a directed application over the row and incorporated with a tiller, or in the planting hole as plants are set. Sphagnum peat moss, well-decayed sawdust or bark mulch are good choices. Peat used directly in the planting hole should be well wetted, or it may cause future moisture stress in the root zone.

Blueberry cultivars vary in flowering dates and maturity period. Similar maturity cultivars should be planted together for best cross-pollination, in alternating blocks of 2-4 rows each. Blocking of cultivars by maturity period also keeps the harvest progressing in an orderly fashion, and makes direction of customers an easier task.

PLANT AND CULTIVAR SELECTION

For the piedmont and mountain regions, northern highbush blueberry is the species of choice. The southern highbush types are more adapted to lower and mid elevation piedmont and coastal regions. They are a more soil adaptable, faster growing and quicker producing alternative to the northern highbush blueberries. They are also more heat and drought tolerant due to their native and rabbiteye genetics. As a negative, they tend to break bud and mature early, and are less cold hardy. Southern highbush performance is not well documented in the state, and growers should proceed on a trial only basis. But by all indications, they may be the blueberry of choice for many Virginia piedmont microclimates. Southern highbush should not be confused with rabbiteye blueberries, which are best adapted to the lower piedmont and coastal plains regions of the state, and should not be planted in the upper piedmont and mountains.

Cultivar selection and locating a reputable nursery source is an important pre-plant task that should begin during the preparation year. Time spent adequately researching the characteristics of cultivars will pay off in the future. Plant growth and fruiting habits, fruit size, maturity period, flavor and disease resistance are important varietal characters to assess. Blueberry plants are sold as either bare-root or containerized stock, with two-year old plants most common. Depending on the planting date, orders should be booked in advance. Planting of bare-root stock should be scheduled as early as possible in the spring (Feb-March), while containerized plants can be set in the fall (Sept-Oct.), in all but the coldest elevational regions. Most smaller growers opt for more expensive containerized plants which offer increased survival and earlier production.

Information about cultivars is available from a number of sources, and your local VCE agent may have information about local experiences. You can also gain insight by visiting with other growers and nurserymen, as well as reviewing extension publications. An excellent regional guide is "Highbush Blueberry Production Guide", NRAES-55, which can be ordered through Virginia Cooperative Extension.

Top cultivar suggestions include:

Maturity	Northern Highbush	Southern Highbush
Early	Collins, Duke, Earliblue	O'Neal, Reveille, Cape Fear
Mid	Bluecrop, Blueray	Blueridge
Late	Jersey, Herbert	-----



Specialty Crop Profile: Blueberries For The Upper Piedmont And Mountain Regions - Part 2

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PLANTING

Planting of bare-root stock should be scheduled as early as possible in the spring (Feb-March) when the danger of severe frost has passed. Containerized plants can be set in the fall (Sept-Oct.), in all but the coldest elevation regions. Fall planting has the advantage of earlier spring growth and root development through the winter. Spring plantings are often delayed by wet conditions.

Spacing: Highbush types should be set 4-5' apart in the row. Highbush cultivars can vary considerably in mature size, and less compact plants should be provided a wider spacing. Allow slightly more room for southern highbush with a 6' in-row spacing.

Plants should be set at the same depth as they were growing in the nursery, in holes at least twice the diameter of the root ball. Holes can be dug by hand, with an auger, or a furrow can be made down the center of the row. As previously noted, moist peat should be mixed with the soil and used for backfill, using about one pound per plant. A peat band can also be used below the plants, but avoid planting into pure organic matter.

During the planting operation, keep roots moist, especially bare-root stock. Containerized plants should be well-watered prior to setting them out. Irrigation after field setting is critical to success.

Following planting, mulch the row centers with 4-6 inches of sawdust or other organic material. This will help to conserve soil moisture, control weeds, and for fall plantings, helps to reduce the effects of winter frost heaving.

In general bare root plants should have 1/3 to 2/3 of the branches removed to balance top growth with the roots. Leave 1 to 3 strong canes per plant, heading back these canes 50% to a strong bud. Containerized plants need only weak and twiggy growth removed, along with moderate heading cuts. Any flower buds (round/plump) should be rubbed or clipped off. Early fruiting is stressful to young plants, and flower buds should be kept off for the first two years after planting.

Row middles should be seeded with a permanent sod as soon as the planting operation is completed. This facilitates equipment access, and decreases the invasion of weeds into the planting. For most locations, turf-type fescues, perennial rye or orchard grass are good choices.

MULCHING

It has been shown in various studies that mulching, even under irrigated conditions, results in larger plants and 2-4x yields over time as compared to non-mulched plants. The primary benefit of mulching is moderation of soil moisture loss and more uniformly moist soils, but also soil temperatures are kept cooler during summer and warmer during the winter, and can keep soils from freezing.

Mulching does result in delayed spring growth and a later crop as compared to no mulching because of delayed spring warm-up. Mulching is not a replacement for irrigation, which will be needed under drought conditions. Mulching should be used with discretion in poorly drained or heavy soils, and in consistently wet sites, characteristic to some mountain regions.

Almost any organic material will function as a suitable mulch. Sawdust has been shown to be a material of choice and is sometimes mixed with hardwood chips to decrease crusting. Pine bark has the advantage of a lower pH than hardwood chips (3.5-4.5 vs. >5.0). A heavy layer of rotted leaves will also work, and is preferable to wheat straw. Fabric mats have the advantage of better weed control, but they increase soil temperatures and do not supply needed organic matter over time as would an organic mulch.

Mulch should be applied every 2-3 years, at a depth of 6 inches. A "once mulched always mulched" policy should be used for the life of the planting. Older plantings losing mulch cover will experience root damage more readily than non-mulched plantings due to a more shallow root system and exposure.

Mulching adds to the expense of growing blueberries for materials and time to spread, and also by increased fertilizer costs. Mulches decay at the point of soil contact through microbe activity, which utilize nitrogen for the process of carbon breakdown. To get enough nitrogen fertilizer through this soil / mulch interface, rates are adjusted to compensate, often by 2-3x, depending on the state of decay of the mulch.

IRRIGATION

Supplemental irrigation for blueberries is considered essential for most areas. Crop water

use is significant: 4-6 gal/day/plant or 1 acre inch/week for mature planting, 2 inches with a full crop load. Blueberries thrive under constant, yet moderate soil moisture. Blueberry rootlets though fine in diameter, are less efficient as compared to other plants because of a lack of root hairs to absorb water and nutrients. While avoidance of droughty conditions and fluctuations is important, it is equally a concern to avoid excess irrigation to reduce root-rot. Soil moisture monitoring is essential to determine true moisture status. A tensiometer or other moisture evaluation tool is a minimal investment to ensure an adequate balance is maintained.

Drip irrigation is a preferable method to overhead irrigation due to increased efficiency and delivery where needed; it also allows concurrent field work activity, and reduces foliar disease incidence. However if the site is frost prone, then overhead should be installed to provide frost protection and supplement moisture. Micro-emitter systems are better than point-source drip systems because they wet a larger surface area, though over-wetting of the crown area should be avoided with this system.

FERTILIZATION

Considerations for blueberry fertilization integrate several factors: age of plants, soil pH / N source, use of and age of mulch and water applied.

Age of plants: Nitrogen (N) application levels are gradually increased each year from planting until a maximum is reached. A general rule of thumb is to apply 20lbs N/acre in the first year, and increase 20 lbs/year until 80-120lbs/acre is applied annually (4-6th years). The final amount is site and growth dependent, however 80lbs is considered a minimum rate on most soils. In the year of planting, wait at least one month before making the first application of 10lbs/N/acre. Then apply 2 more increments of 5lbs each at 6 week intervals. For older plantings the total should be split between an early spring application before bud break, and again 6-8 weeks later. If growth is slow, an additional split may be helpful, but fertilizer should never be applied after July 1. Materials can be applied on a per-plant basis, or banded or broadcast over the row.

Soil pH / N source. Nitrogen fertilizer is available in several forms. Blueberries have been shown to primarily utilize the ammonium (NH_4^+) versus nitrate (NO_3^-) form. The latter is absorbed, but not to the extent of ammonium. One fertilizer that is recommended for blueberries is ammonium sulfate (21%N), which serves two purposes. It is in a form most utilized by the plant, and the sulfate component helps to maintain a low (acidifying) pH. When pH is 5.0 or below, other types of nitrogen can be used such as urea (46%N, also released as ammonium), or a complete fertilizer such as 10-10-10. Soil pH should be regularly monitored at least every two years.

Elemental sulfur can be surfaced applied post-planting if significant pH change is needed. Plants exhibiting high pH sensitivity will have chlorotic leaves which are greenish yellow with dark green veins. This is a sign of poor iron uptake, and it can be corrected by an iron foliar spray and taking long-term steps to lower soil pH.

Use of mulch: The above rates are determined by site conditions and plant growth response under specific conditions. For mature bushes, 6-12" of new growth is adequate, while general leaf yellowing and poor shoot growth is a sign of N deficiency. New applications of fresh mulch, or materials worked into the soil may lead to N deficiency, and supplemental N should be added. Older and thinner mulches do not tie-up as much N, and the total annual rates may be decreased by 1/3 to 1/2 of the above rates (40-60lbs), provided growth is maintained.

Water applied: Soil moisture levels influence N release to plants; too little or too much water can reduce growth. Wet springs and over-irrigating can lead to leaching of fertilizers, but also to increased nitrogen in soil solution and for plant uptake when application rates are high or not split over time. Thus water helps to make nitrogen available, but it also can be a factor for its loss below the root zone. Drought conditions restrict soil release of nitrogen, and excess nitrogen application may cause damage to roots if not dissolved and leached by rainfall or irrigation.

PRUNING

Unlike many fruit crops such as grapes or peaches, failure to annually prune blueberries does not lead to immediate crop failure. However mature bushes will respond to proper pruning with much higher yields and larger fruit sizes. Pruning should be done during the dormant season, with late winter preferable.

After planting, pruning for the next year should consist of removal of weak, damaged or diseased wood and flower buds. The third year, flower buds may be left on the most vigorous shoots. By the fourth season a light crop may be harvested, but flower buds should be thinned to prevent over-fruiting and bending of the shoots. By the 5th to 6th year and later, annual pruning will involve:

1. Pruning small, twiggy growth at the base of the plant and removing dead wood.
2. Removal of older canes at ground level: one cane should be taken out for every 6 present. This is the most important step in mature blueberry planting. It will help to stimulate new shoots and keep the bush productive.
3. Tall new shoots should be headed back to encourage branch development at a lower level and this helps to control bush height
4. Thin the dense growth in the upper part of the canopy by removing crossing and twiggy branches by as much as 50%. This is time consuming, but such "detail" pruning can increase fruit size significantly.

Failure to prune will result in a gradual decline in plant vigor and small fruit size. In the above pruning regime, the canes will be renewed every six years, an age in which individual shoot productivity declines.

HARVEST

Well managed, mature highbush plants can yield up to 10 lbs/plant. Depending on cultivar, weather, and to some extent the level of detailed pruning done, harvest spread can be over a number of weeks. Fruit will hold well on the plant through varying degrees

of maturity. Best quality is reached if picking is conducted every 5-7 days, after the first ripe fruit develop. Southern highbush, like their rabbiteye parents may maximize flavor with 7-8 days allowed between pickings.

Berries should be picked into small buckets or shallow trays, and should not be placed more than 4-5 inches deep in a container. Though considerably firmer than other small fruit, over-ripe and soft berries can detract from the pack when they are crushed.

Blueberries keep well, and pre-picked fruit can store 7-10 days or more under cold storage conditions, and several days in a cool, open market setting.

MARKETING

The primary market for small scale blueberry producers is consumers from surrounding communities. Fruit is direct marketed, and usually sold as pre-picked product, on the farm, or to restaurants and local stores. Most commonly blueberries are sold as a Pick-Your-Own (PYO) commodity. In comparison to strawberries, PYO blueberry markets are less saturated and tend to attract older clientele who do not have to stoop to pick fruit. Usually PYO fruit is sold at 15-25% less than pre-picked fruit. Fruit sold by weight (usually pounds/ounces) must be weighed with state inspected scales (Virginia Dept. of Agriculture and Consumer Services). Sales by volume (i.e. pints, quarts) do not need this oversight.

The successful PYO marketer must be a savvy entrepreneur who must plan ahead, order supplies, train workers, handle harvest logistics such as customer parking and flow, be people oriented and develop a successful advertising program. One must have a feel for the potential PYO trade area, who are the competitors, and what is the best advertising media/approach. In general it requires about 450 customers to harvest one acre (~6,000 pounds) of blueberries.

Adequate insurance coverage is also necessary. Often normal farm insurance plans may not be sufficient for PYO, and the policy should provide for both customer and product liability.

PREDATION CONTROL

Bird predation is the biggest problem faced by blueberry growers. Without protection, losses can exceed 75% of the crop in smaller plantings. Scare devices and exclusion by netting are the most common means to reduce these losses. Netting (1 inch mesh) is usually draped over the rows or supported on a framework. This will eliminate most of the damage, though birds such as ground traversing robins often come through the open bottom. Newer scare devices which emit bird distress calls have provided some degree of protection. Loud propane canons and stationary scare balloons lose their effectiveness over time.

Deer may be a problem on some isolated plantings, though this damage is usually confined to winter twig browsing and not fruit feeding. Fencing and/or trained dogs are effective deterrents.

WEED, INSECT AND DISEASE CONTROL

Weeds compete for water, nutrients and in new plantings for space and light with young plants. In well-mulched plantings, weed problems will be minimal, but can increase over time as the mulch degrades and weed seeds migrate in. Hand pulling or spot spraying with a contact herbicide is generally sufficient. Row middles should be kept mowed to reduce grass invasion and seed drop into the mulched strip. A number of pre-emergent herbicides are available for use in blueberries, which can be applied to the mulch surface to prevent weed seed germination. Label directions should be followed carefully to avoid damage to plants. Cultivation for weed removal should always be shallow to avoid damaging roots.

Insect and disease problems in blueberries are limited but present in Virginia. Maintenance of adequate cultural conditions and healthy plants helps to prevent problems from arising. Growers should be aware of the potential pest problems, and gain an understanding of their biology and life cycles to better target control measures. A number of excellent insecticides and fungicides are available for use on blueberries. Each material has specific one-time and seasonal application rates, re-entry and pre-harvest intervals to consider.

Blueberries have potential as an organically grown fruit, and can often be grown with limited insecticide and fungicide inputs. A number of organically approved spray materials are available, and manure and other organic fertilizers can be substituted for chemical fertilizers.

For a summary of available pesticide materials for blueberries, consult the "Forestry and Horticultural Crops Pest Management Guide" (VCE Pub #456-0147).

FOR FURTHER READING:

In print:

Galletta, G.J. and D.G. Himelrick (eds). 1990. Small Fruit Crop Management. Englewood Cliffs, N.J.: Prentice Hall. [602 pages; 12 small fruit crops]. ISBN 0-13-814609-8

Funt, R.C., M.A. Ellis and C. Welty. 1997. Midwest Small Fruit Pest Management Handbook. The Ohio State University, Bulletin 861. 173 pages. Pritts, M.P., J.F. Hancock, and B. Strik (eds). 1992.

Highbush Blueberry Production Guide. NRAES 55. Ithaca, N.Y.: Northeast Regional Agric. Engineering Service. 200 pp. [Can be ordered through VCE extension agents]

Caruso, F.L. and D.C. Ramsdell (eds). 1995. Compendium of Blueberry and Cranberry Diseases. St. Paul, Minn.: Amer. Phytopath. Soc. 87 pp. ISBN 0-89054-173-6

Pavlis, Gary C. (weekly newsletter; about 4-6 pages/issue). The Blueberry Bulletin. For subscription information, contact: Dr. Gary C. Pavlis, County Agricultural Agent Rutgers

Coop. Extension of Atlantic County, 6260 Old Harding Highway, Mays Landing, NJ 08330. Phone: (609) 625-0056

Some useful web links for blueberries and other small fruit:

1. The Virginia Fruit Web Site: Small Fruit - <http://www.ento.vt.edu/Fruitfiles/VirginiaSmallFruitSite.html>
2. Cornell Fruit Resources: Berries - <http://www.fruit.cornell.edu/berry.html>
3. University of Kentucky New Crops Resources - <http://www.uky.edu/Ag/NewCrops/welcome.html>
4. Northwest Berry and Grape Information Network - <http://berrygrape.oregonstate.edu/>
5. Applied Technology Transfer for Rural Areas (ATTRA), the National Sustainable Sustainable Agriculture Information Service - <http://www.attra.org/>
6. North Carolina Specialty Crops Program- http://www.cals.ncsu.edu/specialty_crops/
7. The Southern Region Small Fruits Consortium - <http://www.smallfruits.org/>