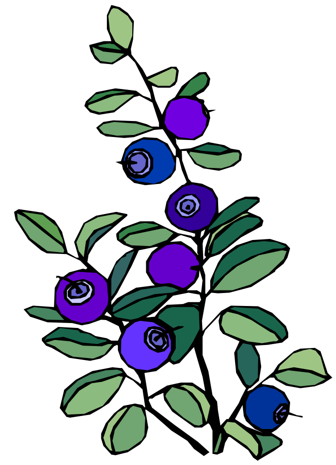
Blueberry Nutrition on Upland Soils



Dr. Marvin Pritts, Department of Horticulture, Cornell University's College of Agriculture and Life Sciences, Ithaca, NY 14853

(For more information visit www.fruit.cornell.edu)

The native peoples of North America have long gathered blueberries (called "star berries" in several Indian languages because of the shape of the calyx) for fresh eating, drying, and flavoring meat, pudding, cake and bread. Europeans were unfamiliar with this delicious fruit when they arrived in the New World, but were fascinated with it. Anne Pollard, a 12-year-old girl who was the first Puritan ashore in North America in 1630, wrote about Boston's Beacon Hill being covered with flavorful, blue-colored berries.

Europeans first gathered the fruit from woods and stream banks, but as villages were established and forests cleared, people desired the convenience of blueberries in their gardens. The first recorded blueberries brought into cultivation were in northeastern Florida in 1887. The story goes that Moses Sapp, a logging contractor "who liked to fish but was forced by his wife to pick blueberries instead" decided to transplant some blueberries into his yard so she could pick the blueberries and he could go fishing. Although this attempt was somewhat successful, many others who transplanted blueberries into their home gardens observed their blueberry plants turn yellow and die. It was as late as 1910 when Fred Coville (Cornell Class of 1888) discovered that the optimal pH for blueberries is 4.3 - 4.8, much lower than that of most home gardens. Once this discovery was made, growers made the appropriate modifications, and now blueberries are widely grown in North America.

Blueberry Nutrition Requirements

Blueberries have unique nutritional requirements compared to most other crops. They evolved in acidic soils where fertility is usually quite low. In addition, in such soils, the predominant form of available nitrogen (ammonium) is usually present at levels that would be toxic to many plants. However, blueberries have evolved mechanisms to cope with these acidic, ammonium-rich, nutrient-poor conditions. First, a symbiotic relationship has developed with endomycorrhizal fungi. These fungi derive carbohydrates from the inner portions of the root system, and in return, help extract nutrients (especially phosphorus and nitrogen) from the soil for the blueberry plant. So, in comparison with other crop plants, blueberries have very low nutritional requirements. In fact, blueberries are sensitive to high levels of some nutrients, and a heavy fertilizer application will injure them.

Blueberries also have the unique ability to directly absorb the ammonium ion. Most plants absorb nitrate, which is then converted to ammonium by nitrate reductase, before incorporation into proteins. However, nitrate fertilizers can be detrimental to the blueberry. For this reason, ammonium forms of fertilizer are recommended, such as ammonium sulfate or urea. Ammonium sulfate is particularly good because it acidifies the soil, and most New York soils tend to have a pH higher than 4.5. Our soils are often underlaid with limestone, or the irrigation water source is neutral to basic. Furthermore, soils with clay slowly release potassium, a basic ion. These conditions tend to increase the pH over time, so even if the soil pH was reduced to 4.5 at planting, it can rise to unacceptable levels by the third or fourth year.

Soil pH

Most nutrient problems in blueberries can be avoided by simply maintaining the soil pH between 4.0 and 5.0. Sulfur is the material of choice for acidifying soil, with the amount dependent on texture and current pH. The higher the pH and the finer the soil texture, the more sulfur will be required (Table 1). In general, soils with more than 40% clay plus silt, or a cation exchange capacity greater than 18, will not support blueberry plants. However, a high soil organic matter content is desirable for blueberry production, especially when they will be grown on upland (mineral) soils. Levels of >6.0% are preferred. In some areas, blueberries are grown on muck soils.

Table 1. Approximate amount of sulfur (lb/A) required to lower soil pH to a value of 4.5.

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

Approximately one year is required for supplemental sulfur to oxidize and reduce the soil pH. Powdered sulfur is faster acting than prills, but is also more expensive and somewhat unpleasant to spread. Oxidized sulfur is available in the form of aluminum sulfate or iron (ferrous) sulfate, but these materials are required in much larger amounts (6-fold and 8-fold, respectively) than elemental sulfur, and they can be toxic to the blueberry plant. Blueberry growers must also be concerned about toxic levels of aluminum and manganese that are present naturally in the soil, since these become very available when the pH is lowered below 5.0.

One of the first signs that the soil pH is too high is interveinal yellowing of leaves. Symptoms usually appear first on the youngest leaves toward shoot tips, and plants exhibit reduced shoot growth and leaf size. The yellow coloration is caused by the lack of chlorophyll production in the leaves, brought on by the plant's inability to use iron. Although the plant may exhibit iron deficiency symptoms, the cause of the symptom is high soil pH. To correct this problem, growers can apply a foliar spray of iron chelate, but the permanent solution is to apply 200 lb/A elemental sulfur, twice a year, to the soil under the plants until the problem disappears.

Macro and Micronutrients

Leaf analysis is a valuable and often underutilized tool in blueberry nutrition programs. It provides a means of accurately identifying nutritional problems that are difficult to diagnose by soil testing or by observing bush appearance. More importantly, growers can identify and correct

potential nutrient shortages before growth or yield is affected. Plants can be nutrient deficient without showing external symptoms.
In New York, leaf analysis results over many years suggest that nitrogen (N) is among the most commonly deficient nutrients. Ideally, levels should fall between 1.7 and 2.0%. Inadequate N causes a general reduction in bush growth. New shoot growth and leaf size are reduced, and few new canes are initiated. Deficient leaves are pale green (chlorotic) in color, as opposed to the lush, dark green of adequately fertilized plants. The chlorotic coloring is uniform across the leaf, with no mottling or pattern. The older or lower leaves usually develop a pale color before younger leaves at the top of shoots. Severely deficient bushes seldom produce more than one flush of growth per season. Leaves of deficient plants often develop fall colors and abscise early. N-deficient plants produce short shoots, usually with fewer flower buds, so yield is reduced.

In mineral soils with low organic matter, applications of an ammonium-based fertilizer will relieve these symptoms. The rule of thumb is to apply 10 lb/A of actual nitrogen for each year old the plant is, up to age 7, then continue with 70 lb/A for the life of the planting. The applications should be split, with the first half being applied at bloom, and the second half six weeks later. If fresh mulch was recently applied, rates may have to be increased. Soils high in organic matter rarely need supplemental nitrogen.

Magnesium (Mg) deficiency is common on naturally-acid soils where many of the cations (Ca, Mg and K) have leached away. Symptoms of Mg deficiency include a distinctive pattern of chlorosis between the main veins of leaves. These regions may turn yellow to bright red while tissue adjacent to the main veins remains green (Photo 3). This produces a Christmas tree-shaped green area in the middle of reddish leaves. Leaves at the base of young shoots are likely to show symptoms first. Young leaves at the tips of shoots are seldom affected. To treat these symptoms, growers fertilize with epsom salts or sul-po-mag (potassium magnesium sulfate); usually 500 lb/A will correct the imbalance.

Potassium levels are rarely low, except on sandy soils. If soil tests or leaf analyses indicate a need for K, use potassium sulfate, or sul-po-mag if Mg is also needed. Potassium chloride (muriate of potash) is used by some growers because it is less expensive, but blueberries are sensitive to the chloride in this material. If high rates are used or the material is applied to young plants or not spread uniformly, damage can occur. Rates of 50 -100 lb K_2O/acre will correct most shortages. Apply K at any time of the year. Excess K can interfere with Mg uptake, so it should not be applied unless a foliar analysis indicates a deficiency.
Phosphorus deficiencies have never been reported for blueberries in the field. Blueberries are good scavengers of P, and when soil P is low, the infection rate from mycorrhizal fungi increases, thereby increasing P uptake.

Boron, zinc and copper levels appear to be relatively low in plantings throughout the Northeast and Midwest. However, foliar sufficiency levels are only best guesses based on greenhouse experiments. Although 88% of samples from New York are below 5 ppm Cu, we are unsure if productivity and plant growth are limited by Cu, and we are unsure how to increase levels in plants. Much more work needs to be done with micronutrients in blueberries, and methods to economically increase their availability in soils.

Proper site selection, coupled with attention to preplant modification, is the major hurdle for blueberry nutrition management. If plants are established properly, they will require little supplemental nutrition, except for nitrogen. So, plants some blueberries then grab the fishing pole. Important work awaits!