Mineral Nutrition of Fruit Trees in Vermont

Unlike annual crops such as vegetables or field crops, the perennial nature of apple trees requires that their nutrient needs be maintained in a holistic and long-term manner. Practices such as fertilizer application, pruning, water management, and pruning can affect tree nutrition status for successive years. Orchard nutrition management should seek to optimize nutrients at ideal levels in the tree, that is not deficient nor excessive.

Fruit trees, like all plants, absorb most of their required nutrients from the soil solution. Therefore a grower should know the nutrient status of their soil, and apply materials to best optimize soil nutrition. Soil samples should be collected on a 3-5 year basis from uniform management units in the orchard. Sites with differing topography or tree health status should be analyzed separately. An accredited soil testing lab can provide specific sampling instructions for their tests, and perform the analysis. The University of Vermont utilizes the Maine Soil Testing Service and Analytical Laboratory to conduct soil and plant tissue analyses. Other laboratories can be found in the latest edition of the New England Tree Fruit Management Guide, available from the Cooperative Extension Service of each New England state. Most important to the fruit grower concerning soil management should be soil acidity and organic matter management. Many soils in Vermont are acidic and can best release nutrients when managed with a liming program. Apple trees prefer a slightly acid pH of 6.0-6.5. Liming instructions for various soil types can be found in the Tree Fruit Guide referenced above. Soil organic matter is a natural source of nutrients and also provides water and nutrient holding capacity to light soils and increased tilth to heavier soils. Cover crops, application of compost, and groundcover management practices can contribute to increasing or maintaining soil organic matter. Generally soil organic matter of 2-5% is considered good for fruit crops, with lighter, sandier soils benefiting more from increased organic matter.

Soil nutrients, however, make up only one part of total orchard nutrition, and their relative abundance as read on a soil report does not reflect their availability to plants nor competitive inhibition that may exist between elements. Growers should collect foliar tissue samples on an annual or at least biennial basis. Fifty to one hundred leaves are collected from the same variety and management unit between July 15 and August 15. These leaves should be from the middle growth of current season's vegetative wood. Leaves should be washed and dried according to lab requirements and submitted for analysis. The resulting report will reveal the nutritional status of the *trees* which may not reflect the mineral content of the soil.

Growers can reference Cornell Cooperative Extension Information Bulletin 219: Orchard Nutrition Management as an excellent source for specific tree fruit nutrient program development. Plants, including apples, utilize macro- and micro-nutrients; these categories refer only to the relative amounts utilized, and does not suggest that some nutrients are necessarily of less concern than others For apples, the macro-nutrients include nitrogen (N), phosphorous (P), potassium (P), calcium, (Ca), sulfur (S), and magnesium (Mg). Micronutrients include iron (Fe), boron (B), manganese (Mn), Zinc (Zn), and copper (Cu).

The principle of limiting nutrients suggests that deficiency of any one of these minerals will decrease plant growth processes, such that increasing nitrogen on a copper-deficient crop, for example, will not allow the tree to 'outgrow' said deficiency. Management of these mineral nutrient levels in the tree is critical for optimal tree and crop development in both conventional and organic systems. Under organic management, the material of choice may differ from a conventional grower, but the tree still requires the same amount of each element to perform its best in the orchard. Specific organic nutrition considerations can be found in the Cornell Grower's Guide to Organic Apples.A private laboratory in Ohio, Spectrum Analytic, has produced another useful guide to Fertilizing Apples, which includes many photos of mineral deficiency symptoms.

Generally, an apple tree should receive 0.1 lbs of added nitrogen per year of age, up to a maximum of 0.5-0.8 lb. Trees grown in sod will require more fertilizer as the grass soaks up some of the nutrients. Nitrogen level should also be adjusted according to the terminal shoot growth on the tree; non-bearing trees should produce 18-24 inches of growth per year, bearing trees 12-18 inches. Trees more or less vigorous than this can have their nitrogen needs adjusted accordingly. On a per acre basis, this translates to annual applications of 25-50 lbs actual N per acre. It is always better to under fertilize a fruit tree than to over fertilize. Therefore trees in their second leaf (second growing season in the ground) with decent growth the previous year should receive 0.2 lbs of nitrogen. A common fertilizer such as calcium nitrate may have a a 15-0-0 analysis (15% N, 0%P, 0%K), so two hundred pounds per acre will provide 30 lbs of nitrogen.

Apple orchards also benefit from annual application of potassium materials to the soil. Rates of 90-150 pounds actual K_2O_5 are commonly applied, but actual rates used by a grower should be calculated based on soil and foliar sampling. High potassium levels in the soil can be antagonistic to magnesium and calcium availability (and vice versa), thus sulfated potash of magnesia, a material that contains potassium and magnesium, is often used in orchards.

Blended fertilizers with different nutrient analyses can also be used, but high phosphorous materials should be avoided. Many fertilizers which also contains other plant nutrients in relatively balanced levels. Use a material whose phosphorus content is derived from rock phosphate which has low solubility and will not contribute to water quality issues due to runoff like manures will. Manures are generally not good fertilizers for fruit trees due to this excessive phosphorus and other nutrient runoff, food safety concerns, variability in nutrient content, and potential weed seed contamination, among others. General nitrogen fertilization should occur between the green tip and petal fall bud stages , or between April 15 and May 30 in northern New England. Nitrogen fertilizers should not be applied after June 15 due to increased late season vegetative growth that is more likely to suffer cold temperature injury during the winter. Other fertilizers can be applied any time that the soil is warm enough to support tree growth.

Foliar fertilizer programs are popular and effective, particularly in maintaining micro-nutrient levels that may be expressed in parts per million in plant tissues, but evels of micronutrients should still be optimized in the soil for long-term health. Vermont orchards commonly apply boron, zinc, copper, manganese, magnesium, and nitrogen materials via foliar application. These practices especially should be coordinated with foliar sampling, because over application of micro-nutrients is easy to do and can result in phytotoxicity.

Foliar calcium programs are very popular in apple orchards and may be essential to maintaining fruit quality. Adequate calcium ensures good cell wall integrity in plants and especially fruit, with apples low in calcium exhibiting a physiological disorder called bitter pit. Affected fruit will have dark sunken spots on the surface at harvest or after storage, and may rot or otherwise decay prematurely. Beginning at petal fall to first cover and continuing roughly every 10-20 days until harvest, a grower may add foliar calcium to spray mixes to boost leaf calcium levels. Care should be taken to avoid potential incompatibility with materials that may lose effectiveness when combined with certain calcium sources. Calcium chloride, for example, is a very effective and cost-efficient foliar calcium material that will raise spray water pH and lead to alkaline hydrolysis, a condition that breaks down the active ingredient in pesticides including captan and many organophosphates. Addition of a pH buffering product can alleviate these concerns. Dr. Wes Autio at the University of Massachusetts has produced a factsheet on maintaining Foliar Calcium for Apples.

Another annual practice used by growers is foliar application of nitrogen (3 lbs urea per 100 gallons), boron (0.1 lb per 100 gallons) and zinc (EDTA formulations applied at label rate) during the tight cluster to pink bud stages, just prior to bloom. Research at Cornell for many years suggested that this combination may increase flower bud hardiness to frost and increase flower part viability. These materials can be applied with other pest sprays so long as they are not incompatible; read the labels carefully to make sure.

Fertilizer materials should be applied within the tree row, ideally spread evenly under the drip line of the canopy, with fertilizing of the grassed row middles avoided unless invigoration of the groundcover is intended. This can be done with a side discharge 'spout' spreader on the back of a tractor, or by hand with a bucket and coffee can for smaller plantings. Application of low per-acre materials can be aided by applying in an herbicide application or injected through drip irrigation. Application of large amounts of macronutrients can be cost prohibitive and difficult through these easily calibrated systems. A good guide for developing fertilizer injection systems is Fertigation Guidelines In High Density Apples And Apple Nurseries In The Okanagan - Similkameen, produced by the British Columbia Ministry of Agriculture.

Fertilizer bags (UVM)

Blast from the Past: The Soil World of Young Apple Trees

(Modified from original article written by former Vermont Extension Tree Fruit Horticulturalist Joe Costante)

The key to a successful orchard, regardless of the size, is the management given to the trees in the first eight years. On top of the list of cultural management practices to follow is the soil preparation before and the two years following planting.

The soil environment of a young apple tree lies within an area approximately 5 feet wide, 6 feet long , and 10 inches deep. This area must be prepared to maintain ideal fertility to allow the young trees unimpeded growth.

A two year preparation program for a new site should involve:

- Correcting the soil pH
- Building the organic matter level in the range of 5% to 7%
- Adding the necessary soil nutrients, such as nitrogen, phosphorous, etc.
- If this is a replant site, you need to have the soil tested for harmful pathogens and nematodes
- Correcting water drainage

The best way to maintain fertility in your newly planted trees includes:

- Conduct leaf and soil analysis annually. Leaf analysis is done from mid-July to mid- August, and soil analysis is done in the fall.
- Water, at least 5 gallons/tree/week for 10-12 weeks during the growing season, particularly during the summer
- Fertilizer, at least 1/3# of actual nitrogen/tree if organic matter is less than 6%, and 1/4# per tree is organic matter is over 6% but under 10%. Double these rates if you are planning on leaving sod around the trees
- For trees 1 to 2 years, spray 1/4# Solubor/acre at 1st and 2nd cover sprays; for 3 to 5 year old trees spray 3/4# per acre at each of the two cover sprays. Boron is an important element in root development.
- Eliminate as much stress from the plant as possible by the applications of herbicide near the tree to eliminate weed competition, and by the addition of mulches around the tree to increase the organic matter.

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