Orchard Fertility

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Introduction

Fertilizer requirements for tree fruits can be determined by nutrient analysis (fruit, leaf, and soil analysis) and observation of tree performance. Leaf and soil analysis has been the most common means for determining nutrient requirements. Fruitlet and pre-harvest fruit analysis can be used to correct potential nutrient deficiency during the growing season and to indicate long-term storage potential for the current season's crop. Nutrient analysis reports and desired nutrient ranges for tree fruits vary from province to province and growers should obtain the desired tree fruit nutrient ranges for their province whenever possible.

Leaf tissue and soil composition may fluctuate from year to year in ways that reflect differences in crop load or weather. These temporary fluctuations should be screened out as much as possible to determine the underlying nutrient status of the soil and trees. In this way one avoids developing a fertilizer program which is tailored to the weather or crop of the previous year as opposed to one which will maintain or improve the nutrient status of the trees and soil. Leaf samples for tissue analysis are collected once terminal growth has stopped which may occur as early as the last week of July. Sampling can be conducted into mid-August. The desired nutrient ranges are based upon sampling at this point in the growing season thus samples need to be collected during this period in order to obtain meaningful results. Leaves for analysis should be collected from the mid-third portion of extension shoots. These are the current season's shoot growth which extends the branch framework of the tree. Do not collect leaves from water sprouts, bourse shoots (shoots that develop from the base of a flower cluster) or dards (short lateral shoots up to 10 cm long with a terminal flower bud). Collect a minimum of 50 to a maximum of 200 leaves from at least 10 trees of the same cultivar from an orchard block. The area included in anyone sample should not exceed two hectares (5 acres).

Collection of leaves.
Source: West Virginia University

Soil pH, Collection of Soil Samples

The desired pH range for tree fruit is 5.5 to 6.6 and when the pH gets below or above these levels nutrient disorders can occur. In general, apply limestone (calcite or dolomite) every third year at 4.5 metric ton/ha (2 tons/acre) until the pH is raised above 5.5 and thereafter is often enough to keep pH within the desired range of 5.5- 6.6. For the purpose of raising and maintaining soil pH use calcitic limestone whenever possible and use dolomitic limestone only if both soil pH and soil Mg need to be increased.

Soil pH should be adjusted prior to the planting of an orchard. Applying limestone and working it into the soil will raise the pH quicker then when it is only surface applied. When limestone is worked into the soil, enough can be applied to raise the pH to within the desired range. A maximum of 6 metric ton/ha can only be applied as a surface application. When limestone is not applied until after trees are planted in an acidic soil, then the combined effects of manganese/aluminum toxicity, low availability of phosphorus/magnesium, and low rates of nitrification, acting over a period of 5 or more years will impact negatively on tree growth to such an extent that the trees may never recover. In addition to these direct beneficial effects of liming on availability of nutrients and preventing toxicity effects there are also indirect beneficial effects to the soil; better structure, improved drainage and better aeration. One should avoid the other extreme, i.e. too much lime, because availability of boron and zinc can be depressed at a high pH.

For the most rapid adjustment of pH, lime should be tilled into the maximum practical depth and mixed well within the soil. Carbonate at the surface of a limestone particle will react with hydrogen ions of the adjacent soil solution; the limestone particle becomes surrounded by soil of high pH. Because the solubility of limestone decreases about 100-fold for each unit increase in pH, such particles of limestone become more or less inert until the adjacent soil is acid again. Consequently, limestone which is not well mixed with soil will also be slow acting.

Soil acidification (need for limestone) is increased by application of fertilizers containing ammonium or urea and herbicides to control groundcover. It is more rapid under the branch spread where these products are applied. Soil samples to test for lime requirement should normally be taken near the area of maximum need, i.e. about 1 metre from the tree trunk and within the herbicide strip, if herbicides are used. To the extent possible, apply limestone preferentially along the tree row so that rates applied per unit area of branch spread are three to five times those applied to travel ways. If modest rates of mineral fertilizers are supplemented with mulches or manures then limestone may not be needed for more than 20 years, provided the land was well limed before planting.

Soil pH can vary with **time of year, soil aeration, location and depth.** In extreme cases these four parameters can cause differences in pH of 2, 3, 3 ½ and 7 units respectively. If samples are collected without regard to these effects then the determinations may not even come close to measuring what one wants to measure.

Time of year: Soil pH declines during the growing season as soluble salts accumulate during dry weather or as warm, moist soil conditions speeds up nitrification. Consequently early August is a good time to sample orchard soil unless the soil is unusually dry or recently leached by unusually heavy rains. If the soil is too dry it is very difficult to extract full 0-15 cm (0-*6"**)* soil samples and a better sample will be obtained by waiting until light rain has moistened the topsoil. In the case of unusually heavy August rainfall (e.g. 10 cm in one day) one should wait if possible until the soil is moderately dry.

Aeration: Soil which is excessively wet and warm enough for biological activity can become reduced and pH will rise to a maximum of about 7.0. This effect can be important if pH of wet soil is measured in the field or measured directly after storage of wet soil in airtight containers. Conversely, if moist soil is stored under warm conditions but open to air then pH may be lowered by high rates of nitrification. Consequently one should sample soil when it is not excessively wet and either measure pH shortly after sampling or air-dry the sample as rapidly as practical if the pH is to be measured at a later date.

Location: The effect of location can be minimized by taking samples at a distance of 1 metre from the tree trunk. A common standard for many years was to take cores in quarter positions but with the advent of smaller trees and narrow herbicide-sprayed strips it is more feasible to take all samples in the line of the tree row.

Depth: The top 15 cm often reflect the accumulation of elements from recent fertilizer applications, while the subsoil may indicate either inherent soil fertility or the long term effects fertilizer and or lime applications. The effect of depth can be minimized by taking samples in such a way that the top 15 cm of mineral soil is equally represented and taking a sample of the subsoil. Depending upon the soil, specialized augers may be required.

The following section on orchard nutrition and the table of recommendations (Table 2) can be used to guide fertilizer usage when leaf and soil analyses are not available.

APPLE

Nitrogen - N

Trees that are low in nitrogen have low vigor, pale green or yellowish leaves and highly colored, small apples. Increasing nitrogen from low to moderate levels will increase shoot growth and yield. Higher nitrogen will increase fruit size provided thinning is used to avoid overset. Excessive nitrogen decreases fruit color, keeping quality and yields.

Response to an increase in nitrogen fertilizer is most rapid (first year) when the orchard is low in nitrogen and when there is no ground cover or sod to act as a buffer. Conversely, response to either an increase or a decrease in nitrogen fertilizer is least rapid (2 or more years) when the orchard is high in nitrogen and when there is a dense sod cover. An unusually wet summer will increase release of nitrogen from organic matter and increase nitrogen fertility late in the year. Raising the soil pH above 5.5 will also increase the availability of organic nitrogen. The nitrate form of nitrogen is more rapidly available than either the ammonia or urea form because it is more readily leached into the root zone, but it is also more readily lost by leaching. A fertilizer that supplies approximately half of the nitrogen in the nitrate form and half in the ammonia form is recommended. Ammonium nitrate and mixed fertilizers with most of the nitrogen supplied as ammonium nitrate (34%N) are examples of such fertilizers. Other commonly available sources of nitrogen are: calcium ammonium nitrate (27.5%N), urea (46%N), calcium nitrate (15.5%N) and diammonium phosphate (18%N). Need for nitrogen fertilizer varies with variety, type, extent of pruning, ground cover management and with soil fertility. For example, Red Delicious usually needs twice as much nitrogen as McIntosh but spur-pruned Red Delicious needs no more nitrogen than McIntosh pruned by scaffold renewal. Unusually heavy pruning or increasing the area that is sprayed with herbicide will decrease need for nitrogen fertilizer.

Phosphorus - P

The phosphorus requirement of mature trees is minimal and their response to phosphorus fertilizer is rare. The roots of fruit trees have the ability to exploit a large soil volume and accumulate phosphorus during periods when it is not required for growth. Satisfactory tree growth will occur in soils where cover crops and vegetable plantings would fail due to phosphorus deficiency. Low soil levels of phosphorus should always be corrected prior to planting fruit trees.

When first planted, the tree needs a high level of soil phosphorus. The root system is poorly developed and the roots occupy only a small volume of soil. As the tree grows, and is able to forage more effectively, the need for phosphorus fertilization decreases. Table 2 suggests annual use of a 1-1-1 mix until trees are bearing. There is however no need to apply any phosphorus if a soil test shows P_2O_5 to be adequate.

Potassium - K

As with phosphorus, the need for potash fertilization are greatest with young trees and fertilization may be discontinued once the tree is well established, or after initial potash shortage in the soil is corrected. Excessive potash fertilization will induce magnesium deficiency and increase calcium deficiency disorders such as bitter pit. To minimize these disorders, potash fertilizer should be used sparingly or not at all once the tree is established.

Potash is often perched (trapped) in the upper soil layers. In such cases mulching will increase uptake of potash. Either dry weather, which reduces root activity near the soil surface, or excessive water, which decreases soil aeration, will decrease potash uptake.

Potassium deficiency in apple trees is evidenced by a grey or dull brown cast near the leaf margins which spreads inwards toward the midrib as marginal scorch develops. These symptoms first appear on leaves of fruiting spurs and basal leaves of extension shoots in late July and August. Temporary shortage of water can cause very similar symptoms.

Magnesium – Mg

The typical symptoms of Mg deficiency in apple trees are yellow or brown patches between the main veins of older leaves, early shedding of leaves and premature drop of fruit. These yellow or brown patches (foliar symptoms) usually develop first near the midrib and spread outward, between the main veins, toward the leaf margin. Leaves of fruiting spurs and basal leaves of extension shoots are usually the first affected. Slight development of these foliar symptoms of Mg deficiency is more or less normal and not indicative of a real deficiency that should be corrected. Excessive pre-harvest fruit drop is associated with moderate Mg deficiency.

Tree growth and yield are likely to be decreased if foliar symptoms are severe (more than 20% of leaves affected by late summer).

Measures to prevent or correct magnesium deficiency include use of: dolomitic limestone of high magnesium content (40% magnesium carbonate), potassium-magnesium sulphate (Sul-Po-Mag or K-Mag), Epsom salts foliar sprays and decrease in potash fertilization.

Dolomitic limestone is the most economical way to supply Mg but is slow acting if applied to the surface and not tilled in. By using soil and leaf analysis it is possible to anticipate Mg deficiency. Correct it long before it becomes a real problem, and avoid overcorrecting (avoid applying too much Mg). Excessive Mg can cause Ca deficiency problems and dolomitic limestone should be used on orchard soils only if a definite need to increase soil Mg needs has been established.

Potassium-magnesium sulphate should be used only where tissue and soil tests have demonstrated a need for potash fertilization on soils marginal in magnesium and too high in pH to be limed.

Epsom salts foliar sprays (see, 'Nutrient Sprays' section) will correct magnesium deficiency. There is no carry-over from year to year. Potash fertilization is a key factor in magnesium and calcium nutrition.

Potash fertilization should be reduced to the minimum that will avoid potassium deficiency where Mg or Ca deficiency is present or anticipated.

Magnesium deficiency may vary from year to year depending upon weather conditions and the cropping pattern of the trees. Unusually wet or dry soil conditions and high temperatures intensify Mg deficiency. The relationship between Mg deficiency and cropping pattern is complex and more or less unpredictable. In irregular bearing trees the Mg content of leaf tissue tends to be higher in on-crop years. On the other hand, there is an opposing tendency for foliar deficiency symptoms (at a given Mg concentration in leaf tissue) to increase as crop load increases. In practice, this year to year variation simply means that leaf analysis and observation of symptoms over a period of several years may be required in order to get a reasonably accurate measure of Mg status.

Calcium - Ca

Low calcium concentrations in apple fruit causes physiological disorders such as bitter pit and early development of breakdown. Consequently, pre-harvest fruit analysis can be used to indicate long-term storage potential of apples provided Ca-related disorders predominate. Leaf Ca cannot be used for this purpose because leaf Ca and fruit Ca are not well correlated.

Methods, within the fertilizer program, to minimize Ca problems include: use of calcitic limestone, sprays of Ca salts (see 'Nutrient Sprays' section), application of gypsum and avoidance of excessive of K, Mg and N. However, optimum soil management will have relatively little effect unless other conditions are also favorable. Fortunately most of these conditions which are conducive to good fruit Ca, such as good pollination and low leaf to fruit ratio are conditions which are desired in any case. An outstanding exception is the common desire to increase fruit size. If fruit size is increased excessively, especially if this is done by increasing cell size as opposed to increasing cell number, then it may be at the expense of poor fruit Ca, shelf life, quality and lost markets.

Boron – B

Boron deficiency can give rise to a great variety of symptoms. Any external cracking or internal browning of apples before harvest is indicative of boron deficiency. In addition there may be die-back of wood, poor set, or early drop of apples. Those which do not drop may be small, distorted, dry or woody. This deficiency can be prevented by the use of boron in mixed fertilizer at a nitrogen to boron ratio of about 50:1 (e.g. 10:0.2 or 17:0.3), by application of about 2 kg/ha (2 lb/acre) boron every third year or by routine application of one spray of Solubor each year. Excessive liming raising the soil pH above 7.0 can cause boron deficiency. Such lime-induced deficiency can be corrected by applying more than the usual amount of boron.

Zinc - Zn

There may be some orchards in the Atlantic Provinces which would benefit from use of zinc sprays.

Symptoms suggestive of zinc deficiency include: poor shoot growth, failure of lateral buds to develop or open (seen as sparse branching, few spurs and growth only from the several buds nearest the tip of last year's growth), delayed opening of buds, slow leaf development, pale or yellowish leaf color early in the year, small and narrow leaves, die-back or abnormal current growth, small apples and poor fruit color.

When a zinc spray is tried, it is suggested that this be done on a small test area typical of the rest of the orchard, and in consultation with the Tree Fruit Specialist in the area. The use of a test area is of particular importance for if the entire block is sprayed and something unusual develops, there is no way of knowing what caused it.

Mulches and Manures

Hauled in organic mulches are usually beneficial. Mulching deserves consideration whenever cheap mulch material is available and especially when improvement in some soil conditions can be expected. Examples include light soil with poor water and nutrient holding capacity, heavier soils with poor structure, soils with limited rooting depth, soils subject to heaving, low uptake of potash, erosion of topsoil, and bare earth following repeated use of herbicide. Mulch acts to insult the roots and can help to reduce root damage where sub-freezing temperatures occur. This becomes particularly important where herbicide strips are maintained and during winters without snow cover.

Organic mulches should be applied early in the growing season while the soil is still moist. Relatively sparse hay mulch (0.5-1 kg/m ^{2}; 0.1-0.2 lb/f^2) applied each spring, shortly after herbicide application, leads to year-round mulch cover and maximum benefit per unit mulch. On the other hand, deep mulch encourages mice, especially if applied late in the year. A deep mulch layer decays more rapidly than sparse mulch because the lower portions are moist for longer periods. If applied to dry soil, it can temporarily decrease moisture availability by intercepting light summer rains. Decomposable organic mulches can reduce fertilizer needs and if rich enough, (e.g. hay from fertile land), can entirely replace mineral fertilizer.

A broadcast application of manure can replace mineral fertilizers. Likewise the use of manure high in bedding material used for mulch can replace the need for mineral fertilizer. Because

composition varies with source, age and storage, it is difficult to judge how much to use and with richer manures it is easy to over fertilize. The fertilizer needs of a mature orchard vary from more than 27 metric tons/ha (12 tons per acre) cow manure stored outside to less than 4.5 metric tons/ha (2 tons per acre) of fresh poultry droppings. Manures should not be spread in orchards from May 1to November 1 and the guidelines for the management and use of animal manure should be followed.

Sod

When sod is being established between the tree rows additional fertilizer is required. Use 300 to 600 kg/ha of seeded area (300-600 lb/acre) of 10-20-20 + 0.2B at the time of seeding. Supplement in later years as necessary to keep the sod in the desired state of vigor by 0 to 200 kg per ha (0-200 lb/acre) of 17-17-17 + 0.3B. Once sod is established it will usually need no or limited additional fertilizer.

For best results seed in the late summer; ideally by August 15th but before September 1st. Germination is greatly improved by using special grass seeders such as the Brillion seeder. When seeding with this type of machine, seeding rates can be reduced to a total of 25 kg/ha (25 lb/acre) and a nurse crop such as oats is not necessary.

Mixtures of various grass seed have been recommended for the establishment of sod in the orchard. Volunteer grass and ground covers will establish on their own but the sod may be variable. Certain mixes require frequent mowing while others proved too competitive with the trees. In an effort to find a better orchard sod, various grasses were tested as a pure stand and in combinations. These tests were conducted in the Annapolis Valley. Following are the results of these tests.

Canada bluegrass is a very low growing pasture type grass that is hardy and does not appear to respond to added fertilizer. It is not very competitive with the tree. This sod is particularly suited to orchards because it will go dormant during dry periods in the summer. It is also easily burned back with Paraquat. It appears to require the least mowing of all grasses tested.

Kentucky bluegrass will establish well and is a typical lawn type grass making a dense sod. It will grow more vigorously than Canada bluegrass and appears to need a little more mowing. This sod will look good but if left will go to seed and grow to ten inches or higher. As with Canada bluegrass it appears to withstand vehicle travel well

Timothy and orchardgrass tend to grow fairly tall and require mowing early in the season. Late fall growth could also provide cover for mice. They are both hardy, and do go fairly dormant during dry weather.

Clovers add nitrogen to the soil but are not generally long lived and do not withstand vehicle travel well. Clovers can harbor buffalo tree hopper which injure bark of young trees. Frequent mowing and, if necessary, sprays of insecticide will prevent such injury.

Growers have been quite satisfied with a 50-50 mixture of Canada and Kentucky bluegrass.

Timing and Placement

Fall application of nitrogen increases the chance of winter injury and the chance that nitrate nitrogen will be lost by leaching. Late spring and summer application of nitrogen could decrease fruit color of certain varieties, e.g. McIntosh because of the high level of tissue nitrogen. For

these reasons, the recommended time for nitrogen application is from late April to early May; shortly after grass starts to show new growth.

Whether potash and phosphorus are applied along with nitrogen in a mixed fertilizer, or separately at some other time of year, is a matter of convenience. Season of application does not influence effectiveness of phosphorus and potash fertilizer, provided they are not spread on snow or frozen ground.

Placement of fertilizer is not critical, provided the area of soil explored by the tree roots is kept in a state of moderate fertility. The greatest concentration of tree root activity per unit area is within the area of branch spread. Roots may extend out to 3 times the diameter of branch spread. The recommended placement is to concentrate most of the fertilizer along the tree row under the branch spread. Spread enough broadcast to maintain adequate sod growth, only if sod is unhealthy, between the rows.

Uptake of nutrients from nutrient sprays is rapid. Foliar nutrient sprays can be used to remedy temporary shortages, such as those caused by unusual weather conditions, and to supply nutrients at times of peak demand. For these reasons timing is important.

An unusually dry or, an unusually cold and wet spring can cause a temporary shortage of boron. In such circumstances, a spray of Solubor or micronutrient spray containing boron should be used at the pre-pink stage. Sprays as late as 3 weeks after petal-fall can be beneficial. In addition, a temporary shortage can develop in some orchards in relatively normal years and cause poor fruit set. Where fruit set is a persistent problem, a spray of a boron compound applied at the pre-pink stage is one possible remedy. Tissue analysis should be used to verify a suspected boron deficiency.

Where magnesium deficiency is severe, sprays of magnesium salts should start at the pink stage. Low magnesium at any period during leaf expansion will cause deficiency symptoms and reduce effectiveness of later sprays. Low magnesium during bloom and the early stages of fruit development will cause poor set. Where magnesium deficiency is slight and only one maintenance spray is used, the application can be delayed to the two-week period after the calyx stage.

The timing of urea sprays depends upon the purpose for which they are being used. Urea sprays from the pink stage to two weeks after calyx stage can be used to increase set, e.g. on irregular bearing orchards in an off year. Routine use of one urea spray near bloom on fresh market apples is recommended. Such sprays near bloom give a temporary boost of nitrogen, when it is most needed, without causing high nitrogen late in the summer. Routine use of at least two sprays on Red Delicious if low vigor is a problem is also recommended. In addition, urea sprays can be used from the tight-cluster stage to mid-July, to remedy a nitrogen shortage. Sprays after mid-June to trees which are not deficient in nitrogen can reduce fruit color at harvest.

Sprays of calcium to reduce the incidence of calcium disorders in the fruit can begin in July and carry on up to harvest depending upon the severity of the disorder. The calcium has to be applied to the fruit to be effective thus applications close to harvest will add more calcium to the fruit then those applied shortly after bloom. Apply calcium on a biweekly interval working back from the anticipated harvest date.

New Plantings
Land intended for orchard should be brought into a state of high fertility over a period of several years before planting. Based upon a soil test and recommended nutrient rates, spread and till in potash, limestone and phosphate prior to planting. Spread potash the fall before planting or earlier. For maximum benefit spread limestone the fall before planting or earlier and superphosphate in a 1-metre (3') band along the tree row shortly before planting.

An excess of rapidly soluble fertilizer can damage tree roots resulting in stunted growth or if sever enough tree mortality. The chance of injury is minimized by not using such fertilizer in the year of planting until shoot growth is well underway and by spreading the fertilizer uniformly over a large area. The suggested fertilizer schedule is 150 grams (113 lb) of 17-17-17 + 0.3B per tree, spread over an area about 2 meters (6 feet) across after shoot growth is at a stage corresponding to full bloom.

Other Tree Fruits
Fertilizer requirements of pear, plum, cherry and peach are similar to those of apple. Annual applications of nitrogen would only be required to soils that have a moderate to high levels of phosphate and potash. Slightly higher rates of nitrogen need to be applied to stone fruit than that for apples. Foliar tissue analysis should be used to determine nutrient levels with in the tree and determining fertilizer rates. Fertilize peach for 30-60 cm (12"-24") growth in young trees and 20 cm (8") growth in mature trees. Apply potash to mature peach and cherry trees in a 1:1 ratio of $N:K_2O$. Stone fruit do not respond to sprays of urea.

NUTRIENT SPRAYS

Concentration
The nutrient spray recommendations that follow are given at dilute spray rates [a full dilute spray is 3400 L/ha (300 Imp. gal/acre)]. The safety of concentrate sprays depends upon **uniformity** of spray **pattern** and spray **deposit**. Solubility is not a problem; spray solutions of all these materials can be prepared at concentrations greater than 10X.

The margin for error with Epsom salts is relatively wide. Spray deposits of this material four times that which is desired cause no injury. However, with other nutrient sprays there is almost no margin for error. If the **spray deposit** is not expected to be **uniform**, then the dilute rate of that nutrient must be reduced accordingly.

When applying nutrients in a concentrated spray using half the recommended rate has proven to be safe in typical orchards. To take urea as an example, an 8X spray of urea at half rate would contain 24 kg/1000 L (24 lb/100 gal) i.e. ½ of 8 times 6 [the dilute rate of 6 kg/1000 L (6 lb/100 gal)]. For a benefit equivalent to one full dilute spray a second half-rate spray of the same nutrient would be required. Successive sprays should be spaced more than 48 hrs apart. Amounts applied by one full dilute spray are shown in Table 1.

Before concentrating nutrient spray; with other spray materials, check for precipitation with a small test mix.

Weather Conditions
Weather influences absorption of nutrients from foliar sprays. For example, under conditions that favors slow drying or allows remoistening of the spray deposit (calm, humid and cloudy) up to 40% of a spray deposit can be absorbed within 6 hours. Conversely, under dry windy conditions

up to 75% of a spray deposit can be lost from the leaf surface within 48 hrs, presumably by wind erosion, with no apparent absorption. Absorption ceases at temperatures below approximately 10 degrees Celsius. Applying nutrients sprays following a frost can increase the injury to leaves, flower buds or fruit. The application of urea during cool and slow drying conditions may contribute to fruit russetting.

Wetting agents
Nutrient foliar sprays are usually applied with a pesticide and wetting of plant surfaces will normally be good because most pesticide formulations contain wetting agents. However, if nutrients are applied alone or if poor wetting is noted then a wetting agent (also called spreaders or surfactants) should be added to nutrient sprays at a sufficient rate for good but not excessive wetting. Rates greater than 100 mL/1000 L (8 fl. oz./500 Imp. gal) would seldom be needed.

BORON DEFICIENCY
If an immediate increase in boron is required, Solubor [1 ½ kg/1000 L (1 ½ lb/100 gal)] may be applied from pre-pink to one week after petal fall. **Do not use with oil or Epsom salts.** Soluble pesticide bags will not fully dissolve in a solution containing boron. Pesticides in this type of package should be pre-dissolved before being added to the tank when boron is being applied. Boron may also be applied as a mixed micronutrient spray containing boron but the cost per unit of Boron may be considerably higher.

One routine annual spray of Solubor may also be used as a substitute for B in the fertilizer program. Solubor contains 20.5% B. One dilute spray at full rate (or two concentrate sprays at half rate) will apply approximately 1 kg of boron per ha orchard (1 lb/acre).

MAGNESIUM DEFICIENCY
Depending on severity of magnesium deficiency, apply up to three sprays of Epsom salts (at 2 week intervals) at 20 kg/1000 L (20 lb/100 gal), starting at pink. **Do not use Epsom salts with oil or Bordeaux.**

NITROGEN SUPPLEMENT
Urea [6 kg/1000 L (6 lb/100 gal)] may be used from Pre-pink to mid-June as a nitrogen supplement. Under urea may cause slight marginal leaf scorch. Under certain conditions, the biuret present in commercial urea may cause slight marginal leaf scorch. For this reason low biuret (less then 0.5%) urea formulations are preferred. Do not combine urea with oil.

CALCIUM DEFICIENCY
Sprays of calcium salts will reduce the incidence of calcium disorders such as bitter pit and senescent breakdown. Apply up to 6 sprays of calcium chloride 77-80% flake at 4 ½ kg/1000 L (4 ½ lb/100 gal) spaced over the two months before harvest. Calcium chloride increases the pH of the spray solution and depending upon the pH of the water this may need to be corrected. Adding 125-200 ml of vinegar (5%) per kg of calcium chloride should correct this problem. Soluble, granular calcium nitrate may be substituted for calcium chloride but applied at a rate of 6 kg/1000 L (6 lb/100 gal). Thorough coverage of the apple surface is essential. There are many commercial Ca formulations on the market and the benefit is directly proportional to the quantity of Ca applied. The greater convenience of a formulated product may in some cases offset additional cost. To compare these formulations with technical calcium chloride, calculate the cost per unit weight of Ca.

Foliar injury can occur with the application of calcium chloride and appears as a burn at the margin of the leaves. It is felt that this is often related to inaccurate sprayer

Leaf and fruit burn from calcium spray.

calibration. If margin burn is noted then reduce the rate of calcium chloride. Fruit spotting of Delicious and Golden Delicious has been reported with the use of calcium nitrate, likewise fruit spotting has been observed with high rates of Stop-it.

ZINC DEFICIENCY

For a suspected mild deficiency use zinc sulphate at ½ kg/1000 L (½ lb/100 gal) with captan at Calyx, First and Second Cover. Do not use on russet-prone varieties such as Golden Delicious. Alternatively, use several sprays of one of the EDBC group of fungicides or zinc chelate early in the season. For a probable deficiency use either zinc sulphate 3 kg/1000 L (3 lb/100 gal) after harvest or zinc sulphate 10 kg/1000 L (10 lb/100 gal) as a late spring dormant spray (just before Silver Tip) or a zinc chelate at recommended rates during the growing season.

Table 1. COMPOSITION OF COMMON NUTRIENTS SPRAY MATERAILS AND AMOUNTS APPLIED PER DILUTE SPRAY

Materials	Content	Kg/ha applied in one dilute spray
Solubor	20.5 % Boron (B)	1.0 kg B
Epsom salts	9.9 % magnesium (Mg)	6.7 kg Mg
Urea	45% Nitrogen (N)	9.2 kg N
CaCl2 77-80% flake	28-29% Calcium (Ca)	4.4 kg Ca
Zinc sulphate	36% Zinc (Zn)	3.7-12.2 kg Zn

Table 2. GENERAL FERTILIZER RECOMMENDATIONS FOR TREE FRUIT IN ATLANTIC PROVINCES

Specific Fertilizer Recommendations Require Leaf Tissue Analysis and a Soil Test

Kg of nutrients per hectare (lb/acre)						
Conditions	**Ratio**	**N**	**P_2O**	**K_2O**	**Example**	**Kg/ha**
Non-bearing trees	**1:1:1**	**-**			**17-17-17+0.3 B****	**--*****
Bearing trees						
Every third year		**30-60**	**30-60**	**30-60**	**17-17-17+0.3 B****	**175-350**
Other years		**30-60**	**0**	**0**	**Ammonium Nitrate**	**90-180**

* If leaf and soil samples show that P and K are adequate there is no need to appl y phosphorus and potash.
** Custom mixes which supply about half of the nitrogen as n itrate is preferable to standard mixes which may contain no nitrogen in the nitrate form.
*** Use abo ut 150 gram s (1/3 lb) of 17-17-1 7+0.3B per y ear of tree age. When sod is being established, apply 300 to 600 kg of 10-20-20 +0.2 B per ha of seed area.

References for deficiency photos

http://tfpg.cas.psu.edu/part1/part12b.htm
http://postharvest.tfrec.wsu.edu/marketdiseases/bitterpit.html
http://www.agf.gov.bc.ca/cropprot/tfipm/calcium.htm
http://www.nrs.mcgill.ca/whalen/nutrient/Potash/Potash.html
http://www.omafra.gov.on.ca/english/crops/facts/apple_disorders/apple_disorders.htm

Original Authors

D.H. Webster, Retired Soil Physiologist
Agriculture & Agri-Food Canada
Atlantic Food & Horticulture Research Centre
Kentville, NS

William E. Craig, Tree Fruit Specialist
Formally with NS Dept of Agriculture & Marketing
Atlantic Food & Horticulture Research Centre
Kentville, NS

For more information, please contact:
Chris Duyvelshoff
Horticulturalist
(902) 678-7722

NOVA SCOTIA
Agriculture and Fisheries