Micronutrient Management in Apple Orchards

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Micornutrients such as zinc, boron, and copper are often deficient in New York orchards. Cost–effective programs to improve micronutrient status of apples involve soil and foliar applications of boron and foliar applications of zinc and copper. Occasional problems with other micronutrients are often caused by low or high pH or poor soil drainage.

The quantities of individual micronutrient elements required to promote optimal performance of apple orchards are relatively small in comparison with calcium, potassium, nitrogen or magnesium. Estimates of actual amounts of individual micronutrients removed per acre from the orchard in a crop of apples include: boron - 120 grams; iron - 90 grams; zinc - 70 grams; copper - 30 grams; and manganese - 20 grams. However, it is the significant roles that these elements play in the physiology of the trees that makes them major factors in orchard nutrition management programs.

Both deficiency and toxicity problems must be considered in developing appropriate programs for managing micronutrients. Some of the more common problems contributing to deficiencies and toxicities of micronutrients are given in Table 1.

Boron

Boron is essential in the normal development of new tissues in shoot tips, flowers, fruit, and roots. Boron has long been essential in pollen development, pollination and fruit set. The boron content of unopened flower buds tends to be fairly high and as growth proceeds the boron content of the resulting tissues tends to decline. Leaf sample analysis and soil testing both provide information needed in evaluating boron status.

Although the most commonly recognized symptoms of deficiency occur in the form of various types of corking and cracking of the fruit, poor development of roots associated with boron deficiency is a significant factor that limits uptake and utilization of various other nutrients such as calcium and potassium.

Foliar applications of boron are effective in providing this element to the aboveground parts of the tree to which they are directly applied. Thorough coverage is essential with boron and it is suggested that these be applied as 1X to 3X tank mix concentrations if possible, and not over 6X to 8X.

Various forms of boron materials are available for use in foliar sprays, the most common being Solubor[R] and Borosol[R] at rates of one pound and one quart per 100 gallons dilute equivalent, respectively. Depending upon the boron content of leaf samples, boron sprays may be recommended at the tight-cluster to pink stage of development when the previous season's leaf analysis shows low (less than 35 PPM) B or when buds have been injured by cold weather. Pre-bloom sprays have been beneficial in improving bud development, pollination, fruit set, early season leaf and shoot growth, and in some cases have improved calcium uptake. Pre-bloom sprays generally do not have an appreciable effect on the boron content of leaf samples taken at the normal 60-70 days after petal fall timing.

Post-bloom sprays of boron are frequently needed to maintain adequate levels of boron to avoid development of deficiency problems in the fruit. These applications may be made at petal fall, first cover (7-10 days after petal fall) or third cover (approximately 30 days after petal fall). Applications of boron sprays later in the season should not be made because of the possibility of stimulating abnormal ripening and breakdown of the fruit.

Boron is not readily translocated within the woody tissues of the tree. Therefore, foliar sprays are not effective in supplying the boron needs of the roots. Annual soil applications of a suitable boron carrier are necessary to maintain an adequate supply in the root zone. The amount of boron needed in soil applications will vary with soil texture. Finer-textured soils have a higher buffering capacity and require higher concentrations of boron to meet crop requirements than those of coarser texture. Soil tests for boron should be used to determine actual rates of application needed. These rates may vary from none to as much as three pounds of actual B per acre, or even four pounds per acre per year on very fine-textured clayey soils.

Boron is soluble in water and can also be applied effectively through fertigation.

Zinc

Zinc deficiency is one of the most common nutrient deficiencies in tree fruit orchards. Zinc is not mobile within the soil and its availability for plant uptake is limited by high soil pH, high levels of phosphorus in the soil, high soil organic matter content, and low soil temperature. Movement of zinc into and through the tree can be limited by precipitation as insoluble zinc phosphate compounds on the root surfaces and in the conducting tissues of the trunks, shoots and leaves. An annual zinc spray program is usually necessary to obtain optimal performance of most orchards.

Zinc has been referred to as the "growth" element because of its role in hormone production in buds. Deficiency of zinc primarily affects the above ground portions of trees, resulting in poor leaf and shoot growth, reduced flowering and fruit set, and reduced size and coloring of fruit. Zinc is also important in the movement of calcium within the tree. Zinc, and potassium, have been shown to be significant factors in minimizing cold damage to flowers and woody tissues.

Soil application of various forms of zinc have been neither consistently nor sufficiently effective to be economical for use in orchards. Applications of various forms of zinc through fertigation have likewise been too inconsistent and/or too expensive for general recommendation.

Application of zinc sprays is the most consistent and cost effective method of applying this element in orchards. The most common methods for applying zinc include late-dormant sprays of zinc sulfate, summer application of zinc chelates or other materials, and post-harvest sprays. Zinc containing fungicides have been partially effective in established orchards, but have not met total requirements nor completely corrected a zinc deficiency.

Application of zinc sulfate (20 to 36 percent zinc) at dormant to silver-tip is effective in supplying part of the total zinc requirement. This material is applied at rates of approximately 3.5 to 5 pounds of actual zinc per 100 gallons of dilute spray, either alone or safened with fresh hydrated lime. This spray must be applied dilute or up to a 2X tank-mix concentration to obtain thorough coverage of buds and shoot surfaces. Oil sprays applied after the zinc sulfate spray increase penetration of the zinc sulfate into buds and spur tissues and have resulted in severe damage. Likewise, freezing weather (frosts) occurring within two to four days before or after the dormant spray has increased uptake of the zinc sulfate and resulted in killing of spurs. For these reasons, this method of applying zinc is not recommended.

There are numerous zinc materials available, but not all are equally effective for use in foliar sprays. NZN[R](10-0-0-5% Zn), basic zinc sulfate (zinc oxysulfate) and various chelated zinc products have been effective sources of zinc when used according to label directions. However, some zinc products, chelated and non-chelated, have caused injury when used as sprays while others, such as zinc oxide, have not been effective. In general, more frequent applications at low rates are preferred over less frequent applications at higher rates.

Approximately 20–25 percent of the zinc in various zinc-containing fungicides is available to the trees, but the remainder is present in or on leaves as an inactive contaminant. There appears to be little or no carryover of zinc from one season into the next. It is therefore necessary to ignore the zinc content of leaf samples and to proceed with an annual full-season zinc spray program.

TABLE 1

Contributing factors to micronutrient deficiency and toxicity symptoms

Micronutrient	Contributing Factors to Deficiency Symptoms
Boron	Coarse-textured soils, low soil B, dry soil conditions, leaching
Zinc	High soil pH, high phosphate levels, high soil organic matter
Copper	High soil pH, high phosphate levels, high soil organic matter
Manganese	High soil pH, highly leached soils
Iron	High soil pH, high phosphate levels, poor soil drainage
Molybdenum (seldom seen in apples)	Low soil pH
Micronutrient	**Contributing Factors to Toxicity Symptoms**
Boron	Application of excessive rates boron
Manganese	Low soil pH (below about 5.6), poor soil drainage
Aluminum	Low soil pH, poor soil drainage

TABLE 2

Foliar nutrient spray use suggestions – apples and pears. (Consult Cornell Cooperative Extension Information Bulletin 219 "Orchard Nutrition Management" for further details)

Nutrient	Green tip-1/4" green	Half-inch green	Tight cluster-Pink	Cover sprays	Comments
Copper (8-8-100 Bordeaux COCS Kocide	Apply from silver tip to 1/4" green and/or after harvest				Later applications or use during freezing temperatures will cause injury to apples.
Boron Solubor (1 lb/100 gal) Borosol (1qt/100 gal)		Assist recovery from winter injury	Improve fruit set and correct low boron levels in tissues.	7-10 day after petal fall and 20-25 days after petal fall	Do not mix with oil. Not compatible with water soluble packages.
Manganese				7-10 days after petal fall	
Zinc (1) EDTA-Zn chelae, NZN[R] (10-00-0-5%Zn Basic zinc sulfate (zinc oxysulfate)		Assist recovery from winter injury	When leaf analysis shows deficient levels or symptoms of winter injury are evident.	2 to 4 cover sprays required to obtain adequate response	

Note (1) Some forms of zinc chelate have caused injury when applied as a sprays. These have included and EDTA-chelate in which the zinc sulfate was not adequately safened.

Copper

Copper is immobile within the soil. As with zinc, copper availability in the soil is frequently limited by high soil pH, high soil phosphorus, and high soil organic matter contents. Copper is involved in various enzyme reactions and processes related to photosynthesis. Symptoms of copper deficiency include abnormal and stunted leaf development, stunted shoot growth with dieback, reduced flowering and fruit set, and small fruit with poor color and quality. Toxicity of copper in the soil results in death of roots, but this has not been observed in New York State orchards.

Soil applications of copper, either to the soil surface or through fertigation, have not provided economically effective correction of deficiencies in apple orchards. Therefore, copper spray applications are the most efficient means for supplying copper to trees. Copper sprays can cause severe russeting of fruit if applied between the time that the florets are exposed in the opening flower clusters until after harvest. Several years of work have not resulted in finding a method for safening copper materials for use during this time period.

At present, the most efficacious method for supplying copper to apple trees is to apply copper fungicides according to the product directions for disease control. This may involve post-harvest and/or very early, not later than the 1/4-inch green stage, pre bloom sprays.

Manganese

Manganese is involved in processes related to photosynthesis and in enzyme reactions. The primary factor governing availability of manganese in most orchard soils is pH. Deficiency symptoms of manganese are frequently observed in orchards when soil pH exceeds approximately 6.3, particularly on coarse-textured soils that have received high rates of lime application. Detrimental effects of manganese deficiency are generally not apparent unless the leaves show chlorosis (loss of chlorophyll).

Although manganese can be effectively supplied through applications to the soil, this method is considered to be too expensive for general recommendation. Foliar sprays are the most cost effective means for supplying manganese to orchards. The manganese in mancozeb fungicides is apparently readily available to the trees. However, restrictions on the use of these materials has resulted in more frequent observations of manganese deficiencies and the need for application of supplemental sprays of other manganese products.

Usually, a single application of manganese sulfate at a dilute equivalent of 4 pounds per 100 gallons applied 7 to 10 days after petal fall is sufficient to prevent the appearance of deficiency symptoms.

Excessive amounts of available manganese associated with low soil pH (below about 5.6) results in "measles," a development of necrotic lesions in the bark of the trunks and limbs of apple trees. Correction of this problem generally requires applications of lime to raise soil pH, and installation of drainage systems, if needed, to improve internal soil drainage.

Iron

Iron is involved in various processes involved in photosynthesis and in enzyme systems in plants. Availability of iron in the soil decreases as soil pH increases. Excessive levels of phosphates or carbonates in the soil reduce iron availability through formation of insoluble iron compounds. Poor internal soil drainage can also result in reduced availability of iron. Organic matter is a source of iron and also complexes and chelates iron.

Iron deficiency is not generally a problem under most orchard conditions. Leaf chlorosis is sometimes seen, particularly on rapidly growing water sprouts but this is not generally a matter of serious concern. There are various proprietary products available for use in correcting iron deficiency. However, determination and correction of the problems that contribute to the occurrence of this condition should be emphasized rather than direct application of iron.

Aluminum

Although aluminum is not required for normal development and performance of apple trees, it is of concern because of the potential toxicity problems associated with its availability in excessive amounts in the soil. Excess aluminum results in root damage that interferes with uptake of the essential nutrient elements. Low soil pH and poor internal soil drainage are the primary factors associated with excess aluminum availability. Correcting these problems with liming to raise soil pH and avoiding soils with poor internal drainage, or installing adequate drainage systems, if feasible, should alleviate problems associated with excess aluminum.

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