Solving Chlorosis Problems and Total Nutrition for Trees

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Nutrition of trees with limited root systems or those planted in small spaces where soils are alkaline has perplexed scientists for years. Calcium or other bases that raise soil pH and reduce availability of micronutrients may be inherent in soil or may be residues from construction or slow accumulation of minerals in the irrigation water or a combination of factors. The end result is poor plant growth and often chlorosis.

Years of work in Florida when micronutrient deficiencies were rampant led me to conduct a huge and complex experiment in 1980 that resulted in Micromax® micronutrient fertilizer. Micromax® is a unique combination of sulfate forms of iron, manganese, copper and zinc plus boron and molybdenum. It has been very effective in eliminating micronutrient deficiencies and accelerating growth of all plants grown in containers. Since about 1985 Micromax® has been the #1 selling micronutrient fertilizer in the world. The product was designed to be used in containers, but it seemed that it should aid plants in landscapes as well. Soon after its invention I did a number of studies where Micromax was placed in holes around chlorotic trees. The treatment had no effect on the trees and excavations later showed micronutrients had reacted with calcium in the soil to become an insoluble cylindrical block.

My focus then shifted to sulfur treatments of the soil surface. An assortment of experiments in Oklahoma showed that if enough sulfur was applied, pH of a few inches of soil could be slowly affected, increasing micronutrient availability. Quantity of sulfur required varied with soil type and level of calcium and other bases in the soil. In some cases, several applications were necessary over a period of two years or more in order to make a change in soil pH without damaging grass or groundcover growing on the soil surface. Sulfur treatments increased availability of all micronutrients and not just iron, plus the long lasting effects that address cause of chlorosis, not just the symptom.

Research that led to Micromax micronutrient fertilizer showed that balance among the six micronutrient elements is very specific. If one element is out of balance with the others, growth restriction and chlorosis occurs even though all others may be near correct levels. Numerous experiences with what appeared to be iron chlorosis were not "cured" by applying iron. In fact, on some occasions "chlorosis" became more severe after applying iron because it was really manganese deficiency. Additional iron made the ratio of iron to manganese wider and increased severity of manganese deficiency. Work has shown that at least some of the chlorosis of trees in Michigan is manganese deficiency. In areas of the southwest, zinc deficiency may cause chlorosis.

In 1986, and another review of the many frustrating factors involved in the chlorosis problem, a possible solution came to mind. Adding all micronutrients in the correct proportions seemed the "best" answer, but how? A combination of sulfur and Micromax micronutrients into one hole might be the answer.

On May 4, 1986, eight chlorotic pin oaks were located. They ranged from mild chlorosis to severe chlorosis with some twig death. Trees ranged in size from five to eight inches DBH. Holes two inches in diameter were augured about 10 inches deep with eight holes per tree. Four holes were drilled about three feet from the stem at the four points of the compass. Four holes were drilled about five feet out and centered between the first holes. The objective was to contact most roots extending radially from the main stem. In the bottom was placed ½ pound of Micromax® micronutrients, then ½ pound of granular elemental sulfur (92%), then the hole was filled with about one pound Osmocote 24-4-10 (Micromax® and Osmocote are products of the Scotts Co).

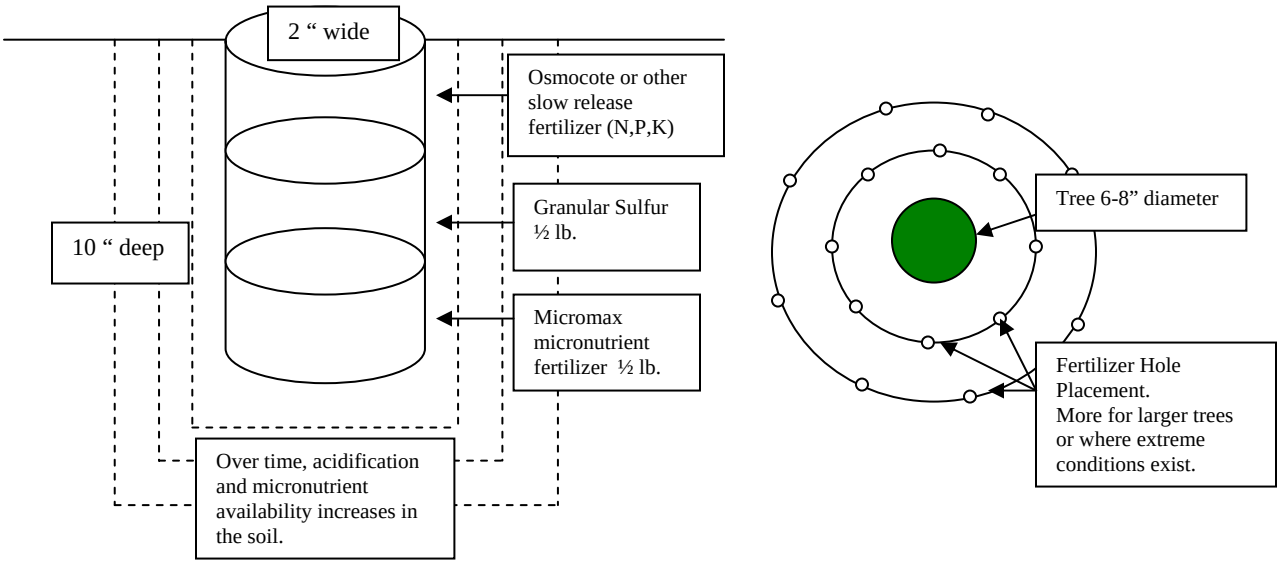
When holes were drilled around the most chlorotic tree, a layer of lime rock, sand and mortar remnants existed about five to six inches below. This debris had been covered with sandy loam topsoil. Beneath the debris was alkaline heavy clay. The other seven trees were all growing in heavy clay soils with pH ranging from 7.2 to 7.8. Only an occasional root was found when drilling holes.

A check of trees on May 25, 1986 showed an improvement in foliage color. Leaf color continued to improve during the growing season. The spring flush in 1987 was a dark green for all trees except the specimen with most severe chlorosis and growing conditions. A check of the trees in September 1987 revealed all had a good green color and a strong bud set for spring. The next time the trees were evaluated in detail was June of 1990. All trees were dark green and attractive, even on the terrible site. A check with homeowners confirmed that only broadcast N, P, K fertilizer had been applied to turf. Soil samples from the worst site and just outside the fertilizer hole contained many fine roots. Analysis showed pH 5.1 and 88 ppm iron and 120 ppm manganese, whereas originally pH was 7.8 and 4.0 ppm iron and 8.1 ppm manganese. Ten years after the initial treatment and with no further treatments other than normal surface N, P, K fertilization, all trees remained a rich dark green and were growing well. During the 2006 growing season, the eight trees were again revisited and evaluated and all trees were dark green and healthy. Seven of the locations were the same homeowners and they confirmed that no further specific treatment of the trees had been made. Three of the homes had sold several times during the 20 years, but it is unlikely that any specific treatment had been made to the trees.

This technique provides a long term slow-release system of micronutrients and sulfur in a zone in and around each hole (sees drawing). The Key is creating sufficient holes to intersect a major portion of the roots. Sequence of events is probably as follows: 1) holes are drilled and micronutrients, sulfur, and fertilizer are placed around the tree. 2) With first wetting, Micromax micronutrients form a hard mass and small amounts of sulfur and N, P, K from the Osmocote are released into the soil. 3) With each successive rain or watering, a small amount of N, P, K and sulfur is released. Sulfur dissolved by water forms a very dilute sulfuric acid, which dissolves a small portion of micronutrients. Micronutrients and sulfur slowly lower pH of soil surrounding each hole. 4) New root growth in and around each hole aids in absorptive capacity of the tree. This is encouraged by N, P, K as well as sulfur and micronutrients and improved aeration. 5) Over a period of time, a zone of soil around each hole is modified to be lower in pH and rich in micronutrients in approximately the correct proportions. Note: in further studies, substitutes for Micromax have worked poorly or not at whereas any long term release Osmocote or similar products appear to work well in supplying slow release N, P, K.

A plant does not require all roots be in soil with optimum nutrient conditions for good growth. Studies have been done showing when one or more roots of a plant are in a soil or medium with favorable conditions of nutrient availability, plant growth is enhanced and problems of deficient nutrient(s) are reduced or eliminated. In *Methods of Studying Root Systems, W*. Bohm lists many techniques and over 1000 references on the subject.

Approximately one hole per inch of stem diameter is a good place to start and has been effective on a variety of trees under Oklahoma conditions. Tree injury from additional holes is unlikely. A series of rings of holes starting about three feet out from the stem has been more effective than a single ring further out (see drawing). Longevity of the treatment has been more than 20 years on my study sites, but would be expected to vary with the severity of the conditions. This technique is an effective treatment for chlorotic trees or shrubs on alkaline soils or trees where root systems have been damaged or reduced, with no risk to tree health and with a cordless drill and two inch bulb planter or spade bit, is relatively easy to install.



Patience is required as tree response to treatment is not immediate. For example, if a tree is treated during summer, typically there is little or no visible response. This treatment requires the combination of release of micronutrients and soil acidification and root growth into the treated zone. However with root growth during the fall and early spring, some green-up response with the first flush of growth occurs. In some cases a few limbs still have chlorotic leaves while other leaves show some green-up. This is because the roots supporting those specific limbs have not yet grown into the treated zone. If some limbs remain chlorotic the second season following treatment, it is likely an insufficient number of holes were used relative to conditions on the site. In one case, a large pin oak had a concrete patio that abutted a house and a concrete drive way on two sides. There was insufficient space for a full complement of holes on those two sides of the tree. Two years later and several limbs still were chlorotic. I then installed more holes just beyond the driveway in an open lawn area. The following spring the entire tree was green and has remained green for what is now 16 years.