AN OVERVIEW OF SYSTEMIC NUTRIENT TREATMENTS IN TREES[1]

by Elton M. Smith

Historically, certain tree species have exhibited habitual chlorosis, particularly when planted along streets and around homes where the original topsoil had been removed or mixed with the subsoil. Urban soils have relatively poor physical, chemical and biological characteristics. Root development and penetration are reduced in heavy clay subsoils that lack adequate aeration and water drainage. In addition, the amount of available nutrients and organic matter is often critically low (3).

Arborists have been coping with these problems for many years and were treating trees in a variety of ways but primarily through soil treatment of fertilizers and acidifying agents. Foliar treatments with minor elements such as iron have been common practice.

Typically, arborists and landscape maintenance personnel were treating with fertilizers with acidic residues such as ammonium sulfate. Acidfying agents in the form of sulfur or aluminum sulfate were used to lower and limestone to increase the soil pH. When available, minor elements were added to the fertilizer, with iron sulfate and later iron chelates commonly used with pin oak, white oak, dogwood, and shrubs such as rhododendrons and other broadleaved evergreens. Shurtleff and Jacobsen (9) claim that over 250 species of plants are susceptible to iron deficiency alone.

Recent Research

During the decade of the 1970's, a flurry of research was conducted as new products became available to the industry in the form of tree trunk implants and injections containing various minor elements. These compounds were effective in reducing or eliminating chlorosis of certain trees. However, controversy arose over the potential injury to the trees over the short and long term as a result of drilling holes in the trees for the implants and injections. This concern led to further research activity in learning more about wound closure following injury, injections or implants of an assortment of chemicals (8). Research was also conducted on internal injuries of trees and the following recommendations for injection treatments were offered (9):

- Make wounds as small as possible.
- Make wounds as shallow as possible.
- Make wounds on the root flare but not in the valleys.
- Do not align wounds in a vertical pattern.
- Do not wound trees annually.
- Do not wound trees when leaves are expanding in spring.
- Do not inject trees with large columns of decay.
- Do everything possible to increase growth of injected trees including watering, fertilizing and pruning.

The compounds receiving the most attention during the 1970's included ferric citrate and ferric ammonium citrate for control of iron chlorosis, manganese sulfate for manganese deficiency and zinc sulfate for yellowing of selected trees in the southern U.S.

Ferric ammonium citrate implants effectively controlled habitual iron chlorosis in willow oak (6), pin oak, scarlet oak, northern red oak, willow oak, and white oak. Also, white pine, Japanese black pine, sweet gum, star and sweetbay magnolia and oriental photinia (11).

Manganese sulfate implants have been found effective in reducing manganese deficiency in flowering cherry (5), sugar maple, Norway maple (4), silver and red maple (11).

In 1980, continued research with "Maple Decline" was conducted by Funk and Peterson (1) in Michigan. They observed that soil fertilization with high nitrogen fertilizer and trunk or foliar treatments with manganese were often effective

1. Presented at the Symposium on Systemic Chemical Treatments in Tree Culture at Michigan State University, East Lansing in October 1987.

in improving the color and growth of sugar maples symptomatic of maple decline. The nutrient level was lower in chlorotic leaves than in healthy leaves for all elements except sodium and aluminum, supporting the thought that salt (sodium chloride) is involved in sugar maple decline along highways.

Pressure trunk injection of zinc sulfate increased leaf zinc levels of zinc deficient pecan trees in Georgia (14).

Few tree species require high levels of zinc for adequate growth, however, pecan trees are the exception and a range of 50-100 ppm zinc in the foliage is desirable. Without adequate zinc, pecan trees develop rosette, which begins with small crinkled terminal leaflets with interveinal chlorosis followed by limb dieback. Soil applications of zinc may take years to correct, especially in alkaline soils. Working with zinc sulfate implants and high pressure injection of zinc sulfate, Worley et al in 1980 (15) found pressure trunk injection the preferable treatment for pecan trees.

Some investigators have researched methods of acidifying the soil to correct chlorosis induced by unavailable iron and manganese in soils above pH 6.2.

According to Messenger (7), restoration of nutrient imbalances and normal leaf color can be accomplished and maintained for several years by topsoil and subsoil treatment with sulfuric acid. The author used 3N sulfuric acid diluted in 5 gallons of water/100 square feet in 2 inch diameter holes (PVC pipe), 2 feet apart, in two circles beneath the crown. Topsoil pH's beneath treated pin oaks were approximately neutral three years after sulfuric acid application. Subsoils treated similarly were still considerably acidic after four years.

Whitcomb (13) applied granular sulfur (96%) at rates of 10 and 20 lbs/100 sq. ft. of surface area of Bermudagrass sod. After 7 months, soil pH had dropped from 8.2 to 7.8 with 10 lbs. of sulfur and to 6.6 with 20 lbs./100 sq. ft. Soluble iron and manganese increased with the added sulfur. Soil samples after 10 years showed that the availability of iron, manganese and zinc all remained higher in the soil as a result of the application of granular sulfur.

It is important to note that Messenger (7) observed injury to Kentucky bluegrass from granular sulfur at rates of 12-18 lbs./100 sq. ft. and unreported research in Ohio has shown injury to Kentucky bluegrass at both 10 and 20 lbs./100 sq. ft.

Research Needed

All the answers for successful prevention and correction of chlorosis problems of trees have not been found. Treating the cause instead of the symptoms is a high priority and continued research is needed to find better techniques to lower the soil pH for extended time periods without injuring the trees, turf or other plants.

More work is definitely needed in the correction of manganese deficiency of trees (2). The injection and implant treatments are only 30-50% effective in work with maples. More effective compounds and/or application methods must be developed.

Most tree research with iron chlorosis has been conducted with pin oak and current commercial treatments have been quite successful. However, other species should be studied and more precise recommendations developed for sweetgum, river birch, red oak, white pine and other species.

Work remains to be done with foliar analysis to more fully define the requirements of various species of trees and the optimum range of iron and manganese. Deficiency levels have been determined (11), but sufficient or optimum ranges have not been thoroughly defined.

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Abstract

HAMILTON, W.D. 1987. **Tree wounds: their cause and treatment.** Arbor Age 6(10):36-39.

Tree wounds are natural in the life of every tree. Scars left by fallen leaves, stubs left by fallen dead branches, and holes made by wildlife are part of tree life. A tree wound is any injury which damages living bark; cambium and wood may also be involved. Bacteria and non-decay fungi are the first to colonize the wood surface. Few of these can grow into wood: usually they are not wound invaders. Organisms that do grow into the wood are faced with chemical protective barriers (phenolic compounds) formed by the tree. Some surmount the barrier: most cannot. Upon examination of decay in tree wounds, it is evident that the whole cross section of a branch or trunk is rarely involved. Usually, there are limits to decay from a particular wound. The size of the wound may be large if pruning cuts are made flush with the trunk, and small but slow to heal if a long stub is left. So a compromise is made. The cut is made on the outside edge of the shoulder tissue, slightly away from the larger limb. Normally, this will be just outside the protective barrier formed by the tree. Late fall and early winter may be the worst time for wounding, due to the abundance of fungal spores. At present there is no proven means of increasing the rate of wound closure other than increasing tree vigor.