SOLVING THE IRON CHLOROSIS PROBLEM[1]

by Carl E. Whitcomb

Abstract. Soil applications of granular sulfur were effective in reducing or eliminating the chlorosis of pin oaks growing on an alkaline heavy clay soil. Granular sulfur at rates of 6 to 10 lbs./100 sq. ft. increased the availability of iron and manganese after 3 to 6 months and in some cases, levels of these two elements remained in the desirable range 10 years after the initial treatment. Soil applications of granular sulfur influences the cause of chlorosis, not just the symptom, and does not injure the plant.

Chlorosis of pin oaks and other species in the urban landscape is a frequent occurrence (1, 6, 9, 12, 13, 14). It is a continuing problem in most of the western and prairie states due to the naturally alkaline soils (1, 4), but may be a problem anywhere construction has occurred and residues remain (3) or irrigation water is alkaline (15). In most areas of the U.S., domestic water contains substantial quantities of calcium, either naturally or as an additive during the water treatment process to precipitate clay. When landscape plants are watered the level of calcium and other bases slowly accumulate, increasing the soil pH and reducing the availability of many of the micronutrients, especially iron and manganese. In many instances, a pin oak is planted and grows well for several years, only to begin showing signs of chlorosis about the time it reaches a functional size in the landscape. The tree is reflecting the gradual change in soil pH and micronutrient availability which goes undetected until *visual* symptoms appear.

Halverson et al (3) found that pH of water from rainfall was raised from 3.99 to 7.64 after it ran across concrete surfaces such as driveways and parking lots. In areas where clay soils exist and percolation of water and minerals through the soil is minimal and root systems are shallow due to poor soil aeration, chlorosis may develop more quickly (14, 15).

Most techniques to correct chlorosis have only short-term success because they treat the symptom instead of the cause. The symptom is leaf chlorosis, whereas the cause is the reduced availability of micronutrients as a result of high soil pH. Fischbach and Webster (2) and Harrell et al (4) noted that in some cases adding iron or manganese gave no response or in some cases increased chlorosis. This is understandable since in some soils, the primary deficient element may be manganese (6, 12), and if additional iron is added the iron-manganese ratio is widened, further decreasing manganese absorption. The reverse situation can also occur.

Trunk injections create undesirable wounds (11) and provide only short-term benefits to the tree since they treat only the symptom (2, 4, 5, 8). On the other hand, soil treatments to reduce pH respond more slowly, but address the cause. Remon et al (10) reported a drastic improvement in the color of pin oaks growing in a heavy clay soil in Oklahoma by treating with elemental sulfur. Messenger (7) observed a decline of soil pH for 1.5 years after treating with granular sulfur at rates of 6 to 10 lbs./100 square feet.

Materials and Methods

On June 6, 1975, granular sulfur (96%) was applied to plots 20 inches wide by 18 ft. long in a Bermudagrass sod at rates of 0, 10 and 20 lbs./100 sq. ft. of surface area. The treatments were replicated 6 times in a randomized block design. Granular sulfur was applied with a drop type fertilizer spreader and watered-in using a low volume sprinkler.

Identical treatments were applied to individual pin oaks with 8 to 12 inch trunks growing in the same area on the same date. Granular sulfur treatments to trees covered an area approximately twice the distance from trunk to drip line. A chlorosis rating was made of all trees before the study began and at intervals thereafter using a 1-10 scale, where 1=very chlorotic and 10=no chlorosis.

Soil samples 3 inches deep and 2 inches in diameter were taken from all plots after 0, 1, 3, 5,

1. Presented at the Annual Conference of the International Society of Arboriculture in Milwaukee in August of 1985.

and 7 months and 10 years. The soil was a heavy red clay which had been disturbed many times over the years by construction, therefore no specific soil classification is possible.

Results and Discussion

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. (Figure 1). Soluble salts increased from about 11 mili mohs to 55 or 63 with 10 or 20 lbs. (Figure 2). Soluble iron increased from 11 ppm to 46 or 65 (Figure 3) while manganese increased from about 9 ppm to 30 and 45 ppm with 10 and 20 lbs. of granular sulfur/100 sq. ft. respectively (Figure 4).

Trees with an average chlorosis rating of 2.2 increased to 6.4 by the end of the growing season and most had a rating of 8 or higher at the end of one year. All trees treated with 10 or 20 lbs. of granular sulfur had a visual rating near 10 after 2 growing seasons.

The bermudagrass turf was not injured by either rate of sulfur, however, most weeds in the sod were killed by the 20 lb. rate. This relates with the findings of Messenger (7) who observed injury to Kentucky bluegrass from granular sulfur at rates of 12 to 18 lbs./100 sq. ft.

The pin oak color improvement was much greater than expected with the soil pH which remained 7 months after the 10 lb. treatment. Subsequent samples were divided into sections from 0-1.5" deep and 1.5 to 3" deep. Note the difference in pH and nutrient availability from the two depths of soil samples taken on May 17, 1985 (Table 1). The soil pH at the 1.5-3" depth was still 7.6, whereas, the 0-1.5" depth was only 5.9. The sequence of events were probably as follows: a) alkaline heavy clay soil b) granular sulfur treatment on the soil surface and watered-in c) sulfur reacts with soil, lowering pH at near the soil surface which in turn releases calcium and other cations and increases soluble salts (see Figure 2) d) as the calcium and other cations move downward in the soil they re-attach to the clay colloid e) this gives an average pH reading of the entire 0-3" depth unusually high, since much of the calcium removed from the surface is still present in the sample f) however, since many tree roots are present in the upper few inches of soil, the tree responds favorably to the improved availability of the micronutrients.

Soil samples after 10 years (May 17, 1985) show that the availability of iron, manganese and zinc all remained higher in the soil as a result of the one application of granular sulfur (Table 1). The slight drop in pH and increase in available iron and manganese in the control (no sulfur) treatment after 10 years is probably due to the acidifying effect of urea (46-0-0) as the nitrogen source for the past 8 years.

As a further example of the long-term benefits of soil applications of granular sulfur, a case history of a chlorotic pin oak approximately 12 in. trunk diameter and 30' tall is also included. The tree

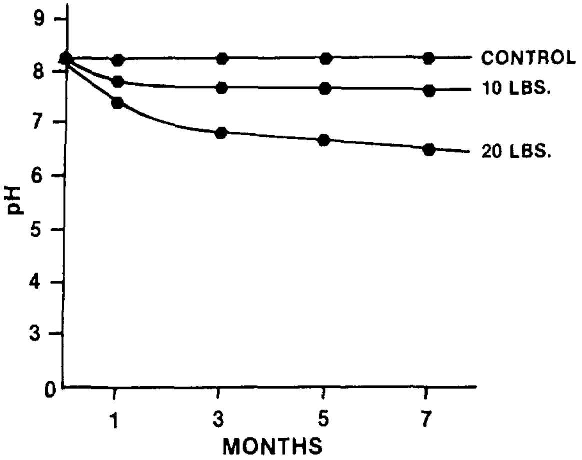

Figure 1. Effects of elemental sulfur on pH of a clay soil.

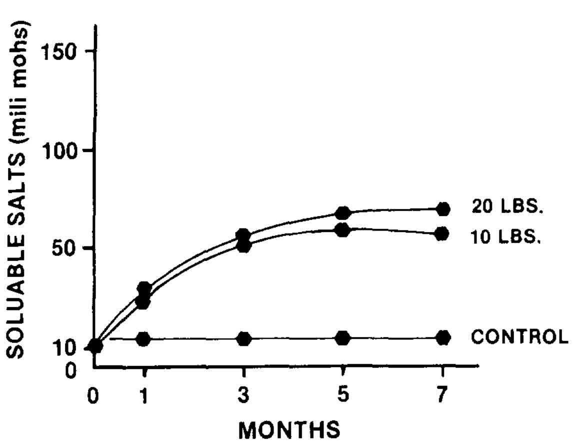

Figure 2. Effects of elemental sulfur on soluable salts in a clay soil.

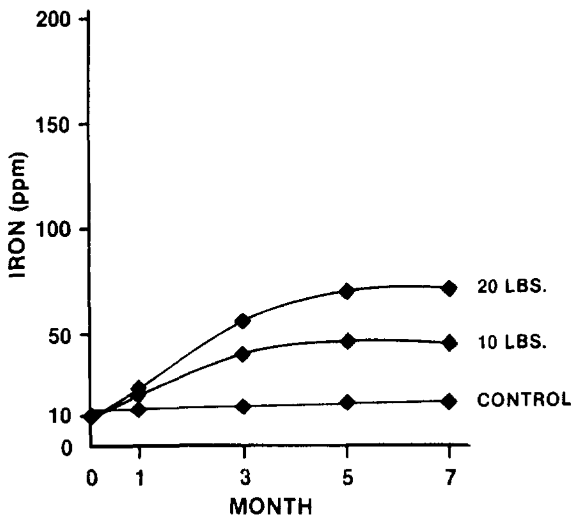

Figure 3. Effects of elemental sulfur on soluble iron in a clay soil.

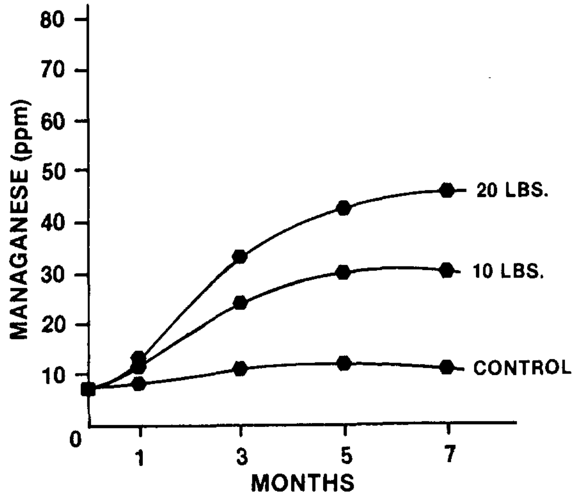

Figure 4. Effects of elemental sulfur on soluble manganese in a clay soil.

Table 1. Effects of one application of 96% granular elemental sulfur @ 10 lbs./100 sq. ft. on micronutrient availability after 10 years. Ten pounds of sulfur applied 6-6-75.

Treatment	*Date & Depth*	*pH*	*Iron*	*Manganese*	*Zinc*
	6-6-75				
	0-3" depth	8.2	11	9	2.2
	1-6-76				
	0-3" depth	7.8	46	30	3.4
	5-17-85				
No	0-1.5" depth	7.9	23	13	3.0
Sulfur	1.5-3" depth	7.7	19	10	3.2
	5-17-85				
10 lbs.	0-1.5" depth	5.9	123	47	3.2
Sulfur	1.5-3" depth	7.6	104	33	4.6

was rated as a 1 on the chlorosis scale of 1-10, however leaf retention was good. A limestone driveway-walkway existed approximately 30 feet from the tree and the soil sloped so that runoff water accumulated near the tree. The soil was a very heavy, poorly drained clay with a pH of 7.9 on October 10, 1974 with 3.5 ppm available iron, 8.7 ppm manganese and 12 ppm zinc (Table 2).

The tree was treated with granular sulfur on May 5, 1975 at 10 lbs./100 sq. ft. well beyond the drip line. During the remaining 1975 growing season, some improvement in leaf color occurred but it was not uniform over the tree. Soil samples were again taken on June 14, 1976 (2" diam., 3" deep) and showed pH 7.7 with 21, 9.1 and 10 ppm available iron, manganese and zinc, respectively (Table 2). On June 17, 1976, an additional 6 lbs./100 sq. ft. of granular sulfur was applied with some further improvement in foliage color. The treatment was repeated June 12, 1978. Beginning with the spring flush of leaves in 1979, the tree has remained green (9 to 10 on the visual rating scale). Growth is slow but this is probably due to the very poor soil conditions. Soil samples were taken on May 17, 1985 and sectioned into 0-1.5 and 1.5-3.0 inch depths (Table 2). The pH of the soil surface is much more acid than the sample below. The iron and manganese availability has increased dramatically at both depths and probably accounts for the improved foliage color. Three applications of granular sulfur (22 lbs./100 sq. ft. total over a 4 year period) made a sufficient adjustment in soil pH near the soil surface to increase available micronutrients to maintain good leaf color for 7 years. The 1985 soil test suggests that further treatments will not be necessary for some time.

Conclusions

a) Granular elemental sulfur (96%) is an effective treatment for chlorosis of landscape plants.
b) Foliage color response may not be seen for several months or until the next flush of leaves.
c) The total amount of granular sulfur needed depends on alkalinity of the soil, the element(s) involved in raising the soil pH, soil texture, chemical composition of the irrigation water, runoff water onto or away from the site in question and probably other factors.
d) The primary soil pH change will occur at or near the soil surface, therefore normal soil sampling and testing procedures may reflect an increase in micronutrient availability with little or no pH change.
e) The effects of soil application of granular sulfur are long-term and address the cause of the chlorosis problem not just the symptom.
f) No detectable injury to the tree trunk or roots occurs.
g) Application is simple and easy with modern dust-free sulfur granules.
h) If concern exists regarding turf or ground cover injury a half rate may be made then another half rate 2 to 4 months later.

Table 2. Case history of a very chlorotic pin oak growing in a poorly drained heavy clay soil where part of the runoff water onto the site was from a limestone driveway. Tree treated with 96% granular sulfur, 10 pounds per 100 sq. ft. on 5-5-75 and 6 pounds per 100 sq. ft. on 6-17-76 and 6-12-78.

		Parts/million available		
Date and depth	*pH*	*Iron*	*Manganese*	*Zinc*
10-10-74				
0-3" depth	7.9	3.5	8.7	12
6-14-76				
0-3" depth	7.7	21	9.1	10
6-7-79				
0-3" depth	7.5	66	16	10
5-17-85				
0-1.5" depth	5.6	332	20	11
1.5-3" depth	7.2	226	58	21

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MARKETING TREE MAINTENANCE CONTRACTS[1]

by Ted Collins

My experience with commercial arborists on a local, state, and national level reveals that we are generally unaware of three critical factors in marketing tree maintenance contracts. These factors are: 1) knowing your market area, 2) knowing the right message and image, 3) getting the message and image to the consumer effectively and economically.

Knowing your market area. This means understanding the geographics and economics of the town, county, or state you service. At Ted Collins Tree and Landscape we concentrate on four or five towns in the eastern suburbs of Rochester, New York. These are the towns with the largest homes and lawns and the most trees. We purposely located our business there. Eighty percent of our volume is realized from customers within 10 miles of our headquarters. We intentionally ignore the other fourteen towns. More on that later.

A detailed map of our county shows some 33 bridges crossing the Genesee River which runs North and South through Rochester. To venture westward from our eastern suburb base, crossing these bridges at peak times to attempt to serve the less affluent residing there would be financial suicide. An exception, of course, is the occasional profitable contract where the distant customer will pay our rates plus travel time.

Knowing the right message and image. A recent survey by the Ohio State Chapter of I.S.A. asked respondents why they chose arboriculture or related fields as their profession. The overwhelming response was "love of trees and the outdoors." Why then, don't we demonstrate that love? Why do we demonstrate our noisy equipment? Why do we feature our spray rigs, chain saws, and chippers in our advertising? I believe the reason is that we have fallen into the trap of demonstrating to "each other," not to the consumer. The buyer does not want to see a cow butchered in order to enjoy a good steak. Venison is a superior, delectable gourmet treat, but the idea of chasing, shooting, and dragging a deer out of the woods and parading it through the streets on top of a car is not marketing it correctly.

I believe the correct marketing approach concerns beauty, shade, flowers, fruit, shelter, and privacy. Any other function such as soil erosion, enframement of a pleasant scene, or tree recognition should also be featured in your promotion. Age of a tree is an example. Guardian Tree Service has photographs of two large trees on the back of their envelopes with these clever words

1. Presented at the annual conference of the International Society of Arboriculture in Milwaukee in August of 1985.