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DECLINE OF CURBSIDE SUGAR MAPLES IN CONNECTICUT

by Saul Rich and Gerald S. Walton

Abstract: Curbside sugar maples in the New Haven area developed decline symptoms and died at an annual rate of 20 to 33%. The severity of symptoms could be correlated with concentrations of sodium in the leaves, twigs, and sap of the trees. Even though symptom severity is negatively correlated with foliage nitrogen, the symptoms could not be alleviated by the application of nitrogen in the root zone. Symptom severity could not be correlated with chloride ion, plant parasitic nematodes, or concentrations of the metallic pollutants lead, zinc, copper, nickel and cadmium. There was significant negative correlation between curb height and symptom severity.

Maple decline is a name given to a set of symptoms exhibited by many sick and dying sugar maples (*Acer saccharum*) throughout their range. The symptoms are smaller, light green leaves, often with scorched edges; thin canopies; early fall coloration and leaf fall; dying twigs and branches; and diminished growth-ring increments. Most trees with such symptoms die within 3 to 5 years. These symptoms have been reported for trees in the woods, in sugarbush plantations, and along roadsides. Known and suspected causes are widely divergent and include poisoning by excessive sodium from deicing salt (LaCasse and Rich, 1964) excessive chloride from deicing salt (Baker, 1965), both sodium and chloride from deicing salt (Hall et al., 1973), nitrogen deficiency (Mader et al., 1969), manganese deficiency (Kielbaso and Ohman, 1976), nematodes (DiSanzo and Rohde, 1969, Riffle and Kuntz, 1966), various fungi (Hepting, 1971), or a miscellaneous group of disorders such as sunscald, gas injury, girdling roots, mower injury, previous severe defoliation, and graft ~~incompatibility~~ (Worf and Kuntz, 1973). Other suggested or possible causes of this syndrome are excessive evapotranspiration, drought, or soil compaction (Banfield, 1967), lack of proper mycorrhizal balance (Guttay, 1976), and air pollution (Hibben, 1969). There is also the possibility that the trees may be poisoned by metallic pollutants such as lead, zinc, nickel, copper, and cadmium from automobiles (Lagerwerff and Specht, 1970).

Experiments, summer, 1975, and winter, 1976

During 1975 and 1976 we examined a group of sugar maples growing along neighborhood streets in Hamden, a town just north of New Haven. About half of their number showed no symptoms while the other half showed various degrees of decline. The trees ranged in dbh from 18 to 38 cm.

On July 31, 1975, we took soil and leaf samples for analyses from 12 of these trees and rated them for decline on a scale that ranged from 1 for trees with no visible symptoms to 6 for trees with completely dead crowns (Mader et al, 1969). On the same day, after sampling, we injected a urea-containing, water-soluble fertilizer (16-32-16) at a pressure of 7 $\times 10^6$ dynes/cm^2 into the soil around the root zone of some of the trees. Each of the selected trees received 132 liters of solution containing either 2.7 or 5.4 kg of fertilizer, the equivalent of either 0.15 or 0.30 kg of nitrogen per tree. The root zones of a similar set of other trees were each injected with 132 liters of water containing no added fertilizer. A second set of soil and leaf samples was collected on September 2, 1975.

All the soil samples were analyzed for plant nutrients using the Morgan soil test, for pH, and for total soluble salts (conductivity bridge). The soil samples of September 9 were also examined for plant parasitic nematodes by P.M. Miller, who used the sugar flotation method (1957) for extraction. The leaf samples were washed, oven-dried, and ground in a Wiley mill (20 mesh screen), and then analyzed for total nitrogen (Kjeldahl), and for chloride ion (Button, 1964). Both soil and leaf samples were also analyzed for sodium, first by extraction with 0.075 N acid mixture and then using a Perkin Elmer Model 303 atomic absorption analyzer.

A set of soil, twig, and sap samples were collected on February 25, 1976. The soil samples were analyzed for nutrients, pH, nematodes, and sodium. The twig and sap samples were analyzed for sodium.

Experiments, summer, 1976

Of the 9 trees that showed symptoms in 1975, 3 were dead by 1976. The experiments were enlarged in 1976 to include 13 additional trees, chosen so that the experiment now included 11 trees with decline symptoms and 11 trees without symptoms. There was no difference between the severity of symptoms on the street side of the trees as compared to the side away from the street. Therefore, no attempt was made in sampling to differentiate between the two sides.

Soil and leaf samples were collected on June 23. On June 30, a 3.5% solution of urea was injected at 7×10^6 dynes/cm^2 into the root zone of some trees at the rate of 57 liters per tree or the equivalent of 1 kg of nitrogen. The root zones of other trees were similarly injected with 57 liters of water containing no added urea. A second set of soil and leaf samples were collected on September 9.

All of the 1976 samples were subjected to the same analyses used in 1975. In addition, the 1976 samples were analyzed by atomic absorption for the metallic air pollutants lead, nickel, zinc, cadmium, and copper.

Results

Mortality — For the two years of the experiment, 3 of the 12 trees in the 1975 set were dead by 1976, and 4 of the 22 trees in the 1976 set were dead by 1977. In this neighborhood, the annual death rate of curbside sugar maples was 20 to 33%. The trees without visible symptoms in 1975 and 1976 were still free of symptoms in 1977.

Soil nutrients — In 1975, there was significantly more nitrogen (Morgan test) in the soil under trees with symptoms than there was under trees without symptoms. For the trees with symptoms, soil nitrate nitrogen was 11.7 ± 3.1 ppm in July and 8.9 ± 2.5 ppm in September. For the symptomless trees, it was 3.8 ± 1.0 ppm in July and 2.8 ± 1.2 ppm in September. This difference was not detected in 1976. The combined mean and standard error for all soil samples on both dates in 1976 was 6.8 ± 0.66 ppm nitrate nitrogen. In neither year did the soil injections of nitrogen or water improve the condition of the trees, regardless of the severity of symptoms.

There was neither a deficiency or excess of the following nutrients: NH_3, P, Ca, K, Ca, Mg, Al, and Mn. The pH range was 4.7 to 6.8, (mean pH 5.7), and could not be correlated with severity of symptoms. The soil was either a sandy loam or a loam and all contained medium organic content. Soluble salts ranged from 0 to 260 ppm and also was not related to symptom severity.

Soil sodium — Concentrations of soil sodium were not significantly correlated with disease severity on any of the 5 sampling dates. The soil sodium ranged from 33 to 97 ppm. The mean soil sodium concentration from the root zone of symptomless trees was 46.8 ± 4.6 ppm, and from trees with symptoms it was 66.7 ± 4.5 ppm.

Nematodes — The plant parasitic nematodes found in sufficient numbers to be counted were species of the following genera: *Hoplolaimus, Macroposthonia, Paratylenchus, Pratylenchus, Tylenchorhynchus, Tylenchus,* and *Xiphinema.* In neither year was a high population of one particular nematode associated with severity of decline symptoms. In September, 1975, however, the mean number of these nematodes per 100 g of soil was 175 ± 70 from samples taken under trees with symptoms and 75 ± 17 from soil under trees without symptoms. This difference was not found in 1976.

Soil metallic pollutants — The soil content of the metallic pollutants was not correlated with disease severity at either of the sampling dates. The combined mean concentrations (ppm) were as follows: lead, 30.6 ± 3.2; zinc, 19.0 ± 1.9; copper, 5.1 ± 0.7; nickel 2.5 ± 0.2; and cadmium, 0.65 ± 0.09. All 5 metallic contaminants diminished in concentration in the soil between June and September, zinc the least (20%) and cadmium the most (47%).

Leaf nitrogen (Kjeldahl) — On both summer sampling dates in both years, trees with symptoms had significantly less foliar nitrogen (1.49 ± 0.05%) than did the foliage of symptomless trees (2.20 ± 0.10%). Leaf nitrogen in both years was significantly negatively correlated (> - 0.69) with symptom severity. The significance of all four correlations exceeded 0.01.

Tree sodium — Except for the first set of samples (July 31, 1975) and the last (Sept. 10, 1976), all the other leaf samples contained sodium concentrations that were significantly correlated (0.05) with symptom severity. Leaves from symptomless trees had a combined mean sodium concentration (ppm) of 504.3 ± 91.8 and those from trees with symptoms 893.0 ± 170.1. The sodium concentrations of both the sap and twig samples of February 25, 1976, were also significantly correlated with disease severity. The mean concentration of sodiüm (ppm) in all the sap samples was 41.1 ± 5.4, somewhat less but still roughly comparable to the sodium concentration in the soil. The mean concentration of sodium (ppm) in all the twig samples was 749.6 ± 109.0, comparable to the concentrations in the leaves.

Leaf chloride — The concentrations of chloride in the leaves at both 1976 samplings were not significantly correlated with either symptom severity or with sodium concentrations. The mean chloride concentrations (ppm) in the leaves was 800.0 ± 100.0 in June, and 1340.0 ± 140.0 in September.

Leaf metallic pollutants — Foliage concentration of the metallic pollutants was not correlated with symptom severity. The mean concentrations (ppm) were as follows: zinc, 31.5 ± 1.7; copper, 15.2 ± 0.8; lead, 10.6 ± 0.7; nickel, 2.07 ± 0.10; and cadmium, 0.34 ± 0.02. This is the same order of concentrations of these pollutants in the soil, except that lead was present in highest concentrations in the soil and is third highest in the leaves. Except for nickel (31%), these metallic pollutants were not lost from the leaves between the two samplings. On both dates, the mean concentrations of zinc and copper were higher in the leaves than in the soil. The reverse was true for lead, nickel and cadmium.

Curbs and intersections — The heights (cm) of the curb at the bases of the trees in this experiment were significantly negatively correlated (>0.01) with disease severity. The mean curb height for symptomless trees was 9.6 ± 0.4 and for trees with symptoms 3.9 ± 1.1. The mean disease grade for the 6 trees at intersections was 3.7 ± 0.56 and for the 19 other trees it was 2.7 ± 0.35.

The presence of paved driveways within the dripline areas of the trees was not related to disease severity.

Discussion

The curbside sugar maples showing decline symptoms in this study were apparently injured by the deicing salt applied to the streets. This was indicated by the repeated significant correlations between plant concentrations of sodium and the severity of symptoms. The severity of symptoms was also significantly negatively correlated with foliar nitrogen. This loss of nitrogen may be the result of sodium toxicity. However, the symptoms cannot be alleviated by the application of nitrogen to the root zone, possibly indicating a root dysfunction. Whether this dysfunction is related to mycorrhizal balance (Guttay, 1976) was not explored in this experiment. We did implant urea into 4 tree limbs showing various stages of decline and could observe no improvement. This indicates that either the branches with symptoms either cannot transport nitrogen or else their leaves cannot use the nitrogen that is transported.

The lack of correlation between the concentrations of soil sodium and tree sodium indicates that there may be genetic differences among sugar maples in their ability to withstand excess soil sodium. This has also been suggested by Baker (1965). The symptomless trees with low tissue sodium may be able to exclude sodium from their roots. This may be related to their mycorrhizal condition as suggested by Guttay (1976). However, some of the symptomless trees had sodium concentrations in the range of those that showed symptoms. These individuals may not be able to exclude sodium from their roots, but instead may be able either (a) to exclude sodium from their mesophyll cells, or else (b) can tolerate higher sodium concentrations within their mesophyll cells.

Suggested precautions are the maintenance of adequate curbing where sugar maples adjoin city streets, and greater care with the use of deicing salts.

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SURVEY OF BUSINESS AND MANAGEMENT PRACTICES OF COMMERCIAL KANSAS ARBORISTS[1]

by Charlotte Jones and Steven M. Still

Abstract. In 1978 a survey of the business and management practices of commercial Kansas arborists revealed that the typical Kansas arborist owns his own business and has been in operation for less than 10 years. Net income is directly related to the size of population served. Fees are based on use of equipment, professional time, and cost of chemicals and materials. Low net incomes are the result of inadequate fee structures, according to the respondents. Skill at financial analysis varies widely between private owners and corporations.

There is a vast range of experience and knowledge in the profession of arboriculture today, much of it fortunately having to do with the care of trees. Apparently, however, many arborists have neglected to improve their knowledge of business practices and do not have a plan for ongoing training in business management to help themselves keep current and operate more efficiently. Actually, little has been written about or studied about the management practices of the commercial arborist, although several interested organizations have recently conducted surveys of various types. The National

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