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five years. In Table 1, the results of this work are summarized. The trees listed as sensitive have been observed to suffer ozone-induced foliar injury in field plots. This injury has generally consisted of upper leaf surface stipple or flecking and/or premature leaf drop. Trees listed as tolerant have not shown any injury symptoms.

In Table 2, we've summarized research findings on the relative susceptibility of some common shade trees to deicing salt spray. This list utilizes information from several studies, including those by Lumis *et al.* (1973) and Shortle and Rich (1970). Since roadside trees subjected to deicing salt spray drift are also commonly faced with toxic salt build-up in their soil, this listing only contains tolerant trees that are also tolerant to salt accumulation in soils.

Summary

Air pollution continues to be an important stress factor on shade trees. Pollutants that are particularly damaging to trees are ozone, sulfur dioxide; hydrogen fluoride, herbicide drift, and deicing salt spray.

Acknowledgment

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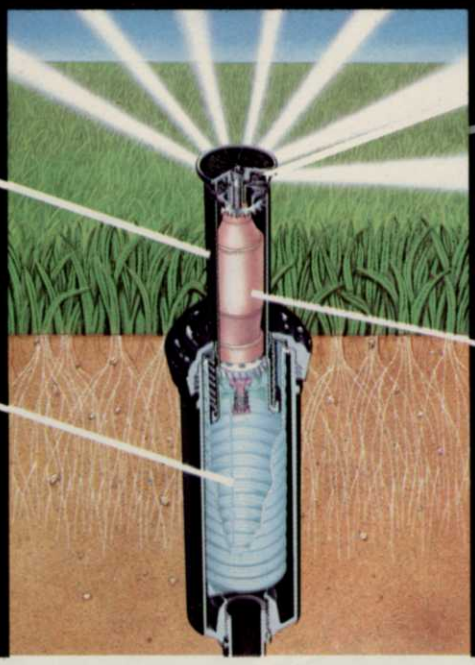

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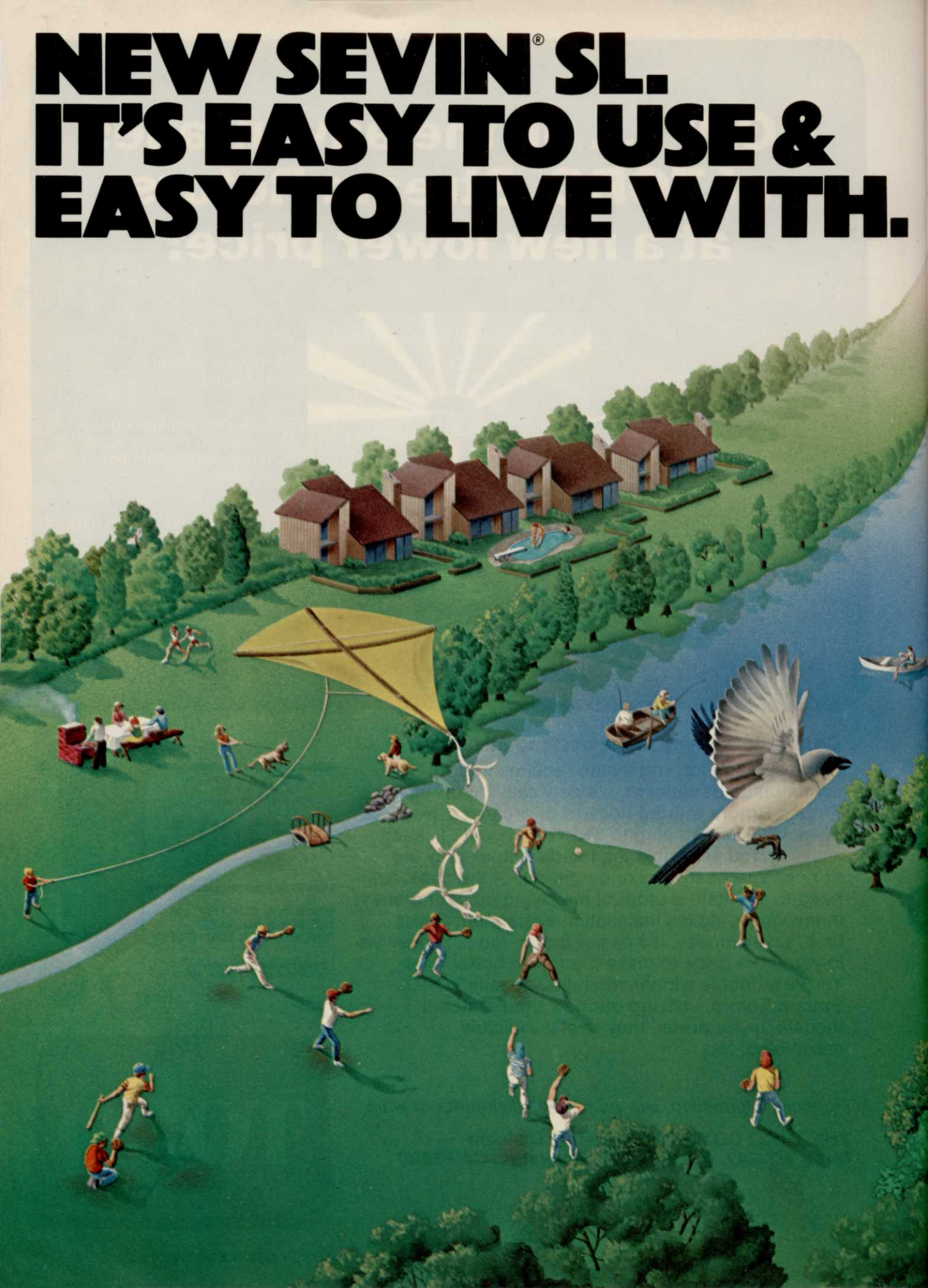

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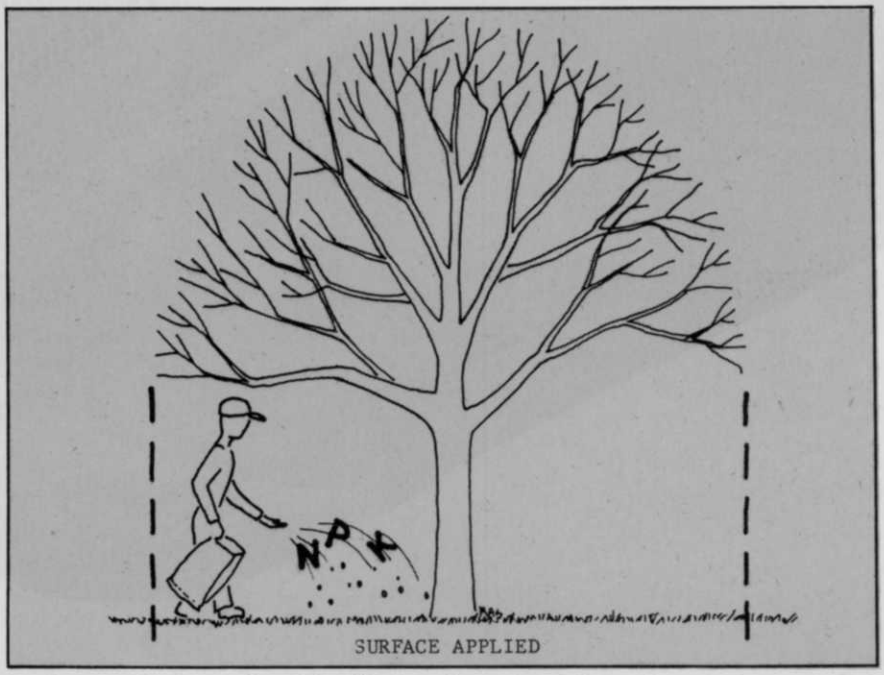
FERTILIZER FACTS:

TIMING AND METHODS FOR LANDSCAPE TREES

By DOUGLAS J. CHAPMAN



Surface application of turf fertilizer at three times the turf rate prior to spring green-up but after the soil thaws is most effective.

Fertilization of trees is one of the key practices for grounds management. Timing and method of application are paramount in tree culture. The questions remain: when does a tree need fertilizer, how much, and with what? These questions and the method of application need to be answered when developing long-term goals for landscape maintenance.

The symptoms of poor health or vigor of a tree are manifested in small, paler leaves, little or no annual growth, twig elongation or trunk diameter, and increased amounts of dead wood within the tree. If any of these symptoms appear in your tree, fertilization is in order.

Trees that are fertilized generally are less suscept to borer attack, look better, have more intense fall color, are better able to withstand drought and/or one or two insect defoliations, and, lastly, are more resistant to diseases, e.g. Verticillium Wilt or Shoestring Root Rot.

Timing of fertilizer application is particularly important. Work done by Neely at the University of Illinois and by Chapman, Reisch, and Chadwick of Ohio State showed clearly that timing of application greatly increased the plant's response; that is, fertilizer should be applied to the tree prior to the commencement of growth in the spring.

Soil type will have some effect on when to apply fertilizer. For sandy or loam soils spring application after the frost is out of the soil and before bud break is best. For clay loams fertilizer can be applied late in the fall, e.g. mid-November, prior to the soil freezing but after leaves have fallen or the plant is completely dormant.

Having the fertilizer available in the root zone at or slightly prior to commencement of growth in the spring, results in the maximum plant response. That does not mean if one has a tree with disease or in poor vigor that some fertilization any time wouldn't help, but for maximum response, fertilizer applied in spring is best. This also integrates well into an overall management program.

There has been much discussion as to how to apply fertilizer. For years the recommendation was based on trunk diameter, e.g. three to five pounds 10-6-4 of fertilizer per inch of diameter and putting holes every two feet apart in concentric rings from two feet from the trunk to the foliage line. These holes would be twelve to fifteen inches in depth. This pinch-bar method is effective in providing plant nutrients to the tree but often causes damage to the lawn and unsightly holes in the sod and damages some roots.

Some recommended the application of foliar fertilizers, that is, applying the fertilizer during the growing season, dissolved in water and sprayed on the foliage of the plant. The general recommendations have been well developed, e.g. 50 ounces per 100 gallons of water. Some absorption does occur through the leaf but maximum absorption of fertilizer is from the soil by the roots.

The third and best method of applying fertilizer is the application to the soil surface of fertilizer prior to growth starting in the spring. The rate is three to five pounds of actual

Continues on page 68

Douglas J. Chapman is a Horticulturist at Dow Gardens, Midland, Michigan

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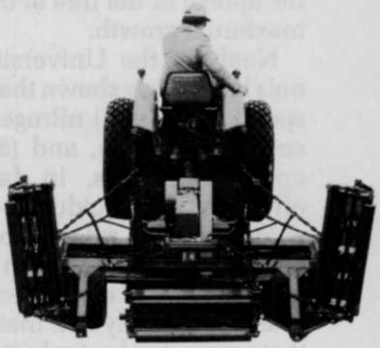

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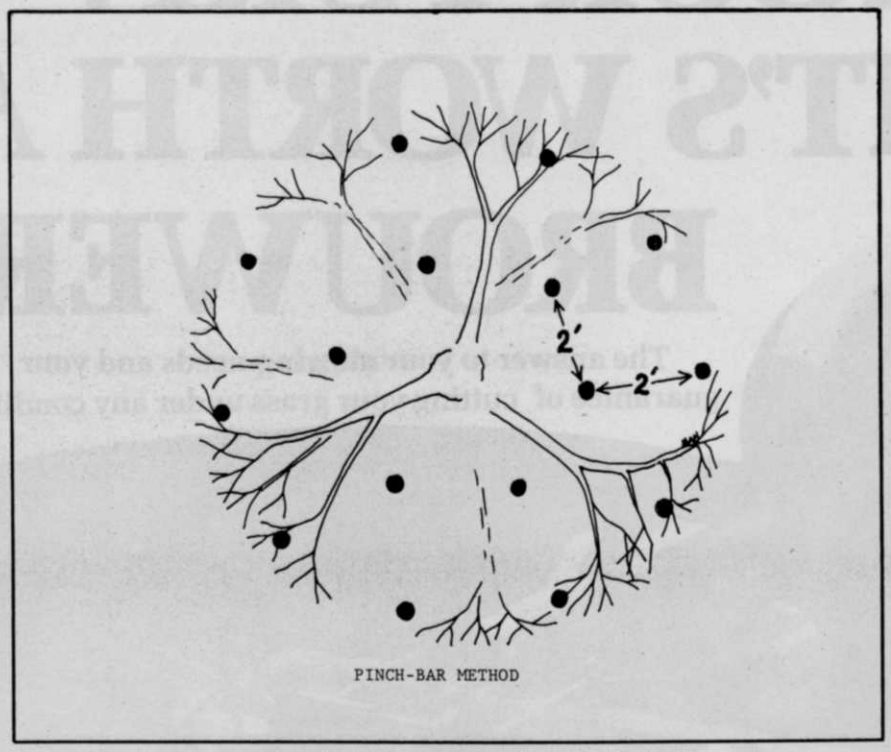

Subsurface injection of tree fertilizers may not be practical under average maintenance conditions. If used, holes should extend to the edge of the canopy and be 12- to 15-inches apart.

nitrogen per 1,000 square feet on soil surface under the canopy of the tree. This recommendation is valid for large and small trees. The application time is after frost leaves the soil yet before grass growth starts. This results in little or no damage to the turf, yet the fertilizer is leached into the root zone, thus available for uptake of the tree at the time of maximum growth.

Neely of the University of Illinois has clearly shown that trees respond most to (1) nitrogen and (2) early application, and (3) surface application was, in fact, most effective. For deciduous trees, the recommended rate is four to six pounds of actual nitrogen per 1,000 square feet. For evergreen trees the rate is essentially half that or two to three pounds of actual nitrogen per 1,000 square feet. This fertilizer can be applied in the form of ammonium sulfate, urea, or as a complete fertilizer, e.g. 18-4-12.

One must realize that the tree's maximum response is to nitrogen. When considering the other two nutrients (phosphorus and potassium) the recommendations vary and vary significantly.

If one has opportunity to review the literature, there are very few times phosphorus has been proven to be deficient. Trees are very efficient extractors of soil phosphorus.

Potassium is needed in amounts of one-half to two-thirds that of nitrogen per 1,000 square feet or one and one-half to three pounds per 1,000 square feet of soil surface under the tree canopy. Potassium is a relatively mobile nutrient and, therefore, although much less leachable than nitrogen, it can be surface applied with effectiveness.

Pragmatically speaking, unless some unique condition exists, probably most maintenance superintendents could apply a lawn fertilizer, such as 18-4-12 at two to three times the recommended turf rate early in the spring prior to the commencement of growth with the result—healthy, vigorous trees.

Micronutrients—

The two micronutrients generally reported to be deficient are iron and manganese. The problem of iron deficiency is related to soil pH and the plant's ability to extract iron in sufficient amounts. The symptoms include pale green leaves with dark green venation. It is most commonly a problem on Pin Oak, although iron deficiency has been noted on Norway Maple, Sugar Maple, and Red Maple, to mention a few. It can be corrected by the foliar application of chelated iron (as recommended on the label), soil application of iron sulfate or sulphur, or, most recently, as recommended by E.M. Smith at Ohio State, the use of Medicaps. This method is boring holes in the trunk of the tree and putting in a small plastic cap containing iron citrate which is absorbed by the plant. This is the most rapid method to correct iron deficiency. Generally speaking, the earlier the application of any of the above materials, specifically before bud break, is optimal.

Having the fertilizer available in the rootzone at or before commencement of spring growth results in maximum plant response.

Managanese deficiency was originally researched by Kielbaso at Michigan State University. His work showed that many street trees were, in fact, manifesting symptoms similar to iron deficiency but were suffering from a lack of adequate amounts of magnesium. Several methods have been tried, e.g. manganese sulfate (soil or foliar applied), but the Medicap technqiue seems most responsive.

Generally speaking, trees need to be fertilized every one to three years. They are more in need of fertilizer in turf situations than in native stands. When considering fertilizer applications, one should apply the fertilizer at the rate of two to six pounds of actual nitrogen per 1,000 square feet of area up to the tree canopy on the soil surface after the frost is out of the soil, before commencement of growth.

This method of fertilization not only lends itself well to an overall grounds maintenance program but reduces damage to turf and results in healthier, more vigorous trees better able to withstand the ravages of insects, drought, and disease. **WTT**

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