EFFECT OF NITROGEN FERTILIZER ON TREE GROWTH OF SELECTED NURSERY AND LANDSCAPE TREES.

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The green movement in the United States has forced examination of past practices to determine whether they are environmentally sound and based on scientific research. Fertilization practices by the green industry needs to be examined closely to insure that growers are using nutrients in the most efficient and environmentally friendly method. With the desire to determine the appropriate amounts of nitrogen fertilizer to prevent pollution issues, yet maintain proper tree growth and development, nursery managers, arborist and landscape managers are seeking information to keep in step with the regulations but not limit tree growth. Green industry professionals who wish to be proactive and not wait for restrictive nutrient management legislation are interested in science based answers to the most efficacious fertilization rates and timing. A new incentive to maximize fertilizer efficiency applications has risen in the green industry. For years fertilizer has been relatively inexpensive. With recent increases in petroleum fuel costs, which are used as an energy source in the production of chemical fertilizers, the cost of producing fertilizer has risen which has been passed along to the users. Other factors include the strong export market that was not previously a major concern.

Nursery managers, arborists and landscape managers see the future involving a prescriptive plan for fertilization of shade trees based on analysis of the site, soil testing, species of plant and desired growth of the plant. Landscape managers often seek to invigorate and maintain older trees or improve vigor of young trees in poor quality soils. A nursery manager's goal is to increase caliper size of younger trees quickly, increase height and width of shrubs and evergreen plants and increase plant color in a cost-effective manner that keeps them competitive in the marketplace. The American National Standards Institute (ANSI) states that the reason for the fertilization of plants is to supply nutrients to achieve a defined objective (Smiley, et al 2002) (American National Standards Institute (ANSI), 1998). Optimizing fertilizer applications serves the market objective of supplying healthy trees with a specified trunk caliper (usually 2"-6") as quickly as possible without waste.

The need for a prescriptive program is further highlighted by negative impacts of high nitrogen applications, as published by Miller (1998, 2000). Herms and Mattson suggested that high nitrogen applications reduce the concentration of defensive compounds, increasing the trees' susceptibility to certain pests (Herms and Mattson, 1992). Plants with damaged foliage may reduce the vigor of the plant and herbivore feeding injury can reduce or delay salability of the summer-dug stock for in-leaf sales.

After market implications, of obligatory concern to industry professionals, is compliance with laws enacted to preserve water quality by regulation of soil-applied nutrients. The strongest documentation of correct timing and rate of fertilization has been conducted in turfgrass research. When reviewing the effect of spring application of nitrogen and its potential run-off, one study noted that N leaching was less in a lawn situation than on bare soil. Bluegrass sod was shown to absorb 31% of the labeled N fertilizer within 18 days of application. If clippings were removed, labeled N was lost, but if grass clippings were returned to the turf, then the N in the thatch represented a slow release source of N which became increasingly available as the season progressed and the thatch decomposed (Rose 1999). Over-application of nitrogen is not only expensive, but also detrimental to the environment, potentially contaminating ground water and surface water sources.

Nitrogen is typically the limiting nutrient that must be replaced on an annual basis for plants in general. (Struve, 2002). Most fertilizer recommendations range from 1 to 6 pounds / 1000 sq. ft. (Rose, 1999) (Struve, 2002) (Smith 1991). Struve notes that the N fertilizer type (organic/ inorganic) does not appear to be a key factor in plant health and growth. He also notes that little difference has been found among fertilizer application methods. Broadcast is as effective as subsurface applications (Struve, 2002). Smiley (personal conversation, 2003) feels that the most absorptive place on a tree is at the tree trunk flare and that fertilizer applications should be directed at the area.

Elton Smith (1991) conducted a multi-year study of fertilization of two tree species. Smith noted that tree growth improvement based upon fertilizer treatment after yearly application of nitrogen based fertilizers found a decrease in response by the ninth year of a study using both *Tilia cordata*, littleleaf linden and *Acer saccharum*, 'Sentry' sugar maple. The results of his 18-year study provide the basis for many of the currently used guidelines today: the nitrogen rate of between 1 and 6 pounds per square foot; surface application and early spring timing.

Nitrogen use by trees is also related to timing of application. In a trial by Weinbaum, et al (1978), it was determined that N-labeled fertilizer applied in the spring accounts for 25% of the total foliage nitrogen. The trees used in this study were Almond (*Prunus dulcis*) field grown in both light and heavy soils. The remaining 75% of the total N was absorbed from the previous growing season. A positive correlation was found between the advancement of the growing season and the greatest Nitrogen Utilization Efficiency (NUE). The greatest NUE was found after leaf bud when trees had leaves, showing a range of 30-39% between April and September 30. November applications produced 16% NUE; December a mere 4%.

MATERIALS AND METHODS

This was a 2-year field trial conducted at Ruppert Nursery, Laytonsville, Maryland. The purpose of this trial was to:

> Obtain information on optimum nitrogen fertilization rates for a selected nursery and landscape tree, in this case *Acer rubrum* (American red maple).

Study Site

The trial site is an established nursery in Laytonsville Maryland. For this trial, the tree species studied was the red maple, *Acer rubrum* 'October Glory'. The trees were established in the

Ruppert nursery in the spring of 2001 and were started in the trial in 2002 and continued through 2003. The soil is a Brinklow Blocktown Channery Silt Loam, and has a 3 to 8 percent slope. The surface soil is noted to be moderate to good for the raising of trees, bedrock is found at 25 to 35 inches. The greatest limitation for this soil is that the surface soils tend to be droughty during periods of below average precipitation. Permeability is moderate to moderately slow**.** Soil tests were performed to determine phosphorus and potassium levels. The soil analysis of the site showed that phosphorus and potassium were in the moderate range based on the Maryland Fertility Index Value (FIV). The phosphorus and potassium were then adjusted to industry acceptable standards to an FIV in the optimum range. Available soil nitrogen is not measured in soil tests, as the nitrogen cycle is highly dynamic and no soil test will provide an accurate measure of the available nitrogen for a single growing season for soils in the humid east. Nitrogen is highly mobile and volatile in these soils. The main goal of the study was to determine the impacts of nitrogen fertilization on tree growth. Four fertilizer treatments were assigned randomly with 10 replicates/blocks (one replicate of each treatment within each block). Blocking was by location of trees in the field. The trees were grouped in 3's down the row for their assigned treatment. The trees received only a single treatment and only the center tree of the three tree clusters was used for data collection to prevent contamination.

Red maple 'October Glory'

The trees were planted in the spring of 2001 as branched bare root liners, with 6 rows of 50 to 60 trees per row spaced 7 feet apart, and a grass strip 10 feet wide between rows. Drip irrigation was installed at the time of planting. There is a buffer row of trees on either side of the trial rows. The secondary goal of this study was to look at the impact of Nitrogen on pest populations. The insect pests monitored were the potato leaf hopper (*Empoasca fabae*), the maple twig borer (*Proteoteras aesculana*) and the maple spider mite **(***Oligonychus aceris***)** Buffer rows were treated separately.

Treatments

Fertilizer rate: An area of 4 feet by 4 feet under the canopy was standardized for the basis of our calculations and fertilizer application. This area was used as it has been shown by previous research that a majority of the roots would be found within that area. The fertilizer was a 43-0-0 with 50% water insoluble nitrogen (W.I.N.). Gill, Klick, and Schuster made the applications on April 24, 2002 and were repeated on April 14, 2003.

Three fertilizer rates were compared to an untreated control

Treatment	Application Rate	Rate per Tree
Treatment 1	0 Kilograms of nitrogen per 92.903 square meter (0 pounds per 1000 square feet)	0 grams per tree (0 ounces)
Treatment 2	0.9072 Kilograms per 92.903 square meters (2 pounds of nitrogen per 1000 square feet)	33.3 grams per tree (1.1745 ounces)
Treatment 3	1.8144 kilograms per 92.903 square	66.6 grams per tree (2.349

	meters (4 pounds of nitrogen per 1000 square feet)	ounces)
Treatment 4	2.7216 kilograms per 92.903 square meters (6 pounds of nitrogen per 1000 square feet)	99.9 grams per tree (3.524 ounces)

The granular N material was broadcast at the base of each treatment tree. At the time of application the area around each tree was raked, the fertilizer applied and then raked again to incorporate the fertilizer into the soil. Trees were watered by drip irrigation with a .5 acre inch equivalent applied.

Treatment of buffer rows

Red maple buffer rows were fertilized with 1.8144 kilograms per 92.903 square meters (4 Pounds of nitrogen per 1000 square feet) rate and received imidacloprid applied as soil drench to the root zone to control potato leafhopper.

Monitoring of tree caliper

The impact of fertilizer treatments on tree growth was evaluated by measuring tree caliper using industry established standards, on each tree in the trial. Measurements were taken in the fall of 2001 (preliminary), 2002 and 2003. The measurements were taken 6 inches from the grade (necessary to take the measurement beginning above the understock) and the data was recorded in Excel. A Digimatic® Caliper instrument was used to take the measurements.

Monitoring of insect populations

How?

RESULTS

Red Maple Caliper Measurements:

Caliper measurements were taken in the fall (December) of 2001 to establish pre-treatment trunk calipers. Uniform trunk calipers of 33-35mm were recorded. Caliper measurements were taken on October 31, 2002, as a post-treatment measurement. (Chart 1). The range was 46-48mm with little or no detectable difference noted between treatments. Measurements taken on October 30, 2003, showed an increase in trunk caliper for all of the treatments with a range of 64-67mm. The greatest caliper increase was noted from 0 kilogram and 0.9072 kilogram per 92.903 square meter rates (0 and 2 pounds of nitrogen per 1000 square foot) (mean caliper of 63.877 mm for control and 66.768 mm for two pound rate). It was further noted that additional fertilizer did not create the growth response expected. The addition of fertilizer from the 0.9072 kilograms per 92.903 per square meter rate (2 pound per 1000 square foot) to the 1.8144 kilograms per 92.903 square meter rate (4 pound per 1000 square foot) showed a mean difference in caliper of -1.429 mm as compared with the first incremental increase. This trend was also noted in the first year of the trial with a similar difference in mean caliper size of -0.33 mm. While mean caliper size did show increases from the 1.8144 kilograms to the 2.7216 kilogram per 92.903 square meter rate (4 pound rate to the 6 pound per 1000 square foot) (0.62 mm in year 2002 and 1.6 mm in 2003) it was not in the same incremental rate as found in the change from control to 0.9072 kilogram (2 pounds per 1000 square foot).

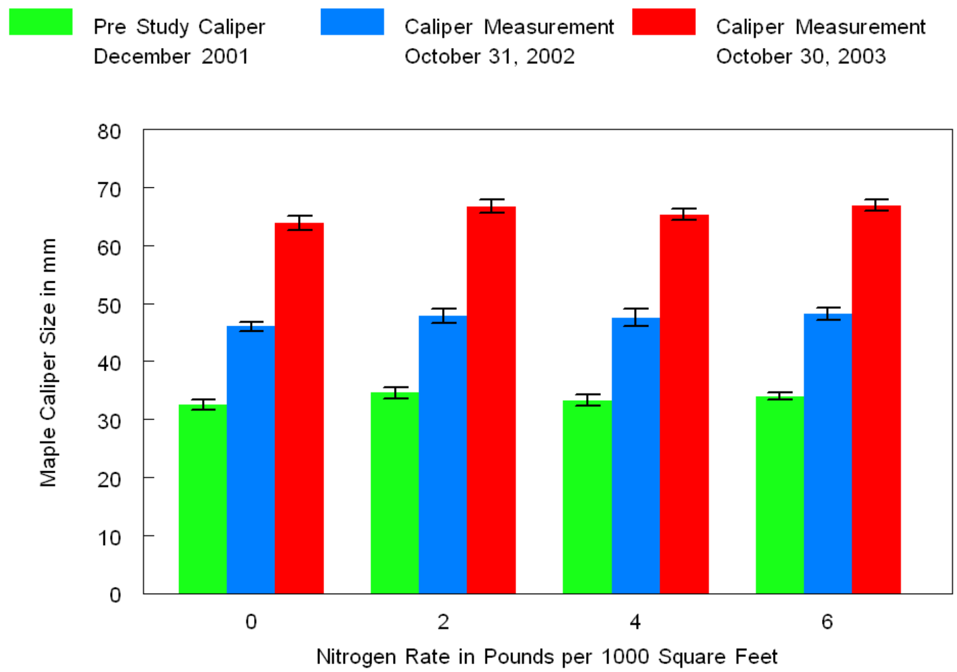

Chart 1

Potato Leafhopper Damage Measurements:

Potato Leafhopper (*Empoasca fabae)* and Maple Spider Mite (*Oligonychus aceris*) damage was evaluated and scored using a team of three (Shrewsbury, Gill and Schuster) and charted (Chart 2). No statistical difference was noted at any of the different nitrogen rates for the Potato Leafhopper, and the Maple Spider Mites population showed an inverse relationship to fertilizer treatments.

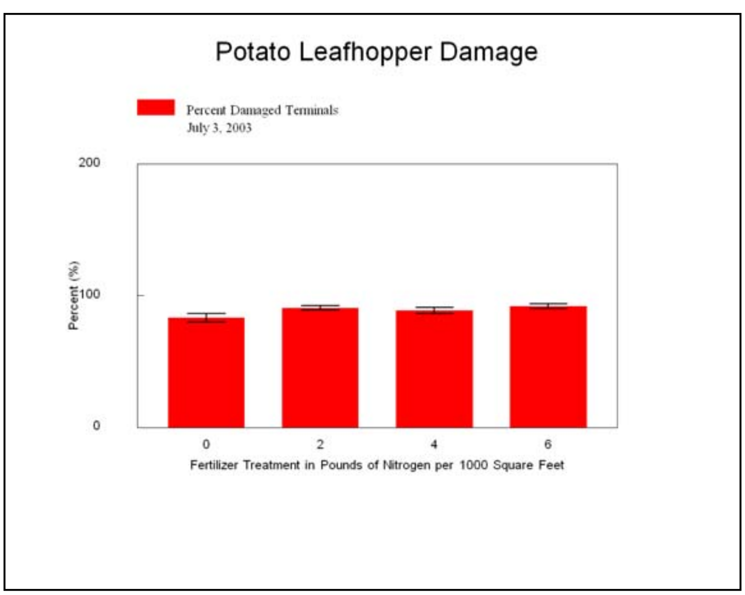

Chart 2

CONCLUSION

A great amount of interest has been

expressed in determining the appropriate amount of nitrogen fertilizer that should be applied for both nursery and landscape trees. This information is useful to decrease pollution, decrease costs and prevent potential herbivore feeding. The rate of nitrogen applied to trees varies for optimum tree growth. To optimize caliper growth each species must be evaluated to determine the appropriate amount needed so unneeded nitrogen is not applied. This will prevent the loss of nitrogen through leaching and volatilization and prevent applications that do not generate a positive response in tree growth. In this trial it can be noted that application of nitrogen fertilizer to the maples maximized growth at no more than 0.9072 kilograms per 92.903 square meters (2 pounds of actual nitrogen per 1000 square feet). Beyond this application input level it was observed that average tree caliper increase was smaller as application rates moved from the 0.9072 kilograms per 92.903 square meter (2 pound to the 4 pound per 1000 per square foot) rate, but showed a small incremental increase when approaching the 2.7216 kilogram per 92.903 square meter (6 pounds per thousand square foot) rate. This was actually a smaller increase in caliper than the trees that were in the control block which received no additional nitrogen fertilizer.

Applications of nitrogen fertilizer beyond the 0.9072 kilogram per 92.903 square meter (2 pound per 1000 square foot) rate do not generate the change in caliper which would lead to faster nursery tree sales and field turning.

In the landscape industry, where nitrogen fertilization may be used to improve plant health and vigor, it will not see an increase in herbivore activity on maples as shown in this trial.