Late-Season Nitrogen Fertilization: Application in Southern Nurseries

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Abstract-Production of high-quality seedlings is the goal and responsibility of the nursery manager. Applying nitrogen fertilizer late in the season is a cultural regime that will improve seedling quality without adverse effects to seedling morphology at lifting. Research in southern production tree nurseries has shown late-season N fertilization to increase seedling N content and concentration, and improve survival and growth. Implementing a late-season N fertilization program is simple and economical.

INTRODUCTION

Successful reforestation begins with the production and planting of high-quality seedlings. Therefore, as the nursery manager and responsible for seedling production, your goal is to produce a crop of high-quality seedlings at a minimum cost. A high- quality seedling is one that demonstrates acceptable levels of performance (survival and growth) on a given site (Duryea 1985). Cultural activities applied in the nursery like top clipping, root wrenching, seedbed density, irrigation, and nutrient management directly effect seedling quality. How effective cultural activities are at improving seedling quality can be measured by evaluating **material attributes** (bud dormancy, water and carbohydrate status, morphology, mineral nutrition, and levels of growth regulators, enzymes, etc.) and **performance attributes** (vigor, root growth potential, frost hardiness, and seedling temperature) (Ritchie 1984). Evaluating the quality of a seedling by its "grade" alone is still valid, but technology and science has gone beyond this. I'm sorry, but the rules have changed!

To obtain specific production objectives it may involve some sort of change. Research is the driving force behind most changes, and lessons learned by "trial and error" in the nursery are just as important, particularly when it comes to the applied side of things. Changes in the technology and science of tree nursery production result in changes in the quality of seedlings produced. Nevertheless, the status quo of seedling production is no longer an option! Examples of change in nursery production may be the purchase of a new precision sower for greater control of seedbed density; development of a new protocol for seed collection, handling, and treatment to complement genetic gains; or adoption and implementation of a cultural regime that has been shown to improve seedling quality. Cultural practices applied to seedlings in the nursery bed influence seedling morphology and physiology at lifting, and ultimately 'a seedling's ability to grow and survive after outplanting. The ava ilability of nitrogen (N) to the seedling crop is of particular importance. Foliar N content and concentration are quantifiable indices of quality, and are directly related to the physiological status of a seedling (Duryea and McClain 1984; Landis 1984). This paper will describe a fertilizer regime that can effectively increase seedling N levels at the time of lifting, and

make recommendations to help southern nursery managers evaluate its effectiveness.

NUTRIENT MANAGEMENT

Production of quality seedlings begins with nursery soil management. Before initiating actions to alter nursery soil composition, the soil should be tested to determine baseline macro and micro nutrient levels. Management decisions regarding how nutrient level adjustment can then be based on hard data, not on intuition. A range of recommended nutrient levels, pH, and organic matter values for southern pine nursery soils are presented in Table 1 (May 1984). Keep in mind, that these values represent optimum levels at plow down and will not be applicable to every nursery soil.

Table 1. Recommended soil organic matter, pH, and nutrient levels for pine nursery soils. Adapted from May, 1984.

Soil Texture	OM%	N%	pH	P	K	Ca	Mg
Sands & light loamy sands	1.5	0.07	5.3-5.8	50-100	75-125	400-600	50-60
Loamy sands & sandy loams	2.0	0.10	5.3-5.8	75-100	125-175	600-900	60-90
Loams, silt loam & clay loam	>3.0	0.15	5.3-5.8	75-125	150-250	>900	>90

Depending on nursery soil characteristics, precipitation, and genetic quality of seed, the amount of N fertilizer applied during the growing season of 1 -0 pine seedlings will typically range from 150-200 pounds per acre for most nursery soils (May 1984). It is important to control the availability of N to insure an adequate supply is available during the various stages of seedling growth. Nitrogen can be supplied from both organic and inorganic sources. However, for economic reasons, inorganic forms of N are used most often. For example, it takes 145 pounds of horse manure, compared to three pounds of ammonium nitrate to provide one pound of N (Pritchet 1979). The key to successful N fertilizer management is knowledge of- (1) the properties of the specific fertilizer used; (2) the nursery soil characteristics; and (3) the seedling response to frequency, rate and timing of fertilizer applications. At this point, I want to focus on the third item above, particularly the timing of fertilizer application.

LATE-SEASON N FERTILIZATION

Implementing a late-season N fertilization program is based on the following objectives: (1) to increase seedling N content and concentration prior to lifting, while not adversely effecting seedling morphology; (2) to "prime" the seedlings for a fast start once outplanted; and (3) to increase survival and growth. This concept is not new by any means. Wakeley (1948) was aware of this and felt that increased levels of seedling N at time of planting may improve the ability of a seedling to initiate vigorous root and shoot growth after planting.

And, in the same study, there were no significant morphological changes at the time of lifting. Other studies have shown mixed results regarding growth and survival after outplanting. Growth of loblolly pine (P. taeda) after outplanting has been positively correlated to foliar N concentration (Switzer and Nelson 1963; Larsen et al. 1988). Late-season N fertilization studies of southern pine by Ursic (1956) and Shoulders (1959) found reduced survival, whereas Gilmore et al. (1959) found no effect, and Switzer and Nelson (1963) reported an increase.

Researchers have evaluated the effects of late-season N fertilization on southern pine species. Late-season N fertilization in the nursery was found to increase seedling N concentration from 1.08 percent to 1.20 percent in slash pine (Pinus elliottii var. elliottii Engelm.) (Duryea 1990). In another study, foliar N concentration of slash pine seedlings (Figure 1) decreased under normal cultural practices, while those receiving late-season N fertilization treatments increased (Irwin 1991).

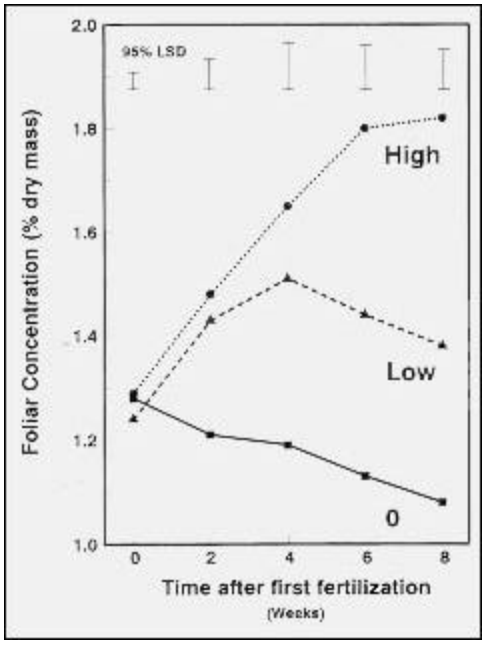

Figure 1. Foliar N concentrations of slash pine seedlings during the 8-week sampling period as affected by soil application of ammonium nitrate only: Low N - one application 57 kg N ha^{-1} on November 15, 1989; High N - three applications at 57 kg ha-1 on November 15 and 29, and December 13, 1989.

MAKING A DECISION

Operationally, a late-season N fertilization program is simple. The actual application is no different than any other. The difference lies in that it is just applied late in the season - 6 to 8 weeks prior to lifting. Nitrogen fertilizer should be applied at a rate of around 50 pounds of N per acre after seedlings have entered the quiescent stage and winter buds appear. Ammonium nitrate has been found to perform best when top dressed and watered in to prevent "burning" of the seedlings. At this rate, the possibility of initiating bud burst and top growth is minimized, but the seedlings are capable of active absorption of the additional N.

Economically, a late-season N fertilization program represents minimal cost. What would be a reasonable amount to spend on a cultural practice that could improve seedling quality and increase survival and growth? Is $0.03 to $0.05 per thousand seedlings too much? This is the approximate cost for one application of N (ammonium nitrate). Nursery managers should find this economically justifiable considering the potential benefits of improving seedling quality.

RECOMMENDATIONS

Implementing a late-season N fertilization program requires more than just the application of fertilizer. The nursery soil should be tested in the spring prior to any other activities, and provide the following: macro and micro nutrient levels; pH; and organic matter content. This information will provide the nursery manager with the appropriate decision making tools to determine the range of critical and acceptable levels of soil fertility. The next step is to

establish small trial plots in the nursery and a planting site to monitor field performance. If in-house expertise is not available for developing the experimental design, contact a USDA Forest Service Nursery Specialist for assistance.

As part of the nursery trial, seedling tissue will need to be sampled throughout the trial and analyzed to determine N content and concentration. From this, the effectiveness of the late-season application can be evaluated, as well as the efficiency of recovery by the seedlings.

Late-season N fertilization is a cultural practice that will improve seedling quality in southern pine nurseries. It has been demonstrated to improve survival, and if growth of those seedlings is vigorous, the stocking density is maintained and the value of the stand at harvest will be increased. Therefore, one application of 50 pounds of N late in the season is a cultural practice well worth the investment.

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