Auburn University
Southern Forest
Nursery Management
Cooperative

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WINTER NITROGEN FERTILIZATION OF LOBLOLLY PINE SEEDLINGS

by
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INTRODUCTION

Several studies have shown that conifers have greater growth after outplanting following fall and winter fertilization of N (Anderson and Gessel 1966, Margolis and Waring 1986, Irwin et. al. 1998) while other studies have shown that fall fertilization with N did not enhance outplanted growth of conifers (Gleason et. al. 1990, South and Donald 2002). A fall N fertilization study initiated by the Coop in 1999 showed that winter fertilization with N can increase outplanted growth of loblolly pine (see Research Report 02-07). That experiment tested 50 and 100 kg/ha of N fertilizer applied in the winter, but probably did not maximize the response to fertilizer. Based on that study, a higher rate of N fertilization was tested to determine if the previous results could be repeated.

METHODOLOGY

A randomized complete block design with 4 blocks was used to test 4 winter application levels of N in a central Alabama nursery. The four rates of N were 0, 50, 100, and 200 kg N/ha (0. 44.5, 89, 133.5 lbs/ac). Nitrogen was applied using a perforated can in split applications of 25, 50, and 100 kg/ha during the first week of January and four weeks later. Treatment plots were 2.7 m (9 feet) long and 1 bed wide.

Plots were sampled at the time of establishment, at the second fertilization, and at lifting. A 0.30 m (1 foot) by 1.22 m (4 feet) counting frame was used to define the sample plot which was randomly located within the plot. Approximately 80 to 100 seedlings were removed using a shovel. Root-collar diameter (RCD) and total seedling height were measured on every fourth seedling until a sample of 25 was obtained. Total shoot and total root dry weights were collectively obtained from all 25 seedlings sampled. N concentration of the top 15 cm of shoots was also obtained collectively from the 25 seedlings. Nitrogen concentration was determined by the Auburn University Soil and

Plant Testing ,aboratory.

Thirty-six seedlings were randomly selected from each plot to be outplanted (March 8th) into sand pits (highly N deficient site) at Auburn University. Total seedling height and diameter were measured for all seedlings at the time of outplanting and height was measured for all seedlings 3 months after planting. At three months after planting, half of the surviving number of seedlings per plot were randomly sampled for additional measurements. These were bulked together to obtain dry weight of shoots and roots. Height and weights were measured at 6 months after planting for the remaining seedlings. The initial seedling measurements at time of planting can be found in Table 3.

RESULTS

Morphological measurements of seedlings sampled in the nursery during January, February and March found no treatment differences for height, diameter, root dry weight, shoot dry weight, or seedling total dry weight. This is similar to the results of the previous Coop study (VanderSchaaf and McNabb 2002). However, N concentrations increased as the rate of fertilizer increased in February and March (Table 2). While starting out at around 1.5 % in January,

Table 1. Morphological characteristics of winter fertilized loblolly pine seedlings at time of outplanting (March). There are four replications of 36 seedlings.

Kg/N/Ha	Height (cm)	RCD (cm)
	March	
0	29.1	3.7
50	28.7	3.7
100	28.8	3.7
200	28.4	3.7
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	Probability > F-value	
Linear	0.395	0.592
Quadratic	0.924	0.855
Cubic	0.668	0.926

Table 2. Seedling N concentrations in January prior to fertilization, in February one month after initial fertilization, and in March, 4 weeks after second fertilization. There are four replications of 25 seedlings.

Kg/N/Ha	January	February	March
0	1.57	1.40	
50	1.49	1.48	
100	1.48	1.72	
200	1.54	1.79	
	Probability > F-value		
Linear	0.561	0.000	0.000
Quadratic	0.121	0.934	0.134
Cubic	0.948	0.123	0.613

fertilization resulted in significantly increased levels of seedling shoot nitrogen in both the February and March sampling. Shoot nitrogen increased from 1.5% to 1.8% from January to March for the 200 kg N/ha treatment. This is an increase of 19% N content in 8 weeks. Note also, that average seedling N content of unfertilized (check) seedlings fell during the 8 week study period, from 1.57 to 1.3% (a drop of 17%).

Measurements at 3 and 6 months after outplanting found no significant differences between treatments for seedling height and diameter (Table 3). Nor were there any differences in survival (average = 98%). There was a significant trend, however, for total dry weight (Table 4). Overall seedling weight increased from 10.4 g to 11.6 g for the check and 200 kg N/ha treatments, respectively, at 6 months after planting. A similar trend could be seen for root dry weight.

Seedling growth after planting was also increased by nursery fertilization although differences were not statistically significant after the first 3 months (Table 5). Unfortunately, diameter was not measured in August, but had shown a similar trend to height at 3 months after planting.

Winter fertilization of loblolly pine in the nursery results in seedling uptake of nitrogen and increases in shoot nitrogen content. Seedlings showed increased growth rate after planting when fertilized in the nursery at levels of at least 100 kg/ha of elemental nitrogen. This growth increase is a result of nitrogen that seedlings take with them in their tissues to the field. One may conclude that either (1) seedlings are going to the field with too little nitrogen, or (2) the planting site was nitrogen deficient, or (3) both 1 and 2. Since the planting occurred in a sand pit, there was undoubtedly a lack of available nitrogen after planting. The next step therefore is to determine if the same type of growth response would occur on sites with more available nitrogen and how long would any growth impact last.

Table 3. Average seedling height, RCD, and survival of winter fertilized loblolly pine seedlings 3 (June) and 6 months (August) after outplanting.

Nursery N	June		August
	Height (cm)	RCD (cm)	Height (cm)
0	34.5	4.8	36.2
50	33.8	4.9	34.9
100	34.6	4.8	35.4
200	34.1	5.0	36.3
		Probability > F-value	
Linear	0.820	0.486	0.660
Quadratic	0.816	0.549	0.055
Cubic	0.276	0.469	0.507

Table 4. Dry weight of winter fertilized loblolly pine seedlings at 3 and 6 months after outplanting.

	June		
Kg/N/Ha	Root weight (g)	Shoot weight (g)	Total weight (g)
0	1.4	5.3	6.7
50	1.5	5.3	6.8
100	1.5	5.7	7.2
200	1.7	5.7	7.4
		Probability > F-value	
Linear	0.161	0.325	0.263
Quadratic	0.739	0.928	0.876
Cubic	0.582	0.611	0.807
		August	
0	1.9	8.5	10.4
50	1.9	8.3	10.2
100	1.8	9.6	11.4
200	2.1	9.5	11.6
		Probability > F-value	
Linear	0.332	0.061	0.051
Quadratic	0.177	0.998	0.725
Cubic	0.540	0.207	0.293

Table 5. Growth from the time of planting (March) to 3 months after planting (June) and 6 months after planting (August).

	June		August
Kg/N/Ha	Height (cm)	RCD (cm)	Height (cm)
0	5.5	1.1	6.8
50	5.1	1.1	6.3
100	5.7	1.0	6.9
200	5.8	1.3	8.4
	Probability > F-value		
Linear	0.071	0.167	0.011
Quadratic	0.145	0.124	0.031
Cubic	0.027	0.097	0.809

MANAGEMENT IMPLICATIONS

Loblolly seedlings will respond to winter nitrogen fertilization in the nursery in relatively short time, certainly within 4 weeks, and perhaps even sooner. Whether or not this should be standard practice is yet to be determined.

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