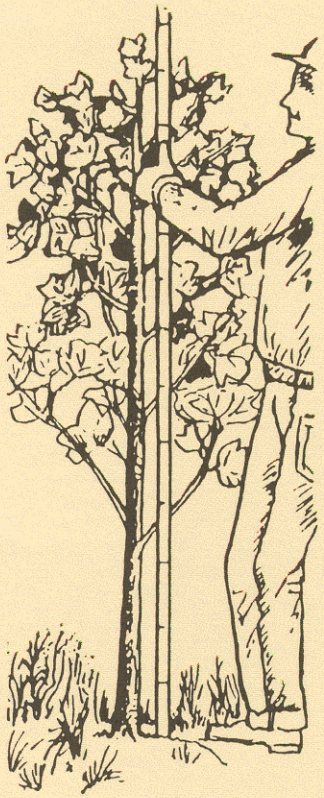

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EFFECT OF NITROGEN FERTILIZATION RATE IN THE SEEDBED ON GROWTH IN THE FIELD

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Abstract

Varying rates of nitrogen were applied to loblolly pine seedlings in the seedbed in two different studies. In one study, the rates were 150, 300, and 450 pounds of elemental nitrogen per acre and in the other study, the rates were 300 and 600 pounds combined with either ½ or 1 inch of sawdust tilled in just before seeding. In the first study, $^{6}/_{32}$ - and $^{7}/_{32}$ - inch diameter seedlings from each ntirogen rate were planted on the field. In the second study only, $^{5}/_{32}$ - inch seedlings were planted.

Nitrogen rate did not have a statistically significant effect on survival, height growth, or diameter growth after seven seasons in the field, in either study.

Introduction

In 1987, we worked with the Auburn University Nursery Co-op to establish a study at our New Kent Nursery to compare 3 levels of nitrogen at 2 seedbed densities. They established the same study in 2 other nurseries. At New Kent, the target densities were 20 and 30 seedlings per square foot and the nitrogen rates were 150, 300, and 450 pounds of elemental nitrogen per acre. There were 4 seedbed replications of the 6 treatments using plots 50 feet long. Seed was sown using a vacuum seeder, and the seeder did not perform as expected. Average seedbed densities in September were 19.5 and 17.8 seedlings per square foot for the target densities of 20 and 30 seedlings per square foot. Auburn decided to abandon the study, but we went ahead with it, modifying the design to compare $^{6}/_{32}$ - and $^{7}/_{32}$ -diameter seedlings from the 3 nitrogen rates. We lifted samples from the 12 plots sown at the higher seedling rate (which actually produced slightly lower stocking) to ensure getting enough of the larger seedlings.

Also in 1987, we installed monitor plots at our Sussex Nursery to compare 2 different rates of sawdust mixed into the soil just before seeding (½ and 1 inch)

each receiving either the operational nitrogen rate during the season or double the operational rate[1]. We use these plots to help us decide whether we are applying enough nitrogen during the season. The operational rate at the Sussex Nursery in 1987 ranged from 270 to 300 pounds of elemental nitrogen per acre. These plots were replicated 6 times in different seedbeds scattered about the nursery. We lifted samples from 3 of the 4 treatments, from 3 seedbed replications. The treatments lifted provided the extremes for nitrogen status plus our operational treatment:

① Low N -- 1 inch of sawdust with operational N
② Operational -- ½ inch of sawdust with operational N
③ High N -- ½ inch of sawdust with double N

Lifting and Measuring the Seedlings

Auburn Study

Seedling samples were lifted on January 25. A total of 36 samples was lifted, each 6 inches wide across the seedbed for a 2-square-foot sample. Three samples were lifted from each plot, evenly spaced within each 50 foot plot.

Seedlings were measured on January 26 and 27, separating the seedlings in each sample into $^{1}/_{32}$ -inch diameter classes and then measuring the top length of each seedling. From the 3 samples from each plot, we proportionally selected twenty $^{6}/_{32}$ - and twenty $^{7}/_{32}$ -inch seedlings for planting 2 rows of 20 seedlings each in a field replication. Consequently, the seedlings from each of the 4 seedbed replications were kept separate in each of 4 field replications.

Sussex Study

Seedling samples were lifted on February 3. A total of 18 samples was lifted, each 6 inches wide across the seedbed. Two samples were lifted from each plot, evenly spaced within each 10-foot-long plot.

Seedlings were measured on February 10, separating the seedlings in each sample into $^{1}/_{32}$ -inch diameter classes and then measuring the top length of each seedling. For 8 of the 9 plots, there were more $^{5}/_{32}$ -inch seedlings than any other diameter class. Consequently, we selected only $^{5}/_{32}$ -inch seedlings for planting in the field. From the 2 samples from each plot, we selected 15 seedlings, proportionally from each sample, for planting in the field (we did not

[1] See VDF Occasional Report 94, A Five-Year Study of Different Sawdust and Nitrogen Rates in a Loblolly Pine Nursery.

have enough $^{5}/_{32}$ -inch seedlings from 1 of the 9 plots to plant 20 seedling rows). The seedlings from each of the three seedbed replications were kept separate in each of 3 field replications.

Seedbed Results

Auburn Study

Average root collar diameters and top lengths, and also average seedbed densities (number per square foot), are presented in Table 1. Seedlings were not top-clipped during the growing season.

Table 1. Average root collar diameter (32^{nds} inch) and top length (inches) by nitrogen rate.

Nitrogen Rate	Diameter	Top Length	Seedbed Density
150	6.46	9.8	18.4
300	6.61	10.1	18.8
450	6.44	8.9	18.6

The highest nitrogen rate produced the shortest seedlings, but the differences were not statistically significant. This has happened in other studies we have done.[1] Nitrogen rate had little effect on diameter.

Sussex Study

Average root collar diameters and top lengths, as well as average seedbed densities, are presented in Table 2. Seedlings were operationally top-clipped 3 times during the growing season.

Table 2. Average root collar diameter (32^{nds} inch) and top length (inches) by nitrogen status.

Nitrogen Status	Diameter	Top Length	Seedbed Density
Low	4.37	8.19	38.8
Operational	4.79	8.67	38.1
High	5.18	8.71	32.6

The low nitrogen seedlings were the smallest. It was obvious during the season that this treatment was not providing enough nitrogen, because the seedlings were chlorotic and smaller. Average bed densities were similar for the low and operational nitrogen plots, but bed density was considerably lower for the high nitrogen plots, which would be expected to favor diameter growth. An analysis of covariance was performed to adjust average root collar diameters for differences in bed density. The effect of nitrogen status on diameter was statistically significant (probability of a larger F = 0.033).

Field Planting

Both studies were planted on March 1, 1988. The Auburn study was planted in 4 randomized blocks, each block containing a 20-seedling row of each of the 6 treatments (2 diameter classes times 3 nitrogen rates). The Sussex study was planted in 3 randomized blocks, each block containing a 15-seedling row of each of the 9 treatments (3 nitrogen status times 3 seedbed locations). Auburn and Sussex blocks were alternated in the field, so performance of the 2 different seedling sources could be compared. Spacing was 6.6 by 6.6 feet for both studies.

Seedling heights were measured at ages 1, 2, 3, 4, and 7, and at age 7, diameters at breast height were measured to the nearest 0.1 inch.

Field Results

Auburn Study

Average survival decreased only 0.4 percentage point between age 1 and 7, combining all 24 rows in the field. At age 7, $^{6}/_{32}$ -inch seedlings survived slightly better than $^{7}/_{32}$ -inch seedlings and seedlings receiving 450 pounds of nitrogen had the best survival followed by seedlings receiving 150 pounds of nitrogen (Table 3). However, in an analysis of variance, after first transforming to arc sine percent, the differences were not statistically significant (probability of a larger F = 0.259 for diameter and 0.262 for nitrogen rate).

Table 3. Average survival at age 7 by nitrogen rate and initial seedling diameter.

	Diameter		
Nitrogen Rate	$^{6}/_{32}$	$^{7}/_{32}$	Means
150	92.5	85.0	**88.8**
300	85.0	86.2	**85.6**
450	91.2	90.0	**90.6**
Means	**89.6**	**87.1**	**88.3**

Average height at age 7 was slightly greater for the 300- and 450-pound nitrogen rates, and $^{7}/_{32}$ -inch seedlings were slightly taller than $^{6}/_{32}$ (Table 4), but in an analysis of variance, the differences were not statistically significant (probability of a larger F = 0.328 for nitrogen rate and 0.782 for initial diameter).

Table 4. Average height at age 7 by nitrogen rate and initial seedling diameter.

	Diameter		
Nitrogen Rate	$^{6}/_{32}$	$^{7}/_{32}$	Means
150	20.3	20.2	**20.2**
300	20.8	20.6	**20.7**
450	20.5	21.1	**20.8**
Means	**20.5**	**20.6**	**20.6**

Average DBH at age 7 was slightly greater for the 300 and 450 pound nitrogen rates, and there was no difference between $^{6}/_{32}$ - and $^{7}/_{32}$ -inch seedlings (Table 5). In an analysis of variance, the differences among nitrogen rates were not statistically significant (probability of a larger F = 0.346).

Table 5. Average DBH at age 7 by nitrogen rate and initial seedling diameter.

	Diameter		
Nitrogen Rate	$^{6/}_{32}$	$^{7}/_{32}$	Means
150	3.8	3.8	**3.8**
300	4.0	3.9	**3.9**
450	3.9	4.0	**3.9**
Means	**3.9**	**3.9**	**3.9**

Sussex Study

Average survival decreased 2.0 percentage points between age 1 and age 7, combining all 27 rows in the field. At age 7, survival was identical for all 3 nitrogen rates (Table 6).

Average height and DBH at age 7 are also presented in Table 6. The small differences among the three treatments were not statistically significant (probability of a larger F = 0.464 for height and 0.336 for DBH).

Table 6. Average survival, height (in feet), and DBH (in inches) at age 7, by nitrogen status.

Nitrogen Status	Survival	Height	DBH
Low	88.9	19.3	3.6
Operational	88.9	19.0	3.4
High	88.9	19.2	3.5

Conclusions

There does not seem to be any benefit from applying more than about 300 pounds of elemental nitrogen per acre to our sandy nursery soils at New Kent and Sussex. There were no gains in survival, height, or DBH, after 7 seasons in the field, from applying heavier rates.