COMPARISON OF SLOWLY AND RAPIDLY AVAILABLE NITROGEN FERTILIZERS FOR NURSERY PRODUCTION OF PINE SEEDLINGS

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In the spring of 1960, TVA's Division of Forestry Development initiated a series of production-scale tests at its Clinton Forest Nursery, in Clinton, Tenn., to compare the effectiveness of several nitrogen fertilizers in the production of pine seedlings. The production tests had two purposes: (1) To find out if there is a better nitrogen source than ammonium nitrate for production of seedlings and (2) to determine whether any of the sources have a residual effect on plantation development.

Five rapidly soluble sources, including ammonium nitrate, which has been used by TVA as a standard nursery fertilizer for 28 years, and four slowly soluble sources were compared in the production of both loblolly and shortleaf pine. In recent years there has been special interest in the newer, slow-dissolving forms which make nitrogen available longer, sometimes throughout a growing season. Soluble forms usually leach from the soil in 3 to 4 weeks. Soluble nitrogen sources tested were standard ammonium nitrate-33 percent N, ammonium sulphate-20 percent N, sodium nitrate-16 percent N, urea-43 percent N, and diammonium phosphate-20 percent N. Slowly available sources were melamine-65 percent N, oxamide-32 percent N, ureaform-38 percent N, and magnesium ammonium phosphate-8 percent N.

Nursery Phase

In both 1960 and 1961, all fertilizers were applied to nursery beds[1] just prior to seeding at 100 pounds of nitrogen per acre. The tests involved 18 beds of loblolly, 400 by 4 feet, and 18 beds of shortleaf, 200 by 4 feet. There were two replications of each fertilizer,

[1] Since beds receiving diammonium phosphate and magnesium ammonium phosphate received phosphorus as well as nitrogen, concentrated superphosphate was added on the other beds to equalize the effect of the phosphorus.

randomly assigned, one kind per bed. Otherwise, the beds were prepared, seeded, irrigated, and maintained in the customary manner.

Seeding production data obtained at the end of each year were analyzed by number of plantable 1-0 seedlings per square foot, percentage of plantable seedlings, stem diameter, height, and fresh- and overdry weight. Results for both years were comparable. Data from the 1961 tests are presented in table 1.

Loblolly pine: First-year results on effectiveness of the various fertilizers showed that none were significantly better than ammonium nitrate in number or percentage of plantable seedlings, height, stem diameter, or dry weight of seedlings. The second-year tests confirmed first-year results. Of the slowly soluble forms, magnesium ammonium phosphate, ureaform, and oxamide produced more plantable seedlings per square foot than melamine.

Shortleaf pine: Results for both years showed that no treatment was better than ammonium nitrate for any of the measurement criteria. Although in the second-year tests, magnesium ammonium phosphate yielded more seedlings than all other nitrogen fertilizers, differences were not great enough to be significant.

Field Phase

To determine whether use of the various nitrogen fertilizers in the nursery produced any unusual growth or survival characteristics after outplanting, loblolly seedlings from the 1960 nursery tests were set at 11 locations and shortleaf seedlings at 8 locations in Georgia, North Carolina, Kentucky, and Tennessee. Each test planting consisted of four blocks; seedlings from each fertilizer treatment were planted at random in 25-tree rows within each block. Average first- and second-year plantation height growth and two-year survival are given in table 2.

Loblolly seedlings grown with ammonium nitrate had a significantly greater first-year height growth than seedlings grown with all other fertilizers except diammonium phosphate. While not significant, second-year growth was also greatest for ammonium nitrate seedlings. The kind of fertilizer did not affect survival, which ranged from 92 percent for ammonium nitrate and ureaform seedlings to 85 percent for melamine seedlings.

TABLE 1.--Comparison of nine nitrogen fertilizers in production of pine seedlings, 1961

Measurement	Nitrogen sources									
	Rapidly available					Slowly available				
	Ammonium nitrate	Ammonium sulphate	Sodium nitrate	Urea	Diammonium phosphate	Melamine	Oxamide	Urea-form	Magnesium ammonium phosphate	D[1]
Loblolly pine										
Grade 1 and 2 seedlings per square foot[2].....	34	28	24	26	26	11	26	31	32	14
Average height of lifted seedlings, centimeters	16.9	16.9	14.8	17.4	17.5	12.8	16.5	17.3	16.4	1.5
Total dry weight per seedling, grams.....	1.39	1.36	1.16	1.35	1.42	.67	1.36	1.25	1.49	.38
Shortleaf pine										
Grade 1 and 2 seedlings per square foot[2].....	22	21	21	18	16	16	20	20	24	([3])
Average height of lifted seedlings, centimeters	13.7	16.7	14.6	14.1	14.3	12.5	14.5	15.5	15.8	3.7
Total dry weight per seedling, grams.....	1.89	2.17	2.65	2.20	2.28	1.11	1.91	2.04	2.19	.81

[1] Significant levels at 5 percent as computed by Snedecor's modification of Tukey's test. D represents the least significant difference between any pair of treatment means.
[2] Minimum height, 6 inches; minimum diameter, one-eighth inch.
[3] Not significant.

TABLE 2.--Average height growth and survival of outplanted seedlings grown in the nursery with nine nitrogen fertilizers

Measurement	Nitrogen sources									
	Ammonium nitrate	Ammonium sulphate	Sodium nitrate	Urea	Diammonium phosphate	Melamine	Oxamide	Urea-form	Magnesium ammonium phosphate	D[1]
Loblolly pine										
Plantation height growth, feet:										
1961	0.61	0.56	0.56	0.51	0.57	0.43	0.51	0.54	0.46	0.05
1962	1.41	1.35	1.35	1.28	1.32	1.22	1.26	1.34	1.27	([2])
Plantation survival after 2 years, percent	92	90	91	91	90	85	91	92	90	([2])
Shortleaf pine										
Plantation height growth, feet:										
1961	0.37	0.42	0.38	0.40	0.42	0.47	0.45	0.39	0.39	0.06
1962	1.03	.93	.92	.97	.94	.98	1.00	.92	.97	([2])
Two-year plantation survival, percent	64	68	63	70	69	85	76	68	74	([3])

[1] Significant levels at 5 percent as computed by Snedecor's modification of Tukey's test. D represents the least significant difference between any pair of treatment means.
[2] Not significant.
[3] For comparison, transform percents to arcsin percent and use D=5.75 to test for significance.

Shortleaf seedlings fertilized with melamine had the best first-year height growth, but by the end of the second year seedlings grown with ammonium nitrate were tallest. Two-year survival of shortleaf seedlings was best for those grown with melamine and oxamide. Both of these are nitrogen-carbon type compounds of very low water solubility, and it is doubtful that any nitrogen was available to the seedlings. The range in survival was 85 percent for melamine seedlings to 63 percent for sodium nitrate seedlings.

Summary

These nursery tests did not show any of the fertilizers to be better than standard ammonium nitrate, and its use will be continued at the Clinton Nursery. Detailed test data are available from TVA's Division of Forestry Development, Norris, Tenn.

Subsequent tests indicate that application of ammonium nitrate at planting time is less productive than top dressing 6 to 10 weeks after emergence of the seedlings. Results of these tests will be available soon.