Auburn University
Southern Forest
Nursery Management
Cooperative

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NITRATE LEACHING FROM DIFFERENT FERTILIZER MATERIALS IN A PINE SEEDLING NURSERY

by
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INTRODUCTION

The Coop has tested slow release fertilizers as a possible substitute for ammonium nitrate in forest tree nurseries. Slow release technology could theoretically allow for a single nitrogen application at the beginning of the year instead of the dry weather dependent and multiple top dressings of ammonium nitrate. Results from field trials by Coop members and research trials by the Coop staff have been mixed. However, as slow release fertilizers (SLRs) did not consistently produce seedlings of a quality comparable to ammonium nitrate, their general suitability regarding seedling production is not clear.

One of the possible advantages of using SLRs comes from the supposition that a slow release of nitrogen would better match the actual nutrient needs of the tree. This would theoretically increase the percentage of applied nitrogen taken up by the seedling and reduce nitrate leaching. In order to determine if slow release fertilizers show any difference in reducing nitrate leaching we installed an experiment in an Alabama Coastal Plain nursery and periodically sampled water captured in buried lysimeters.

METHODOLOGY

A randomized complete block design, with 3 blocks and individual plots 12m long, was used to test two slow release fertilizer materials, Nutricote and Meister (Table 1) and ammonium nitrate at equivalent rates of 224 kg N/ha or elemental N. They were applied in early April, 1998, and worked to a 5 cm soil depth with a bed shaper. The following fertilizer application regimes were installed:

- Ammonium Nitrate: A biweekly top dressing beginning early June, 8 times,

28 kg/ha each, Total N = 234 kg/ha.

- Nutricote: 180 day release, 13-13-13, incorporate prior to sowing at 1680 kg/ha – 218 kg N /ha. Total N = 228 kg/ha.
- Meister: 270 day slow release, 21-7-4 incorporated prior to sowing at 1064 kg/ha. Total N = 233 kg/ha
- Liquid: 32-0-0 formulation of ammonium nitrate, applied weekly for 16 weeks, June 4 - September 18, at rates ranging from 17 to 34 kg/ha. Total N = 375 kg/ha.

The entire nursery received 48 kg/ha of liquid diammonium phospate (10-34-0) on June 1 and June 10. Ammonium nitrate and Meister plots received triple superphosphate to equalize phosphorus fertilization with the Nutricote. This particular nursery uses 336 kg N/ha liquid ammonium nitrate as its standard treatment and areas immediately adjacent to each of the experimental blocks were also sampled, allowing for a direct comparison with the granular fertilizers. Two zero tension lysimeters (16.5 cm diameter) were placed in each plot at a depth of 30 cm and sampled during the growing season according to rainfall amount. Two lysimeters were placed along the irrigation line and used as "checks" (zero fertilizer). The area received a total of 962 mm of rainfall during the study period (April to February).

RESULTS

Seedling Morphology

There were no statistically significant differences ($\propto = 0.05$) between fertilizer treatments in terms of seedling height (range 28.3 - 30.6 cm) and root collar diameter (range 4.8 – 5.3 mm). Seedlings were top-pruned in August and this undoubtedly influenced seedling height comparisons between treatments. Seedling dry weights showed similar results among treatments (Figure 2), although there was a statistically significant decline in root dry weight for liquid fertilized seedlings and a corresponding reduction in the average root/shoot ratio (although statistically insignificant).

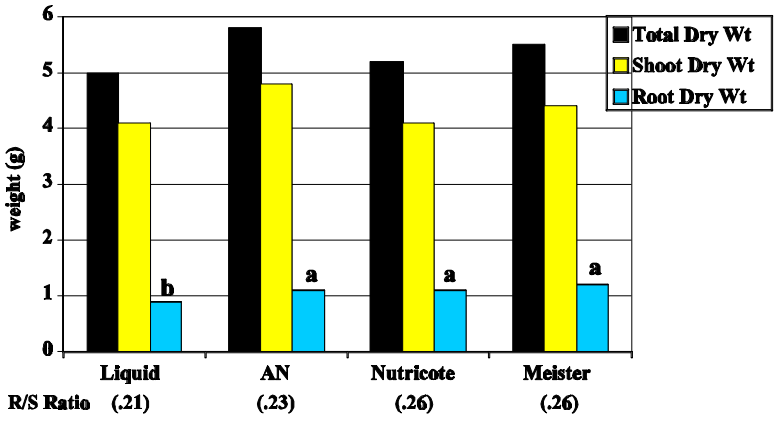

Figure 2. Seedling dry weight in December by fertilizer treatment.

Lysimeter Collection

The amount of water captured by lysimeters varied greatly. The dates when rainfall received at the nursery was sufficient to move water into the lysimeters in shown in Table 1. A total of 7 sampling events occurred during the 11 months the lysimeters were monitored. Within each of these events the amount of water in individual lysimeters varied from 0 to 1250 ml with little water moving through the soil profile in summer. Rainfall in the area during the study period was 962mm.

Table 1. Lysimeter sample dates, number of lysimeters with water, and range of sample volumes.

Sample Date	Number	Volume
1. April 20, 1998	19	0-1180 ml
2. June 12	16	0-1150
3. July 29	10	0- 760
4. Sept. 9	8	0 - 390
5. Sept. 30	19	0-1250
6. Nov. 30	24	0-1130
7. Feb. 3, 1999	25	0-1250

The amount of water captured by lysimeter sampling events as a portion of actual rainfall is summarized in Table 2. The amount of water captured by the lysimeters represents a small portion of rainfall reaching the ground. With percent rainfall capture varying from 13 to 22%, a large portion of rainwater was lost as surface runoff, evapotranspiration, or moved around the lysimeters. The amount of rainfall captured in lysimeters did not vary between blocks, indicating that drainage characteristics were similar across the entire area of the study. Also, variability between plots in terms of the amount of rainwater captured by the lysimeters occurred, although statistically non-significant.

Table 2. Rainwater captured by lysimeters during the 11 month sample period.
There were no significant differences between either block or treatment.

Block	Liters/ha	% of Rainfall
1	2.04 n.s.	21
2	1.49	16
3	1.44	15

Treatment	Liters/ha	% of Rainfall
Nutricote	2.09 n.s.	22
Ammonium Nitrate	1.68	17
Liquid	1.56	16
Meister	1.24	13

Nitrate Leached

Nitrate concentrations in lysimeter samples were highest during the months of June through July in plots receiving slow release fertilizer and ammonium nitrate (Figure 3). The liquid fertilizer continued to be found in relatively high concentrations until the end of September. The latter is a function of application date as the liquid was applied weekly until mid-September. Interestingly, nitrate concentrations sampled from the slow release fertilizers were higher during the summer than ammonium nitrate, indicating they released their nitrogen quickly. Nitrogen may not have been available to seedlings beyond mid-summer. Nitrate leaching was less in November for all fertilizers in the study.

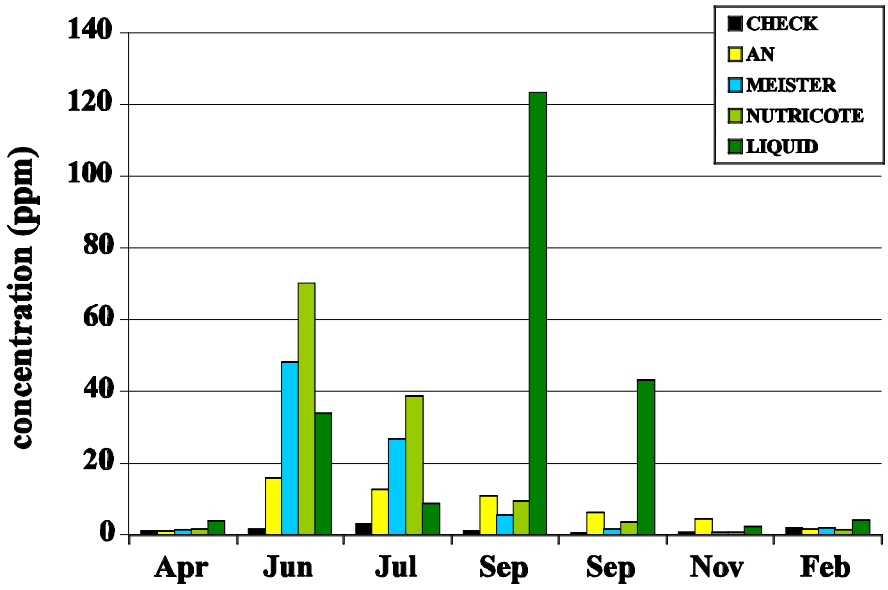

Figure 3. Nitrate (NO_3) concentrations by fertilizer treatment for each sample event.

There were significant differences between fertilizers when comparing the concentrations of nitrate in lysimeter samples (Table 3). The Meister formulation averaged only 1.9 mg/L of nitrate while the liquid averaged 13.2 mg/L. The leachability of liquid fertilizers is easily understood, but the low concentrations in the Meister plots are more difficult to explain. As noted above (Table 2) the lysimeters in Meister plots captured less water than the other lysimeters and this probably affected the results. The amount of nitrogen leached as a percent of nitrogen applied was 12% , 14%, 6%, and 2 % for liquid, Nutricote, ammonium nitrate, and Meister fertilizers, respectively. These results agree with others who have indicated that slow release fertilizers do not reduce nitrogen loss (Cox 1993, Yeager and Cashion 1995). The nitrogen found in the check lysimeters came from rainwater and dust.

Table 3. Concentrations and calculated amounts of NO_3 leached.

Treatment	Concentration mg/L	Amount kg/ha
Liquid	13.2 a	46 a
Nutricote	9.2 a	31 a
Ammonium Nitrate	7.1 ab	15 ab
Meister	1.9 b	4 b
Check	1.5†	5

† The check values come from two lysimeters placed along a rizer line and were not included in the statistical analysis.

MANAGEMENT IMPLICATIONS

The slow release formulations used in this study produced seedlings of the same quality as ammonium nitrate, but, the application rates (228 - 375 kg/ha N) were much higher than "standard" fertilization levels. Any fertilizer material will produce adequate seedlings if enough is applied. Liquid fertilizer produced smaller root systems.

There is no evidence that slow release fertilizers reduced nitrate leaching. In fact, SLRs tended to release nitrogen early in the growing season when the seedlings are smaller. Thus, the nitrogen leached by SLRs is comparable and perhaps even larger, than ammonium nitrate applications. The liquid nitrogen, on the other hand, moved readily through the soil and resulted in peaks of nitrate concentration in soil leachate after rainfall events.

Citations:

Cox, D.A. 1993. Reducing nitrogen leaching-losses from containerized plants: the effectiveness of controlled-release fertilizers. J. of Plant Nutr. 16(3):533-545.

Yeager, T. and G. Cashion. 1993. Controlled-release fertilizers affect nitrate nitrogen runoff from container plants. HortTechnology 3(2):174-177.