AUBURN UNIVERSITY
SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE

RESEARCH NOTE 95-4

Nitrate Leaching at a Coastal Plain Nursery in Alabama

by

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INTRODUCTION:

The use of nitrogen fertilizers, primarily ammonium nitrate and ammonium sulfate, is an integral component of tree seedling culture in nurseries. Any potential contribution to groundwater contamination needs to be closely monitored. Furthermore, losses of fertilizer nutrients through leaching indicates a non-productive loss of fertilizer input. Several factors directly relate to the particular concerns of forest nursery managers; (1) nurseries are usually located on sandy soils; (2) applications are made in the late spring and early summer during a period of normally heavy rainfall; and (3) relatively high application rates—130 to 170 kg/ha of elemental N—are common.

The objectives of this study were to determine the concentrations of nitrate-N (NO_3-N) below the rooting zone of tree seedlings grown in a forest tree nursery in order to assess potential nitrate loss through leaching. Movement from the root zone may indicate potential groundwater contamination in addition to fertilizer loss.

METHODOLOGY:

A coastal plain nursery in Alabama producing 20 million bare-root loblolly was selected for the location of this study. The soil is a Blanton-Bonifay. Rainfall averages 1310 mm/yr fairly evenly distributed but with peaks in January/February and June/July. A total application of 165 kg/ha of nitrogen in the form of Ammonium nitrate or Ammonium sulfate, was made in 5 applications of 33 kg/ha spaced two weeks apart from May to July.

A series of 42 piezometers were set in a grid pattern covering approximately 3 ha of seedling production area. Surrounding buffer areas and a drain were included in the grid. Piezometers consisted of a 5 cm inside diameter perforated PVC pipe placed so the bottom would sit on the clay soil horizon, a depth of 1.8 to 2.2 m. Piezometers were installed in June of 1991 and monitored until March 1992. Water levels were recorded in each piezometer after significant rainfall events, then they were purged of all water, allowed to refill, and sampled using a vacuum pump to pull water into a 500 ml flask. Samples were stored frozen until analyzed.

RESULTS:

From June of 1991 to March 1992, there were 5 rainfall events of sufficient magnitude to provide samples from the piezometers. A rainfall of about 76 mm within a 48 hour period was necessary before sampling could occur. The level of water varied considerably between wells for each sampling event (Table 1). For example, water depth for the June 27 samples of wells in the seedling production area varied from 0 to 132 cm, with a 51 cm average. Other sampling events had similar results. Because the depth to clay is fairly uniform across the seedling production area, this variability may result from differences between wells in downward drainage or perhaps shallow groundwater moves in uneven depths or flows. Wells on the north side of the field tended to be wetter.

Nursery fields are located and often landscaped to drain effectively. Well water depths in this study indicate that drainage waters moved quickly from the nursery production area to the border and drains. Samples taken from the wells surrounding the seedling area consistently had more water in them. In addition, range of depths is far less than in the seedling production area. It is likely that vadose zone water movement had been slowed by the roads and culverts surrounding the study area.

Average nitrate concentrations for wells in the seedling production area varied from 78 ppm on July 8 to 117 on November 27. Similar to water depth, there was considerable variability, between wells in terms of nitrate concentration. Concentrations varied from 9 to 199 ppm among individual wells. There was no discernable pattern of nitrate concentration related to field location or depth of water in wells. Nitrate concentrations decreased dramatically for those wells located outside the seedling production area (Table 2). Averages for each sampling event varied from 8 to 32 ppm in the border areas—those immediately adjacent to seedling areas. Furthermore, wells located in the drain had even lower nitrate concentrations, averaging from 5 to 13 ppm between the 5 sampling events.

The cause of this decrease is difficult to ascertain. There may be a dilution effect related to more water moving through the border and drainage areas. Certainly at the time of sampling, wells in these areas consistently had more water. Secondly, denitrification could be reducing nitrate concentrations through anaerobic activities in these areas were water movement is inhibited, although, anaerobic conditions exist only for short periods of time after heavy rainfall. Finally, some drain and border area nitrogen could be incorporated into on-site vegetation. It is not expected that this incorporation is significant, as these areas are planted to Bahia grass which is mowed periodically but not removed and should be in equilibrium with nitrogen loss.

MANAGEMENT IMPLICATIONS:

There was considerable variability within and among sample areas for both shallow groundwater depth and nitrate concentrations. This may reflect underground patterns of water movement which influence concentrations. This must be taken into consideration when setting up nitrate sampling schemes. There is little doubt that the level of nitrates potentially moving through nursery beds warrents further investigation. A sample values of 180 ppm is high.

It is apparent that border and drainage areas play important roles in the overall nursery nitrogen budget. These areas are important buffers between seedling production areas and other areas on and off the nursery. Fertilization practices, ground cover species, and drainage patterns in these areas may influence their effectiveness as a buffer.

Table 1. Depth of Water in Piezometers for each sampling event.

Sample Area	Sampling Date				
	6/27	7/8	11/27	1/14	2/27
Seedling Beds (20 Piezometers)					
X Depth (cm)	51a*	43a	13a	26a	47a
Range (cm)	0-132	1-122	0-51	0-84	0-164
Border Areas (12 Piezometers)					
X Depth (cm)	87a	50a	19a	88b	94b
Range (cm)	33-142	28-88	0-39	37-129	51-129
Drains (5 Piezometers)					
X Depth (cm)	160b	106b	17a	123c	133c
Range (cm)	94-189	85-121	0-58	79-152	91-160

* Identical letters within a column indicate no significant difference.

Table 2. PPM nitrate (NO_3) from forest tree nursery piezometer samples.

Sample Area	Sampling Date				
	6/27	7/8	11/27	1/14	2/27
Seedling Beds					
No. of Samples	10	11	10	11	16
X ppm NO^3	102a*	78a	117a	111a	76a
Range (ppm NO^3)	52-190	54-141	56-194	9-199	18-109
Border Areas					
No. of Samples	12	12	11	12	12
X ppm NO^3	12b	8b	24b	32b	11b
Range (ppm NO^3)	1-39	1-23	4-99	1-124	1-29
Drains					
No. of Samples	5	5	3	5	5
X ppm NO^3	6b	9b	13b	8b	5b
Range (ppm NO^3)	1-15	1-26	2-20	2-26	1-11

* Identical letters within a column indicate no significant difference.

Figure 1. Experiment layout.