HORTSCIENCE 25(11):1388-1391. 1990.

Nitrogen Leaching from Cypress Wood Chips

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Additional index words. landscape mulch, PVC columns, nitrogen carriers, nitrogen rate, irrigation rate, *Taxodium distichum*

Abstract. **Columns (4 × 15 cm) of incubated (25C, 7% volumetric moisture) milled cypress *[Taxodium distichum* (L.) L. Rich] wood chips received 180 mg of each ionic form of N applied to the surface from dry NH_4NO_3, KNO_3, or $(NH_4)_2SO_4$ and were leached daily with 16 ml deionized water (pH 5.5). After 10 days, >85% of applied N leached from the columns in all treatments. After 25 days, all N leached from the NH_4NO_3 and KNO_3 treatments, and 93% leached from the $(NH_4)_2SO_4$ treatment. In subsequent experiments, columns received 360 mg N from NH_4NO_3 and were leached daily with either 16, 32, 48, or 64 ml of deionized water for 50 days. The rate of N leaching increased with increasing water application rate, although total N leached per column was similar for all water rates after 25 days. Columns that received 45, 90, 180, or 360 mg N/column were leached daily with 16 ml of deionized water. Nitrogen concentrations in the leachate ranged from 3406 ppm NO_3^--N and 2965 ppm NH_4^+-N at day 5 for the 360-mg rate to 3 and 5 ppm, respectively, at day 35 for the 45-mg rate. In all experiments with NH_4NO_3, more NO_3^--N leached than NH_4^+-N and more NO_3^--N leached than applied, indicating vitrification occurred. NH_4^+-N and NO_3^--N broadcast over cypress wood chips in the landscape would leach quickly into the soil.**

Cypress wood chips and bark of various pine *(Pinus* L.) species are often used as a mulch for landscape plantings in southeastern and subtropical regions of the United States. Such mulches buffer soil temperatures (Ashworth and Harrison, 1983), reduce weed growth, may immobilize soil N, and maintain soil moisture levels (Robinson, 1988). Cypress-mulched landscape plants are commonly fertilized by broadcasting over the surface of the mulch. However, the influence of the cypress mulch on leaching of N is unknown. Previous research revealed that NO_3^--N leached rapidly when surface-applied to pine bark, whereas NH_4^+-N leached only after exchange sites were saturated (Foster et al., 1983). We, therefore, determined the influence of N carriers, N application rate, and water application rate on N retention by cypress wood chips.

General procedures. Freshly milled cypress wood chips (whole-ground tree) were passed through a 6.3-mm sieve and oven-dried at 60C to a constant weight. Particle size distribution (by weight, but separated by dimension) was 33.3% less than 0.5 mm, 46.9% between 0.5 and 1.4 mm, 18.4% between 1.4 and 4.0 mm, and 1.4% greater than 4.0 mm (U.S. Series sieve no. 35, 14, 5, and 3, respectively). Total cation exchange capacity of the wood chips was 0.43

Received for publication 6 Nov. 1989. Florida Agricultural Experiment Station Journal Series no. R-00189. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.
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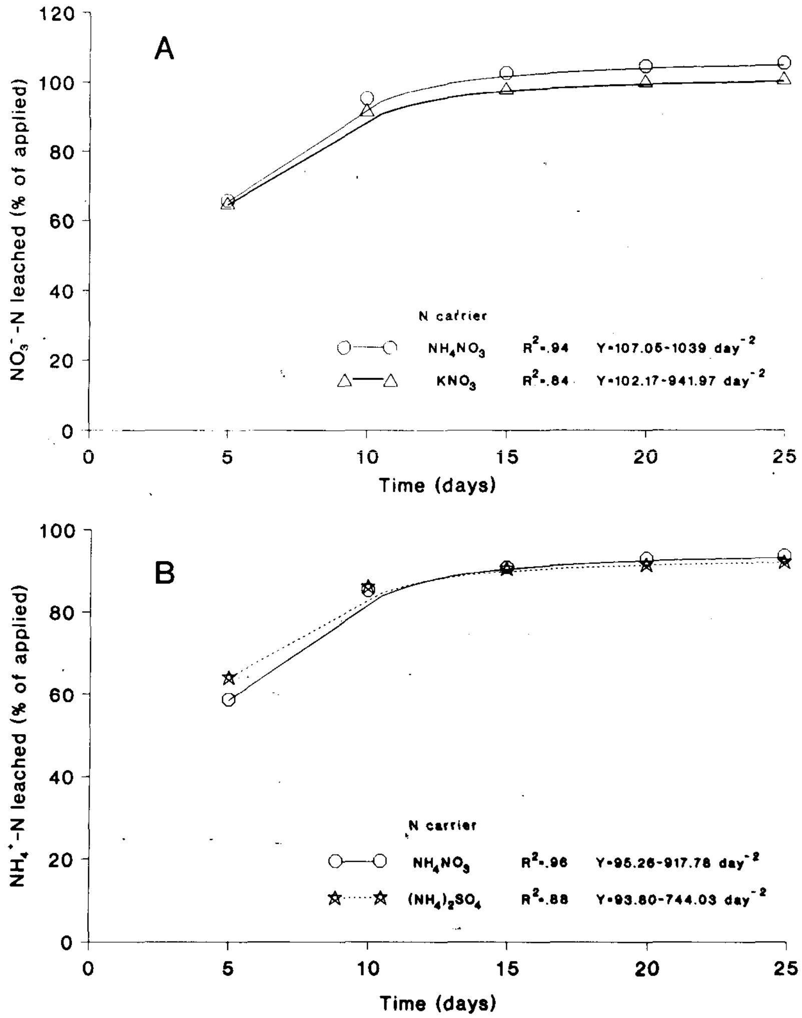

Fig. 1. Percent of applied (**A**) NO_3^--N and (**B**) NH_4^+-N leached from columns of milled cypress wo chips receiving NH_4NO_3, KNO_3, $(NH_4)_2SO_4$, or no N (control). Columns were leached daily w 16 ml of deionized water (pH 5.5). Less than 0.5 mg NO_3^--N or NH_4^+-N leached from the cont: (data not presented).

Table 1. Nitrogen applied and leached after 25 days from columns of cypress wood chips that received a dry surface application of one of three N carriers.

	Nitrogen (mg N/column)[z]			
	NH_4^+-N		NO_3^--N	
Nitrogen carrier	Applied	Leached	Applied	Leached
None (control)	0	---[y]	0	---
NH_4NO_3	180[y]	171**	180	191**
KNO_3	0	---	180	183[NS]
$(NH_4)_2SO_4$	180	168**	0	---

[z]Mean of 10 columns; columns were leached with 48 ml·day^{-1} on day 1 and 16 ml·day^{-1} thereafter for 25 days.
[y]Less than 0.5 mg N.
**,[NS]Significantly different from amount applied at P = 0.01 or nonsignificant, respectively.

meq/100 cm^3 and anion exchange capacity was 0.013 meq/100 cm^3 (Agro Services International, Orange City, Fla.). Plastic bags containing 28 g of cypress wood chips were hand shaken for 1 min after addition of 11.2 g of deionized water and incubated at 25C in a Precision Incubator Model 818 (SGA/ Precision Scientific Group, Chicago). Deionized water (pH 5.5) was added to each bag about twice weekly during incubation to maintain 7% volumetric or 40% gravimetric moisture.

Cypress wood chips from each bag were placed in a polyvinyl chloride (PVC) column (4 × 15 cm or 4 × 20 cm) described by Yeager and Barrett (1984). Forty columns, supported by a metal frame, were arranged in a completely randomized design in a laboratory (21 to 26C). Analytical-grade N carriers were ground with a mortar and pestle, passed through a 500-µm sieve, and evenly distributed on the surface of the cypress wood chips. Six pieces of filter paper (Whatman no. 42), cut to fit the inside diameter of the column, were placed on top of the fertilizer to minimize disturbance and to accomplish uniform distribution of water applied. The appropriate volume of deionized water (pH 5.5) was measured with a syringe and added to each column. Columns were covered with a plastic cap with a 2-mm-diameter hole in the center and allowed to drain until dripping ceased. Leach ate volume from each column was recorded daily and pH determined on day 1 and every 5 days thereafter using a Corning Model 12 pH meter (Coming Glass Works, Medfield, Mass.). Leachates were frozen until NO_3^--N and NH_4^+-N were determined with an Orion Ionalyzer Model 901 using the Model 93-07 NO_3^- electrode and the Model 93-12 NH_3 electrode (Orion Research, Boston).

Nitrogen carriers (Expt. 1). After 35 days of incubation, cypress wood chips were placed in columns and 360 mg N/column from NH_4NO_3 or 180 mg N/column from KNO_3 or $(NH_4)_2SO_4$ was evenly distributed on the cypress surface. Ten columns (4 × 15 cm) received each N carrier and 10 did not. Each column was leached the first day with 48 ml of deionized water to thoroughly wet the cypress wood chips. Thereafter, each column received 16 ml daily until termination of the experiment on day 25. Leachates from five consecutive days were combined into one sample for NO_3^--N and NH_4^+-N determination.

Water rate (Expt. 2). After 48 days of incubation, cypress wood chips from each plastic bag were placed in a PVC column (4 × 20 cm). To eliminate indigenous N from the wood chips, each column was leached with 48 ml of deionized water daily until the leachate NO_3^--N concentration was <1 ppm (14 days). Then, 360 mg N/column from NH_4NO_3 was evenly distributed on the surface of the cypress wood chips. Deionized water was applied to each of 10 columns at 16, 32, 48, or 64 ml/column daily until day 50. Leachate from each column was collected separately for days 1 through 15 and then every 5th day to day 50. Leachates were combined from days 16 to 19 and 21 to 24.

Nitrogen rate (Expt. 3). After 35 days of incubation, eight columns received NH_4NO_3 at either 0.0, 45, 90, 180, or 360 mg N/ column. Each column was leached the first day with 48 ml of deionized water to thoroughly wet the cypress wood chips. Thereafter, each column received 16 ml deionized water daily for 50 days. Leachates were collected every 5th day until day 50.

Sixty-five percent of applied NO_3^--N and ≈60% of NH_4^+-N leached from the cypress wood chips by day 5 in Expt. 1 (Fig. 1 A and B). Ninety-two percent and 85% of applied NO_3^--N and NH_4^+-N, respectively, leached by day 10, a result similar to that with pine bark in which >95% of the N from NH_4NO_3 leached after 8 days (Foster et al., 1983).

Total NH_4^+-N leached from NH_4NO_3 and $(NH_4)_2SO_4$ was less than that applied, indicating sorption by the wood chips and/or volatilization (Table 1). Nitrification may also have occurred and resulted in more NO_3^--N leached than was applied. However, negligible NO_3^--N was recovered for the $(NH_4)_2SO_4$ treatment, and leachate pH was similar for all carriers (6.2). Nitrate N leached from KNO_3 was similar to that applied.

Nitrogen leached at a faster rate as water application rate increased (Fig. 2 A and B). However, more water was required to leach a given amount of N at the higher water rates than at the lower rates. For example, a total of 256 ml of water applied over 4 days at 64 ml·day^{-1} leached 86% of the NO_3^--N, whereas only 176 ml was required to leach this amount

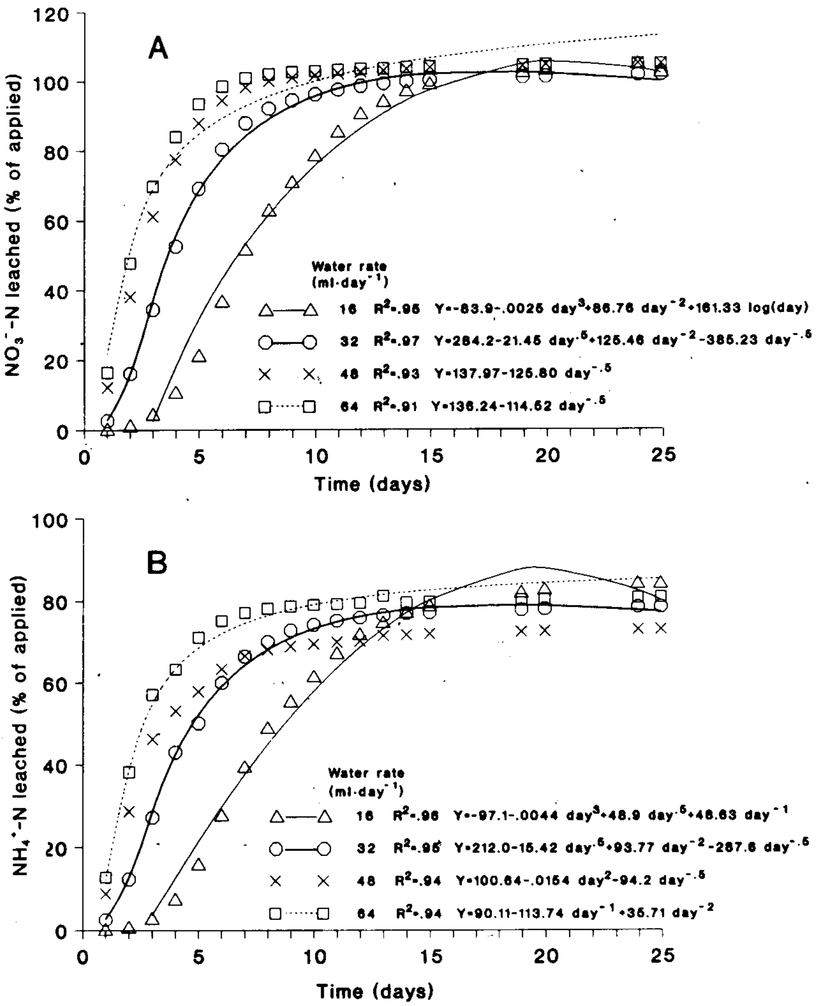

Fig. 2. Percent of applied (A) NO_3^--N and (B) NH_4^+-N leached from columns of milled cypress wood chips receiving 16, 32, 48, or 64 ml of deionized water (pH 5.5) daily. Each column received a surface application of 360 mg N from NH_4NO_3.

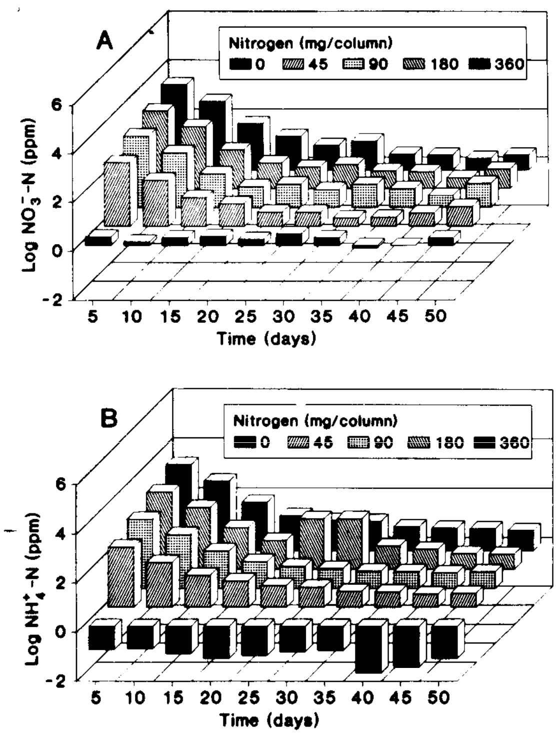

Fig. 3. Log_{10} of (A) NO_3^--N and (B) NH_4^+-N concentrations of leachate from columns of milled cypress wood chips receiving 0, 45, 90, 180, or 360 mg N from NH_4NO_3. Each column was leached daily with 16 ml of deionized water (pH 5.5).

at the 16-ml·day^{-1} rate. This result indicates that a single rainfall event of 5 cm would leach less N than two events of 2.5 cm. Regardless of water rate, more NO_3^--N leached than was applied, indicating that nitrification occurred.

The NO_3^--N and NH_4^+-N concentrations during Expt. 2 decreased rapidly for each water rate and were lowest at the higher water application rates due to the dilution effect of the greater water volume (data not presented). Total N (NO_3^--N plus NH_4^+-N) concentration for the 16-ml·day^{-1} treatment on day 25 was <80 ppm, an optimal level for container-grown 'Helleri' holly *(Ilex crenata* Thunb.) (Niemiera and Wright, 1982; Wright and Niemiera, 1985). Total N concentration in Expt. 3 for the 360-mg rate was < 80 ppm by day 20 (Fig. 3 A and B). At the 45-mg rate (equivalent to 140 g·m^{-2}), total N concentration in the leachate was <80 ppm by day 10, after 15 cm of water was applied. Nitrate-N and NH_4^+-N concentrations on day 50 ranged from 5 to 7 ppm for the 360-mg treatment and from 7 to 4 ppm for the 45-mg treatment, respectively.

More than 92% of the NO_3^--N and 85% of the NH_4^+-N leached through cypress wood chips from a surface application of NH_4NO_3, KNO_3, or $(NH_4)_2SO_4$ after applying 15 cm of water over 10 days. Leaching was faster at the higher water application rates. Therefore, NH_4^+-N and NO_3^--N broadcast over cypress wood chips in the landscape would leach rapidly into the soil. Leaching would be slower from water-insoluble N carriers that are often used to fertilize landscapes. Concentration of N leaching from cypress wood chips that received 45 mg N (140 g·m^{-2}) was >80 ppm only for the first 10 days after fertilizer application when 12 mm of irrigation water was applied daily. Since, for most of the year, many landscapes do not receive water at this rapid rate, application of soluble N fertilizer would result in leachate concentrations >80 ppm for longer than 10 days. Although optimum growth for woody plants in containers occurs at 80 ppm N, the optimum concentration for plants growing in the landscape is not known.

The amount of N leached through cypress wood chips can be reliably predicted as a function of time at a constant water application rate. This function is fairly consistent among a variety of soluble N carriers. The rapid leaching of soluble N emphasizes the need for fertilizing landscapes with controlled-release N carriers. Leaching characteristics of controlled-release N carriers and those of soluble carriers remain to be compared.

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