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Selections have been made from the 'October Glory' × 'Autumn Flame' and the 'Red Sunset' × 'Autumn Flame' progenies; several of these clones have been propagated and distributed for national evaluation. All combine consistent and excellent color with lower leafhopper susceptibility.

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Nitrogen Leaching from Osmocote-Fertilized Pine Bark at Leaching Fractions of 0 to 0.4[1]

Alexander X. Niemiera and Carol E. Leda[2]
Department of Horticulture,
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0327

Abstract

Pine bark-filled PVC columns with 1 g Osmocote (14N-6.3P-11.6K)(14-14-14) per column were irrigated five days a week for 12 weeks with a leaching fraction (LF) of 0, 0.2, or 0.4. Every two weeks cumulative N content of collected leachate and medium solution N concentration (pour-through method) were determined. The total amount of N leached from bark at 0.4 LF was 61% greater than at 0.2 LF. Medium solution NO_3-N concentrations of 0 LF were four to eight times greater than at 0.4 LF for all sampling dates. After 84 days, there was no difference in amount of N remaining in Osmocote prills for the LF treatments.

Index words: container-grown, soilless media, fertilization, controlled release fertilizer

Significance to the Nursery Industry

Nutrient loss from soilless substrates of container-grown plants is directly related to irrigation regime. Results of this study show that leaching fraction has no affect on the release rate, and hence duration of Osmocote, but dramatically affects the amount of N available to plants and the amount leached from the container. To increase the amount of N availabe to plants and to decrease the amount of N lost via leaching, growers should irrigate with the lowest leaching fraction possible.

Introduction

Irrigation of container-grown crops has a profound influence on fertilizer concentration in the medium solution and on the amount of fertilizer leached from the medium. Leaching is usually quantified by the term leaching fraction (LF) which is defined as volume of solution leached/volume of solution applied. Much research is reported without reference to LF which is a significant omission due to the current attention and emphasis on fertilizer pollution.

Ku and Hershey (2) applied 300 mg N/liter to container-grown poinsettia and obtained leachate EC of ≈ 14, 8, and 4 at LF of 0.1, 0.2, or 0.4 dS m^{-1}, respectively. There is considerable commercial as well as scientific interest in controlled release fertilizers (CRF) such as Osmocote, since plants fertilized with CRF may lose less nutrients via leaching (5) than liquid fertilizer. Hershey and Paul (1) irrigated container-grown plants at a LF of ≈ 0.27 for 11 weeks and found that liquid fertilizer N leaching losses were greater than CRF. However, CRF N losses depended on application rate and ranged from 0.3 to 0.8 g per pot which, relative to the amount N applied, was a 12% to 23% N loss. Thus, N loss from CRF can be significant. The objective of this work was to determine the affect of a 0, 0.2, and 0.4 LF on N loss from Osmocote prills and N leached from Osmocote-fertilized pine bark.

Materials and Methods

Ninety grams of moist pine bark (*Pinus taeda*) (38 g oven dry weight) amended with 3 kg dolomitic limestone and 1

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[2] Assistant Professor and Laboratory Specialist, respectively.

kg Micromax (Grace-Sierra, Milpitas, Calif.)/cubic m were put into each PVC column (4.1 cm × 15 cm) in which one end was covered with plastic-weave shade cloth to retain bark during irrigation. Bulk density of bark was 0.19 g/cubic cm with a particle size distribution of 4.5% ≤ 0.11 mm, 7.6% ≤ 0.25, 15.8% ≤ 0.5 mm, 20.2% ≤ 1.0 mm, 23% ≤ 2.0 mm, and 29.8% ≤ 4.0 mm. To wet and settle bark, 180 ml of distilled water were beaker-applied to each column. One gram of Osmocote, 14N-6.3P-11.6K (14-14-14), enclosed between upper and lower cheesecloth circles (diameter 4.6 cm), was placed 0.5 cm below the surface of bark. Nitrogen carriers were ammonium nitrate and ammonium phosphate with 59% N as NH_4-N and 41% as NO_3-N. LF of 0, 0.2, and 0.4 were obtained using the formulae $V_a = X{\cdot}E$, $V_a = (LF \times E)/(1 - LF) + X{\cdot}E$, and $V_a = (LF \times E)/(1 - LF) + X{\cdot}E$, respectively, which are modified forms of a formula from Ku and Hershey (2) where V_a is the volume to be applied, E (determined gravimetrically) is the amount of water that evaporated from bark since the last irrigation, and X, the multiplier of E, was a value that was adjusted over time to achieve targeted LF values. X was 0.85 and 0.65 during the first and second week, respectively, for LF of 0, 0.2 and 0.4. For weeks six through twelve, X was 0.55, 0.55 and 0.45 for LF of 0, 0.2 and 0.4, respectively. Irrigation water (distilled) was dripped on the surface of bark via a tube at 2.2 ml/min. Columns drained for 1 h, and collected leachate was analyzed for NH_4-N and NO_3-N using ion-selective electrodes. Columns were stored in a growth chamber at 22°C (72°F) except during irrigation and drainage. Leachate was cumulatively collected and stored at 7°C (44°F) during each two week period. At 14 day intervals, medium solutions were sampled on the same irrigated columns 2 h following irrigation using the pour-through technique (6) by applying 30 ml distilled water to the bark surface; collected leachate was analyzed for NH_4-N and NO_3-N. Pour-through leachates were analyzed within 2 days of collection and cumulatively collected leachates were analyzed within 2 days following the 14 day collection period. Treatments were applied daily, Monday through Friday, for 12 weeks. After 12 weeks, N analysis of bark via micro-Kjeldahl technique and Osmocote prills (analyzed by Grace-Sierra Laboratory, Allentown, Pa.) was conducted. There was one column per block per treatment in each of six blocks. Columns were arranged in a randomized complete block design and data were subjected to analysis of variance (ANOVA).

Table 1. Nitrogen leached from pine bark containing 140 mg N from Osmocote (14 N - 6.38 P - 11.6 K) (14-14-14) with 0, 0.2, and 0.4 leaching fractions.

Leaching fraction	N leached (mg) Day 0–14	Day 15–28	Day 29–42	Day 43–56	Day 57–70	Day 71–84	Total
				NH_4-N			
0	0.05	—	—	—	—	—	0.05
0.2	0.17	0.92	1.63	0.24	0.10	0.10	3.16
0.4	0.48	2.09	3.02	0.28	0.19	0.17	6.23
Significance[z]	***	*	***	ns	***	***	***
				NO_3-N			
0	0.49	—	—	—	—	—	0.49
0.2	5.85	5.98	7.45	9.15	6.10	5.73	40.26
0.4	8.76	8.71	12.09	15.47	11.68	7.05	63.76
Significance	***	**	***	***	***	*	***
				Total N			
0	0.54	—	—	—	—	—	0.54
0.2	6.02	6.9	9.08	9.38	6.21	5.83	43.42
0.4	9.24	10.81	15.11	15.76	11.87	7.22	70.01
Significance	***	**	***	***	***	*	***

[z]ns,*,**,*** Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

Table 2. Pour-through medium solution N concentration of Osmocote-fertilized (14 N - 6.3 P - 11.6 K) (14-14-14) pine bark over time at 0, 0.2, and 0.4 leaching fractions.

Leaching fraction	Medium solution N ($mg \cdot liter^{-1}$) Day 14	Day 28	Day 42	Day 56	Day 70	Day 84
			NH_4-N			
0	7	26	34	6	4	2
0.2	12	15	8	3	2	1
0.4	8	10	5	<1	2	<1
Significance[z]	ns	ns	**	*	ns	ns
			NO_3-N			
0	199	151	226	204	269	68
0.2	59	33	61	58	41	23
0.4	27	19	51	25	33	16
Significance[z]	**	*	**	***	***	***

[z]ns,*,**,*** Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

Results and Discussion

The total amount of N leached from bark at 0.4 LF was 61% greater than leached at LF of 0.2 (Table 1). The amount of leached NO_3-N greatly exceeded the NH_4-N amount. Since the N component of this Osmocote product was 41% NO_3-N and 59% NH_4-N, nitrification in the medium or leachate must have been very active. Virtually, no N leached at 0 LF (all dates). In most cases the amount of NO_3-N and NH_4-N leached between days 71 and 84 was less than preceding periods which coincides with the manufacturer's prescribed three to four month nutrient release period of the Osmocote used in this study.

For all dates the medium solution NO_3-N concentration of 0 LF was four to eight times the NO_3-N concentration of the 0.4 LF (Table 2). There was a similar trend, but to a lesser degree, for medium solution NH_4-N concentration differences. Similar to leachate N (Table 1), medium solution NO_3-N concentrations were much greater than NH_4-N concentrations. Since medium solution N concentration can be interpreted as a measure of plant availble N, the effect of LF on N availability is dramatic. Additionally, the ratio of Osmocote to media volume was approximately proportional to the recommended Osmocote rate for container-grown plants. In this respect the medium solution N concentration of the LF 0 treatment, when compared with suggested N concentrations of applying liquid fertilizer at each irrigation (3), would be sufficient and in some cases excessive for several greenhouse crops.

Osmocote prill N content at the end of the experiment was not different between LF treatments (Table 3). Thus, LF did not affect the release rate of Osmocote but did affect

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Table 3. Distribution of N from Osmocote (140 mg) after 84 days as influenced by leaching fraction.

Leaching fraction	Distribution (%)				
	Leached	Pour-through	Medium	Osmocote prill	Missing
0	0.4	13.3	12.9	22.9	50.5
0.2	31.0	5.4	15.0	22.9	25.7
0.4	50.0	2.9	12.1	22.5	12.5

the removal of nutrients from the container. The sum of N in prills at the end of the experiment, in leachate and in bark, was 50%, 74%, and 88% of the initial amount of N in prills for 0, 0.2, and 0.4 LF treatments, respectively. The reason for the unaccountability of all N may be due to ammonia volatilization, dentrification, or analytical errors.

This work demonstrates the profound influence of LF on N leaching and N availability for Osmocote in a soilless medium. Researchers should focus on irrigation methods for container-grown crops that result in minimal nutrient leaching. Poole and Conover (4) found that plant quality of two species of container-growh foliage plants was not affected at a 0 LF compared to a LF of 0.10. With a minimum leaching irrigation strategy, growers could reduce current fertilizer application rates as well as irrigation amounts.

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