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Nitrate in Runoff Water from Container Grown Juniper and Alberta Spruce Under Different Irrigation and N Fertilization Regimes[1]

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Abstract

Juniperus horizontalis Moench 'Plumosa Compacta Youngstown' (compact Andorra juniper) and *Picea glauca* Moench (Voss) 'Conica' (dwarf Alberta spruce) were grown for one season in 2.2 l (#1) nursery containers in a potting medium containing composted hardwood bark, sphagnum peat moss and sand (1:1:1 by vol). The containers were placed over lysimeters permitting continuous collection and measurement of water passing through and around the containers. Slow release or soluble N was applied at an annual rate of 1.6 g of N per pot. Containers were irrigated by either trickle or overhead methods and water volumes were recorded. Subsamples of leachate were collected and analyzed for nitrate. Much less nitrate was leached by the trickle than by the overhead irrigation. Although slow release N sources lost considerably less nitrate in runoff water, there is still sufficient nitrate lost by these sources to pollute ground water unless annual fertilizer needs are supplied by split applications. Depending on sources, 58–80% of the N applied as slow release fertilizers was not recovered in either the plant or runoff water.

Index words: leaching, ground water quality

Introduction

Contamination of ground water with nitrates is a problem in many agricultural areas because concentrations have been shown to exceed the drinking water standard of 10 mg/liter. In Connecticut, where container grown nursery stock is a major agricultural crop, there exists a potential for pollution of ground water. Much of the container stock is fertilized with soluble N fertilizers delivered through overhead irrigation systems at an annual rate in excess of 500–600 kg/ha (450–530 lbs/A).

Nursery crops grown in containers filled with porous, highly organic media are frequently irrigated in excess (2). Unlike other crops, container grown nursery crops are often grown in areas where topsoil has been removed, thus hastening the flow of soluble fertilizer to ground or surface water and increasing the potential for NO_3 pollution (3, 9). Furthermore, depending on the spacing between containers, large amounts of water and soluble fertilizers applied by overhead irrigation falls between containers. Cultural practices that might reduce the nitrate pollution are drip or trickle irrigation and the use of slow release N fertilizers. Drip irrigation reduces needs by applying water and soluble fertilizers directly into containers (10). Slow release fertilizers release their nutrients slowly and are considered more efficient for container culture (8). Research with porous organic soilless media used in golf green construction (1, 5) suggests that slow release fertilizers prevent sudden loss of N. The purpose of this study was to determine nitrate N in runoff water from container grown plants receiving either slow release or soluble sources of nitrogen under drip and overhead irrigation during one growing season.

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Materials and Methods

The experiments were performed in 1982 and 1983 at the Valley Laboratory of the Connecticut Agricultural Experiment Station in Windsor, CT. Forty 51 cm (19.5 in) dia steel lysimeters were modified to collect water that leaches through medium filled containers separately from water falling between containers. Six 2.2 l (#1) plastic nursery containers each with plastic collectors were placed on a grate above each lysimeter. The six collectors from each lysimeter drained into one composite collector located underground. The empty lysimeters were used to collect the water that fell between containers. All containers were spaced 18 cm (7 in) on centers (approximately 250,000 containers/ha or approx. 105,000 containers/A). Each experiment was arranged as a 5 × 2 × 4 factorial in a randomized complete block.

Drip irrigation was provided by a circular drip emitter placed on the media surface of each container. Overhead irrigation was by fine spray nozzles fixed on metal supports 30 cm (11.7 in) above the plants. The two irrigation regimes were independently activated by an irrometer switch placed in an unplanted container under each regime. Both were set to start irrigating at a soil moisture pressure that approximated the water needs of the containers with plants. Municipal water was used in both experiments.

The potting medium was unscreened composted hardwood bark: Canadian peat moss: washed sand (1:1:1 by vol). Amendments were: Triple superphosphate (0-21.4P-0) 1.2 kg/m^3 (2 lbs/yd^3); iron sulfate 0.6 kg/m^3 (1 lb/yd^3); minor elements (Micromax) 0.6 kg/m^3 (1 lb/yd^3) and ground dolomitic limestone 5.9 kg/m^3 (10 lbs/yd^3) to bring the initial medium pH to 6.0. In 1982, one rooted cutting of juniper (*Juniperus horizontalis* Moench 'Plumosa Compacta Youngstown') was planted in each container. In 1983, rooted cuttings of Alberta spruce (*Picea glauca* Moench (Voss) 'Conica') were used. In 1982, plant shoot growth was recorded and in 1983, both plant quality and growth were evaluated.

Fertilizers were applied at an annual application rate of 1.6 g of N per pot. At a container density of 250,000/ha, this corresponds to 484 kg/ha (432 lbs/A) for the slow release sources and the soluble through trickle irrigation, and 900 kg/ha (800 lbs/A) for the soluble through overhead irrigation. All fertilizers were applied by hand to both irrigation regimes as either dry top dressings for the slow release sources or in solution for the soluble sources. The soluble sources were applied in the same amount of water as would be applied in a normal irrigation. At each application of soluble N, comparable amounts of water were applied to all other treatments. In 1982, the slow release sources were: Scott's Pro Gro (SPG) 31N-2P-5K; SierraBlen (OMC) 18N-3P-10K; a 50%/50% mixture of sulfur coated urea and ureaformaldehyde (SCU/UFA) 30N-2P-6K. The entire annual rate of 1.6 g of N per container was applied at the beginning of the experiment. The soluble N source (SBL) was a 20N-4P-8K formulated with urea, diammonium phosphate, potassium nitrate, calcium nitrate, and ammonium nitrate and was applied by hand at the rates of 0.1, 0.2, or 0.3 g N per pot at weekly intervals from weeks 1–11. An unfertilized control treatment (CTL) was included to measure nitrate contributed by the potting mixture. In 1983, the slow release sources were SPG; OMC; sulfur coated urea (SCU) 24.5N-2P-4K; ureaformaldehyde (UFA) 25.8N-2P-4K. They were applied at the rate of 0.8 g of N per pot twice during the growing season (0 weeks and 6 weeks). SBL in 1983 was a 15N-0P-12K formulated from calcium nitrate and potassium nitrate and was applied by hand at the rate of 0.13 g N per pot weekly for weeks 1–12.

Volumes of leachate and non-leachate (runoff) water were recorded and samples taken weekly for the 12 consecutive weeks from July–September, 1982 and every 3 weeks thereafter until mid-November. In 1983, samples were taken weekly for 12 weeks from June–August and every three weeks until mid-November. Samples were kept refrigerated and analyzed for nitrate by the chromotropic acid method (11). Amounts of N leached as nitrate were calculated from the total volume collected and nitrate N concentrations. Results were analyzed by a factorial analysis of variance.

Results and Discussion

Volumes of leachate and runoff water and nitrate N levels for both years are reported in Tables 1 and 2. In 1982, leachate volumes were significantly higher under trickle than overhead due to a faulty irrometer switch. Despite the extra water applied to the trickle irrigation treatments, the amounts of nitrate N in the leachates were significantly less than in the leachates of the overhead treatments. In 1983, leachate volumes collected from treatments under trickle irrigation were significantly less than those under overhead irrigation as reported by others (10).

A convenient means of comparing N losses from field crops in Connecticut is based on the straightforward calculation that an annual loss of 56 kg/ha (50 lbs/A) of nitrogen from the soil profile under average rainfall conditions will result in a nitrate concentration in ground water of 10 mg/l. To apply this comparison to container-grown ornamentals, the additional volume of water used for irrigation should be taken into account; thus, an annual loss of approximately 70 kg/ha (62.5 lbs/A) of N would be a more appropriate reference for comparison.

In 1982, each of the slow release sources contributed nitrate N in runoff water in excess of 70 kg/ha (62.5 lbs/A) under overhead irrigation but not under trickle (Table 1). The soluble N (SBL) contributed nitrate N in excess of 70 kg/ha (62.5 lbs/A) under both irrigation types but the amount was far greater under overhead than trickle because much of the solution passes around the container.

The patterns of release of N from the various sources are revealed by the nitrate N in runoff water that passes through the containers. The cumulative nitrate N in runoff is plotted against time for 1982 and shown in Fig. 1. The curves for all three slow release types under either irrigation regime began to level off by day 30 suggesting that N release ceases at about that time.

Table 1. Volumes collected and nitrate N levels in leachate and runoff water from container grown Junipers as influenced by fertilizer source and irrigation. (Container density = 250,000/ha). 1982.

	Volumes (cubic meters/ha)[z]			Nitrate N (kg/ha)		
N Source	Leachate	Runoff	Total	Leachate	Runoff	Total
Trickle Irrigation	2258	969	3226			
SPG				49.3	9.6	58.9
OMC				23.3	12.0	35.3
SCU/UFA				41.7	9.5	51.2
SBL				105.4	9.4	114.8
CTL				10.1	5.9	16.1
Overhead Irrigation	1505	1862	3367			
SPG				118.3	9.7	128.0
OMC				67.8	18.4	86.2
SCU/UFA				123.6	15.8	139.4
SBL				429.2	276.0	705.2
CTL				13.2	9.2	22.4
Significance						
Irrigation	***[y]	***	NS	***	***	***
N Source				***	***	***
Irr × N				***	***	***

[z]254 cubic meters/ha = 1 acre inch

[y]NS, *** = Not significant, significant at the 0.1% level, resp.

Table 2. Volumes collected and nitrate N levels in leachate and runoff water from container grown Alberta spruce as influenced by fertilizer source and irrigation. (Container density = 250,000/ha). 1983.

N Source	Volumes (cubic meters/ha)[z]			Nitrate N (kg/ha)		
	Leachate	Runoff	Total	Leachate	Runoff	Total
Trickle Irrigation	1263	1003	2265			
SPG				12.0	4.3	16.3
OMC				14.9	4.6	19.5
SCU				26.9	5.5	30.8
UFA				10.5	4.1	14.7
SBL				163.3	5.9	169.2
Overhead Irrigation	2555	1573	4127			
SPG				23.0	6.4	29.4
OMC				23.6	7.2	30.8
SCU				27.7	6.2	33.9
UFA				17.1	7.2	24.3
SBL				162.6	156.5	319.1
Significance						
Irrigation	***[y]	***	***	*	***	***
N Source				***	***	***
Irr × N				NS	***	***

[z]254 cubic meters/ha = 1 acre inch

[y]NS, *, *** = Not significant, significant at the 5% level and 0.1% level, resp.

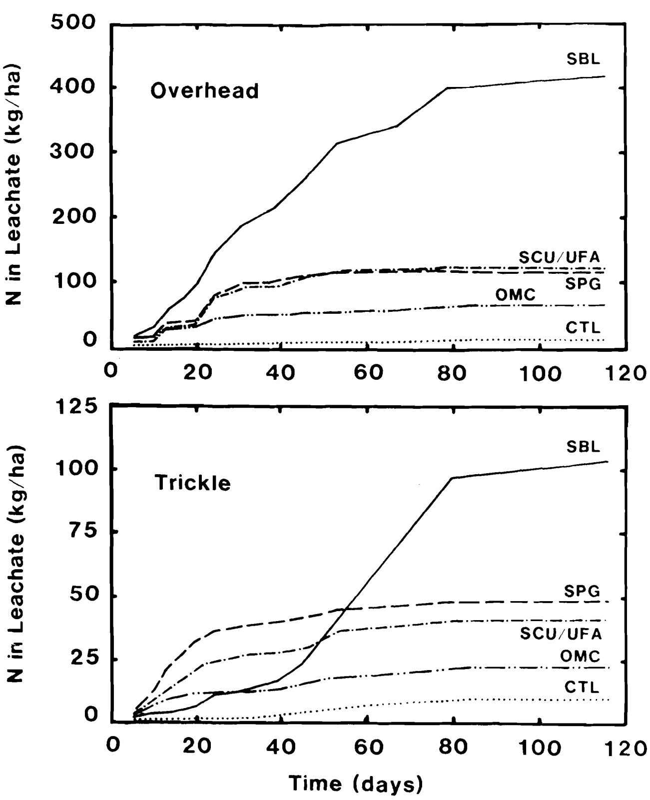

Fig. 1. **Cumulative nitrate N in leachate as influenced by different N sources vs. time under trickle and overhead irrigation in container grown juniper, 1982.**

The results in 1982 were the basis for designing the experiment conducted in 1983. To avoid losing large amounts of N in the first 30 days from slow release sources, they were applied at 6 week intervals at 0.8 g N per pot. Soluble N was applied in a more regular fashion than in 1982. Alberta spruce was selected for this experiment because it is slow growing and would likely take up less N, thereby increasing the potential amount of N leached. The nitrate N in runoff water (Table 2) reflects the adjustments made. Only the soluble N under both irrigation types had nitrate N levels above 70 kg/ha (62.5 lbs/A); the mean for all other treatments was 25 kg/ha (22 lbs/A).

Heavy rainfalls shortly after an irrigation and excess water due to the faulty irrometer switch for the trickle irrigation in 1982 occasionally resulted in minor overflows of water from the tops of pots. This is reflected in the nitrate N concentrations in water passing around the pots in 1982 (Table 1). The runoff total for CTL under trickle reflects the amount of nitrate N in rainfall and corresponds well with numbers previously reported for rainfall in Windsor, CT (6). The somewhat higher numbers for the fertilized treatments under trickle irrigation are likely due to overflows. The proportionately higher nitrate N concentrations for all treatments under overhead irrigation reflect the nitrate N in the water source (0.1–0.2 mg/l of N). The nitrate N concentrations in the water around the pots in 1983 (Table 2) reflect the closer attention paid to irrigation.

In 1982, shoot growth of junipers was similar for all fertilized treatments regardless of the irrigation regime. The average dry weight for fertilized plants was 8.7 g. The total nitrogen concentration in a well fertilized juniper is about 2.5% (unpublished data) which would account for approximately 13.6% of the applied N, assuming that all N was taken up from the fertilizer. This, combined with the N measured in runoff water gives an estimated recovery of 20–42% of applied N for the slow release sources and the SBL under trickle. Using the same calculations, the N recovery in plants and runoff water from the SBL under overhead was about 98%. Approximately 58–80% of the N applied as slow release sources was not recovered in these experiments. Much of the N may have been lost as ammonia in the leachate as previously reported (7). Additional losses may have occurred as ammonia volatization.

Significance to the Nursery Industry

The large amounts of nitrate N recovered in leachate and runoff water from container-grown stock receiving soluble sources of N, especially those under overhead irrigation, suggest that such methods may lead to contamination of ground water with nitrate. Trickle or drip types of irrigation can help to reduce N loss due to leaching. Altering the application of annual slow release N from one application to two applications six weeks apart can reduce the amount of nitrate in runoff water to levels that are not likely to adversely affect ground water.

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Control of Prostrate Spurge (*Euphorbia humistrata*) and Large Crabgrass (*Digitaria sanquinalas*) in Container Grown *Ilex crenata* 'Compacta' With Herbicide Combinations[1]

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Abstract

Granular herbicide combinations were evaluated for longevity of prostrate spurge (*Euphorbia humistrata* Engelm.ex.Gray) and large crabgrass (*Digitaria sanguinalis* L.) control. Rout (oxyfluorfen + oryzalin), Ornamental Herbicide 2 (oxyfluorfen + pendimethalin), Ronstar plus Modown (oxadiazon + bifenox) and Ronstar (oxadiazon) were applied at labeled rates and twice labeled rate in container grown Compact Japanese Holly (*Ilex crenata* 'Compacta'). Weeds were reseeded each month but herbicides were not reapplied. The normal use rate controlled both weeds during the first 30 days after treatment (DAT) while twice this rate controlled the weed species at 60 DAT. No herbicide treatment effectively (>80%) controlled prostrate spurge 90 DAT. The high rate of Rout controlled (>80%) crabgrass at 90 DAT. Weed numbers and above ground biomass reflected visual control ratings. Compact Japanese Holly was not injured by any treatment.

Index words: crabgrass, prostrate spurge, *Ilex crenata* 'Compacta', herbicide combinations, weed control

Herbicides used in this study: Rout (oxyfluorfen + oryzalin) [2-chloro-1-(3-ethox-4-nitrophenoxy) -4-(trifluoromethyl)benzene] + (-3-5-dinitro-N,N-dipropylsulfanilamide); Ornamental Herbicide 2 (oxyfluorfen + pendimethalin) N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine; Ronstar + Modown (oxadiazon + bifenox), 2-tert-butyl-4-(2,4-dichloro-5-isopropoxyphenyl) -1,2,3-oxadiazolin and methyl 5-(2,4-dichlorophenoxy)-2-nitrobenzoate; and Ronstar (oxadiazon).

Introduction

Chemical weed control is a standard practice in most container nurseries. Ronstar (oxadizon) has been used for several years providing excellent plant safety and effective control of many annual weeds (4). Certain weed species such as prostrate spurge are tolerant to Ronstar at labeled rates (7). Herbicide combinations that contain Goal (oxyfluorfen) are effective in controlling prostrate spurge as well as other troublesome weeds (1). These herbicide combinations with Goal are commercially available as Ornamental Herbicide 2 [(OH-2) oxyfluorfen (2%) + pendimethalin (1%)] and Rout [oxyfluorfen (2%) + oryzalin (1%)]. A granular formation of Ronstar (oxadiazon 2%) with Modown (bifenox 3%) is also being evaluated by Rhone–Poulenc, Inc. for nursery weed control. Ornamental Herbicide 2 (OH-2) at 3.3 kg/ha (3 lb/A) provided excellent control of common groundsel for periods of 10 to 12 weeks after application (1). Ronstar plus Modown at 11.2 kg/ha (10 lb/A) provided control similar to OH-2 for 5 weeks after ap-

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