



Abstract

Nitrogen (N) availability from five natural organic (NO) fertilizers manufactured from a variety of nutrient sources was quantified by measuring N uptake by perennial ryegrass (*Lolium perenne* L.) over a two-year period. Nitrogen sources in the NO products included feather meal, soybean meal, blood meal, dried poultry manure, dried poultry waste, nitrate of soda, or dried biosolids. Three synthetic fertilizer sources [ammonium sulfate (AmS), calcium nitrate (CaNO₃), and polymer coated sulfur coated urea (PCSCU)] were also included. Cumulative recovery of N in leaf tissue over two years was highest from CaNO₃. Nitrogen recovery from PCSCU was 85% of that from CaNO₃. Relative N recovery from the five natural organic sources averaged 86% (range 81% to 93%) compared to PCSCU, a synthetic slow-release N source.

Introduction

Availability and use of natural organic (NO) fertilizers in the turfgrass industry is increasing. Nutrient sources are more variable with respect to origin and nutritional characteristics compared to synthetic organic (SO) fertilizers such as coated urea, IBDU, methylene urea, and ureaformaldehyde. Data on availability and plant utilization of N from NO fertilizers is scarce. The objective of this research was to quantify N availability from several commercially-available NO fertilizers in comparison with SO and inorganic fertilizers.



Figure 2. Plot harvesting, June 2007. Shoot tissue represents growth since fertilizer application in April 2007.

Materials and Methods

- Fertilizer sources: Five NO fertilizers, one slow-release SO fertilizer, two quick-release inorganic fertilizers, and an unfertilized control (Table 1).
- N rate: 196 kg N ha⁻¹ yr⁻¹, applied in four equivalent applications of 49 kg N ha⁻¹.
- Application schedule: Apr, Jun, Sep, and Nov of each year. First application was Sep 2006. Treatments will continue through Jun 2010.
- Quantification of N uptake: Plots harvested four times per year at height of 5 cm, immediately prior to fertilizer application. Clippings dried, weighed, ground, and analyzed for % tissue N. Total N uptake calculated as (% tissue N) x (clipping mass).
- Total N uptake converted to Apparent Nitrogen Recovery (ANR).
 - ANR = (N uptake in fertilized plot) – (N uptake in unfertilized control).
- Data reported from Sep 06 – Nov 08; encompasses nine fertilizer applications and subsequent harvests (total application of 441 kg N ha⁻¹).

Table 1. Fertilizer products and manufacturers, nutrient analyses, and nutrient sources for organic and inorganic fertilizer products. All information comes from product labels.

Product name and manufacturer	Guaranteed minimum analysis (percent by weight)	Nutrients derived from
Milorganite 6-2-0	6% N	Biosolids
Milwaukee Sewerage Commission Milwaukee, WI	0.5% WSN** 4.5% WSN**	
	2% P ₂ O ₅ 0% K ₂ O 4% Fe	
	1.2% Ca	
Ringer Lawn Restore 10-2-6 Woodstream UH, PA	10% N 2.4% WSN 7.6% WSN	Hydrolyzed poultry feather meal, nitrate of soda, potassium sulfate, bone meal, soybean meal
	2% P ₂ O ₅ 6% K ₂ O	
Nature's Intent 9-3-4 Pacific Calcium Tonasket, WA	9% N 3% P ₂ O ₅ 4% K ₂ O 3% Ca 1% S	Feather meal, steamed bone meal, potassium sulfate, gypsum
RichLawn 5-2-2 RichLawn Turf Food Inc. Plattville, CO	5% N 1.25% WSN 3.75% WSN	Dried poultry manure
	3% P ₂ O ₅ 2% K ₂ O	
	4% Ca	
Whitney Farms 8-2-4 Rod McLellan Company Independence, OR	8% N 2% WSN 6% WSN	Blood meal, dried poultry waste, feather meal, bone meal, sulfate of potash magnesia
	2% P ₂ O ₅ 4% K ₂ O	
	4% Ca	
Best Turf 5-24-3-20 JR Simplot Company Lathrop, CA	5% N 24% Ca 3% P ₂ O ₅ 10% K ₂ O 12% S 1.0% Fe 0.20% Zn	Polymer coated sulfur coated urea, ammonium phosphate sulfate, potassium sulfate, iron and zinc oxides
Ammonium sulfate 21-0-0 Wagona Northwest LLC Waukesha, WI	21% N	ammonium sulfate
Calcium nitrate Tara International Olathe, Kansas	15.5% N 15.5% N	calcium nitrate
	55.5% quickly available N	
	10% Ca	

** WSN = water soluble nitrogen, quickly available.
** WSN = water insoluble nitrogen, slowly available.

Results and Discussion

ANR on individual harvest dates was generally highest from CaNO₃, followed by PCSCU and AmS. Recovery from AmS declined in Sep and Nov 08 relative to other products (Table 2). Recovery from Milorganite-fertilized plots was low, except in Sep of both years. Relatively high soil temperatures from Jun – Sep probably stimulated N mineralization during this time. Whitney Farms resulted in lower ANR than most other fertilizers for the first year. Beginning in Jun 08, recovery increased relative to other products.

Table 2. Apparent Nitrogen Recovery (ANR) in perennial ryegrass leaf and shoot tissue for each harvest period from Sep 2006 through Nov 2008.

Fertilizer	Nov 06	Apr 07	Aug 07	Sep 07	Nov 07	Apr 08	Jun 08	Sep 08	Nov 08
	kg N ha ⁻¹								
AmS	10.4 ab	20.1	70.4 b	15.0	19.9 bc	19.7 b	27.6	13.1 c	11.5 de
CaNO ₃	9.7 abc	21.7	95.5 a	11.9	27.8 a	27.2 a	48.8	34.6 a	24.5 a
PCSCU	11.4 a	19.7	73.8 bc	16.4	21.9 b	27.9 a	41.9	22.5 bc	16.8 bc
Milorganite	6.1 d	10.7	58.0 bc	18.3	15.5 c	20.0 b	27.6	38.6 a	10.2 a
Ringer	6.7 d	17.1	64.7 bc	13.3	19.8 bc	20.4 b	27.4	35.1 a	16.0 bc
Whitney Farms	3.4 e	14.6	47.2 c	13.5	17.6 bc	18.4 b	33.5	38.0 a	18.3 b
Nature's Intent	7.8 cd	12.7	59.4 bc	11.9	18.2 bc	20.9 b	45.9	32.4 ab	11.9 cd
Rich Lawn	8.4 bcd	15.9	74.3 b	15.8	19.9 bc	24.3 ab	29.6	34.0 ab	12.5 cd
tud (P < 0.05)	2.6	ns	19.6	ns	5.2	6.2	ns	11.5	5.1

Cumulative ANR was calculated for each harvest date by summing values from all individual harvest dates. Cumulative recovery was consistently the highest from CaNO₃, followed by PCSCU (Table 3).

Ringer and Nature's Intent, both feather meal based products, had similar cumulative ANR throughout the study.

Cumulative ANR from Rich Lawn was significantly higher than from Whitney Farms through Apr 08, and was numerically higher through Nov 08. Both are poultry manure/waste based products. Milorganite and Whitney Farms resulted in the lowest cumulative ANR throughout the study, although values for both became numerically closer to other fertilizers during 2008. This was especially true for Whitney Farms, where ANR was high in Sep and Nov 08 (Table 2). This indicates probable long-term release of recalcitrant fertilizer N.

Averaged across all products, NO fertilizers resulted in 86% of the ANR of synthetic slow-release PCSCU through Nov 08.

Table 3. Cumulative ANR in perennial ryegrass leaf and shoot tissue for selected harvest dates from Sep 2006 through Nov 2008.

Fertilizer	Nov 06	Jun 07	Nov 07	Jun 08	Nov 08	% of N applied
	kg N ha ⁻¹					
AmS	10 ab	101 bc	136 bc	183 bc	*208 bc	47
CaNO ₃	10 abc	127 a	167 a	243 a	302 a	68
PCSCU	11 a	105 ab	143 ab	213 ab	252 b	57
Milorganite	6 d	75 d	109 cd	156 c	205 c	46
Ringer	7 d	88 bcd	122 bcd	169 bc	220 bc	50
Whitney Farms	3 e	65 d	96 d	148 c	205 c	46
Nature's Intent	8 cd	80 cd	110 cd	177 bc	221 bc	50
Rich Lawn	8 bcd	99 bc	134 bc	188 bc	234 bc	53
tud (P < 0.05)	3	24	29	49	46	

ANR from all NO fertilizers was converted to a percentage basis, relative to ANR from PCSCU, using the following formula:

$$\% \text{ relative recovery} = (\text{ANR fert A} / \text{ANR PCSCU}) * 100.$$

Results appear in Figure 2.

Relative recovery from Rich Lawn was high and stable beginning in Jun 07.

Relative recovery from Whitney Farms and Milorganite was low early in the study (30 and 54% respectively). Both increased to 81% by Nov 08. The curves illustrate long-term N release for all products. After 26 months, cumulative ANR from NO fertilizers ranged from 81 to 93% of ANR from PCSCU.

This study will continue through Sep 2010 to determine whether or not the N recovery gap between NO and synthetic fertilizers closes.

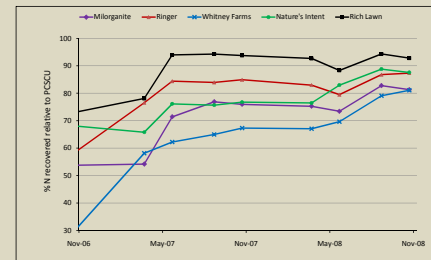


Figure 2. N recovery in perennial ryegrass leaf and shoot tissue following application of five natural organic fertilizers, expressed as a percentage relative to recovery from PCSCU (recovery from PCSCU = 100% on all dates).

Conclusions

- The two feather meal-based products (Ringer Lawn Restore and Nature's Intent) resulted in similar ANR. The products based on poultry manure (Rich Lawn) or poultry waste (Whitney Farms) had dissimilar ANR results. There was inconsistency with respect to nutrient source materials and plant N uptake.
- Milorganite (biosolids) resulted in relatively low ANR, except in Sep of both years, likely due to higher soil temperatures and N mineralization rates in the Jun – Sep period. Cumulative ANR was similar to Whitney Farms.
- ANR from natural organic fertilizers was lower than from synthetic fertilizers, especially during the first year of fertilizer application. After 26 months, ANR from NO fertilizers averaged 86% of ANR from PCSCU, and ranged from 81 to 93%.
- Application rates of NO fertilizers should be increased, at least during the first year of application, to compensate for lower N availability.