Relative N Fertilizer Efficiency and Mineralization of Organic Amendments as Assessed by Tall Fescue (*Festuca arundinacea*)

Abstract

A capability to determine the availability of nitrogen in organic amendments is necessary to ensure that such materials will provide sufficient nitrogen to the growing crop and cause minimal environmental degradation. Greenhouse bioassays were used to evaluate N availability of organic by-products, including several employed in the field study of this research. Tall fescue was grown in greenhouse pots amended with Huck's Hen Blend yard waste compost, Panorama yard waste compost, Wolf Creek biosolids compost, Rivanna biosolids compost, and pelletized poultry litter at concentrations estimated to supply 100% agronomic N. Five inorganic N treatments applied at 0N (0% agronomic N), 0.5N (50% N), 1N (100% N), 1.5N (150% N), and 2N (200% N) were used to establish an N calibration curve. Yield, plant nitrogen uptake, and total Kjeldahl N, NO_3^- and NH_4^+ concentrations of amended soils were compared against the inorganically fertilized treatments in order to determine organic N mineralization rates and N fertilizer values. Nitrogen mineralization rates were greatest in the poultry litter (21.4%) and Panorama yard waste compost (4.5%) amended plots. Nitrogen uptake (120 mg/pot, 133 mg/pot, respectively) in these treatments were greater than that achieved in the control (0N) (91.3 mg/pot) treatment. Wolf Creek biosolids compost and Huck's Hen Blend yard waste compost induced N immobilization (-5.00% and 0.18%, respectively), and had N uptake values similar to the control (92.6 mg/pot and 95.7 mg/pot). Rivanna biosolids compost immobilized N (-14.8%) but N uptake (136 mg/pot) was greater than that in the control due to the relatively high inorganic N content in the amendment. The total N concentration and C:N values were less reliable variables in predicting N mineralization when a significant portion of the total N was in the inorganic form.

Introduction

Organic by-products are routinely used as alternative fertilizer sources in agriculture. It is critical to accurately estimate nitrogen availability of these by-products as improper application rates can result in suboptimal crop yields, delayed crop maturity, and impaired water quality (Mugwira, 1979; Faulkner, 2001).

Prediction of compost nitrogen availability however, is difficult as nitrogen availability can vary considerably among composts (Jedidi et al., 1995; Sikora and Yakovchenko, 1996). Compost applications may be based on estimated plant available nitrogen contents. Plant available nitrogen (PAN) consists of the sum of inorganic N not lost via ammonia volatilization and the fraction of organic N that mineralizes to inorganic N during the season of application (Gilmour and Skinner, 1999). Increases in total Kjeldahl N (TKN), one measure of total N, and decreases in C:N generally increase PAN.

A commonly employed method for estimating PAN of various organic wastes is the use of greenhouse studies that compare plant N uptake from known rates of inorganic N to known rates of organic residuals containing known amounts of inorganic and organic N. In such studies, the above ground N content of plant tissue serves as an index of the relative nitrogen fertilizer equivalency of compost compared to inorganic fertilizer (Muñoz et al., 2004). This method is based upon the assumptions: 1) fertilizer nitrogen is 100% available and 2) all crop nitrogen in amended soils is due solely to differences in available nitrogen. An advantage of the difference method is that it is less expensive than the direct recovery technique which uses ^{15}N (Muñoz et al., 2004).

Nitrogen mineralization is controlled by compost properties including organic carbon content, C:N, total nitrogen, and plant available nitrogen; soil moisture; microbial activity; and soil texture (Eghball et al., 2002; Agehara and Warnke, 2005; Cabrera et al., 2005). Lower C:N values are often observed in non-composted materials as composting incorporates inorganic N into microbial biomass and humic substances (Epstein, 1997). Compost C:N greater than 25:1 have been shown to immobilize nitrogen in soils (Tester et al., 1982; Chen et al.,1996; Douglas et al., 2003; Nishio and Oka, 2003; Flavel et al., 2005). Although often used to estimate nitrogen mineralization (Sikora and Yakovchenko, 1996; Kumar and Goh, 2003; Khalil et al., 2005), some researchers concluded that C:N did not accurately estimate nitrogen mineralization and stated that total nitrogen was a better estimator of nitrogen mineralization (Kuo, 1995; Kessel and Reeves, 2003; Cabrera et al., 2005).

Many researchers have observed that the nitrogen content of organically amended soils is higher than soils receiving inorganic fertilization (Singh and Ghosh, 1999; Ceuvas et al., 2000; Chang and Cheng, 2000; Khatik and Dikshit, 2001; Sullivan et al., 2003; Rodriguez et al., 2005). This is likely due to relatively slower and constant mineralization rates that provide nitrogen steadily over time and the decreased likelihood of nitrogen leaching.

The objectives of this study were to determine organic N mineralization rates and percent N fertilizer values of various organic by-products that are being employed as soil amendments and nutrient sources in the field portion of this research. I hypothesize that the N mineralization and percent N fertilizer values of these organic by-products will increase as N concentration increases and the C:N ratio decreases.

Materials and Methods

A Fauquier silty clay loam (fine, mixed, mesic ultic Hapludalf) soil excavated from the field research site in Orange, Virginia was used in the greenhouse study. The soil was air-dried, ground to pass a 5 mm sieve and analyzed for routine soil testing variables (Donohue and Heckendorn, 1994).

Nitrogen mineralization and the percent N fertilizer value of five organic by-products were studied. These by-products included: Hucks Hen Blend (HYWC), a yard waste-poultry litter compost (Lightfoot, Virginia) which consisted of poultry litter (PL) and yard waste (YW), including ground leaves, branches, and stumps, composted at ratios of 1:8-10 (PL:YW). Panorama Pay Dirt (PYWC), a yard waste-poultry litter compost (Earlysville, Virginia) which was comprised of poultry litter and yard waste (leaves only) composted at a ratio of 1:2 (PL:YW). Each product was composted for four months.

Biosolids compost was obtained from the Rivanna Water and Sewer Authority (RBSC; Charlottesville, Virginia). Lime-dewatered biosolids (BS) and woodchips (WC) were composted at a ratio of 1:2 (BS:WC) for five consecutive days at 66°C and then passed through a 0.95 cm sieve to remove woodchips and cured an additional 10 days. Class A Wolf Creek biosolids compost (WBSC) was obtained from the Wolf Creek

Wastewater Treatment Plant (Abingdon, Virginia). Three month digested biosolids were combined with woodchips at a ratio of 1:2 (BS:WC) and composted a minimum of 30 days, with three consecutive days between 66-71°C. The material was cured four months, with internal temperatures maintained at 77°C, and then passed through a 0.95 cm sieve to remove woodchips. The material was further cured for an additional month. Commercially-processed, granulated poultry litter (PL) was obtained from Valley Pride Compost (Harrisonburg, Virginia).

All five organic amendments were analyzed for total Kjeldahl nitrogen (TKN) by USEPA 351.3 (USEPA, 1979), NH_4-N by EPA 350.2 (USEPA, 1979), NO_3-N and NO_2-N by SM 4500-NO3F (AWWA, 1998), pH by EPA 150.1 (USEPA 1979), available P, K, Ca, Mg by USEPA 3052 (USEPA, 1999), and solids by SM 2549 G (AWWA, 1998) at A&L Eastern Agricultural Laboratories, Inc. (Richmond, Virginia).

The experimental design was a completely randomized design comprised of 10 treatments and four replications. Five rates of inorganic fertilizer N (as ammonium nitrate) at 0N (0% agronomic N), 0.5N (50% N, 22.5 mg/kg soil), 1N (100% N, 45 mg/kg soil), 1.5N (150% N, 77.5 mg/kg soil), and 2N (200% N, 90 mg/kg soil) were used to establish plant response calibration curves. The five organic by-products were applied at rates designed to supply 100% agronomic N (45 mg N/kg soil) using estimated organic N mineralization factors of 10% for the composts and 60% for PL. One basal rate of monopotassium phosphate (75 mg/kg soil) was applied to all treatments, and inorganically fertilized treatments were limed with calcium hydroxide (1110 mg/kg soil). The final mass of all pots was 2.5 kg. Chemical analyses of the amendments and total amount of amendment applied are listed in Tables 2.1 & 2.2.

The pots (15-cm diameter) were wetted with a total of 600 ml of water during a 48-hr period to facilitate equilibration of amendments, after which, pH values were determined. Five hundred grams of amended soil were removed from all pots for an additional incubation study (Spargo, 2004). Following a 48-hr incubation at 75% field capacity, pots were planted to tall fescue (*Festuca arundinacea*) (300 seeds per pot), misted daily, and covered loosely with burlap to minimize evaporation. The pots were rotated and moisture was added weekly to bring the soil to 90% field capacity using the mass balance technique beginning 14 days after seedling emergence. Greenhouse temperature was maintained between 20° and 30°C, and supplemental incandescent light was provided for16 hrs/day.

The tall fescue was clipped to a 6-cm height at 42, 84, and 168 days after planting (DAP), and the tissue was dried in a forced-air oven at 65°C for 24 hours. The dried clippings were ground to pass through a 0.85-mm Wiley mill press. Air-dried soil samples removed on Day 168 were ground to pass through a 2-mm sieve. The prepared leaf and soil samples were analyzed for TKN using block digestion and QuickChem autoanalyzer industrial methods (Diamond, 1996). The soil samples were also analyzed for KCl extractable NO_3-N and NH_4-N. A five gram subsample was extracted with 50 ml of 2 M KCl for one hour on a reciprocating shaker. Extracts were filtered through a 0.45 µm Millipore filter and analyzed colorimetrically for NO_3-N and NH_4-N with a QuickChem autoanalyzer (Methods No. 12-107-04-1-B and No. 12-107-06-2-A; Lachet Instruments, 1986).

Total nitrogen uptake was calculated as the product of leaf nitrogen concentration and aboveground biomass. The regression equations of the inorganic N uptake graphs were used to determine nitrogen equivalencies of the organic amendments. Briefly, the N uptake of the organically amended pots (y-value) was used to solve for nitrogen equivalency (x-value). The nitrogen equivalency was used to determine % N mineralization in the following equation.

$$\%\text{ N Mineralization} = \left(\frac{[(\text{N equiv}*2.5\text{ kg soil}) - \text{Organic N added}]}{\text{Inorganic N added}} \right) * 100$$

The percent N fertilizer value (NFV) of the organic amendments quantifies the proportion of amendment nitrogen that behaves as fertilizer nitrogen irrespective nitrogen source (i.e. inorganic or organic pool) (Muñoz et al., 2004) and was calculated as

$$\%\text{ Fert Value} = \left(\frac{\dfrac{[N_{\text{uptake-trmt}} - N_{\text{uptake- ctrl}}]}{\text{Total } N_{\text{trmt}}}}{\dfrac{[N_{\text{uptake-1N}} - N_{\text{uptake- ctrl}}]}{\text{Total } N_{\text{1N}}}} \right) * 100$$

Where $N_{uptake\text{-}trmt}$ is the amount of N taken up in the organically amended pots, $N_{uptake\text{-}ctrl}$ is the the amount of N taken up in the 0N pots, Total N_{trmt} is the amount of N added in the treatment, $N_{uptake\text{-}1N}$ is the amount of N taken up in the 1N pots, and

Total N_{1N} is the amount of N added to the 1N pot (45mg/kg soil).

Data is reported as the means of four replications that were subjected to analysis of variance using the Statistical Analysis System (SAS Institute, 1990).

Results & Discussion

Characteristics of Organic By-products

Total Kjeldahl nitrogen (TKN) values varied considerably among the amendments. The PL (58700 mg/kg) had the greatest TKN followed by RBSC (18700 mg/kg), PYWC (17000 mg/kg), WBSC (15900mg/kg), and HYWC (5400 mg/kg) (Table 2.1). The greatest N pool in the composts was organic N (Table 2.1). Composting incorporates inorganic N into microbial biomass and humic substances (Epstein, 1997). The PL also had a significant organic N pool, but there was a considerable inorganic N content as well (Table 2.1).

The RBSC (10:1), WBSC (17:1), PYWC (18:1), and HYWC (29:1) had C:N values indicative of the composting process and were greater than PL (8:1) (Table 2.1). The HYWC had the greatest C:N value, likely due a relatively high yard waste input.

Plant available nitrogen (PAN) values are based on fractions of inorganic and organic N pools that are available for plant uptake during the growing season. The relative rankings of PAN (PL>RBSC>PYWC>WBSC>HYWC) reflect the TKN and C:N values of these materials (Table 2.1).

Effects of Treatments on Soil Properties

The soil test levels of the unamended Fauquier soil (Table 2.3) were adequate to support tall fescue growth (Donohue and Heckendorn, 1994; Ball et al., 2002). The soil pH of all treatments increased within two days after liming and amendment additions, with the organically amended soils having a greater pH value than the inorganically fertilized soils (Table 2.4). By Day 172, all compost amended soils had greater pH values than the PL amended soil, inorganically fertilized, and control treatments. The relatively higher organic matter additions in the composted treatments may have buffered soil acidification caused by N mineralization and nitrification (Stamatiadis et al., 1999). The soil pH values of all treatments were within the optimal range for tall fescue during the entire study.

Yield and Nitrogen Uptake

Early seedling growth (0-21 days after emergence) was stunted due to residual Lumax® herbicide that was present in the soil prior to collection. The S-metolachor component of Lumax® is absorbed through the shoots of emerging seedlings and inhibits chlorophyll and protein synthesis (Extension Toxicology Network, 2003). Consequently, there was low correlation of determination (R^2=0.55, p =0.004) between inorganic nitrogen applied and cumulative biomass yield 42 DAP (Figure 2.1, Table 2.5). The crop was apparently able to assimilate the plant available nitrogen under the ammonium nitrate fertilization after the young seedlings overcame the phototoxicity as there was a strong correlation of determination (R^2=0.92, p <0.0001) between nitrogen applied and cumulative nitrogen uptake (Figure 2.2, Table 2.5) 42 DAP. Relative to 1N (45 mg/kg soil), all organic amendments had lower N uptake and N equivalency values 42 DAP (Table 2.6).

At 84 and 168 DAP there was a strong correlation of determination (R^2=.93, p<0.001; R^2=.99, p<0.001, respectively) between N applied and cumulative biomass yield in the inorganically fertilized treatments (Figure 2.1, Table 2.5). Cumulative N uptake (Figure 2.2, Table 2.5) and N equivalency (Table 2.6) were lower in the organically amended treatments relative to 1N.

By the end of the study, the RBSC and PYWC had the greatest N uptake (RBSC = 135.86 mg/pot, PYWC = 133.47 mg/pot) and N equivalency (RBSC = 43.3 mg/kg soil, PYWC = 40.8 mg/kg soil) among the organic amendments (Table 2.6). The PL had a relatively lower N uptake (119.88 mg/pot) and N equivalency (26.66 mg/kg soil). The HYWC and WBSC had the lowest N uptake (HYWC = 95.71 mg/pot, WBSC = 92.61 mg/pot) and N equivalency values (HYWC = 1.62 mg/kg soil, WBSC = -1.6 mg/kg soil) (Table 2.6).

N Mineralization and Percent N Fertilizer Value

By 42 DAP, net N immobilization occurred in all organically amended soils (Figure 2.3, Tables 2.6 & 2.7). By 84 and 168 DAP net immobilization of organic N had occurred in the HYWC-, WBSC- and the RBSC-amended treatments (Figure 2.3, Tables 2.6 & 2.7).

The percent fertilizer N values (NFV) (Table 2.7) of the amendments differed from the N mineralization rates due to the variability in inorganic and organic fractions of the byproducts. The WBSC had a relatively low C:N value of 17:1 (Table 2.1), but N mineralization and NFV were -5% and -0.66%, respectively. The long digestion (i.e., 3 months) and curing (i.e., 5 months) period to which the Wolf Creek biosolids was subjected likely produced a more stabilized product than is typically generated during biosolids composting. The RBSC (C:N=10:1) gave an N mineralization value of -14% despite its NFV of 30%, due to the sizeable fraction of inorganic N. This is typical of many biosolids composts, whose composting and curing times are normally based on pathogen and vector attraction reduction rather than stabilization and maturity criteria. The HYWC had 0.2% N mineralization and NFV of 0.19%, which was not surprising as the C:N value of 29:1 would be expected to cause significant immobilization. A ratio of C:N above 25:1 has been shown to induce immobilization (Tester et al., 1982; Chen et al.,1996). The PYWC, which had a C:N ratio of 18:1, had 5% N mineralization and an NFV of 10%. The PL had 21% N mineralization and a NFV of 49%. Stepwise multiple regression of organic amendment PAN against TKN, organic N, inorganic N, and C:N reveal that the strongest predictor of PAN is inorganic N (Table 2.8).

There were no differences in soil TKN-N, NH_4-N, or NO_3-N among the ten treatments at the conclusion of the study (Table 2.9).

Conclusion

The results from the two yard waste composts (PYWC and HYWC) and PL amendment support the hypothesis that nitrogen mineralization and NFV are directly related to N content and C:N of organic amendments. The greater nitrogen concentration of the PYWC coupled with a relatively lower C:N resulted in net nitrogen mineralization and greater NFV. The HYWC had a relatively low TKN concentration and high C:N ratio. Nitrogen mineralization and NFV were zero for this treatment. The PL had the lowest C:N, greatest TKN, the greatest N mineralization, and the greatest NFV among the treatments.

The results from the two biosolids composts do not support the hypothesis of this study. The variability in N forms and degree of stability contributed to actual N mineralization and NFV values. The WBSC contained a moderate TKN concentration and relatively low C:N. Net immobilization and a negative NFV occurred because most of the N was in organic form. The RBSC contained a greater TKN value and lower C:N. There was a larger percentage of net immobilization, but the NFV was the highest among the composts. The assumption that an increase in N mineralization occurs with a reduced C:N ratio may hold only for organic amendments whose N is all largely in the same, organic form. Multiple stepwise regression revealed that inorganic N content is the strongest predictor of PAN. Calculation of expected PAN needs to account for the differences in feedstock type and fractions of inorganic and organic N in amendments.

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Tables

Table 2.1. Chemical and physical properties of five organic amendments. HYWC=Huck's Yard Waste Compost; PYWC=Panorama Yard Waste Compost; RBSC=Rivanna Biosolids Compost; WBSC=Wolf Creek Biosolids Compost; PL=Commercial Poultry Litter Product.

	Residue				
Variable	**HYWC**	**PYWC**	**RBSC**	**WBSC**	**PL**
pH†	7.9	6.6	7.2	6.7	7.6
TKN‡(mg/kg)	5400	17000	18700	15900	58700
Organic N (mg/kg)	5400	17000	18700	15900	47100
NH3-NH4(mg/kg)	0	0	0	100	11600
NO2-NO3 (mg/kg)	11	923	4480	491	18
PAN§ (mg/kg)	551	2623	6350	2181	39878
C:N	29	18	10	17	8
Ca(mg/kg)	22000	24900	189000	57100	28000
P(mg/kg)	3500	4500	14300	9400	15400
K(mg/kg)	3100	6500	800	3700	27800
Vol Solids (%)	26.34	53.45	33.42	45.5	82.94
Mg(mg/kg)	1600	4800	3400	13900	5700
Na(mg/kg)	300	700	200	0	6900
Fe (mg/kg)	7990	17200	32300	16100	645
Al (mg/kg)	9050	7430	11800	13700	638
C:P	44	69	14	28	31
% dry matter (8/18)	0.57	0.39	0.62	0.57	0.79
EC (mS/cm)	1.12	2.71	13.88	3.06	17.41
TOC (mg/kg)	153139	310755	194302	264534	482209

†1:1 w:v. EPA 150.1 (USEPA, 1979).

‡ Total Kjeldahl Nitrogen, EPA 351.3 (USEPA, 1979).

§Plant available nitrogen. Estimated by adding 100% of the measured (NO_3+NH_4)-N and the fraction of organic N estimated to be mineralizable during the first season. Mineralization coefficients used were 0.1 for composted materials and 0.6 for poultry litter.

Table 2.2. Fertilization treatment rates applied to the Fauquier silty clay loam used in the greenhouse study. HYWC=Huck's Yard Waste Compost; PYWC=Panorama Yard Waste Compost; RBSC=Rivanna Biosolids Compost; WBSC=Wolf Creek Biosolids Compost; PL=Commercial Poultry Litter Product.

	Amount N Needed (g N/kg soil)	Estimated PAN† in Amendment (%)	Amount Residue Applied (g/kg soil)	Amount Residue Applied (g/kg soil)	Actual PAN in Amendment (%)	Total Amount N Applied (mg N/pot)	Total Amount Organic N Applied (mg N/pot)	Total Amount Inorganic N Applied (mg N/pot)
			dw	mw				
Amendment								
HYWC	0.045	0.06	78.36	137.96	0.06	1060.01	2.15	1057.86
PYWC	0.045	0.19	24.11	62.61	0.26	1080.31	55.63	1024.68
WBSC	0.045	0.18	25.32	44.19	0.21	322.35	11.50	310.85
RBSC	0.045	0.58	7.82	12.56	0.64	1467.29	283.58	1183.71
PL	0.045	3.68	1.24	1.56	3.99	150.56	35.73	114.83

†Plant available nitrogen. Estimated by adding 100% of the measured (NO_3+NH_4)-N and the fraction of organic N estimated to be mineralizable during the first season. Mineralization coefficients used were 0.1 for composted materials and 0.6 for poultry litter.

Table 2.3. Soil test analyses by the Virginia Tech Soil Testing Laboratory of unamended Fauquier silty clay loam.

Variable	
pH (1:1 w:v)	5.59
P†	14 ppm
K	141 ppm
Ca	716 ppm
Mg	106 ppm

†Mineral availabilities were based on Mehlich 1 Extraction

Table 2.4. Effects of treatments on pH values of Fauquier silty clay loam 2 and 172 days after liming. Treatment means (four replications) followed by the same letter are not significantly different within the column at 0.05 level of significance. HYWC=Huck's Yard Waste Compost; PYWC=Panorama Yard Waste Compost; RBSC=Rivanna Biosolids Compost; WBSC=Wolf Creek Biosolids Compost; PL=Commercial Poultry Litter Product.

	---------pH---------	
Treatment	**Day 2**	**Day 172**
0N	5.96 cb	6.18 de
0.5N	5.88 cd	6.09 ef
1N	5.86 cd	6.06 ef
1.5N	5.76 d	5.78 f
2N	5.83 cd	6.08 ef
HYWC	6.27 a	6.62 b
PYWC	5.81 d	6.31 c
RBSC	6.24 a	6.77 a
WBSC	5.87 cd	6.46 c
PL	6.08 b	6.13 e

Table 2.5. Effects of treatments on cumulative tall fescue yields and N uptake grown in a Fauquier silty clay loam at 42, 84, and 168 days after planting. HYWC=Huck's Yard Waste Compost; PYWC=Panorama Yard Waste Compost; RBSC=Rivanna Biosolids Compost; WBSC=Wolf Creek Biosolids Compost; PL=Commercial Poultry Litter Product.

	Cummulative Biomass Yield (g)			**Cummulative N Uptake(g/pot)**		
Treatment	42 DAP	84 DAP	168 DAP	42 DAP	84 DAP	168 DAP
0N	1.73	3.73	4.55	52.05	81.82	91.27
.5N	2.86	5.06	5.85	81.99	112.81	121.81
1N	2.71	5.72	6.47	99.05	134.73	140.53
1.5N	2.86	6.41	7.33	101.77	139.49	148.89
2N	2.90	6.60	8.07	119.43	173.80	187.08
HYWC	2.54	4.51	5.20	56.83	87.32	95.71
PYWC	2.98	5.79	7.70	65.38	108.67	133.47
WBSC	1.84	4.00	5.38	41.16	75.86	92.61
RBSC	2.44	5.21	6.40	77.08	121.67	135.86
PL	2.25	5.07	6.30	68.01	108.14	119.85

Table 2.6 Nitrogen uptake and equivalency 42, 84, and 168 days after planting. HYWC=Huck's Yard Waste Compost; PYWC=Panorama Yard Waste Compost; RBSC=Rivanna Biosolids Compost; WBSC=Wolf Creek Biosolids Compost; PL=Commercial Poultry Litter Product.

42 DAP			84 DAP			168 DAP		
Trmt	N Uptake (mg/pot)	N equivalency (mg/kg soil)	Trmt	N Uptake (mg/pot)	N equivalency (mg/kg soil)	Trmt	N Uptake (mg/pot)	N equivalency (mg/kg soil)
HYWC	56.83	-4.60	HYWC	87.32	0.99	HYWC	95.71	1.62
PYWC	65.38	7.96	PYWC	108.67	24.00	PYWC	133.47	40.79
WBSC	41.16	-27.63	WBSC	75.86	-11.55	WBSC	92.61	-1.60
RBSC	77.08	25.15	RBSC	121.67	38.01	RBSC	135.86	43.27
PL	68.01	11.83	PL	108.14	23.43	PL	119.85	26.66

Table 2.7. Cumulative percent N mineralized and percent N fertilizer values (NFV) of organic amendments relative to agronomic N fertilizer treatment (45 mg PAN/kg soil) 42, 84, and 168 days after planting. Treatment means (four replications) followed by the same letter are not significantly different within the column at 0.05 level of significance. HYWC=Huck's Yard Waste Compost; PYWC=Panorama Yard Waste Compost; RBSC=Rivanna Biosolids Compost; WBSC=Wolf Creek Biosolids Compost; PL=Commercial Poultry Litter Product.

	% N Mineralized			% NFV
Treatment	42 DAP	84 DAP	168 DAP	
HYWC	-1.29	-0.03 ab	0.18 b	0.19 cd
PYWC	-3.49	-0.43 ab	4.52 b	10.1 c
WBSC	-25.9	-13.0 b	-5.00 b	-0.66 d
RBSC	-18.6	-15.9 ab	-14.8 b	30.0 b
PL	-4.26	15.8 a	21.4 a	48.9 a

Table 2.8. Stepwise multiple linear regression of plant available nitrogen against five variables of N measured from organic amendments.

Variable	In	Out	Partial R^2	Model R^2	p>F
Inorganic N	X		0.9949	0.9949	0.0002
TKN-N†	X		0.0047	0.9996	0.0424
Organic N		X			
C:N		X			

† Total Kjeldahl Nitrogen, EPA 351.3 (USEPA, 1979).

All variables in the model are significant at the 0.100 level.

Table 2.9. Effects of treatments on soil N concentrations in Fauquier silty clay loam 168 days after planting. There were no differences at the 0.05 level of significance. HYWC=Huck's Yard Waste Compost; PYWC=Panorama Yard Waste Compost; RBSC=Rivanna Biosolids Compost; WBSC=Wolf Creek Biosolids Compost; PL=Commercial Poultry Litter Product.

Treatment	TKN-N†	NH_4-N‡	NO_3-N‡
	---------------------	mg	--------------------
0N	1342	2.84	0.86
0.5N	1431	1.39	0.87
1N	1439	2.84	0.98
1.5N	1526	1.22	0.76
2N	1380	2.00	0.93
HYWC	1506	1.78	1.10
PYWC	1407	3.54	1.07
WBSC	1578	1.71	0.66
RBSC	1544	1.40	0.83
PL	1430	2.18	0.95

[†] Total Kjeldahl Nitrogen, EPA 351.3 (USEPA, 1979).

[‡] KCl extractable N, Methods No. 12-107-04-1-B and No. 12-107-06-2-A (Lachet Instruments, 1986).

Figures

Figure 2.1. Effect of inorganic fertilizer N rate on tall fescue biomass accumulation 42, 84, and 168 days after planting.

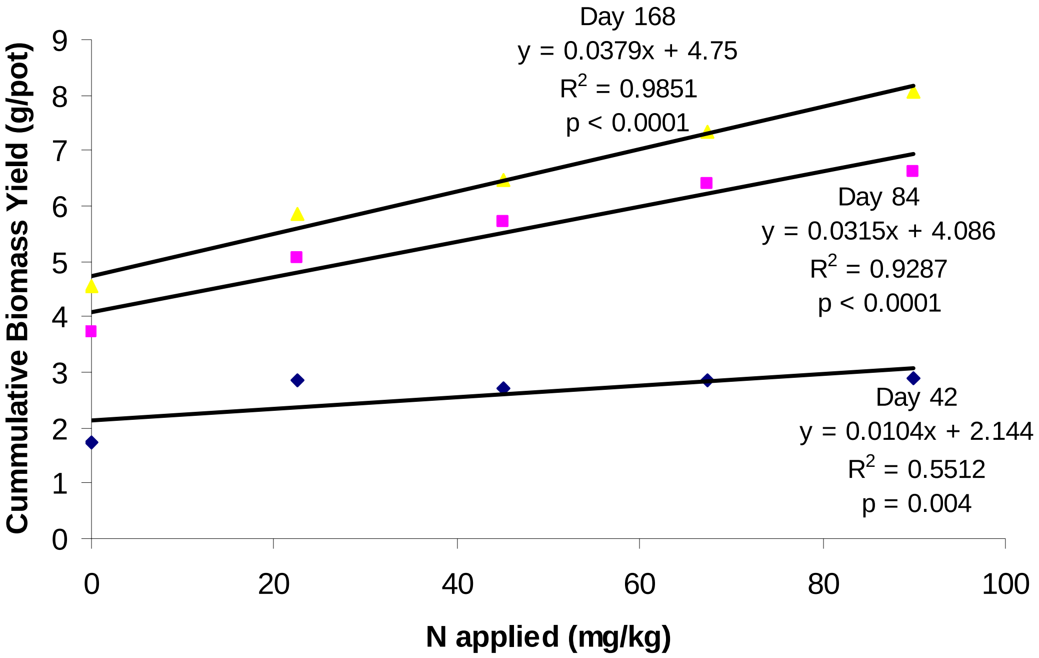

Figure 2.2. Effects of inorganic fertilizer N rate on tall fescue N uptake 42, 84, and 168 days after planting.

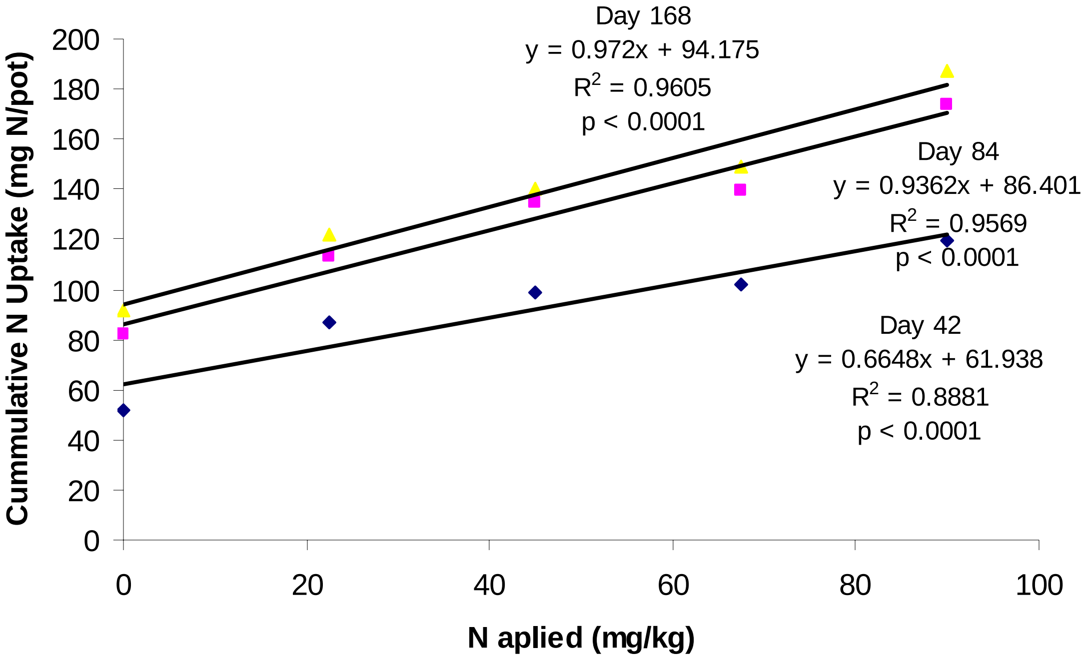

Figure 2.3. Cumulative N mineralization at 42, 84, and 168 days after planting as assessed by N uptake by tall fescue N grown in a Fauquier silty clay loam amended with NH_4NO_3. Data are means of four replications. HYWC=Huck's Yard Waste Compost; PYWC=Panorama Yard Waste Compost; RBSC=Rivanna Biosolids Compost; WBSC=Wolf Creek Biosolids Compost; PL=Commercial Poultry Litter Product.