Compost Science & Utilization, (2004), Vol. 12, No. 2, 145-152

Regeneration of Nitrogen Fertility In Disturbed Soils Using Composts

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Soil disturbance often results in loss of soil organic matter and nitrogen (N) fertility, making revegetation of barren areas difficult. Yard waste composts are a potential source material to regenerate soil fertility so that revegetation success is improved. The N release behaviors of several compost materials produced within California were evaluated during a long-term, 586-day aerobic incubation. Two general types of compost were tested, including yard waste compost materials (lawn clippings and chipped brush) and co-composted materials (biosolids bulked and composted with yard waste materials). Nitrogen release from composted material was measured using periodic soil solution extraction and soluble N analysis. Nitrogen release rates varied widely between source materials during the initial portions of the incubation period, with cocomposts having much greater release rates than the yard waste composts. Yard waste composts that were poorly cured or had high woody fiber content showed net immobilization of N during the initial incubation periods, which could potentially lead to N-limitations for plant growth in field conditions. Following additional curing in the soil, however, all yard waste compost materials had positive net N mineralization release rates. Release rates were similar to some of the native soils used as reference materials. The relationship of long-term aerobic N release and several other indicators of mineralizable or "bioavailable" N were evaluated, but the relationship of these other indicators with the aerobic incubation data was low. Because the cumulative N release from yard waste compost materials was a small fraction of the material's total N content, N leaching losses in field conditions are expected to be small and of short duration. Steady, long-term N release patterns were observed from composts throughout the second half of the study and would be expected to continue for an extended period in the field. Composts are shown to provide a suitable replacement source of slowly available N for plant establishment on drastically disturbed, low nutrient soils.

Introduction

Soil disturbance of wildlands sites during construction or erosion often results in loss of nutrient-rich topsoils and decreased plant available nitrogen (N). When soil organic matter is removed, the content, decomposition and cycling of organic N within soils is also decreased, reducing long-term sources of plant available N. Yard waste composts are a potential resource for replacement of depleted soil organic matter on disturbed sites because they increase the soil's organic matter content, increase N released by microbial decomposition (mineralization) and provide other beneficial plant growth responses (Stolt *et al.* 2001, Noyd *et al.* 1996). Yard waste composts have been used as soil amendments in agricultural and horticultural systems (Grobe and Buchanan 1993; Hartz *et al.* 1996) and for erosion control on roadway embankments (Ettlin and Stewart 1993; Storey *et al.* 1995; Metro 1994). Increased plant available N is a common objective of compost amendment, but N release from composts has previously been found to be variable or negative depending on process and source material (Hartz *et al.* 1998).

Because soluble N can be lost from the soil by ammonia volatilization, denitrification or nitrification and leaching after it is mineralized from organic forms, compost products are expected to be variable depending on source, age and weather conditions during production. This variability influences field behavior of compost by changing the N available for revegetation, the type of residual organic material added to the soil and the associated microbial activity during decomposition. Product variability makes appropriate amendment of compost in field situations difficult, contributing to poor plant establishment if N release is low, or to weedy invasion if N release is excessive.

Composts are increasingly being used for revegetation projects on California Department of Transportation roadway projects as a replacement soil organic matter source on drastically disturbed soils (CCREF 2003). An improved understanding of the field performance of compost amendments is critical for appropriate field application. A survey of the available compost resources within California was initiated and has been summarized previously (Claassen 2000). The specific objective of the work reported here was to select a representative subset of compost materials and to characterize N mineralization and release patterns as indicated by long-term, aerobic incubation.

Materials and Methods

Selection of Compost Materials

Twenty-three commercial and municipal compost producers located throughout the state of California were selected to represent the type of compost material that would be available for application on large scale revegetation projects. Producers were visited in December 1998 and January 1999 and samples were collected from compost piles that were, according to each producer, "ready for sale." From this larger group, a subset of six composts (four yard waste composts and two cocomposted biosolids/yard waste compost mixtures) were selected for more intensive N release evaluation in the study presented here.

All compost materials were sampled from four evenly spaced locations around the "finished" pile. A 4-liter (1.057-gal) volume was collected at each sampling point. Each sample was collected at a depth of one meter into the pile about midway between the base and top of the pile. Surface samples were not collected because this zone made up relatively little of the total volume of the pile. One composite sample was created for each source material and was submitted to a commercial laboratory for compost analysis (A91 compost evaluation, Soil and Plant Laboratory, Santa Clara, California). Selected analytical results are listed in Table 1.

The six selected compost materials were intended to represent general types of compost produced by facilities within California. Yard waste compost (YWC) 1 was composted according to EPA 503 regulations, but had minimal (< 60 day) processing time. YWC 2 was from a municipal facility with moderate (approximately 120 days) curing. The YWC 3 material was produced by a municipal facility, but had an atypically long (18 month) post-compost curing. This extended curing was caused by a lack of demand for compost products during a wet year, resulting in retention of the stockpiled material until the following season. YWC 4 was from a commercial facility that utilized about 100 days processing time (initial grinding to final product) but with frequent monitoring and turning. YWC 2 and 3 were from locations in the Central Valley of California that are thought by some producers to have greater proportions of green lawn clippings in the feedstock, while YWC 1 and 4 were from coast range locations with potentially greater proportions of shrubby or woody feedstocks. Cocomposted material A (CCM A) was from a conventional outdoor, mixed pile cocomposting (biosolids and yard waste) process, while CCM B was produced at an intensive, in-vessel agitated-bed composting facility.

TABLE 1.
Chemical, physical and site characteristics of incubated soils and composts.

Sample	Material Type Wildland Soils	Total C ($g\ kg^{-1}$)	Total N ($g\ kg^{-1}$)	C/N	Particle Size ($g\ kg^{-1}$) Sand	Silt	Clay
GT	Granitic topsoil (sandy-skeletal, mixed Entic Cryumbrept)	28.24	1.17	24.14	890	80	40
GS	Granitic subsoil	2.53	0.15	16.87	910	60	40
ST	Sedimentary topsoil (fine, mixed, superactive, thermic, Mollic Haploxeralf)	31.84	2.14	14.88	430	320	260
SS	Sedimentary subsoil	2.77	0.39	7.10	470	220	320
DG	Decomposed granite (saprolite)	2.44	0.12	20.33	941	57	2
	Composts					Dry bulk density kg/m^3 (lb/yd^3)	
YWC 1	Yard waste material (short curing time)	313.19	17.04	18.38		237 (399)	
YWC 2	Yard waste material (typical processing time)	171.78	11.46	14.99		600 (1010)	
YWC 3	Yard waste material (18 month curing time)	242.66	15.86	15.30		492 (828)	
YWC 4	Yard waste material (highly processed)	201.73	13.77	14.65		408 (687)	
	Cocomposts						
CCM A	Biosolids/yard waste (windrow)	143.74	15.77	9.11		630 (1060)	
CCM B	Biosolids/yard waste (in-vessel)	346.02	29.13	11.88		270 (455)	

Selection of Reference Soil Materials

Because the compost materials were intended to be used as amendments on drastically disturbed field soils, reference topsoil and subsoil materials were included in the experiment so that N release amounts and rates could be compared to existing soil systems from several actual field locations within northern California. The soils labeled with a first code letter "G" are from high elevation (2400 m) granitic substrates in the Lake Tahoe Basin (Luther Pass, El Dorado Co., State Route 89, mile post 2.5). The soil labeled "GT" was a native granitic topsoil mapped as a Meeks series very stony loamy coarse sand (sandy-skeletal, mixed Entic Cryumbrept) (Rogers 1974). This topsoil supported a diverse plant community of Jeffrey pine (*Pinus jeffreyi* Grev. & Balf. (Pinaceae)), mountain big sage (*Artemisia tridentata* Nutt. ssp. vaseyana (Rydb.) Beetle (Asteraceae)), snowberry (*Symphoricarpos mollis* Nutt. (Caprifoliaceae)), mule's ears (*Wyethia mollis* A. Gray (Asteraceae)) and California brome (*Bromus carinatus* Hook. & Arn. var. carinatus (Poaceae)). The granitic subsoil labeled "GS" was from an adjacent road cut area that supported a moderate vegetative cover of intermediate wheatgrass (*Elytrigia intermedia* (Host) Nevski ssp. intermedia (Poaceae)) and lupine (*Lupinus spp*). Both soils were collected from the 20 – 100 mm depth.

Sedimentary soil samples (labeled with a first letter of "S") were collected in the Coast range in western Colusa county (State Route 20, mile post 8.6) at 300 m elevation. The sedimentary topsoil (labeled "ST") is mapped as a Contra Costa loam (fine, mixed, superactive, thermic, Mollic Haploxeralf) (Reed 1999). "ST" represents a sedimentary topsoil collected from the 20 – 100 mm horizon beneath a community of dense perennial grass (*Nassella pulchra*) (A. Hitchc.) Barkworth (Poaceae) and scattered oaks (*Quercus kelloggii*) Newb. (Fagaceae). Soils labeled "SS" are from a cutslope that was very sparsely vegetated with scattered annual grasses (*Avena*, *Bromus*) and California broom (*Lotus scoparius* (Nutt.) Ottley (Fabaceae).

A very low N content, sandy substrate of decomposed granite was selected to mix compost treatments into, to facilitate soluble N extraction and to simulate a potential revegetation substrate. This material was selected from a nonvegetated, talus slope that was disintegrating directly from granitic saprolite at an exposed road cut near Emerald Bay, (El Dorado Co. State Route 89, mile post 19.0).

Chamber Loading, Extraction and Nitrogen Analysis Methods

Nitrogen release from compost materials was measured by aerobic incubation (Stanford and Smith 1972) in cylindrical, 400 mL PVC chambers (50 mm diameter x 200 mm height). Soil solutions containing mineralized nitrogen were collected in porous extraction lysimeters positioned in a 30 mm thick bed of quartz sand at the bottom of the chamber. Organic amendments were mixed with very low N-content decomposed granite (DG) sands. Composts were loaded into the incubation chambers at a uniform amounts equivalent to 500 kg total N/ha (surface area basis).

The incubation chambers used for testing the reference soils were loaded with equal volumes of soil material (sieved to less than 6.3 mm) and clean quartz sand (50:50 ratio) to improve aeration, percolation and to facilitate removal of extractant solution. Soil or compost amended substrate depths were about 150 mm. All incubation treatments were replicated three times.

All columns were extracted at biweekly intervals initially, and then subsequently at monthly intervals after the initial rapid period of N release. Periodic extractions were continued until 586 days of incubation. Chambers were maintained in aerated conditions at about 60% of field capacity at 30°C. Soluble ammonium and nitrate that was produced by microbial decomposition of organic matter was removed from the columns by leaching with two successive pore volumes of 0.01 M $CaCl_2$ (Stanford and Smith 1972). After leaching, soil moisture was replaced using a dilute nutrient solution, minus N. The two extracted pore volumes obtained from each column were combined. Soluble NO_3^- and NH_4^+ contents were measured by continuous flow, conductimetric analysis using a column of copper coated zinc shavings to reduce nitrate to ammonium (Carlson 1978, 1986). After the first few weeks, nearly all of the leached N was in the nitrate form. After extraction, the columns were covered with ventilated plastic lids to reduce evaporation and they returned to the incubation chamber.

Available N was also estimated by anaerobic incubation and by autoclave/hot KCl methods to evaluate potential alternative N release assays that were more rapid than the long-term incubation. The anaerobic incubation (Waring and Bremner 1964; Keeney 1982) involved one week, 40°C, waterlogged incubation of 10 g samples. Ammonium was analyzed as described previously. The autoclaved/hot KCl method was adapted from the hot KCl method (Gianello and Bremner 1986) and the autoclaved $CaCl_2$ method of Stanford and Smith (1976). Ten grams of material were loaded into glass jars with 50 mL 2 M KCl and brought to 120°C for 2, 6, or 18 hours. Ammonium and nitrate were analyzed as described previously.

Data are plotted as N mineralization in milligrams of soluble nitrate and ammonium N per incubation chamber. The N yield of the DG matrix is subtracted

from the compost N yields before graphing. All data were analyzed by ANOVA ($p < 0.05$) with comparison of means by least significant difference, or by correlation analysis using Statistica software (StatSoft, Inc. 1997, Tulsa, Oklahoma).

Results and Discussion

The N release characteristics of various yard waste composts differed widely even though they were all from the same general type of source material (Figure 1). Composts 2 and 3 (moderately- to well-cured composts) provided a positive N release as soon as they were incorporated to the soil. YWC 1 (minimally cured) and YWC 4, however, required additional decomposition in the soil before net N mineralization occurred. These two materials were more fibrous and had lower dry bulk densities (Table 1). Composts 1 and 4 were collected from locations in the Coast Range rather than in the Central Valley of California. The Coast Range has a cooler climate and may have had a higher proportion of woody material in the compost feedstock, while the Central valley sources may have had a greater proportion of green lawn clippings.

An extended period of negative N yield (immobilization) caused YWC 1 to have the lowest cumulative N release of all compost materials and soils (Table 2). Composts 2, 3 and 4 attained similar cumulative N yields at the end of the incubation period. N release was approximately equal to that of the low fertility granite subsoil. The cocompost materials yielded about 4 times greater cumulative mineralized N than the yard waste composts. They released about twice the N as the granite topsoil, but only about two thirds of the cumulative N release as the nutrient rich, sedimentary topsoil.

Interpretation of these incubation data for field loading amounts suggests that an application of approximately 1000 kg / ha (total N in compost) would approach the net N release amount of the granite topsoil if YWC materials were used (Table 3). If

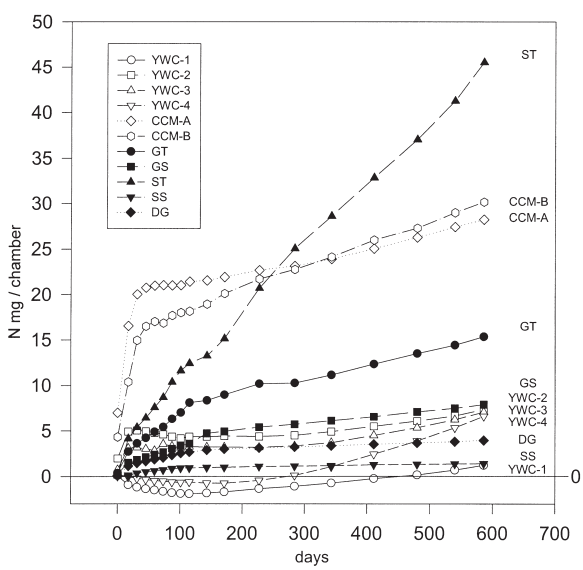

Figure 1. Nitrogen yield (mg N) from a 586 day aerobic incubation period (30 ºC). Filled symbols represent cumulative mineralizable N release from sedimentary topsoils (ST) and subgrade material (SS), from granitic topsoil (GT) and subsoil (GS), and from decomposed granite matrix material (DG). Open symbols represent cumulative mineralizable N release from yard waste composts (YWC 1, 2, 3, and 4), and cocomposted materials (biosolids and yard waste)(CCM A and CCM B). All compost amendments were loaded into DG matrix at amounts equivalent to 500 kg N/ha. Data are presented in mg N yield per pot, minus the N release from the DG control matrix.

TABLE 2.
Cumulative mineralizable N yield at 586 days incubation (mg N/chamber). Means followed by different letters differ significantly ($p < 0.05$) using comparison of mean values by least significant difference tests (n = 3).

Incubation Material	Average Yield mg N/chamber
Yard waste compost 1	1.24 a
Colusa subgrade	1.42 a
Decomposed granite control	3.98 b
Yard waste compost 4	6.64 c
Yard waste compost 3	7.09 c
Yard waste compost 2	7.37 c
Luther pass subgrade	7.91 c
Luther pass topsoil	15.36 d
Cocompost A	28.25 e
Cocompost B	30.17 e
Colusa topsoil	45.53 f

TABLE 3.
Estimated cumulative mineralizable N yield of reference soils and composts if compost amendments were applied at 1000 kg total N/ha.

Sample	Material Type	Cumulative Minerizable N Release (kg N/ha)
	Wildland soils	
GT	Granitic topsoil (sandy-skeletal, mixed Entic Cryumbrept)	85.6
GS	Granitic subsoil	44.1
ST	Sedimentary topsoil (fine, mixed, superactive, thermic, Mollic Haploxeralf)	253.7
SS	Sedimentary subsoil	7.9
DG	Decomposed granite (saprolite)	22.2
	Composts	
YWC 1	Yard waste material (short curing time)	11.7
YWC 2	Yard waste material (typical processing time)	69.4
YWC 3	Yard waste material (18 month curing time)	66.8
YWC 4	Yard waste material (highly processed)	62.5
	Cocomposts	
CCM A	Biosolids/yard waste (windrow)	266.1
CCM B	Biosolids/yard waste (in-vessel)	284.2

CCM materials were used at this application amount, the N release would approximate that of the sedimentary topsoil. Because N cycling data and N requirements for drastically disturbed soils are not well characterized, caution should be used in applying these examples directly to other field sites. In this study, we use equal volumes of the reference soils and the compost amended granite matrix for comparison purposes. Field plant communities will typically have deeper soil volumes available for root growth and nutrient uptake, although the amendment depths are often limited to the top 150 mm of the substrate, as was used in these incubation chambers. Soil depth, rock content and weed pressures should also be considered during selection of field application levels, especially for N amendment.

If the amount of N released is expressed as a proportion of the total N content in the soil or compost organic matter, a qualitative comparison of N release from the different organic matter types can be seen (Table 4). Net N release averaged 6.6% of the total N content in the yard waste composts (except 1% for YWC 1). Net N release averaged 27.5% in the cocomposted materials. These data indicate that yard waste composts 2, 3, and 4 and the granite topsoil release the same proportion of their total N content as cumulative mineralizable N during the total incubation period. Because the compost release rates varied during the incubation period, however, interpretation for field situations is less simple than indicated by the overall, cumulative N release amounts.

Evaluation of the slopes of the curves in Figure 1 shows that, although YWC 2, 3, and 4 end up with similar cumulative amounts of N release at the end of the experiment, the rates of N release per month vary between the first and last portions of the incubation period. Long-term rates of N release were calculated by using an average of the last five measurement intervals from 284 through 586 days. By this measure, the intensively processed YWC 4 provides N at rates exceeding the other three yard waste composts as well as the granitic topsoil and one of the cocomposts (Table 5). Even though YWC 2, 3, and 4 provide the same cumulative N release amount (Table 2), the long-term N release rate from YWC 4 is over twice that of YWC 2 and 3. Plant growth response to these N availability differences would be expected to be large, reiterating the view that the maturity of compost materials is an important variable for compost utilization in field conditions.

The short-term, initial N release rates of various yard waste composts showed greater variation than the long-term rates (Table 6). During the initial 31 day period, composts 1 and 4 have negative release rates, resulting from immobilization of N into microbial biomass during this period. This trend is interpreted as reflecting the process of decomposition of the fibrous materials contained in these particular composts. The immobilization phase appeared to withdraw between 1 and 6 kg N/ha from the soil during the first 31 days of incubation. A maximum withdrawal of 4 to 10 kg N/ha was estimated at about 150 days incubation.

TABLE 4.
Cumulative mineralizable N yield at 586 days expressed as a percent of initial total N content. Means followed by different letters differ significantly ($p < 0.05$) using comparison of mean values by least significant difference tests (n = 3).

Incubation Material	% of Total N Content
Yard waste compost 1	1.17 a
Colusa subgrade	1.91 a
Yard waste compost 4	6.25 b
decomposed granite control	6.38 b
Luther pass topsoil	6.47 b
Yard waste compost 3	6.68 b
Yard waste compost 2	6.94 b
Colusa topsoil	12.02 c
Luther pass subgrade	20.25 d
Cocompost A	26.61 e
Cocompost B	28.42 e

TABLE 5.
Rate of long-term mineralizable N release from incubation chambers (30°C), averaged for the final 302 days of incubation (day 284 to 586), when loaded at amounts equivalent to 500 kg N/ha. The left data column lists micrograms of N mineralized per day of incubation per chamber. Mean values followed by different letters differ significantly ($p < 0.05$) using comparison of mean values by least significant difference tests (n = 3). The right hand column lists the estimated amount of N yield per hectare per 30 day month.

Incubation Material	Rate μgN/day	Estimated Field Rate kg N/ha month
Colusa subgrade	0.867 a	0.1
Decomposed granite control	2.363 a	0.4
Luther pass subsoil	7.035 b	1.1
Yard waste compost 1	7.611 b	1.2
Yard waste compost 2	9.078 b,c	1.4
Yard waste compost 3	12.224 c	1.9
Luther pass topsoil	16.366 d	2.5
Cocompost A	17.125 d	2.6
Yard waste compost 4	21.402 e	3.2
Cocompost B	24.995 e	3.8
Colusa topsoil	66.801 f	10.2

In contrast, YWC 2 and 3 have positive N mineralization rates, releasing a cumulative total equivalent to 25 and 16 kg N/ha during the first 31 days. Topsoils released N equivalent to 18 and 27 kg N/ha during this period, although sieving and aggregate disruption may have increased N release values above ambient soil levels. Cocomposts A and B had much greater release rates of 76 and 102 kg N/ha during this period even though they were also loaded at 500 kg total N/ha. Initial plant growth will be strongly influenced by this range in short-term available N, which varies from immobilization (removal of N from the ambient soils) with some of the yard waste composts to abundant short-term available N released from the cocomposted materials.

While the long-term, aerobic incubation data provide a realistic comparison of N release from compost materials and soils, the time required for these measurements is excessive for routine compost evaluation. Simpler and more expedient methods than the long-term incubation are needed. Available N release was estimated by anaerobic incubation and by hot KCl (autoclave) methods as potential rapid evaluation protocols for compost and soil material evaluation (Table 7). Studies that report useful correlations between anaerobic incubation yields and field plant performance or other measures of plant available N have involved existing soils and ambient soil organic matter (Shumway and Atkinson 1978; Powers 1980). The relatively fresh compost materials used in this study, however, had poor correlation to the N released in the aerobic incubations. The length of heating time was varied in our evaluation of the autoclave/KCl extraction methods. Longer heating times released greater amounts of N yield, suggesting that some variation of the method could potentially be used to evaluate "plant available" N as indicated by the aerobic incubation chambers. Changes in the period of autoclaving, however, did not change the strength of the correlation.

Additional work on extraction or detection methods is needed to provide a short term method to detect trends of long-term N mineralization. The fact that patterns of N release rate of composts with different feedstock sources and production methods become similar as the incubation proceeded suggests that similar chemical or physical characteristics are developed within the cured composts. Efficient detection of these characteristics is needed in order to predict long-term compost performance in field conditions. While existing compost evaluation methods are currently established (USCC 2003), these methods address compost production stages and quality. Evaluation of compost performance in field applications requires analytical methods that focus more on the behavior of organic matter residues rather than on moisture, temperature or the more labile components.

TABLE 6.
Rate of aerobic mineralizable N yield of various substrates for the initial 31 day period of incubation. Means followed by different letters differ significantly ($p < 0.05$) using comparison of mean values by least significant difference tests (n = 3).

Incubation Material	Rate mg N/Month	Estimated Rate kgN/ha Month
Yard waste compost 1	-1.167 a	-5.9
Yard waste compost 4	-0.195 a	-1.0
Colusa subgrade	0.380 a,b	1.9
Decomposed granite control	1.467 b	7.5
Luther pass subsoil	1.839 b,c	9.4
Yard waste compost 3	3.184 c	16.2
Luther pass topsoil	3.637 c,d	18.6
Yard waste compost 2	5.053 d	25.8
Colusa topsoil	5.398 d	27.5
Cocompost B	14.957 e	76.3
Cocompost A	20.015 f	102.1

TABLE 7.
Correlation and significance values for relationship of cumulative N mineralization at 586 days (top section of table) or long-term release rate (lower section) using various N availability indicators. Coefficients of determination values (r^2) are listed, followed by significance values (p) in parentheses.

Sample group	Anaerobic Incubation With KCl Extraction r^2 (p)	Autoclave/KCl Extraction Methods 2 hr r^2 (p)	6 hr r^2 (p)	18 hr r^2 (p)
Coefficient of determination data for 586 day cumulative N mineralization				
YWC	0.02 (0.87)	0.35 (0.41)	0.39 (0.37)	0.42 (0.35)
YWC + SOILS	0.05 (0.54)	0.03 (0.65)	0.02 (0.73)	0.01 (0.76)
YWC + SOILS + CC	0.07 (0.44)	0.23 (0.14)	0.23 (0.13)	0.22 (0.15)
Coefficient of determination data for long-term N release rate (284-586 days)				
YWC + SOILS + CC	0.04 (0.55)	0.01 (0.82)	0.00 (0.89)	0.00 (0.92)

Conclusions

Composts from different feedstock sources or production histories provided different amounts of mineralizable N release, including some materials with negative net rates (immobilization). After varying periods of time of in the laboratory incubation chambers, however, all composts provided positive net N release to the soil. Yard waste compost materials that are well cured during production, or that have had additional curing time in the soil appear, to be able to release N at amounts and rates similar to moderately fertile reference soils. Compost amendment levels of 500 kg total N/ha appear to provide similar cumulative amounts of N release as the granitic subsoils under these experimental conditions. Application of about 1000 kg total N/ha is estimated to approach the cumulative N release amounts of the reference granitic topsoil. The rates of long-term N release also approach those of the selected reference soil materials, depending on compost type. Initial periods of immobilization appear to occur for uncured or fibrous yard waste compost materials. Use of such materials could potentially reduce initial plant establishment and growth, although such materials may function well when used as surface mulch applications that decompose more slowly.

Net nitrogen mineralization rates from cocomposted materials are much higher than from yard waste composts initially, although the long-term N release rates were more similar. Sizable initial releases of available N may occur from cocomposts, which may potentially allow leaching losses to watersheds or may facilitate weedy invasion. Release of N from yard waste composts, however, was similar to or less than soil materials, suggesting that the potential for N leaching losses from yard waste compost materials is limited.

Approximately 1 to 7% of the total N contained in the yard waste composts was released during the incubation period, suggesting that yard waste composts have the potential to continue to mineralize N for many years after application to field soils. In contrast, the cocompost materials released about 27%, providing much more short term available N, but less potential for continued N release.

Alternative available N evaluation protocols, including anaerobic mineralizable N and autoclave / hot KCl methods, were poorly related to N release data from the aerobic incubations. Better evaluation methods are needed for monitoring of compost performance in field applications in order to track and compensate for markedly different initial performance of yard waste composts. After additional curing time in the soil, however, all compost materials used in this study appeared to provide a positive contribution to N availability of the decomposed granite matrix that was used as an example of a drastically disturbed, very low N soil material.

Acknowledgements

This study was supported by funds from the California Department of Transportation (RTA # 59A0100) and California Integrated Waste Management Board (#IWM-C6016). Compost materials were provided by BFI Organics, Milpitas, California; Mt. Vernon Recycling Facility, Bakersfield, California; Solid Waste Division, City of Sacramento, California; Sonoma Compost, Petaluma CA; Laguna Treatment Plant, Santa Rosa, California; and San Joaquin Compost, Lost Hills, California. Reviews of the manuscript were generously provided by Will Bakx, Matt Curtis, John Haynes, and Will Kleiner.

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