BIOSOLIDS RECYCLING
research notes
NORTHWEST BIOSOLIDS MANAGEMENT ASSOCIATION

Estimating Nitrogen Availability from Biosolids

Researchers and Collaborators
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Table 1. Biosolids used in N availability field experiments at WSU Puyallup

Location	State	Process
Chelan	WA	anaerobic digest, drying bed
Ellensburg	WA	anaerobic digest, drying bed
Entiat	WA	oxidation ditch, clarifier, air-dried
Hillsboro	OR	anaerobic digest, belt-filter pressed
Tacoma	WA	aerobic/anaerobic thermophilic digestion, belt-filter
Everett	WA	17-year lagoon storage, dewatered
Baltimore	MD	anaerobic digest, heat-dried
Stayton	OR	aerobic digest, belt-filter pressed, lime-stabilized
Vancouver	BC	anaerobic digest, 6-8 years in a lagoon, dewatered
San Jose	CA	anaerobic digest, 2 -2.5 years in a lagoon, air dried
Seattle/King Co.	WA	anaerobic digest, primary-secondary mix, dewatered
Portland	OR	anaerobic digest, primary-secondary mix, dewatered
Bingen	WA	aerobic digest, centrifuge, drying bed
Milwaukee	WI	anaerobic digest, heat-dried

Background

Recycling biosolids in agriculture is based on supplying enough biosolids nutrients to satisfy crop needs, while protecting the crop, soil, and water from environmental harm. In most cases, nitrogen is the element that limits biosolids application rate. Too much nitrogen applied from biosolids can reduce crop yield and lead to contamination of groundwater. The same is true of nitrogen from other nutrient sources, including manure and inorganic fertilizer.

Biosolids contain a substantial amount of nitrogen (typically 3 to 6 % by weight). The nitrogen is not immediately available to crops, but is released slowly by biological activity, the same as the slow release of nitrogen from manures and other organic fertilizers. If we can predict how much biosolids nitrogen becomes available to crops during the growing season, we can recommend application rates that will meet the goals of crop production and environmental protection. Because biosolids are produced and handled by different processes at different treatment plants, it is important to know if those treatment processes affect how much nitrogen becomes available to plants.

Objectives

Improve our predictions of nitrogen availability from biosolids produced by different treatment processes.

Methods

In 1998 we applied biosolids from eight different treatment plants to tall fescue field plots at approximate rates of 400 lb total N/acre. We included four rates of inorganic N fertilizer and an unfertilized control applied to identical plots. We assigned treatments randomly to blocks in the field, and replicated each treatment four times. In 1999 we repeated the experiment on an adjacent piece of land, comparing biosolids from nine different treatment plants. Three of the biosolids from 1998 were used again in 1999. We measured grass N uptake for two years following biosolids application, and calculated plant available N in the biosolids, by comparison with N uptake from the inorganic N fertilizer treatments.

Results

We found that the type of biosolids treatment (aerobic vs. anaerobic; mesophilic vs. thermophilic; heat-dried vs. air dried vs. dewatered; lime stabilization) had little effect on N availability from the biosolids. The only exception was for biosolids that had been stored in lagoons. Biological changes during lagoon storage make the biosolids more resistant to decomposition in the soil, resulting in less release of nitrogen in soil. Plant available N from biosolids averaged 37 ± 5% of total N during the first growing season after application (not including lagoon materials). Available N from lagoon materials ranged from 8 to 25% of total N during the first growing season, with the oldest lagoon biosolids releasing the least N.

During the second growing season average N release from dewatered and air-dried biosolids was an additional 13 ± 2% of the total N applied in Year 1. Only half as much N was released from the heat-dried biosolids during the second season. Heat-dried biosolids released N rapidly soon after application, with less N available in the second year. Lagoon biosolids released 0 to 12% of total N during the second year. More than half of the plant available N captured during the second growing season was taken up in the spring harvest of the grass, indicating that much of the second-year N became available during the cool season.

Significance

The results confirm that biosolids are a reliable source of plant-available N. Available N was similar across a range of biosolids types. Biosolids producers, users, and regulators can use this information in developing economically and environmentally sound biosolids application plans for a similar range of materials in similar climates. Where warm season annual crops are grown, timely planting of a cover crop could conserve N released during the cool season and reduce the potential for leaching loss.

Table 2. Average N availability from biosolids in the first and second years after application.

Biosolids type	Plant-available N		
	First growing season (May to Sept)	Late fall/early spring (Oct to April)	Second growing season (May to Sept)
	% of total N applied (dry weight basis)		
Fresh*	37	7	6
Fresh, heat dried	36	4	2
Lagoon (2 to 17 yr)	8 to 25	0 to 5	0 to 3

*includes biosolids produced via aerobic, anaerobic, mesophilic, or thermophilic digestion; and biosolids processed by air-drying, dewatering or lime stabilization

Keywords: plant-available nitrogen, tall fescue **Revision Date**: January, 2003