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SEWAGE SLUDGE AS AN ALTERNATIVE FERTILIZER FOR TROPICAL PASTURE GRASSES

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Abstract

This study was conducted to determine the effects of source (Liquid sludge at pH 7 (LS7) or pH 11 (LS11), cake biosolid (CB) or ammonium nitrate (AM)) by rate (0, 80 or 160 kg ha^{-1}) of N application on bahiagrass forage yield, quality and tissue composition. Same plots were fertilized in March 1998 and 1999. Forage yield was measured at 30 d intervals from May through November and subsamples were dried and ground for quality analyses. The 2-year mean forage yield was similar for AM, LS7 and LS 11 fertilizer applications. Forage yield from CB application was 30% lower than yield from other N sources at comparable N rates. Forage crude protein content was highest for the AM treatment only during the initial harvest. Tissue concentrations of plant nutrients were increased by organic sources of fertilizer. These results, in conjunction with data from soil and groundwater analyses, suggest that processed domestic septage could be a safe and inexpensive substitute to inorganic fertilizer for tropical pasture grasses.

Keywords: Sewage sludge, organic fertilizer, *Paspalum notatum*, pasture fertilization

Introduction

Bahiagrass pasture production in Florida relies heavily on inputs of nitrogen. Recently, ranchers have reverted to using increasing amounts of domestic septage to reduce their annual fertilizer budget. In the past, there was concern over heavy metal contamination from sludges, but the U.S.A. Environmental Protection Agency (EPA) came out with specific heavy metal limits for sludges which must be met before any sludge can be applied to land. By law, the concentrations of nutrients and heavy metals in a sludge should be provided by the sludge hauler to the end user. Researchers at the Range Cattle Research and Education Center (RCREC) have conducted several field and laboratory experiments to evaluate the potential use of processed sludge and biosolids as an alternative to the more costly inorganic fertilizer for pasture grasses. This study was part of that continuing effort.

Material and Methods

The experiment was conducted at Ona, Florida (27^o 26' N, 82^o 55' W) on Pomona fine sand (sandy, siliceous, hyperthermic, Ultic Haplaquods). Nine fertilizer treatments, consisting of liquid sludge of pH 7 or pH 11, cake biosolid and ammonium nitrate fertilizer, each at 80 or 160 kg ha^{-1}, and a non-fertilized control, were assigned to bahiagrass plots in a randomized complete block design with three replicates.   Each fertilized grass plot measured 6.25 by 6.25 m with a 6.25 perimeter border maintained free of vegetation. Established bahiagrass plots were cut back to 5 cm stubble height and fertilized with the same treatments in March 1998 and 1999. Fertilizer amounts were calculated based on the total solids and N concentrations in the material to meet prescribed N rate and materials were applied manually. Grass regrowth was repeatedly harvested each year at 30 d intervals to estimate forage dry matter yield.   Dried forage subsamples were analyzed for quality (Gallaher et al., 1976;

Moore and Mott, 1974) and selected minerals (P, K, Ca, Mg, Fe, Zn, Cu and Mn) (Kitson and Mellon, 1944). Data were subjected to statistical analyses SAS (1998).

Results and Discussion

Pathogen and trace metal content of sewage sludges used were in compliance with the United States Environmental Protection Agency guidelines (USEPA, 1993). The fecal coliform counts averaged 177,500 CFU/g for the CB, 33,000 CFU/g for the LS7 and 148 CFU /g for the LS11. This means that liming of sludge material to a pH of 12 for 24 hours was effective both as a pathogen and an odor reduction technique.

Annual forage yield was similar for the liquid sludges and ammonium nitrate in both 1998 and 1999 (Table 1). However, forage yield from the AM fertilizer was highest immediately following fertilizer application (harvests 1 and 2). By mid season, the effect of AM had waned due to rapid uptake and leaching losses while the liquid organics sustained a more uniform forage production throughout the growing season. This created a fertilizer treatment by harvest date interaction ($P<0.05$) in 1998, but not ($P>0.12$) in 1999. Seasonal forage yield from the CB was only 65 to 70% the yield from the other N sources at comparable N rates (Table 1). In their study, Muchovej and Rechcigl(1997) estimated a minimum N recovery rate from biosolids by bahiagrass of 70% over a two-year period with the remaining 30% becoming available over time. The slow nutrient-release action from sewage sludges is advantageous in reducing nutrient leaching losses on corse-textured sandy soils in the humid tropics. Greater forage was produced from the 160 N rate than the 80 N rate (Table 1) at the beginning of the 1998 season, but throughout most of 1999 which was a drier year. Nitrogen is the most limiting nutrient for grass production on tropical sandy soils as evidenced by the lowest yield from the non-fertilized control in contrast to the N fertilized plots.

The effect of fertilizer treatment on forage crude protein concentration followed a similar pattern to that described for forage yield. Highest mean seasonal CP concentration in forage resulting from AM fertilizer was due primarily to its early season impact (Table 2). None of the fertilizer treatments was able to overcome the usual summer (July-August) slump in forage quality (CP and IVOMD) experienced in Florida. By late September, bahiagrass regrowth had slowed down due to shorter days and cool temperatures and forage quality improved under fertilized and non-fertilized treatments (Table 2).

Concentrations of plant macro- and micro-nutrients in forage tissue showed a general increase when bahiagrass was fertilized with the sludges rather than ammonium nitrate. This was partly due to the intrinsic availability of plant nutrients in sludge materials, but probably also due in part to the soil ameliorating properties (pH, CEC, OM) sludges carry.

The data reported here suggest that yield, protein, digestibility and minerals of bahiagrass forage were significantly increased with the addition of liquid sludges and biosolids. Other, preliminary information (Adjei and Rechcigl, 2000) confirm that sludge may in fact become the Best Management Practice for pasture fertilization over their expensive inorganic counterparts because of their long-term nutrient release property, their liming capacity, their organic matter amendment potential and their minimal impact on surface groundwater plant nutrients.

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Table 1 - The effect of source and rate of N fertilizer application on bahiagrass forage dry matter yield during the 1998 and 1999 growing seasons.

Fertilizer	1998 harvest date							
treatment	4-20	5-19	6-18	7-22	9-2	9-30	11-3	Mean
	----------Mg ha^{-1}----------							
AM-80	0.58ab	0.64bc	1.31ac	1.07a	0.87a	0.29b	0.19bc	4.95
AM-160	0.97a	1.08a	0.94abc	0.99a	0.93a	0.45ab	0.28ab	5.64
LS7-80	0.43ab	0.48c	1.01ab	1.18a	1.04a	0.45ab	0.23bc	4.82
LS7-160	0.39ab	0.78abc	1.09a	1.34a	0.85a	0.58a	0.37a	5.40
LS11-80	0.87ab	0.65bc	0.60bcd	1.18a	0.97a	0.44ab	0.20bc	4.92
LS11-160	0.99a	0.93ab	1.41a	0.91a	0.91a	0.59a	0.33a	6.07
CB-80	0.39ab	0.27c	0.35d	0.92a	0.85a	0.34ab	0.14cd	3.27
CB-160	0.68ab	0.44c	0.54cd	0.86a	1.05a	0.26b	0.18bc	4.00
Control	0.30b	0.26c	0.33d	0.75a	0.76a	0.19b	0.10d	2.69
N contrast								
80 vs 160	*	*	NS	NS	NS	NS	NS	**
0 vs 80	NS	*	*	NS	NS	NS	NS	*
Fertilizer	**1999 harvest date**							
treatment	5-5	5-27	6-23	7-21	8-18	9-14	10-13	Mean
	----------Mg ha^{-1}----------							
AM-80	0.59ab	0.46abc	0.74cd	0.56abc	0.68bc	0.40bcd	0.23bc	3.66b
AM-160	0.71a	0.50ab	1.06ab	0.84a	0.74b	0.54ab	0.31ab	4.70a
LS7-80	0.34bc	0.33abcd	0.51def	0.53bc	0.69bc	0.45abcd	0.28bc	3.14b
LS7-160	0.61ab	0.61a	1.20a	0.77ab	1.01a	0.51abc	0.39a	5.12a
LS11-80	0.37bc	0.44abc	0.57de	0.54bc	0.65bc	0.44bcd	0.24bc	3.25b
LS11-160	0.71a	0.42abcd	0.92bc	0.75ab	0.83ab	0.62a	0.39a	4.64a
CB-80	0.26c	0.15d	0.41ef	0.36c	0.50cd	0.36cd	0.21bc	2.24c
CB-160	0.38bc	0.26bcd	0.55de	0.65ab	0.68bc	0.48abc	0.28bc	3.28b
Control	0.16c	0.19cd	0.26f	0.35c	0.41d	0.29d	0.17c	1.84c
N contrast								
80 vs 160	**	NS	*	*	*	*	*	*
0 vs 80	NS	NS	*	*	*	*	*	*

*Values within a harvest date or mean not followed by the same letter are different ($P<0.05$) according to the Duncan's Multiple Range Test. *, ** N contrasts indicate statistical differences at P=0.05 and P=0.01, respectively.

Table 2 - The effect of source and rate of N fertilizer application on bahiagrass forage crude protein (CP) and in vitro organic matter disappearance (IVOMD) during the 1998 growing season

Fertilizer treatment	1998 harvest date						
	5-19	6-18	7-22	9-2	9-30	11-3	Mean
	---------------------CP, g kg^{-1}---------------------						
AM-80	145b*	102abc	100a	72ab	82c	88b	98
AM-160	172a	103ab	83a	77ab	94ab	95ab	104
LS7-80	--	83cd	86a	73ab	79c	92ab	83
LS7-160	--	116a	83a	83a	96a	101a	96
LS11-80	112c	73d	89a	70ab	79c	89ab	85
LS11-160	126c	79bcd	86a	77ab	86abc	98ab	92
CB-80	95d	79bcd	80a	68b	77c	87b	81
CB-160	106d	97abcd	81a	71ab	86abc	97ab	90
Control	96d	75dc	82a	72ab	84abc	92ab	83
N contrast							
80 vs 160	**	NS	NS	NS	*	*	**
0 vs 80	*	NS	NS	NS	NS	NS	NS
Fertilizer treatment	**1999 harvest date**						
	5-19	6-18	7-22	9-2	9-30	11-3	Mean
	---------------------CP, g kg^{-1}---------------------						
AM-80	580ab*	526a	440b	470ab	478ab	497a	499
AM-160	595a	505ab	462ab	432bc	479ab	518a	499
LS7-80	--	508ab	491a	447abc	452c	500a	480
LS7-160	--	522ab	484a	427c	486a	514a	487
LS11-80	583ab	516ab	480a	467ab	471abc	522a	507
LS11-160	590a	488b	472ab	445abc	484a	533a	502
CB-80	542cd	509ab	484a	472ab	457bc	488a	492
CB-160	552bc	517abd	468ab	445abc	472abc	514a	495
Control	511d	494ab	474ab	478a	455bc	493a	483
N contrast							
80 vs 160	*	NS	NS	NS	NS	NS	NS
0 vs 80	*	NS	NS	NS	NS	NS	NS

*Values within a harvest date not followed by the same letter are different (P<0.05) according to the Duncan's Multiple Range test. *, ** N contrasts indicate statistical differences at P=0.05 and P=0.01, respectively.