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USE OF POULTRY LITTER AS FERTILIZER ON COASTAL BERMUDAGRASS PASTURE

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Summary

Four and 8 tons per acre of poultry litter applied in a single or split application were compared to 0, 100, 200, and 400 lb nitrogen (N) per acre split in two applications on 'Coastal' bermudagrass (*Cynodon dactylon* (L.) Pers.) at the TAMU Agricultural Research and Extension Center at Overton. Phosphorus (P) and potassium (K) were applied to the N fertilizer treatments in a N-P-K ratio of 3-1-2. Assuming 60% availability of the N in poultry litter in the application year, Coastal bermudagrass yields from poultry litter treatments were similar to commercial N fertilizer. Applying all the poultry litter in late spring produced 10% more forage than splitting it between late spring and mid-summer applications. After 2 years, salinity, P, K, and magnesium (Mg) levels were significantly higher in soils treated with poultry litter. Residual soil P from poultry litter applications could be utilized if additional N and K fertilizer were applied. Nutrient content of poultry litter is quite variable depending on poultry house management and number of batches of broilers raised since last clean out. Therefore, poultry litter should be analyzed before purchase to be sure plant nutrient content is average or higher.

Introduction

The poultry industry in Texas generates over 1.2 million tons of poultry litter (manure + bedding) a year. Most of this poultry litter (PL) is applied as fertilizer to permanent pasture. Its economic value as a fertilizer depends on its nutrient content, which is quite variable due to poultry house management, number of batches of broilers since last clean out, and other factors. Poultry litter has additional advantages besides the N, P, and K content. It contains secondary nutrients such as calcium (Ca), sulfur (S), and Mg, and the micronutrients boron (B), copper (Cu), zinc (Zn), and iron (Fe), as well as organic matter. The added organic matter improves water and nutrient holding capacity of the soil. Poultry litter is especially beneficial to the acid East Texas soils because it decreases acidity (Hue, 1992). Unlimed East Texas pastures that have received PL for 8 to 10 years generally have a soil pH near 7.0 compared to strongly acid soils in pastures receiving high N rates and no lime for 3 years or longer.

Keywords: Poultry litter / fertilizer / soil fertility / pasture.

The average N-P-K ratio in litter from broiler houses is 1-1-1. The estimated N-P_2O_5-K_2O removal by bermudagrass ranges from 3-1-2 to 4-1-5. Long term annual applications of only PL to cool-season perennial grass pastures resulted in P, K, Ca, Mg, Cu, and Zn buildup in the soil (Kingery et al., 1993). When PL is surface applied to pastures, an estimated 30% of the N is lost through volatilization, 60% is available to the plant the first year, and 10% is not available until after the first year (Payne and Donald, 1990). About 70 to 80% of the K and P in PL is available to plants. A study was conducted for 2 yr at the TAMU Agricultural Research and Extension Center at Overton to compare PL to commercial fertilizer on Coastal bermudagrass.

Procedure

Experimental design was a randomized complete block with four replications. Plot size was 6 by 15 ft. Treatments were 0, 100, 200, and 400 lb N/acre split in two applications and single and split applications of 4 and 8 tons PL/acre. Nitrogen fertilizer treatments were applied in late spring and mid-summer. Phosphorus and K were applied in late spring in an N-P-K ratio of 3-1-2. Single rates of PL were applied in late spring and split applications applied in late spring and mid-summer. Poultry litter was obtained from a broiler house each spring which was sampled and analyzed by the Soil, Water, and Forage Testing Laboratory at Texas A&M University.

Plots were harvested at a 2-in. cutting height every 5 to 6 weeks during the growing season. A subsample of the harvested forage was collected from each plot, dried at 140°F for 48 hr, and used to calculate dry matter percentage. After the second growing season, soil samples were collected from 0 to 6 in. from each plot and analyzed by the Texas A&M University Soil, Water, and Forage Testing Laboratory for pH, nitrate-N (NO_3-N), salinity (by electrical conductivity), P, K, sodium (Na), Ca, and Mg. Analysis of variance was performed on the data with PC-SAS (SAS, 1982) with mean separation by Waller-Duncan Multiple Range Test at 0.05 level of significance.

Results and Discussion

There was a 10% yield advantage when all PL was applied in late spring vs. splitting it into two equal applications in 1992 (Table 1). Temperature and moisture conditions are more favorable for Coastal bermudagrass growth in May and June than July and August. Spring application of all the PL allowed for more plant nutrients to be available to the grass during the period of optimum bermudagrass growth. Applying 8 tons (344 lb estimated available N) and 4

tons (172 lb estimated available N) of poultry litter in late spring produced yields comparable to applying 400 and 200 lb of commercial N fertilizer in a split applications. An advantage of PL over commercial N fertilizer is the slower release of organic N during the growing season. Most of the N fertilizer is immediately available and therefore subject to leaching on sandy East Texas soils. Nitrogen use efficiency (lb forage produced per lb N applied) decreased as N rate increased.

Poultry litter used in 1993 contained only 42 lb N/ton which made the 8 (258 lb N/acre) and 4 ton (129 lb N/acre) rates similar to the 200 and 100 lb commercial N rates. This demonstrates the variability in nutrient content among poultry farms. As in 1992, applying poultry litter in a single spring application instead of two split applications produced higher yields and N use efficiency (Table 2). After 2 yr, soil pH had dropped to 5.0 in plots treated with 400 lb N/year (Table 3). Although not significant, plots receiving poultry litter had a slightly higher pH than the N fertilizer treatments. Low levels of NO_3-N were found in all plots since it leaches easily from sandy soils if not taken up by plants. Concentrations of salt, P, K, and Mg were significantly higher in the PL treated plots than in N fertilizer treated plots. These data support the concept that if poultry litter is the only fertilizer applied, P and K in excess of bermudagrass needs will accumulate in the soil. This is especially true of P.

Pollution of surface and ground water from land application of animal waste is always a concern. Application rate and soil texture and slope, application to bare soil versus grass sod are some of the factors which influence pollution potential. Runoff and erosion are the principal pathways for surface losses of P (Edwards and Daniel, 1992). Poultry litter applications to a grass sod resulted in increased infiltration and less runoff than bare soil. Hybrid bermudagrass is an excellent means of PL disposal because of its high plant nutrient removal capabilities.

Poultry litter is an excellent fertilizer for warm-season perennial grasses like hybrid bermudagrasses. Advantages over commercial fertilizers are slow N release, contains other plant nutrients besides N, P, and K, adds organic matter, and will raise soil pH after several years of annual applications. Disadvantages are variability in nutrient content, temporary odor after application, transportation costs prohibit moving long distances, and a soil P buildup if high rates are applied over a period of years. Under a hay harvest situation, 3 to 4 tons PL/acre should be applied in April followed with additional commercial N and K fertilizer after second and succeeding harvests. Only about 2 ton PL/acre should be applied under grazing conditions because of nutrient recycling through the animal. Soil samples should be collected annually and analyzed in both scenarios to monitor residual soil nutrients and adjust PL and/or commercial fertilizer applications to utilize excess mineral buildup in the soil.

Literature Cited

Edwards, D. R., and T. C. Daniel. 1992. Environmental impacts of on-farm poultry waste disposal - a review. Bioresource Technology 41:9-33.

Hue, N. V. 1992. Correcting soil acidity of a highly weathered utisol with chicken manure and sewage sludge. Commun. Soil Sci. Plant Anal. 23:241-264.

Kingery, W. L., C. W. Wood, D. P. Delaney, J. C. Williams, G. L. Mullins, and E. van Santen. 1993. Implications of long-term land application of poultry litter on tall fescue pastures. J. Prod. Agric. 6:390-395.

Payne, V.W.E., and J. O. Donald. 1990. Poultry: Waste management and environmental protection manual. Alabama Coop. Ext. Ser., Circ. ANR-580.

SAS Institute. 1982. SAS users guide: Statistics. Cary, NC.

Table 1. Comparison of poultry litter and commercial fertilizer on Coastal bermudagrass production in 1992.

Treatment	Available N[1]	Yield	N efficiency[2]
	lb/acre	lb DM/acre	lb DM/lb N
8T PL	344	9811 a[3]	14.6
400 N	400	9636 ab	12.2
4T + 4T PL	344	8850 bc	11.8
200 N	200	8679 c	19.5
4T PL	172	8324 cd	20.6
2T + 2T PL	172	7576 de	16.3
100 N	100	7137 e	23.6
0	-----	4774 f	-----

[1]A ton of poultry litter contained 71 lb N, 115 lb P_2O_5, and 77 lb K_2O, assumed 60% availability of N first year.
[2]Yield/lb available N (yield difference between treatment and control (no N) divided by available N).
[3]Yields followed by the same letter are not significantly different at 0.05 level, Waller-Duncan MRT.

Table 2. Comparison of poultry litter and commercial fertilizer on Coastal bermudagrass production in 1993.

Treatment	Available N[1]	Yield	N efficiency[2]
	lb/acre	lb DM/acre	lb DM/lb N
400 N	400	10,458 a[3]	16.0
8T PL	258	9,274 b	20.2
200 N	200	8,294 c	21.2
4T + 4T PL	258	7,838 cd	14.7
4T PL	129	7,451 d	26.3
2T + 2T PL	129	6,927 e	22.3
100 N	100	6,446 e	23.9
0	----	4,052 f	-----

[1]A ton of poultry litter contained 42 lb N, 32 lb P_2O_5, and 48 lb K_2O, assumed 60% availability of poultry litter N from this year and 10% from last year.
[2]Yield/lb available N (yield difference between treatment and control (no N) divided by available N).
[3]Yields followed by the same letter are not significantly different at 0.05 level, Waller-Duncan MRT.

Table 3. Soil pH, salt concentration, and extractible mineral concentration in top 6 in. of soil after 2 years of poultry litter (PL) and commercial fertilizer application.

Treatment	pH	NO_3	Salinity	P	K	Na	Ca	Mg
		ppm						
0 N	6.0 a[1]	1.0 c	52.5 d	3.5 d	81.8 c	20.8 a	558.5 a	48.0 b
100 N	5.8 a	1.5 abc	58.8 d	5.0 d	89.3 c	33.8 a	514.8 a	54.8 b
200 N	6.0 a	1.3 bc	55.0 d	4.3 d	89.8 c	28.5 a	500.8 a	46.8 b
400 N	5.0 b	1.0 c	56.3 d	7.8 d	97.5 c	41.3 a	381.8 a	36.8 b
4T PL	6.3 a	2.0 a	72.5 c	39.3 c	135.5 ab	34.0 a	648.3 a	77.5 a
2T + 2T PL	6.3 a	1.5 abc	73.8 bc	30.0 c	122.3 b	28.0 a	677.8 a	84.5 a
8 T PL	6.3 a	1.8 ab	83.8 ab	85.8 a	152.5 a	29.0 a	603.5 a	97.0 a
4T + 4T PL	6.2 a	1.5 abc	90.0 a	61.3 b	157.8 a	27.8 a	496.0 a	85.8 a

[1]Values within a column followed by the same letter are not significantly different at 0.05 level Waller-Duncan MRT.