EFFECTS OF POULTRY LITTER ON COTTON LINT YIELD

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Abstract

Alabama is a major poultry producing state. In north Alabama, high density poultry production has resulted in excessive application of poultry litter on some farms. The alternative could be to utilize poultry litter on crops and grasslands as N and P source. Urea, fresh and composted poultry litter at 40, 80, and 120 kg N ha^{-1}, as well treated with and without nitrification inhibitor, Craboxymethyl Pyrazole were compared on a decatur silt loam soil at Belle Mina, Alabama. The experiment was laid out in a randomized complete block design (RCBD). Nitrogen sources did not significantly affect plant height but rate of application did; increase of N rate from 40 to 80 kg N ha^{-1} and 80 to 120 kg N ha^{-1} had significantly increased plant height. The two forms of poultry litter did not differ in their effects on cotton lint yield but they both improved lint yield significantly compared to urea. Highest lint yield was recorded at 80 kg N ha^{-1} which was not significantly different from 120 kg N ha^{-1}; 80 and 120 kg N ha^{-1} was significantly better than 40 kg N ha^{-1}. The nitrification inhibitor, Craboxymethyl Pyrazole had no significant effect on height or lint yield of cotton (*Gossypium hirsutum* L.). The results suggest that poultry litter could be used as an alternative source of plant nutrient and thus can decrease the problem of poultry litter disposal in Alabama and SE USA.

Introduction

Poultry industry is growing in the Southeastern region of the USA. In Alabama, it is concentrated in the Sand Mountain region of the state (Kingery et al., 1994). Broiler producers marketed about 900 million birds and their cash receipts amounted to 1.44 billion dollars in 1995 (Vanderberry and Placke, 1995). Based on Mitchell et al., 1989 report, we can extrapolate that Alabama poultry industry now produces about 2.04 million tons of poultry litter per year. Application of poultry litter to crop land may serve as an important means of waste disposal. However, there is a growing concern that the indiscriminate disposal of poultry litter could cause ground water contamination with nutrients and eutrophication of lakes and water sources with run off P (Liebhardt et al., 1979; Pratt, 1979; Sallade and Sims, 1992; Sharpley et al., 1991).

Poultry litter has approximately 3.04: 1.25: 1.37 % of NPK (Mitchell et al., 1989). Composting poultry litter (processing manure aerobically in a static pile, called deep stacking, to produce a uniform and relatively odorless substance called humus) addresses many problems associated with its use as a fertilizer by lowering moisture content, reducing odor, giving looser and more friable texture, reducing weed seed viability, and providing uniform and stable particles that are easier to handle (Victor et al., 1991; Schelegel, 1992). Key ingredients for successful aerobic composting are a proper carbon to nitrogen ratio, proper moisture content and an adequate supply of oxygen for the bacteria. The carbon source could be wood chips, peanut hulls, or similar materials for composting. The microorganisms which function in the composting process are thermophilic (heat-loving). Typical composting temperatures are between 60^0 C and 71^0 C and may be as high as 77^0 C. Typically, 50% to 60% of the total N in fresh manure will be mineralized and become available for crop use in the first year. On the other hand, some reports indicate that composting can reduce the nutrient value by 20 to 30% (Brinton, 1985; Castellanos and Pratt, 1981). One of the disadvantages of the composting process is the volatile loss of ammonia which reduces the total nitrogen content of the manure and particularly the readily available nitrogen fraction.

Two major pathways for losses of fertilizer nitrogen from soil are leaching below the root zone and denitrification (Gerik et al., 1994). Mikkelsen et al. (1989) reported that treating composted poultry litter with nitrification inhibitor improved the nutrient value. The nitrification inhibitor sustains a higher ratio of ammonium to nitrate in soil by blocking conversion of ammonium to nitrate. Gutherie and Bomke (1980) reported that there are a number of advantages associated with delaying nitrification of ammonium-based fertilizers through the use of chemical nitrification inhibitors. By preventing rapid formation of nitrate in the soil, leaching and denitrification losses of nitrogen are minimized, thus increasing the efficiency of the fertilizers. Lower concentrations of nitrate in the soil would result in less nitrate contamination of the ground water as well as reduced emissions of nitrous oxide from denitrification (Guthrie and Bomke, 1980). Crawford and Chalk (1993) reported from their ^{15}N pot study with spring wheat that the use of a nitrification inhibitor resulted in enhanced ammonium nutrition.

The objectives of this study were to evaluate the effects of different sources [urea, fresh poultry litter (FPL) and composted poultry litter (CPL)] and rates [40, 80 and 120 kg N ha^{-1}] of N with and without treatment of nitrification inhibitor, Craboxymethyl Pyrazole (CMP).

Materials and Methods

Location

Experiment was located at the substation of Alabama Experimental System, Belle Mina, Alabama, situated at 34^0 41' latitude and 86^0 52' 30" longitude. The research station

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is situated in a cotton producing region of north Alabama. The soil is classified as Decatur silt loam (Rhodic paleudult).

Experimental Design and Plot Layout

The experiment was laid out in a randomized complete block design (RCBD) with total 20 treatment plots in each replication. The experiment had four replications. The treatments included three sources of nitrogen, urea, FPL, and CPL; three nitrogen rates, 40, 80, and 120 kg N ha^{-1}; with and without nitrification inhibitor, CMP arranged in a factorial set up of 3x3x2. In addition, two control plots (i) no nitrogen and no CMP and (ii) no nitrogen and CMP treatment were included thus forming a total of 20 treatments.

Each experimental plot consisted of 6 rows cotton of 30 feet long (0.00558 ha=0.0056 ha). Plant height was collected from rows 2 and 5. The center two rows 3 and 4 were used for yield estimates. Rows 1 and 6 were used as guard rows.

This experiment was initiated in 1994 cropping season. Since that time, treatments were continuously applied on the same plots. However, this presentation only includes 1998 season results.

Poultry Litter

FPL had 12% moisture content and 3.2% total N and was collected directly from a poultry house in Alabama. CPL was prepared by the TVA facilities at Muscle Shoals, Alabama. The poultry litter was composted for a total of 9 months. On a wet basis, CPL had 6.54% moisture and 3.46% total N. Available nitrogen from both CPL and FPL was estimated at 60% of the total N based on prior green house studies.

Carboxymethyl Pyrazole (CMP)

The nitrification inhibitor, CMP, was obtained from Department of Botany and Plant Pathology, Purdue University. It is an experimental nitrification inhibitor, two to four times more effective and less volatile than nitrapyrin. It was applied at 0.56 kg ha^{-1} a.i. The inhibitor was diluted 50:50 solution of ethanol and acetone, a total of 116 mL per plot was used. Urea, FPL and CPL were mixed thoroughly with CMP.

Cultural Operations

Based on initial soil chemical analysis at the beginning of the experiment in 1994, a blanket application of 336 kg ha^{-1} of 0-20-20 fertilizer was applied as a basal dose to all plots resulting in 67.2 kg ha^{-1} of P_2O_5 and K_2O was applied before starting the experiment. It was applied to nullify the effects of P&K additions through poultry litter application. Also to correct Ca and Mg deficiencies, 3359 kg ha^{-1} of dolomite limestone was also applied in 1994.

The inhibitor was sprayed directly on the soil. Urea, FPL and CPL were broadcasted and incorporated immediately into soil with a disk harrow. The cotton variety used for this research was DPL 33 B. It was planted on May 5, 1998. Weeds were controlled each year with preemrgence and postemergence herbicides. Early season seedling pests were controlled with an in-furrow application of insecticide and fungicide. The growth regulator, PIX (Mepiquat Chloride), was applied at the first bloom stage. The experimental site had an over-head sprinkler irrigation system.

Plant Height and Yield Measurements

Plant height at maturity was measured on September 25, 1998. Five plants were randomly selected in second and fifth rows of each plot and height was measured from ground level to mainstem apex. Average height was used for statistical analysis.

Cotton yield was measured from third and fourth rows in two picks on September 29 and October 12, 1998. The area of cotton yield measurement was 200 sq ft in each plot. Ginning percentage was 39%.

Statistical Analysis

Statistical analysis was performed in two ways: using 20 treatments and 4 replications in a RCBD. In addition, eliminating the control plots, the treatments that formed factorial arrangements were analyzed separately. This was done to be able to separate the effects of individual factors and their interactions. Data were analyzed using the GLM procedure of SAS Institute (1985). Means were separated using Tukey’s Studentized Range Test (HSD).

Results and Discussions

A few select data are presented. All sources and levels of N have significantly increased plant height and lint yield compared to control plots. The results from RCBD with factorial arrangement analysis are only presented here.

Plant Height

Plant height at maturity of cotton was significantly affected by rates of nitrogen (P=0.0001), however, it was not significantly affected by sources (P=0.2067) and nitrification inhibitor, CMP (P=0.6768) (Tables 1, 2, 3).

Maximum height of 118 cm was recorded at 120 kg N ha^{-1} followed by 103 cm at 80 kg N ha^{-1} and lowest at 40 kg N ha^{-1} (Table 1).

Lint Yield

Cotton lint yield was significantly affected by sources of nitrogen (P=0.0001) (Table 2) and rates of nitrogen (P=0.0001) (Table 1). However, lint yield was not significantly affected by nitrification inhibitor (P=0.3831) (Table 3).

Lint yield obtained from FPL and CPL plots were not significantly different from each other, however, they both increased lint yield more than Urea (Table 2). The lint yield was 1222 kg ha^{-1} at 40 kg N ha^{-1} and 1460 kg ha^{-1} at 80 kg N kg ha^{-1} but declined to 1409 kg ha^{-1} at 120 kg N ha^{-1} (Table 1). Regression equation showed a significant quadratic relationship between the lint yield and rate of N received.

$$\text{Yield} = 695.583 + 671.042\,(\text{kgN}) - 144.375\,(\text{kgN})^2 \qquad R^2 = 0.40$$

Summary

The fresh and composted poultry litter increased cotton growth and lint yield as well or better than urea. This allows the poultry industry in Alabama and SE USA to dispose off poultry waste on crops such as cotton as a nutrient source. This alternative use for poultry litter will help reduce the accumulation of poultry wastes around the poultry houses.

References

Brinton, W. F. 1985. Nitrogen response of maize to fresh and composted manure. Biol. Agric. Hort. 3:55-64.

Castellanos, J. Z. and P. F. Pratt. 1981. Mineralization of manure nitrogen-correlation with laboratory indices. Soil Sci. Soc. Am. J. 45:354-357.

Crawford, D. M. and P. M. Chalk. 1993. Sources of N uptake by wheat (*Triticum aestivum* L.) And N transformations in soil treated with nitrification inhibitor. Plant Soil. 149:59-72.

Gerik, T. J., B. S. Jackson, C. O. Stocckle and W. D. Rosenthal. 1994. Plant nitrogen status and boll load of cotton. Agron J. 86:514-518.

Guthrie, T. F. and A. A. Bomke. 1980. Nitrification inhibitor by microbial and nitrogen changes in poultry manure. J. Environ. Qual. 4:275-278.

Kingery, W. L., C. W. Wood, D. P. Delaney, J. C. William and G. L. Mullins. 1994. Impact of long-term land application of broiler litter on environmental related soil properties. J. Environ. Qual. 23:139-147.

Liebhardt, W. C., C. Golt, and J. Turpin. 1979. Nitrate and ammonium concentration of ground water resulting from poultry manure applications. J. Environ Qual. 8:99-125.

Mitchell, Charles C., James O. Donald, and John Martin. 1989. The value and use of poultry waste as fertilizer. Agriculture and natural resources. Circular ANR-244.

Mikkelsen, R. L., J. B. Martin and C. M. Hunt. 1989. Response of sorghum to additions of poultry waste and a nitrification inhibitor. TVA Muscle Shoals Greenhouse Exp. 423-A. Muscle Shoal, AL.

Pratt, F. P. 1979. Management restrictions in soil application of manure. J. Anim. Sci. 48:134-43.

Sallade, Y. E. and J. T. Sims. 1992. Evaluation of thiosulphate as a nitrification inhibitor for manures and fertilizers. Plant Soil. 147:283-291.

SAS Institute. 1985. SAS/STAT user's guide for personal computers. Version 6. SAS Inst., Cary, NC.

Schelegel, A. J. 1992. Effect of composted manure on soil chemical properties and nitrogen use by grain sorghum. J. Prod. Agric. 5:153-157.

Shaarpley, A. N., W. W. Troeger, and S. J. Smith. 1991. The measurement of bioavailable phosphorus in agricultural runoff. J. Environ. Qual. 20:235-238.

Vanderberry, H. L. and W. T. Placke. 1996. Alabama agricultural Statistics. Montgomery, Alabama. Bulletin 38. 1994-1995.

Victor, W. E., Payne and James O. and Donald. 1991. Poultry management and environmental protection manual. Circular AANR-580. Auburn, AL.

Table 1. Effects of rates of nitrogen on final plant height and lint yield of cotton, Belle Mina, 1998

Rates of N (Kg ha^{-1})	Height (cm)	Lint Yield (kg ha^{-1})
40	90c	1222b
80	103b	1460a
120	118a	1409a

*Means followed by same letter are not significantly different

Table 2. Effects of sources of nitrogen on final plant height and lint yield of cotton, Belle Mina, 1998

Sources of N	Height (cm)	Lint Yield (kg ha^{-1})
Fresh Poultry Litter	106a*	1420a
Composted Poultry Litter	103a	1388a
Urea	101a	1284b

*Means followed by same letter are not significantly different

Table 3. Effects of nitrification inhibitor on final plant height and lint yield of cotton, Belle Mina, 1998

Inhibitor (CMP)	Height (cm)	Lint Yield (kg ha^{-1})
With CMP	103a	1380a
Without CMP	104a	1350a

*Means followed by same letter are not significantly different