USE OF ALUMINUM SULFATE TO REDUCE SOIL TEST PHOSPHORUS LEVELS IN SOILS FERTILIZED WITH POULTRY LITTER

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Surface application of poultry litter to pastures can result in high concentrations of phosphorus (P) in runoff (Edwards and Daniel, 1993). Runoff of phosphorus (P) from fields receiving poultry litter has been speculated to be a principal factor affecting water quality in regions where the poultry production industry is concentrated. Many studies have linked increased total P concentrations in lake water to accelerated eutrophication (Vollenweider, 1975; Effler *et al.*, 1985).

Recent studies my Moore and Miller (1994) have demonstrated that the addition of aluminum sulfate (alum) to poultry litter converts P to nonsoluble forms. Shreve *et al.* (1995) found that P runoff from fescue plots fertilized with alum-amended litter was 87% lower than plots fertilized with normal litter. However, there is little information about the effects alum-treated litter additions have on the availability of P in the soil. The objective of this study was to compare soil P levels (Mehlich III extractable and water soluble P) in tall fescue plots treated with alum-amended litter, untreated poultry litter, and ammonium nitrate.

MATERIALS AND METHODS

The study was conducted using 52 small plots (1.52 by 3.05 m, with 5% slope) located at the Main Agricultural Experiment Station of the University of Arkansas on a Captina silt loam soil (fine-silty, siliceous, mesic Typic Fragiudult). The plots had been in continuous tall fescue production for 2 years. There were a total of 13 treatments; four rates of alum-treated poultry litter, four rates of untreated poultry litter, four rates of ammonium nitrate, and one unfertilized control. Litter application rates were 2.24, 4.49, 6.73, and

8.98 Mg ha^{-1} (1, 2, 3, and 4 tons $acre^{-1}$. These treatments were applied annually in the spring of the year for 34 consecutive years (1995, 1996, and 1997). There were four replications of each treatment in a completely randomized design. The poultry litter used for this study was collected from six commercial broiler houses in northwest Arkansas that had been used in a prior study to examine the effects of alum on ammonia volatilization (Moore *et al.*, 1997). Alum had been applied to half of the houses at a 1816 kg $house^{-1}$ rate after each growout. Alum was applied and mixed into the litter using a litter "decaker". This resulted in the alum-treated litter being approximately 10% alum by weight.

Soil samples (0-5 cm) were taken from each plot (10 cores/plot) periodically throughout the study. Mehlich III soil test P (Mehlich, 1984), and water soluble soil P (modification of Pote *et al.* (1996), with a 1:10 as opposed to a 1:25 dilution factor) were determined.

RESULTS AND DISCUSSION

Water Soluble Phosphorus

One year after the initial fertilizer treatment, plots that received the 8.97 Mg ha^{-1} untreated poultry little application had significantly higher water soluble P values than plots treated with the 8.97 Mg ha^{-1} alum-amended litter treatment (32.5 vs 23.5 mg P kg^{-1}). During the second study year, water soluble P values for plots treated with the 6.73 and 8.97 Mg ha^{-1} untreated litter applications were significantly higher than plots treated with the 6.73 and 8.97 Mg ha^{-1} alum-amended litter. Results from the third year of the study followed the same pattern, with the soil water soluble P values being higher in the untreated litter plots compared to equivalently treated alum-amended litter plots.

The most significant differences between treatments occurred during the third study year (Fig. 1). As application rates for the untreated litter increased, water soluble P concentrations increased. However, there were no significant differences in water soluble P values between unfertilized control plots and the plots fertilized with the four rates of alum. There were also no differences in water soluble P values between the unfertilized control and plots treated with NH_4NO_3.

Mehlich III Phosphorus

Mehlich III P values in the plots treated with untreated poultry litter increased significantly with an increasing application rate during the third study year (Fig. 1).

However, there were no significant differences in Mehlich III P values between the plots treated with the 4.48, 6.73, and 8.97 Mg ha^{-1} applications of alum-amended poultry litter. The unfertilized control and plots treated with NH_4NO_3 had the lowest Mehlich III P values.

CONCLUSIONS

After three years of treating tall fescue grass plots with alum-amended poultry litter, there were no significant differences in soil water soluble P values when compared to the unfertilized control. However, water soluble P levels in plots receiving untreated poultry litter increased each year, particularly at the higher rates of application. Alum-amended litter plots had significantly lower Mehlich III P values compared to equivalently managed untreated litter plots after two years of litter applications. This study is being continued to observe the long term effects of untreated poultry litter and alum-amended litter on P levels in the soil.

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REFERENCES

Edwards, D.R. and T.C. Daniel. 1993. Effects of poultry litter application rate and rainfall intensity on quality of runoff from fescue grass plots. J. Environ. Qual. 22:361-365.

Effler, S.W., C.T. Driscoll, M.C. Wodka, R. Honstein, S.F. Devan, P. Jaran, and T. Edwards. 1985. Phosphorus cycling in ionically polluted Onondaga Lake. New York. Water Air Soil Pollut. 24:121-130.

Mehlich, A. 1984. Mehlich 3 soil test extractant: A modification of Mehlich 2 extractant. Commun. Soil Sci. Plant Anal. 15:1409-1416.

Moore, P.A., Jr. and D.M. Miller. 1994. Decreasing phosphorus solubility in poultry litter with aluminum, calcium and iron amendments. J. Environ. Qual. 23:325-330.

Moore, P.A., Jr., B.E. Haggard, T.C. Daniel, D.R. Edwards, B.R. Shreve, and T.J. Sauer. 1997. Demonstration of nutrient management for poultry litter using alum precipitation of soluble phosphorus. Rep. #9006749920, U.S.E.P.A., Washington, DC.

Pote, D.H., T.C.Daniel, A.N. Sharpley, P.A. Moore, J., D.R. Edwards, and D.J. Nichols. 1996. Relating extractable soil phosphorus to phosphorus losses in runoff. Soil Sci. Soc. Am. J. 60:855-59.

Shreve, B.R., P.A. Moore, Jr., T.C. Daniel, D.R. Edwards, and D.M. Miller. 1995. Reduction of phosphorus in runoff from field-applied poultry litter using chemical amendments. J. Environ. Qual. 24:106-111.

Vollenweider, R.A. 1975. Input-output models with special reference to the phosphorus loading concept in limnology. Schweiz. Z. Hydrol. 37(1):53-84.

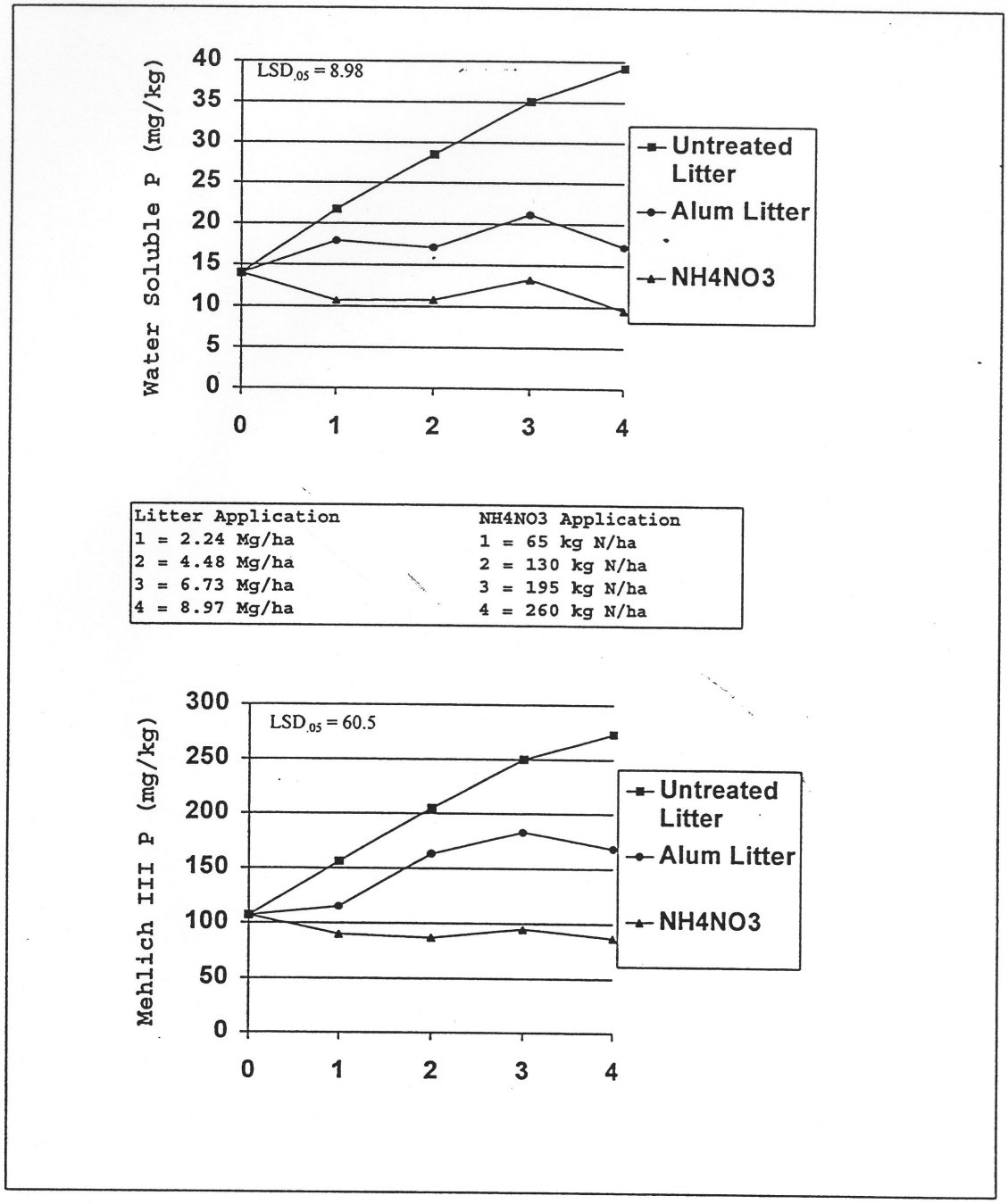

Figure 1. Soil Water Soluble P and Mehlich III P, June 1997.