Effect of long-term nutrient management strategies for pastures on phosphorus in surface runoff and soil quality

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Introduction Manure, whether mechanically applied or deposited by grazing animals, has been associated with increased risk of non-point source pollution, especially phosphorus. This is especially true in areas where the industry, especially poultry, has been concentrated in geographical areas that are grain deficient, resulting in a reliance on imported grain for poultry feed. Intensification has resulted in the production of large quantities of poultry manure, within relatively small geographical areas. Surplus litter is typically land applied as a nutrient source or used as an animal feed. The objective of this project was to evaluate the effects of long-term nutrient management strategies using poultry litter as a feed and fertiliser for grazed pasture systems in the Shenandoah Valley of Virginia on soil quality, selected soil chemical characteristics and P losses in surface runoff.

Materials and methods The original experiment was established in 1994 and consisted of stocker cattle grazing endophyte-free tall fescue (*Festuca arundinacea* schrub. KY-31). Treatments included: (1) no fertiliser control (i.e., no feeding of broiler litter or soil application of fertiliser or litter) (C); (2) surface application of inorganic fertiliser (AIF); (3) surface application of broiler litter (ABL); and (4) feeding broiler litter (FBL) to the grazing cattle (all they would eat). Applied broiler litter and inorganic fertiliser supplied the same amount of total N, P, and K as was fed as broiler litter to the steers (FBL) in the previous year. The amount of broiler litter fed to the cattle and land applied averaged 2600 kg/ha per yr (29 kg P/ha per yr). The experimental area was divided into 12 x 1.03-ha paddocks (three paddocks per treatment), with four steers grazing from Dec. through Sept./Oct. Surface applications of broiler litter and inorganic fertilisers were made in late spring (June) each year. Soil samples from the surface 0-10 cm were collected in the autumn of each year for routine chemical analysis

Phosphorus losses in surface runoff were measured in 2001 (7th-year of the trial) using protocols established for the National P Runoff Project (Sharpley *et al*., 1999). Portable rainfall simulators were used to evaluate the relationships between P concentrations in surface runoff and soil test P (STP). Two runoff plots were located in each paddock on a slope of 5-8% and within each plot, paired 0.75 x 2-m subplots (one 1.5 x 2-m plot split along the long axis) were used. Soil was sampled adjacent to the runoff plots prior to the simulated rainfall events. Runoff was collected for a 30-min period and analysed for dissolved inorganic P (DPi), molybdate reactive P (MRP), total dissolved P (TDP), particulate P (PP) and total P (TP) (Pierzynski, 2000). The paddocks were also sampled in 2001 and the autumn of 2004 for selected soil chemical and soil quality characteristics.

Results Feeding broiler litter (FBL), ABL and AIF resulted in a significant increase in the levels of Mehlich-1 extractable soil P in the surface 0-5 cm layer as compared to the no fertiliser control (C). Concentrations of DPi, MRP and TDP in simulated surface runoff were higher in AIF, ABL, and FBL as compared to the C treatment. These concentrations in runoff were higher in AIF and ABL as compared to FBL, indicating that feeding broiler litter to cattle decreased the potential mobility of P. This may be due in part to the absorption of soluble P from the litter by the animals. Particulate P losses were lower than the MRP fraction, constituting 27, 42, and 27% for AIF, ABL and FBL, respectively, compared to 50% in the C treatment. Regression analysis showed that there was a significant relationship between soluble P concentrations (DPi, MRP and TDP) and selected soil test P methods. Soil analysis data suggests that fertilisation improved soil chemical and physical characteristics.

Conclusions Results of this long-term study demonstrate that the use of broiler litter as a fertiliser or as a feed for cattle increased the levels of extractable soil nutrients and improved soil physical characteristics of grazed pastures. The results also demonstrated that soluble P losses in surface runoff using simulated rainfall increased with increasing soil P levels, but the risk of P losses in surface runoff was no greater with using broiler litter as a nutrient source as compared to inorganic fertiliser.

References

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