USING THE GEORGIA P-INDEX TO IDENTIFY HIGH RISK MANAGEMENT OF POULTRY LITTER

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Abstract. The Georgia P Index was developed as a tool to evaluate the risk of bioavailable P loss in fields under various management practices. We compared the results of the P Index with four years of data from 1.5 m by 4.6 m bermudagrass plots fertilized with poultry litter at 8.9 Mg ha^{-1} (recommended rate); poultry litter at 17.9 Mg ha^{-1}; composted poultry litter, poultry litter with alum, commercial fertilizer; and a control (no amendments). P Index ratings above 75 indicate high risk where management should be changed. The P Index indicated management changes would be needed for the 17.9 Mg ha^{-1} treatment during all 4 years, for composted PL during year 4, and for PL with alum during years 3 and 4. The P Index did not indicate management changes were necessary using the recommended rate of 8.9 Mg ha^{-1} after 4 years of application; however, volume-weighted P concentrations in the 8.9 Mg ha^{-1} treatment were double the control concentrations during years 3 and 4. The comparison indicates that the P Index does identify high risk management practices under the conditions of this study.

INTRODUCTION

Broiler chickens are the primary cash commodity in Georgia generating $2.14 billion in 2003 (Georgia Agricultural Statistics Service, 2004). Over 1.26 billion birds are produced each year. Broiler production has been concentrated in north Georgia and many poultry farmers also have cow-calf operations. The litter produced in the poultry houses has been an important source of fertilizer for the pastures and hayfields of these types of operations. Litter is usually applied to meet the nitrogen needs of the forages. Poultry litter typically contains 3% nitrogen, 3% phosphorus, and 2% potassium (Ritz and Merka, 2004). Because forages require approximately four times more nitrogen than phosphorus, phosphorus is over-applied. Over time, soil test phosphorus (STP) increases above concentrations needed for crop growth. STP measures the amount of phosphorus available for plants, and is lower than total phosphorus due to the high sorption capacity of the clayey soils in north Georgia. High STP is not necessarily detrimental to crop growth, but has been linked to increased phosphorus in surface waters, which can trigger eutrophication (Sharpley et al., 1994; Pote et al., 1996). The risk of phosphorus impacting surface waters is dependent not only on a source, but also on transport (Lemunyon and Gilbert, 1993).

The Georgia P Index was developed to help farmers identify situations where there is a high risk of impacting surface waters (Cabrera et al., 2002). The P index calculates a risk for an individual field (low, medium, high, and very high) and contains recommendations for management practices to maintain the risk in the medium range. The P Index asks farmers to identify phosphorus sources: STP, commercial fertilizer, and animal wastes. The runoff curve number is used to estimate the risk of runoff from the field. The Revised Universal Soil Loss Equation 1 (RUSLE 1) is used to generate sediment loss. Leaching risk is estimated through the Percolation Index (Williams and Kissel, 1991). Since October of 2002, farmers have used the P Index as part of their nutrient management plans. The objective of this study was to use an existing data set to determine if the P Index was identifying high-risk situations under the conditions of the study.

METHODS

Plot Data

The data used for the comparison comes from an existing plot study evaluating by-product's effects on bermudagrass (*Cynodon dactylon*) hay production, hay quality, soil chemistry, and runoff water quality. The plots are located near Calhoun, GA at the Northwest Georgia Research and Education Center's Redbud Farm. The plots were established on a Waynesboro soil (Fine, kaolinitic, thermic Typic Paleudult) with a 2% slope. Borders were installed to create 1.5 m by 4.6 m runoff plots on which surface application of poultry litter at 8.9 Mg ha^{-1}; poultry litter at 17.9 Mg ha^{-1}; composted poultry litter, poultry litter with

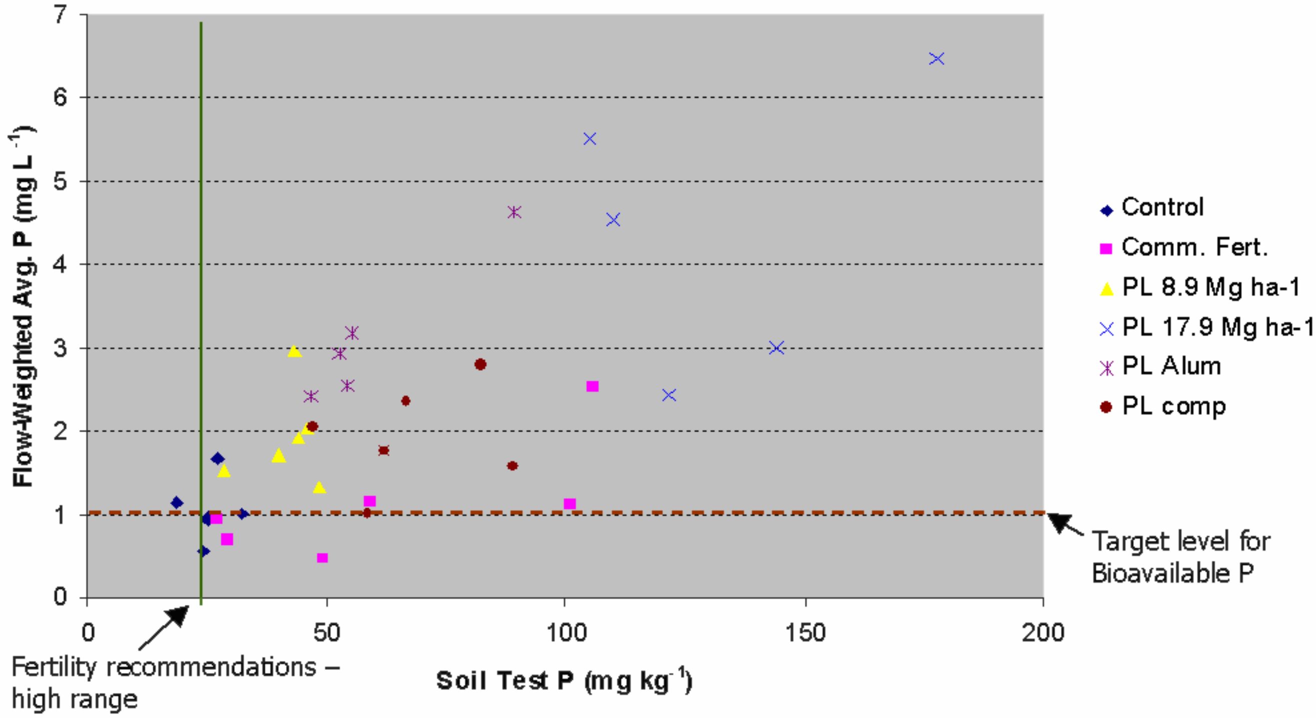

Figure 1. A comparison of STP and the average annual total P in runoff.

alum, and commercial fertilizer occurred. A control with no amendments was also established. The poultry litter treatments were applied annually at the recommended target N rate of 202 kg ha^{-1} except 17.9 Mg ha^{-1}, which is double the recommended rate. Duplicate plots were established for each treatment. Hay was harvested from the plots three to four times during the growing season.

Three years of data in which at least five runoff collections occurred per year were used. Runoff collections were biased towards larger rainfall events, usually 2.54 cm or more in a 24-hour period because the smaller events did not generate enough volume for sampling. The time span between the application of litter and the first substantial rainfall ranged between two to six weeks. The total annual rainfall for 2001, 2002, and 2003 was 994, 1079, and 1399 mm respectively. The 47-year average annual rainfall for the site is 1422 mm (Georgia Automated Environmental Monitoring Network, 2005). A subsample of the total runoff was analyzed for total P and dissolved reactive P. Total volume collected and concentration of P was used to calculate a flow-weighted annual average. Soil samples were taken annually from each plot at a depth of 0 – 10 cm and analyzed for Mehlich I P, Ca, Mg, Mn, and Zn, pH, and lime requirement. The poultry litter applied was analyzed each year for total P by Inductively Coupled Plasma using EPA method 200.7 (USEPA, 1994).

P Index

The P index was calculated for each test plot for three years. The STP and amount of P applied in the litter were input from the data described above. Commercial P fertilizer was applied to commercial plots in 2001, as indicated by the STP. The type of manure variable was set at “Poultry Litter w/o Alum”. Although one poultry litter treatment had alum added, it was added in the house to control ammonia volatilization at a rate of 0.45 Mg flock^{-1}. This is below the recommended rate for P immobilization (1.8 Mg flock^{-1}). Manure P Method was “surface applied, not incorporated Nov, Mar, Apr”, because all applications were surface-applied by hand in April. The hydrologic soil group was set to “Waynesboro” based on the soil series classification of the site. A runoff curve number of “70” was used based on the hydrologic soil group B for the Waynesboro series and pasture or range in good hydrologic condition. The yearly sediment loss of “0.0388” ton acre^{-1} year^{-1} (86 kg ha^{-1} year^{-1}) was calculated using RUSLE 1 with a bermudagrass hayfield with 90% cover, 2% slope, and 4.6 m slope length. Vegetative buffer width was zero. Significant differences between the calculated P Index, average annual runoff P, STP, and P applied were tested

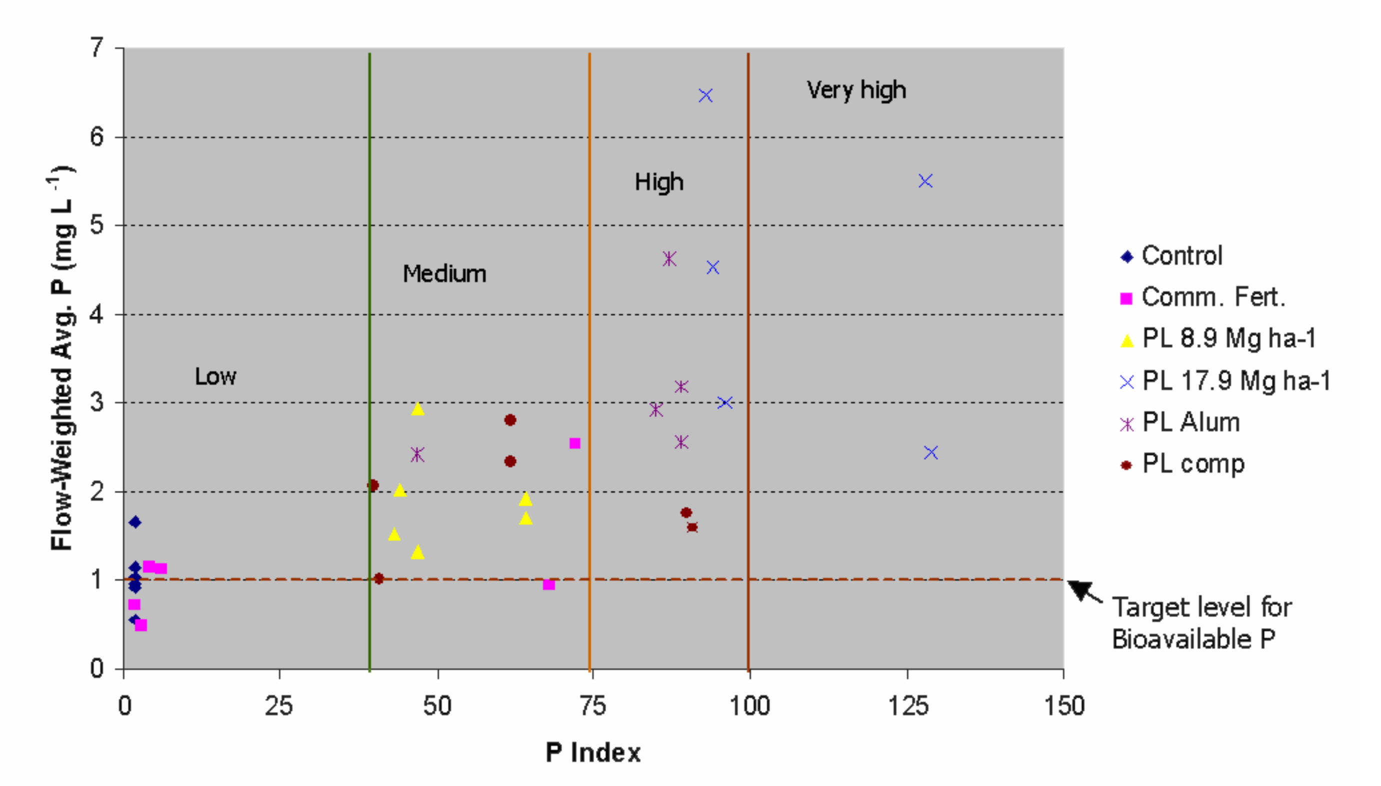

Figure 2. The Georgia P index calculations for each runoff plot compared to average annual total P in the runoff.

Table 1. P Index Performance

Index	Avg. Annual Runoff	Soil Test P	P Applied
Low	0.98a	39.1a	0a
Medium	1.97a	52.7a	113b
High/V High	3.51b	96.6b	221bc

with an ANOVA at p=0.05. If significant differences were found, different from groups were determined using a Tukey-Kramer Multiple Comparison (Hintz, 2000).

RESULTS AND DISCUSSION

STP results ranged from 19 mg kg^{-1} in the control to 178 mg kg^{-1} in the plots with poultry litter applied yearly at 17.9 Mg ha^{-1} (Figure 1). Based on data from benchmark soils in Georgia (Schroeder et al, 2004), the P Index sets STP at 225 mg kg^{-1} as the critical level above which P in runoff would exceed a target concentration of 1 mg L^{-1}. None of the plots had STP above that critical level; however, several plots had average annual total P in the runoff above the 1 mg L^{-1} target. The higher average annual concentrations of total P in the runoff are due to the P supplied by the poultry litter on the surface. In general, the higher amount of P applied, the higher average annual P concentration in the runoff (data not shown). The annual average total P in runoff from the control plots with no P additions also exceeded the 1 mg L^{-1} target. Phosphorus concentrations greater than 1 mg L^{-1} from mineralization of dead grass on the soil surface has also been seen in pastures at Eatonton, GA (Kuykendall et al., 1999)

Farmers are encouraged to keep the P Index below 75. Above 75, management changes need to be made to reduce the risk to surface waters. In general, the P Index flagged situations that would be high risk (Figure 2, Table 1). For example, the overapplication of poultry litter (17.9 Mg ha^{-1}) was always identified as high risk. However, many of the practices identified as medium risk had average annual total P concentrations in the runoff two to three times higher than the target of 1 mg^{-1}. The control and commercial plots were low risk, except when commercial P fertilizer was applied in 2001 to the commercial plot, the risk then increased to medium. The average annual runoff P was significantly different for plots with high and very high P Indices (Table 1). Soil test P was also significantly different for these plots.

CONCLUSION

Under the conditions of this small-scale study, the Georgia P Index did flag situations where management would need to be changed. However, in the medium risk category, the average annual TP runoff is two to three times greater than the target of 1 mg mg L^{-1}. The USEPA ambient water quality criteria recommendation for streams and rivers in the Ridge & Valley province is 0.035 mg L^{-1}. All of the average annual TP concentrations were well above this concentration, even in the control plots with no fertilizer additions. These concentrations reflect runoff without any buffers or vegetation filters. Natural buffers have been shown to be effective in reducing nutrient loadings to surface waters (Vellidis et al., 2003). The average annual runoff TP of around 1 mg mg L^{-1} in the control indicates natural vegetation buffers may be needed to reduce water quality impacts.

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