

TIMELY INFORMATION

Agriculture & Natural Resources

Water Quality Benefits of Subsurface-Banded Poultry Litter

Introduction

Poultry industry is one of the largest industries in the state of Alabama. About half of Alabama's agriculture export, on a dollar-value basis, comes from poultry products. The industry and its allied partners also play an important role in providing around 80,000 jobs to local citizens. Alabama poultry growers market more than 1 billion birds per year, making the state the third-largest poultry producer in the United States. Although the poultry industry provides significant economic benefit to the state, there are threats to production due to water quality problems associated with poultry (broiler) litter over-application. More than 1.25 million tons of broiler litter is produced annually (Aksoy et al., 2008). In many cases, this litter is applied near the production facilities to pastures as a cheap alternative to commercial fertilizers. This has resulted in long term repeated application of poultry litter to the same agricultural fields.

In the past, poultry litter was applied based on nitrogen (N) requirement of a crop to reduce the nitrate loss through leaching to groundwater (Sharpley et al., 1994). Since crops generally need three to four times more N than Phosphorus (P), N-based poultry litter application caused surplus of P spread or applied on agricultural fields, such as pastures. This surplus P application eventually causes excessive accumulation of P in soils. The excess P in soils can be transported to nearby surface waterbodies mainly through surface runoff. Thus, the application of poultry litter on agricultural fields and pastures results in water quality problems and associated eutrophication issues.



Figure 1. Left side view of the four-row prototype implement for subsurface band application of poultry litter developed at the USDA-ARS National Soil Dynamics Laboratory (Auburn, Alabama).

In Alabama, nutrient management planning is required for concentrated animal feeding operations (CAFOs) and suggested for animal feeding operations (AFOs). Although AFOs do not require nutrient

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management plans, they have to meet or exceed NRCS technical standards and guidelines for applying animal waste on fields. NRCS technical standards also state that a soil test should be done on every field receiving animal wastes at least every three years. Thus, a soil test is a fundamental best management practice (BMP) to mitigate the P movement to the nearby surface water.

Although maintaining a nutrient management plan and soil tests are effective BMPs, there are other efforts in Alabama which are being tested to reduce the water quality impacts of poultry litter applications. One BMP that is being tested by the USDA National Soil Dynamics Laboratory in Auburn, AL is the subsurface banding of poultry litter (Fig. 1). This information sheet provides information about the water quality benefits of subsurface-banded broiler litter to pastures. These benefits were identified through a research study conducted on a pasture at the Sand Mountain Research and Extension Center in Crossville, AL (Fig. 2). The experiments were conducted by a group of researchers from the Biosystems Engineering Department, Auburn University and the USDA National Soil Dynamics Laboratory in Auburn, AL.



Figure 2. The plots (right) and the subsurface band applicator used for the study at the Alabama Agricultural Experiment Station's Sand Mountain Research and Extension Center in Crossville, AL.

The overall objective of this study was to quantify P loss in surface and subsurface flows from surface-applied and subsurface-banded poultry litter. A plot-scale rainfall simulation experiment was conducted on nine plots (Fig. 2). To measure the quality and quantity of water leaching down, lysimeters were installed in each plot at 50 cm below the soil surface. Runoff and leachate samples collected were analyzed for various nutrient concentrations. Some of the results and conclusion of this experiment are discussed here.

Subsurface Banding of Poultry Litter

The USDA-ARS National Soil Dynamics Laboratory in Auburn, Alabama has developed a four-row prototype implement for subsurface band application of poultry litter (Fig. 1) and has used the implement to apply poultry litter in row crops and pastures. The band spacing is adjustable from 0.25 to 1.0 m (10 to 40 in.) in increments of 25 mm (1 in.). The implement is capable of applying poultry litter in a side-dressing manner to row crops, and the band spacing is then typically equal to the crop row spacing. Also, the implement is capable of applying litter to pastures, and typical band spacings that have been used for pastures are 25 to 38 cm (10 to

15 in.). Before litter is loaded into the implement, the litter does need to be run through a hammer mill or similar size-reduction process to breakdown clumps that are larger than about 25 mm (1 in.) across. Also, to avoid litter-clogging, the litter moisture content should be less than 40% wet basis. Subsurface banding of broiler litter to cotton with this implement has been shown to increase lint yield relative to surface broadcast application of litter (Tewolde et al., 2009). Subsurface band application of broiler litter to tall fescue and bermudagrass pastures using band spacings of 25 and 38 cm (10 and 15 in.), was found to produce forage yields equivalent to those for surface broadcast application of litter (Warren et al., 2008).

Research Findings

Water budget: Water budget from nine plots is summarized in Table 1. The study showed that less than 10% of the rainfall was converted to runoff (Table 1). Sen et al. (2010) also showed that less than 10% of the rainfall occurring over a pasture hillslope contributes to surface runoff. It can be concluded that, irrespective of poultry litter application method, significant subsurface flow occurs in this region of north Alabama. Therefore, transport of nutrients via subsurface flow may be important in this region.

Table 1. Water budget for the experiment showing amount of rainfall applied, runoff generated, volume of water infiltrated, and percentage of rainfall which contributed to runoff and infiltration.

	Litter Treatment		
	Control plots	Surface-applied litter plots	Subsurface-banded litter plots
Rainfall (m ³)	0.56a	0.51a	0.58a
Runoff (m ³)	0.05a	0.04a	0.04a
Infiltrated (m ³)	0.51a	0.46a	0.53a
Percentage of rainfall contributed to runoff	8.9	7.8	6.9
Percentage of rainfall infiltrated	91.1	92.2	93.1

Within each row means followed by the same letter are not significantly different at $\alpha = 0.05$ (LSD).

Phosphorus Transport: Results of nutrient analysis showed that P concentrations as well as loadings (mass load) were higher in the surface runoff for the surface-applied poultry litter plots as compared to the control and subsurface-banded plots. The PO₄-P and total P (TP) loadings were about 88 and 83% more in surface runoff from the surface-applied litter plots than subsurface-banded plots (Fig. 3). The loadings of PO₄-P and TP were reduced by 97 and 47%, respectively, in leachate when broiler litter was subsurface-banded (Fig. 3). These results show that in subsurface-banded litter plots most of the P stayed in the trench where broiler litter was applied. The results show that subsurface application of litter is a better method to control P load in surface runoff in comparison with surface application of litter.

Results also showed that mass loads of PO₄-P and TP (65 and 42%, respectively) were higher in leachate than surface runoff from surface-applied litter plots. This shows that subsurface transport of P can transfer a significantly greater amount of P than surface runoff in this region. Therefore, if the farmers continue to apply litter on surface, they need to think about ways to reduce subsurface transport. This might mean reducing the rate of application, or a BMP (e.g., phytoremediation through deep-rooted plants) that can remove P before subsurface flows reach to a stream or other water bodies.

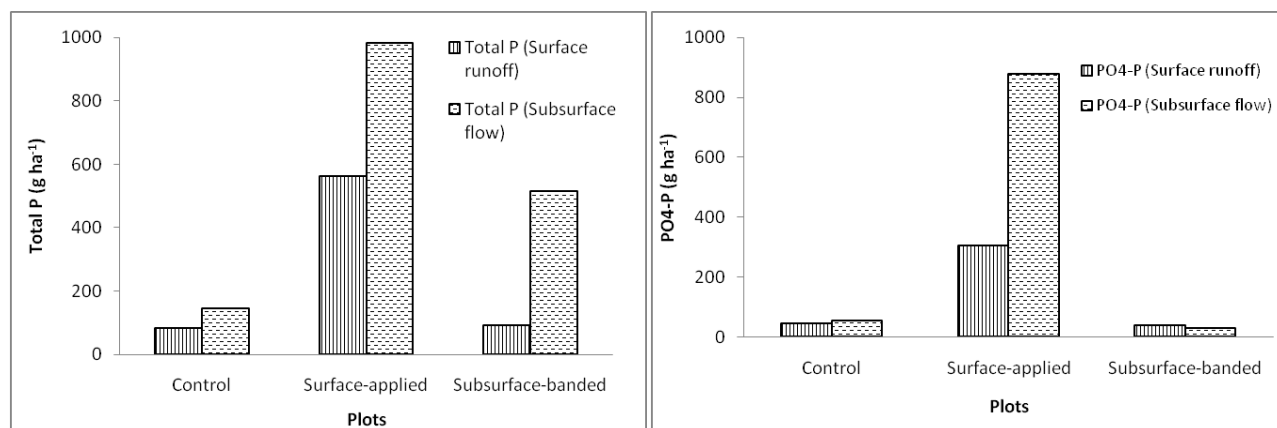


Figure 3. Comparison of TP loading (left) and PO₄-P loading in surface runoff and subsurface flows from control, surface-applied, and subsurface-banded litter plots.

Conclusions: The study showed that more than 90% of water infiltrated down in all the plots (control, surface-applied and subsurface-banded) and thus there is a potential for significant subsurface flows in this region of north Alabama. The results of this study showed that the poultry litter application method affects P loss in surface runoff and subsurface flows. The concentrations as well as mass loss of nutrients were significantly reduced in surface runoff from plots with subsurface-banded poultry litter. This might be because in subsurface application of litter surface runoff does not come in direct contact with broiler litter applied in trenches.

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