Evaluation of Continuous-furrow Knife Aeration to Reduce P Export from Applied Poultry Litter using a Paired-watershed Approach

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INTRODUCTION

Surface-applied manures are of particular concern in the Southern Piedmont (USA) because of high production of broilers and associated manures. As these manures can contribute to P in runoff, a study was conducted to examine the water conservation potential of continuous-furrow knife aeration of grasslands. Knife aeration has potential to reduce P transport by increasing infiltration of rainfall, slowing overland flow, and increasing the binding of P with soil minerals.

OBJECTIVE

To examine the effect of continuous-furrow knife aeration perpendicular to the slope on runoff volume and the export of total P (TP) and dissolved reactive P (DRP) from pastures with applied broiler litter using a paired watershed approach.

MATERIALS AND METHODS

- Six paired, bermed field watersheds (area ranging from 0.72 to 0.79 ha) were monitored by automatic sampling (Fig. 1) during rainfall events from 1995 to 1998 to develop calibration relationships between the paired watersheds
- Knife aeration to an average depth of 10-cm (27-cm spacing between rows) completed using ammonia injection knives attached to a chisel plow frame (Fig. 2)
- One watershed from each pair (Fields 1&2, 4&5, 3&6; Fig. 3) was knife aerated (Fields 2,5,6) in spring and fall 2005, spring and fall 2006, and spring 2007, immediately following broiler litter application
- Runoff samples analyzed for TP and DRP

Fig. 1. Field watershed with H-flume & Coshocton wheel setup

Fig. 2. Aeration equipment and procedure

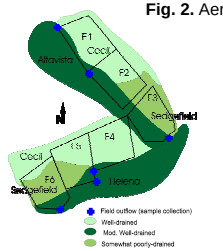


Fig. 3. Soil types and drainage classes of field watersheds

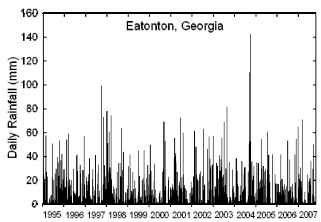


Fig. 4. Daily precipitation at study site from 1995 to 2007

RESULTS

Runoff Volume

- Using historic data before knife aeration, the slope of the regression of runoff from Field 2 (to be aerated) against runoff volume from Field 1 (not aerated) was 1.86 (Fig. 5a.; "Before") which indicates that Field 2 had approximately 1.86 times more runoff than Field 1 while under the same management
- With knife aeration on Field 2, slope of the regression was lowered ($p < 0.05$) from 1.86 to 1.40 (reduction of 22%), while the intercept was unchanged (Fig. 5a; "After")
- No effect of knife aeration on Field 5 (Fig. 5b)
- Slope of regression on Field 6 was reduced from 1.02 to 0.73 ($p < 0.05$), a reduction of 28%

Total P and Dissolved Reactive P Mass Export

- Greatest knife aeration effect on TP ($p = 0.12$) and DRP ($p < 0.001$) export observed from Field 2 (Fig. 6a,b)
- Similar to runoff volume, no effect of knife aeration at Field 5 (Fig. 7)
- Regression slope lower with knife aeration at Field 6 ($p < 0.01$), but with a high level of variability (Fig. 8)

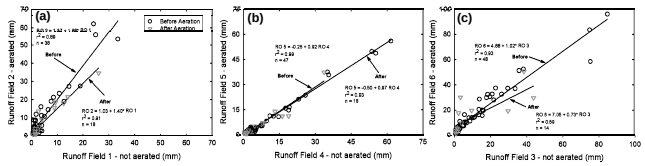
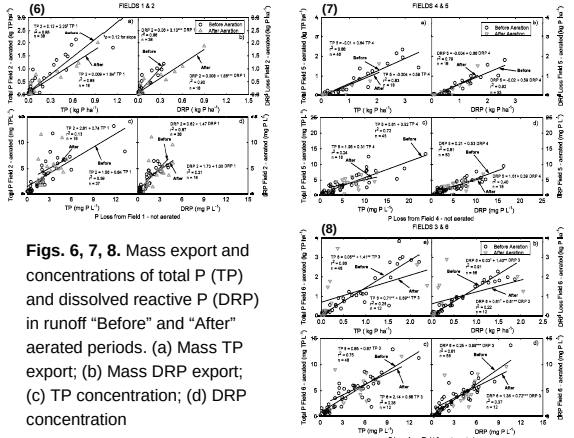


Fig. 5. Runoff volumes from aerated (*y* axis) and nonaerated fields (*x* axis) "Before" and "After" aerated periods. (a) Field 2; (b) Field 5; (c) Field 6



Figs. 6, 7, 8. Mass export and concentrations of total P (TP) and dissolved reactive P (DRP) in runoff "Before" and "After" aerated periods. (a) Mass TP export; (b) Mass DRP export; (c) TP concentration; (d) DRP concentration

CONCLUSIONS

Continuous-furrow knife aeration was most effective in reducing runoff volume (22%) and export of total P (18%) and dissolved P (41%) on Field 2, characterized by predominantly well-drained soils. Knife aeration was less effective on Field 6 (characterized by predominantly poorly drained soils), and was not effective on Field 5 (characterized by predominantly well-drained soils, but relatively high seasonal water table).

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