EFFECT OF GRASS FILTER STRIPS ON REDUCING PO_4-P LOSS IN RUNOFF FROM FORAGE CROPLAND

M.W. Jung, N.C. Jo, S. H. Yoon, W. H. Kim, K.Y. Kim, and S. Sung

Grassland and Forages Division, National Institute of Animal Science, Rural Development Administration, Cheon-an 331-808, Korea.

Key words: Grass filter strips, PO_4-P, Runoff, Livestock manure

Abstract

The performance of grass filter strips (GFS) in abating PO_4-P concentrations from the forage cropland was tested in an experiment on the 10% slope in Grassland and Forages Division, National Institute of Animal Science, Rural Development Administration (RDA) from October 2007 to September 2009. Forage croplands with rye-corn double cropping system applied with chemical fertilizer and livestock manure (LM) were compared in a natural condition. The plots were hydrologically isolated Main plots consisted of the length of GFS, such as 0m, 5m, 10m and 15m. Sub plots consisted of the type of LM, such as chemical fertilizer (CF), composted cattle manure (CCM) and composted swine manure (CSM). Concentrations of PO_4-P in surface runoff water were reduced as the length of GFS increased. Especially, GFS with 10m and 15m reduced PO4-P concentrations significantly compared to that with 0m and 5m ($p<0.05$). The results from this study suggest that GFS improved the removal and trapping PO_4-P from forage croplands.

Introduction

An estimated 42 million tons of LM are collected in South Korea, annually. Environmental contamination can occur when application of LM to the land is in excess of crop utilization potential, or is done under poor management conditions causing nutrient losses due to environmental factors such as soil erosion or surface runoff during rainfall (Ramos *et al.*, 2006). Surface runoff during rainfall can cause significant pollution following the application of LM to the land (Allen and Mallarino, 2008). Also increasing concentrations of P in surface runoff may contribute to eutrophication of lakes and rivers. In Korea, most of crop cultivation lands, except paddy fields, are on a slope and the significant precipitation experienced during a normal summer season leads to runoff of nutrients rather than their leaching into the subsurface. To control the nutrients loss in runoff from agriculture land, GFS are commonly used as a best management practice in some countries. GFS slows runoff and promote infiltration (Meyer *et al.*, 1995) and enhance deposition of soil and organic matter (Melville and Morgan, 2001). Objectives of this study were to determine the effect of GFS on PO_4-P loss in runoff from corn field with LM application.

Materials and methods

The experiment was conducted from October 2007 to September 2009 on the 10±3% slope in Grassland and Forages Division, National Institute of Animal Science, Rural Development Administration. Silage corn cropland received composted cattle manure were compared in a natural condition. The plots were hydrologically isolated. Main plots consisted of the length of GFS, such as 25m^2 (5×5m), 50 m^2 (5×10m), 75

m^2 (5×15m). Sub plots consisted of the type of LM such as CF, CCM, CSM. Application rates were calculated in total nitrogen contents. All plots were applied at 200 kg N ha^{-1} $year^{-1}$ on each plot at 10 days before seeding. GFS were installed in March 2007 with mixed grassland of Orchardgrass, Tall fescue, Perennial ryegrass, Kentucky bluegrass and White clover. The monitoring wells for sampling the surface water in GFS were constructed with 40cm long and capped at the bottom (Figure 1). All representative samples were rapidly collected from plastic sampling bottles when rainfall occurred, immediately frozen in deep freezer and stored at -20°C. All samples were analyzed within 24 hours after collecting the sample. PO_4-P concentrations were determined using HS-2300 Plus -water analyzer (Humas, Korea).

Results and Discussion

Concentrations of PO4-P with Average concentrations of PO_4-P in runoff water were reduced as the length of GFS increased (Figure 3, 4). Especially GFS with 10m and 15m reduced PO_4-P concentrations significantly compared to that with 0m and 5m ($p<0.05$). The effectiveness of GFS in reducing PO_4-P transport in runoff from agriculture land has been recorded by number of authors (Schmitt *et al.*, 1999, Heathwaite *et al.*, 1998). Also The UK Code of Good agricultural Practice for the protection of Water (MAFF, 1991) recommends leaving a 10m buffer strip between agricultural land and adjacent watercourse. This may have been the result of adsorption by plants and infiltration of runoff with colloidal particles (Chaubey *et al.*, 1995). Our results demonstrate the potential for PO_4-P loss in surface runoff where rainfall closely follows fertilizer or LM application (Figure 2). Hooda *et al.* (1997) working in Scotland recorded 42% of annual P loss in the week following slurry application to grassland. Therefore, slurry run-off is carefully handled in aspect of environmental preservation, because 60~70% of annual rainfall (1100~1400mm) of Korea occurs during the summer period (July to September). The results from this study suggest GFS improved the removal and trapping PO_4-P loss from corn field with LM application in forage crop land in Korea. .

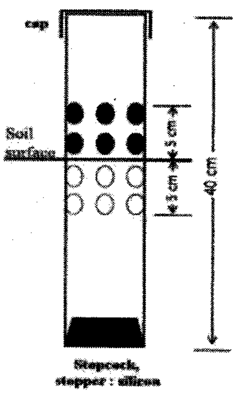

Figure 1. The design of sampling wells used in grass filter strip.

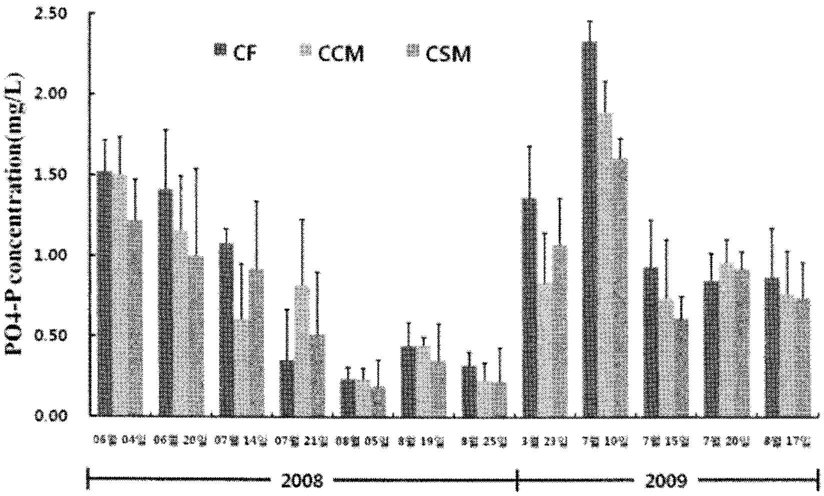

Figure 2. Changes of PO4-P concentration in surface runoff water with application of livestock manure. Values represent the means ± SD of the three replicates. CF:Chemical fertilizer, CCM:Composted cattle manure, CSM:Composted swine manure.

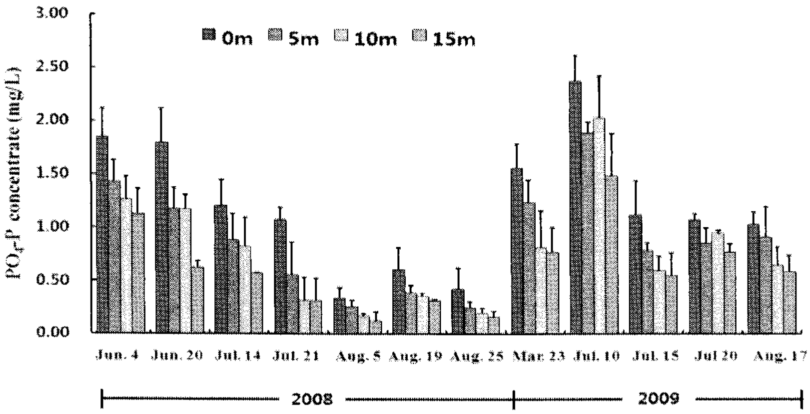

Figure 3. Changes of PO_4-P concentration in surface runoff water with application of the length of grass filter strips. Values represent the means ± SD of the three replicates. 0m, 5m, 10m and 15m : Length of grass filter strips.

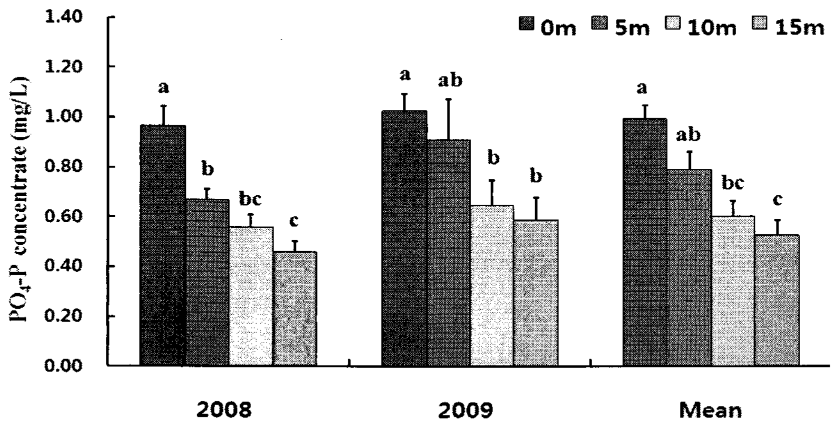

Figure 4. Annual average PO_4-P concentration in surface runoff water by the length of grass filter strips. Values represent the means ± SD of the three replicates. [a, b and c] : Different letters within the same column represents significant differences at the 5% level. 0m, 5m, 10m and 15m : Length of grass filter strips.

References

Allen B.L. and A. P. Mallarino. (2008). Effect of Liquid Swine Manure Rate, Incorporation, and Timing of Rainfall on Phosphorus Loss with Surface Runoff. J Environ Qual 37:125-137.

Chaubey, I., D.R. Edwards, T.C. Daniel, P.A. Moore, Jr., and D.J. Nichols. (1995). Effectiveness of vegetative filter strips in controlling losses of surface-applied poultry litter constituents. Trans. ASAE 38:1687–1692

Gilliam, J.W. (1994). Riparian wetlands and water quality. J. Environ. Qual. 23:896–900.

Heathwaite, A.L., P. Griffiths, and R.J. Parkinson. (1998). Nitrogen and phosphorus in runoff from grassland with buffer strips following application of fertilizers and manures. Soil Use and Manage- ment. 14:142-148

Hooda, P.A., Moynagh, M. et al. (1997). Soil and land use effects on phosphorus in six streams draining small agricultural catchments in Scotland. Soil Use and Management 13. 196-204

MAFF (1991). Code of Good Agricultural Practicefor the Protection of Water. Ministry of Agriculture, Fisheries and Food, MAFF Publication, London SE997TP.

Melville, N., and R.P.C. Morgan. (2001). The influence of grass density on effectiveness of contour grass strips for control of soil erosion on low angle slopes. Soil Use Manage. 17:278–281

Meyer, L.D., S.M. Dabney, and W.C. Harmon. (1995). Sediment-trapping effectiveness of stiff-grass hedges. Trans. ASAE 38:809–815.

Nyamangara J., J. Gotosa and S. E. Mpofu. (2001). Cattle manure effects on structural stability and water retention capacity of a granitic sandy soil in Zimbabwe. Soil Till. Res. 62:157162.

Ramos M. C., J. N. Quinton and S. F. Tyrrel. (2006). Effects of cattle manure on erosion rates and runoff water pollution by faecal coliforms. J. Environ. Manage. 78:97-101.

Schmitt, T.J., M.G. Dosskey, and K.D. Hoagland. (1999). Filter strip performance and processes for different vegetation, width, and contaminants. J. Environ. Qual. 28:1479–1489.