EFFECTIVENESS OF NARROW GRASS HEDGES ON SOIL AND WATER CONSERVATION AND ENVIRONMENTAL PROTECTION

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1 Introduction

In recent years, there has been a lot of interest on the role of grass hedges in soil and water conservation in general and also in some aspects of environmental protection.

The followings are some examples found in recent literature. Although Vetiver was not the plant used, similar conclusions can be applied to Vetiver hedgerows.

2 Grass Hedges and Micro-Basins

Soil and water loss from sloping croplands is a major environmental problem that has attracting widespread attention across the world. Various soil protection techniques, such as terrace and contour tillage, have been used in recent years with limited results. Grass hedges and micro-basins are effective for reducing soil and water loss on sloping croplands in tropical and subtropical regions.

In the paper entitled ***The effects of grass hedges and micro-basins on reducing soil and water loss in temperate regions: A case study of Northern China,*** Bo Xiao et al (2012) (*Soil and Tillage Research 122:22-35*), reported that grass hedges and micro-basins have not been adequately evaluated in temperate climatic regions (for example, in Northern China); thus, they would not be readily accepted by local farmers. The soil and water conservation effects of two native grass hedges (*Pennisetum alopecuroides* (Linn.) Spreng. and Arundinella hirta (Thunb.) C. Tanaka) and micro-basins in the temperate regions of Northern China were investigated using simulated rainfall.

The experiment included two parts: In trial I, three independent variables, including grass hedges (the Arundinella, the Pennisetum, and the control), slope gradient (5%, 10%, 15%, and 20%), and rainfall intensity (36mm/h and 63mm/h) were considered. In trial II, the independent variables were changed to soil protective practice (the grass hedges, the micro-basins, and the control), slope gradient (5%, 10%, 15%, and 20%), and rainfall intensity (36mm/h and 63mm/h). Next, the Vegetative Filter Strip Modeling System (VFSMOD) model was introduced to simulate the runoff and sediment intercepted by the grass hedges. Lastly, cost analysis was conducted based on the cost of labor and seeds or plants for the grass hedge and micro-basin trials.

The use of Pennisetum hedges decreased the mean runoff and soil loss by 56% and 81%, the Arundinella hedges decreased the runoff and soil loss by 55% and 67%, and the micro-basins decreased the runoff and soil loss by 70% and 62%, respectively. Moreover, the runoff and sediment that passed through the grass hedges can be reasonably simulated with the VFSMOD model (the relative errors for runoff and

sediment content were −19.1% and −14.6%, and the Nash–Sutcliffe efficiencies for runoff and sediment content were 0.91 and 0.85, respectively). Conversely, the grass hedges occupied 9% of the farmland in the study area and cost 5,864 Yuans per hectare. In addition, the micro-basins occupied 7% of the farmland and cost 3.000 Yuans per hectare. These results imply that grass hedges and micro-basins are cost-effective when compared with terraces, which cost more than 7,401 Yuans per hectare and typically occupy 18% of farmland. ***Overall, we conclude that the soil protective practices of using grass hedges or micro-basins are effective and efficient for decreasing soil and water loss on sloping croplands in temperate regions. Thus, these practices should be intensively recommended and used widely in similar climatic regions.***

3 Grass-Hedge on Soil, Water, Nitrogen and Phosphorus Loss

In the paper entitled ***Effects of conservation tillage and grass-hedge on soil, water, nitrogen and phosphorus loss in sloping cropland*** Bo Xiao et al (2013) (*Chinese Journal Of Eco-Agriculture 21(3):315-323)* reported that soil and water loss in sloping croplands has been a major environmental problem across the globe. It has been reported that 28% of soil loss was from sloping croplands that account for only 7% of cultivated land areas. In other words, sloping croplands have been the primary source of runoff and sedimentation. It is therefore urgent to develop strategies for controlling soil and water loss on sloping croplands across the globe.

Although various soil protection techniques (eg terrace and contour tillage) have been used in sloping croplands in recent years, the effects of these techniques on soil and water loss remained limited***.*** Conservation tillage with grass-hedge has been effective in reducing soil and water loss in sloping croplands especially in tropical and subtropical regions***.*** These techniques have, however, not been adequately evaluated in North China, thus, which has led to limited adoption by local farmers in this region. In this study, the effects of conservation tillage with grass-hedge on soil, water, nitrogen and phosphorus loss were evaluated under simulated rainfall (rainfall intensity of 60 mm/h) from farmland on slopes with 5%, 10%, 15% and 20% gradients in the Changing District of Beijing, China.

The results showed that:

- Conservation tillage with grass-hedge significantly limited soil, water, nitrogen and phosphorus loss and in the order as follows: ***conservation tillage with grass-hedge > conventional tillage with grass-hedge > conservation tillage without grass-hedge > conventional tillage without grass-hedge.***
- Correspondingly, soil loss decreased by 82%; 66% and 49%
- Runoff under conventional tillage with grass-hedge, conservation tillage without grass-hedge, and conservation tillage with grass-hedge decreased by 56%, 44% and 68%, respectively, compared with conventional tillage without grass-hedge.
- Total nitrogen loss dropped by 56%, 43% and 66%;
- Total phosphorus decreased by 54%, 40% and 70% respectively.

These results suggested that the integration of conservation tillage and grass-hedge was more effective than sole application of either conservation tillage or

grass-hedges in terms of soil, water and nutrient loss control. The results further showed that the effectiveness of conservation tillage and grass-hedge gradually decreased with increasing slope gradient. Although the results suggested that both conservation tillage and grass-hedge significantly limited soil and water loss, their effectiveness was limited under steep slope conditions. Some other engineering techniques (e.g., micro-basin, fish-scale pit, mulch or even landscape shaping) therefore needed to be used in combination in order to prevent soil and water loss under steep slope and intense rain conditions. ***It was, however, concluded that conservation tillage and grass-hedge were critical for control of water, nitrogen and phosphorus loss in sloping croplands.*** These finding was useful in the remediation of soil and water loss in sloping croplands in northern China and other similar landscape regions.

4 Narrow grass hedges in reducing Atrazine runoff

In the paper entitled ***Effectiveness of narrow grass hedges in reducing Atrazine runoff under different slope gradient conditions,*** Qinghai Wang et al (2017) (*Environmental Science and Pollution Research)* reported that Atrazine is frequently detected in surface runoff and poses a potential threat to the environment. Grass hedges may minimize runoff loss of atrazine from crop fields. Therefore, the effectiveness of two grass hedges (Melilotus albus and Pennisetum alopecuroides) in controlling Atrazine runoff was investigated using simulated rainfall on lands at different slope gradients (15 and 20%) in northern China.

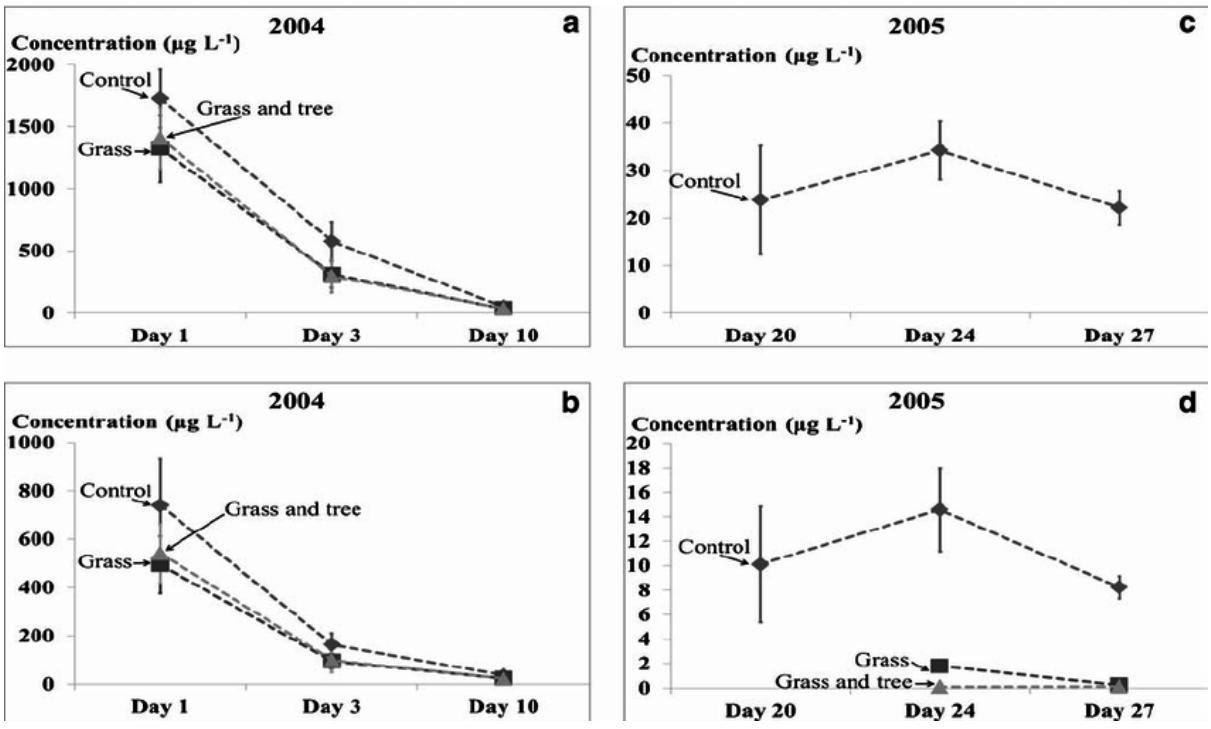
Results showed that a storm (40mm/h), occurring 4h after atrazine application, caused a loss of 3% of the applied amount. Atrazine loss under 20% slope was significantly greater than that under 15% slope in control plots. Atrazine exports associated with the water fraction accounted for the majority of total loss. Pennisetum hedges were more efficient in controlling atrazine loss with runoff compared to Melilotus hedges. No significant difference in the capacity of grass hedges to reduce atrazine exports was observed between 15 and 20% slopes. ***These findings suggest grass hedges are effective in minimizing Atrazine runoff in northern China, and Pennisetum hedges should be preferentially used on sloping croplands in similar climatic regions***.

5 Atrazine and Metolachlor exported in runoff and subsurface water

In the paper entitled ***Temporal evolution of Atrazine and Metolachlor concentrations exported in runoff and subsurface water with vegetated filter strips,*** Emmanuelle Caron et al (2012) (*Agronomy for Sustainable Development 32(4)* reported that Metolachlor and Atrazine are herbicides used in corn agriculture and detected in surface- and groundwater. Vegetated filters reduce masses of herbicides in runoff, but less attention has been given to their impact on degradation products and subsurface infiltrated water. The objective was to study the temporal evolution of dissolved Metolachlor, Atrazine and Deethylatrazine concentrations in runoff and subsurface infiltrated water with two types of vegetated filters over 2 years for the first three rains following herbicide application.

Samples of runoff and subsurface infiltrated water at 90cm depth from 12 plots of 30m X 5m in a completely randomized block design of four replicates of three treatments: 1) control without filter, 2) 5m long grass filter, 3) 5m long grass and tree filter were analysed using gas chromatography/mass spectrometry.

Results show that Controls in runoff generally had the highest average Atrazine, as high as 739 µg/L, and Metolachlor average concentrations, as high as 1,725 µg/L. The first rain after application was mainly responsible for Atrazine and Metolachlor exports. Vegetated filters reduced concentrations of Atrazine and Metolachlor in runoff below their respective Canadian criterion of 1.8 µg/L for Atrazine and 7.8 µg/L for Metolachlor (provisory) (CCME 2002) for the protection of aquatic life when rain did not occur shortly after application. With the need to increase food production and agricultural yields to sustain the increasing world population came the need to develop efficient mitigation tools such as vegetated filter strips to reduce the ecotoxicology impacts of pesticides. The present study is among the few that examined herbicide degradation products and subsurface infiltrated water under filter strips in order to provide new knowledge on the relationship between herbicide loss pathways and the environmental benefits of these strips. Such knowledge will provide much needed information to modellers, decision makers, eco-toxicologists and agronomists involved in the regulation, design and implementation of vegetated filter strips for the protection of water quality.



6 Conclusion

Overall, it can be concluded that:

- Grass hedges are effective, efficient and cost effective for reducing soil and water loss on sloping croplands.

- Conservation tillage and grass-hedges were critical for control of water, nitrogen and phosphorus loss in sloping croplands
- Grass hedges are effective in minimizing Atrazine runoff
- Vegetated filter strips mitigated the ecotoxicology impacts of pesticides by reducing the levels of herbicide degradation products in runoff and subsurface infiltrated water.

Although these papers did not specifically refer to the practice used, two of the papers mention that ***grass hedges have been effective in reducing soil and water loss in sloping croplands especially in tropical and subtropical regions,*** it is obvious that they refer to Vetiver Grass Technology.