GRASS HEDGES REDUCE SOIL LOSS ON NO-TILL AND CONVENTIONAL-TILL COTTON PLOTS

K. C. McGregor and S. M. Dabney[1]

ABSTRACT

Stiff grass *(Miscanthus sinesis)* hedges were transplanted across the lower ends of standard erosion plots near Holly Springs, MS on March 27, 1991. The hedges were transplanted about a month before the initiation of research on runoff and soil loss comparisons from conventional and no-till cotton *(Gossypium hirsutum)*. The cotton study, begun on April 25,1991, was designed to compare runoff and soil loss from conventional and no-till cotton. Hedges were located 1.5 ft upslope from the lower ends of 5% sloping plots that were 133 ft wide and 72.6 ft long. The cotton experiment consisted of five treatments: no-till with and without a grass hedge, conventional-till with and without a grass hedge, and no-till without a grass hedge but with a winter cover crop. Hedges reduced soil loss even though completely consolidated hedges were not produced during 1991. Soil loss during the cotton growing season on conventional-till plots with hedges was 14 t/A as compared with 25 t/A for conventional-till plots without hedges. Soil loss from no-till cotton with hedges averaged 0.8 t/A during the growing season as compared with 1.4 t/A for no-till plots without hedges. Soil loss from no-till plots without hedges but on which winter cover crops would be grown was 3.0 t/A. Results show that grass hedges during the first growing season after transplanting can reduce soil losses. Further research is required to determine the usefulness of hedges in field situations.

INTRODUCTION

Vegetated buffer strips that consist of fine-stemmed forage species, planted in 16- to 50-ft wide intervals between cropped areas, can slow runoff and trap sediment (Hayes et al., 1984; Magette et al., 1989; and Line, 1991). These buffer strips also may remove nutrients and pesticides (Dallaha et al., 1989). The flow-retarding and filtering effectiveness is greatly reduced if concentrated flows force the vegetation into a prone state (Kouwen et al., 1981; Dallaha et al., 1989; and Flanagan et al., 1989). Stiff grass hedges in 1.5- to 5-ft wide strips used together with buffer strips should improve resistance to concentrated flow and reduce the width needed for the buffer strips. Reports indicate that grass hedges in the tropics can be effective in retaining sediments, increasing infiltration, and in gradually reducing slopes across the intervening cropland strips (Tefera, 1983; Abujamin et al., 1985; Thomas, G.W., 1988; and Krishnegowda et al., 1990). Tefera (1983) and Thomas, D.B. (1988) reported that 1.5- to 5-ft wide strips of grass reduced soil loss from runoff plots on a 10% slope hy about two-thirds and water loss by about one-half. Line (1991) found 5- to 20-ft wide grass strips had mean sediment trapping efficiencies that ranged from 50 to 90%, depending on flow rate and strip width.

Cotton production in north Mississippi results in high rates of soil erosion. The severity of the erosion is influenced by the previous cropping history. Mutchler et al. (1985) reported soil loss rates of 33 and 17 t/A for conventional-till cotton after 11 years of conventional-till and no-till history, respectively. Soil losses were 8 and 1 t/A for no-till cotton after reduced-till soybeans and after no-till soybeans and wheat double-cropped, respectively.

Quantitative data are needed to evaluate the erosion control effectiveness of grass hedges. The effectiveness of grass hedges in reducing soil loss on erosion plots was evaluated during the first growing season following transplanting of *Miscanthus sinensis*. The effects on soil loss of conventional-till and no-till cotton following grain sorghum also were evaluated.

PROCEDURE

Three accessions of *Miscanthus sinensis* [grass number 128, 'Gracillimus' (PI 387879); number 129, 'Veriegatus' (PI 9064490); and number 130, an unnamed variety (PI 414060)l were transplanted on March 27, 1991 in a single row on 7-inch centers across and 1 5 ft above the lower end of erosion plots, which were located at the North Mississippi Branch of the Mississippi Agricultural and Forestry Experiment Station, Holly Springs, MS. Plots were 133 by 72.6 ft on 5% slopes with predominately Providence silt loam soils (Typic Fragiudalfs). Plants obtained from the USDA-SCS Plant Materials Center, Baton Rouge, LA were about 1-ft high at the time of transplanting and

[1] USDA-ARS, National Sedimentation Laboratory, Oxford, MS.

had been grown in 1.2-gallon pots from stock maintained by ARS in Beltsville, MD. Plants in each erosion plot were arranged in the same accession pattern, with a single plant of accession 128 at each end of alternating plantings of accession 130 (two plants) and accession 129 (one plant).

Plant growth characteristics (number of total stems, number of dead stems, total height, green height, and clump circumference) were measured approximately every 4 weeks throughout the season from April 23 until October 14. Duplicates of each accession were monitored on each erosion plot. The same plants were observed throughout the season. Clump circumference was measured at a height of 2 inches above ground level.

The erosion plots on which hedges were transplanted also were used to compare runoff and soil loss from conventional and no-till cotton. Cotton was planted on April 25, about 1 month after the three accessions of *Miscanthus sinensis* were transplanted. Conventional-till treatments consisted of disking and harrowing immediately before planting, followed by two cultivations during June to control grass and weeds. Cotton was harvested on all plots, and the stalks shredded in early October. Soil losses and runoff amounts were measured from the plots using FW-1 water level recorders, H-flumes, and N-1 Coshocton-type wheel sampling devices (Carter and Parsons, 1967).

No-till paired plots with and without hedges had a previous 4-year history of no-till grain sorghum *(Sorghum bicolor);* other paired no-till cotton plots without hedges (to be used with a winter cover crop) had a previous 4-year history of minimum-till grain sorghum (McGregor and Mutchler, 1992). In the minimum-till system, tillage was not done at planting time. No more than two cultivations were done during the early growing season for weed control. One plot of each of the conventional-till cotton pairs with and without hedges had previously been in conventional-till grain sorghum; the other plot had previously been in ridge-till grain sorghum. Pairing conventional-till plots in this manner allowed relative comparisons of averages unbiased by the immediate differences in previous cropping history of plots with and without hedges.

RESULTS AND DISCUSSION

Growth Characteristics

All accessions of the transplanted *Miscanthus sinensis* survived a hard frost that occurred only 2 days after transplanting. The frost severely reduced the green height of all accessions; however, in approximately 2 weeks, the grass began to recnver from the damage.

Growth characteristics of individual accessions were not significantly different between tillage treatments, and there were no differences detected between hedges on no-till and conventional-till plots. Hedges grew the most during July and August. The increase in measured growth parameters during the summer months indicated these accessions are warm-season grasses, and should grow well in the mid-South if they have suffcient cold-hardiness to survive the winters. Although all three accessions grew well, gaps as wide as 3 inches existed between some of the plants at the end of the growing season. Obviously, more than one season is needed for these grasses to complete formation of a consolidated hedge with no gaps. In this particular study, grain sorghum residues trapped by unconsolidated hedges caused more deposition to occur above the hedges. The deposition would have been less without the residues. This deposition was probably greater than that which would have occurred with cotton residues.

By September 10, accessions 130, 129, and 128 produced clump diameters of about 8, 5, and 4 inches; plant heights of about 6, 5, and 4 ft; and live tillers of about 400, 500, and 1000 tillers/ft^2 of ground surface area, respectively. Accession 128, the shortest variety, produced the largest number of tillers and fine leaves. Accession 130 produced the fewest tillers; however, it had the coarsest stems and blades and grew the tallest and widest. Thus, accession 130 should do the best job of filling in gaps between plants. Fine stemmed grasses usually were more susceptible to stem deflection and hedge "failure" or prostration, but all of the accessions were stiff enough to withstand the flows associated with the runoff from these plots.

Plants balance top growth with root development. Furthermore, plants divide top growth into either an increase in height or an increase in number of tillers. Unfortunately, the increase in number of tillers for accession 128 as compared with the other plants did not result in a corresponding increase in clump diameter. Accessions 129 and 130 appear to be better selections for hedge development.

Rainfall, Runoff. and Soil Loss

Rainfall (Table 1) during May and June was high and accounted for 40 and 20%, respectively, of the 31.7 inches of the rainfall from planting on April 25 through September. Likewise, most of the runoff (Table 1) and soil loss (Table 2) during the growing season occurred during May and June on both no-till and conventional-till plots. No measurable soil loss occurred on no-till plots during July, August, and September; and the total soil loss on no-till plots was very low for the entire growing season. Conservation benefits of no-tillage as compared with conventional-till during the growing season were reflected in the much lower runoff and soil loss values from the no-till cotton plots during that period. Low soil loss from conventional-till plots during July through September reflected the combined effects of low rainfall, low runoff, incorporated grain sorghum residues, and cotton canopy.

Soil loss (April 25 through September) for no-till cotton without hedges averaged 1.4 t/A for plots that had previously been in no-till grain sorghum. Evidently, the no-till grain sorghum cropping history caused the soil loss to be much lower than the 3.0 t/A soil loss measured from the other no-till cotton plots that also were without hedges but which had previously been used for minimum-till grain sorghum. Grass hedges during April 25 through September reduced soil loss for no-till cotton after no-till grain sorghum to 0.8 t/A. During this same period, grass hedges on conventional-till plots reduced soil loss from 25.1 to 14.5 t/A. A fully developed hedge during April and May would have made this reduction in soil loss even more impressive. By early August, accumulations of crop residues and sediment about 1.5 inches deep were observed immediately upslope of hedges on conventional-till plots and up to 3.5 inches of crop residues and sediment accumulated immediately upslope of hedges on no-till plots.

Rainfall (Table 1) from March 27 to April 25, during the period following transplanting of grass hedges until planting of cotton, was extremely high. Grain sorghum residues remaining on the soil surface kept soil loss low, even for plots that had been in conventional-till. Higher soil loss on the same plots during the early growing season of May and June partially reflected erosion control benefits lost when crop residues are incorporated by tillage during seedbed preparation. Grain sorghum residues left undisturbed on no-till plots after planting of cotton continued to provide erosion control. Residues which accumulated above the hedges on conventional-till and no-till plots contributed to the success of hedges in reducing soil loss.

Discussion of Potential Applications of Hedge Grasses

The usefulness of hedge grasses for erosion control will be greatly enhanced if the hedges can eventually perform in a field situation similarly to terraces. A desirable result of soil accumulating above hedges would be the "bench-terracing" of such fields with a reduction of slope length and steepness between the hedges. Runoff would then be routed through the watersheds in such a manner to provide improved erosion control. Any conservation practice that leaves more of the soil in place on the land also eventually improves the water quality of our streams and lakes. Other structural or vegetative methods (like grass waterways) simultaneously may be needed with use of stiff hedge grasses to control erosion and improve the field topography. Over a long period of time, sediment deposition above hedges may alter flow patterns if hedges are not on true contours, thus concentrating runoff at lower elevations in hedge rows. A potential hazard associated with the use of grass hedges is that in some field situations, and especially during very high intensity rainfall events, serious breakthroughs of hedges may occur at points where concentrated flow occurs. In the latter case, formation of gullies and rills then might reveal greater erosion problems than would have occurred without flow concentration. Future research involving field-size areas is required to answer some of the questions related to the use and limitations of grass hedges in field situations. Such evaluations of advantages and limitations of grass hedges for erosion control also will determine the best applications for their use.

SUMMARY AND CONCLUSIONS

Grass hedges were successfully transplanted on erosion plots at Holly Springs, MS. Three accessions of *Miscanthus sinesis* were used in each of the single rows of hedges that were located across the lower ends of plots. Largest growth rates occurred in July and August. All three accessions grew well, but not well enough for complete formation of a consolidated hedge during the first growing season. Nevertheless, the potential of these hedges for erosion control was very evident during this first year on runoff plots. The developing hedges dramatically reduced soil loss during the growing season on conventional-till and no-till plots

Table 1. Rainfall and runoff (inches) during the growing season of 1991.

		Runoff				
		Conventional-till		No-till		
	Rain	Without Hedge	With Hedge	Without Hedge	With Hedge	With Cover Crop†
Hedges Transplanted (March 27)††						
March 27 to April 25	12.6	3.8	4.4	5.5	6.8	3.6
Tillage; Cotton Planted (April 25)						
April 25-30	5.6	2.1	2.4	2.7	3.6	2.3
May	12.7	7.7	7.7	3.1	5.0	4.7
June	6.4	2.9	2.9	2.2	2.1	1.6
July	2.4	0.5	0.2	0.0	0.0	0.2
August	3.3	1.0	0.5	0.3	0.2	0.6
September	1.4	0.1	0.1	0.0	0.0	0.0
April 25 to Sept. 30	31.8	14.3	13.8	8.3	10.9	9.4

† Also without hedges, but will have winter cover crop. Differs from other no-till plots without hedges by having minimum-till rather than no-till history.
†† Conditions on plots during April reflected previous grain sorghum cropping history.

Table 2. Soil loss (t/A) during the growing season of 1991.

	Runoff				
	Conventional-till		No-till		
	Without Hedge	With Hedge	Without Hedge	With Hedge	With Cover Crop†
Hedges Transplanted (March 27)††					
March 27 to April 25	0.3	0.6	0.2	0.3	0.3
Tillage; Cotton Planted (April 25)					
April 25-30	0.7	0.5	0.1	0.1	0.2
May	9.4	8.9	0.4	0.4	1.7
June	13.0	4.9	0.9	0.3	1.0
July	0.6	0.0	0.0	0.0	0.0
August	1.3	0.2	0.0	0.0	0.1
September	0.1	0.0	0.0	0.0	0.0
April 25 to Sept. 30	25.1	14.5	1.4	0.8	3.0

† Also without hedges, but will have winter cover crop. Differs from other no-till plots without hedges by having minimum-till rather than no-till history.
†† Conditions on plots during April reflected previous grain sorghum cropping history.

as compared with similar plots with no hedges. Differences were detected in soil loss between no-till plots without hedges where the cropping history had included a greater amount of tillage. Further research on plots and field-size areas will improve evaluations of the advantages, limitations, and applications of grass hedges in practical farming situations.

REFERENCES

Abujamin S., A. Abdurachman, and Suwardjo. 1985. Contour grass strips as a low cost conservation practice. ASPAC Food and Fertilizer Technology Center. Extension Bulletin No. 221. pp.1-7.

Carter, C. E. and D. A. Parsons. 1967. Field tests on the Coshocton-type wheel runoff sampler. Trans. of ASAE 19(1):133-135.

Dallaha, T.A., R.B. Reneau, S. Mostaghimi, and D. Lee. 1989. Vegetative filter strips for agricultural non-point source pollution control. Trans. ASAE 32:(2):513-519.

Flanagan, D.C., G.R. Foster, W.H. Neibling, and J.P. Burt. 1989. Simplified equations for filter strip design. Trans. of ASAE 32(6):2001-2007.

Hayes, J.C., BJ. Barfield, and R.I. Barnhisel. 1984. Performance of grass filters under laboratory and field conditions. Trans. of ASAE 27(5):1321-1331.

Kouwen, N., R.-M. Li, and D.B. Simons. 1981. Flow resistance in vegetated waterways. Trans. of ASAE 24(3):684-690, 698.

Krishnegowda, K.T., A.M. Krishnappa, Panduranga, P. Ramanagowda, and B. R. Hegde. 1990. Live bunds for soil and moisture conservation under dryland conditions. Paper presented at International Symposium on Water Erosion, Sedimentation, and Resource Conservation, Oct. 9-13. CSWCRTI, Dehra Dun, U.P. India.

Line D.E. 1991. Sediment trapping effectiveness of grass strips. Proceedings of the Fifth Federal Interagency Sedimentation Conference. March 18-21, Las Vegas, NV, pp. PS-56 to PS-63.

Magette, W.L., R.B. Brinsfield, R.E. Palmer, and J.D. Wood. 1989. Nutrient and sediment removal by vegetated filter strips. Trans. of ASAE 32(2):663-667.

McGregor, K. C. and C. K. Mutchler. 1992. Soil loss from conservation tillage for sorghum. Trans of ASAE 35(6):1841-1845.

Mutchler, C. K., L. L McDowell, and J. D. Greer. 1985. Soil loss from cotton with conservation tillage. Trans. of ASAE 28(1):160-163, 168.

Tefera, F. 1983. Effect of narrow grass strips in controlling erosion and runoff on sloping land. M.S. Thesis. University of Nairobi, Kenya, 140 pp.

Thomas, D. B. 1988. Conservation of cropland on steep slopes in eastern Africa. In Moldenhauer, W. C. and N. W. Hudson (eds.), Conservation Fanning on Steep Lands, Soil and Water Cons. Soc., Ankeny, IA, pp. 140-149.

Thomas, G. W. 1988. Elephant grass for erosion control and livestock feed. In Moldenhauer, W. C. and N. W. Hudson (eds.), Conservation Farming on Steep Lands, Soil and Water Cons. Soc., Ankeny, IA, pp. 188-193.