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EVALUATION OF PLANT SPECIES FOR VEGETATIVE HEDGES

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INTRODUCTION

Stiff grass hedges, also called vegetative hedges, are narrow (3-5 feet wide) strips of stiff, erect, perennial vegetation planted in parallel lines across concentrated flow areas and are perpendicular to the dominant slope in cropland (Kemper et al., 1992). They have potential to trap sediment, reduce sheet, rill, and ephemeral gully erosion (Kemper et al., 1992; McGregor and Dabney, 1993; Meyer et al., 1995).

Proper selection of plant material is important for vegetative hedges to function effectively in controlling soil erosion in concentrated flow areas. Tall fescue (*Festuca arundinacae* Schreb.) is often used in field buffer strips to control erosion on sloping cropland. Tall fescue produces an abundance of vegetative growth rather than stems and thus, it is vulnerable to overtopping by surface runoff and sediment inundation in concentrated flow areas. Therefore, vegetative hedge plants must have coarse stems, sufficient stem density and the ability to overcome sediment inundation. Switchgrass (*Panicum virgatum* L.), vetivergrass [*Vetiveria zizanioides* (L.) Nash], miscanthus (*Miscanthus sinensis* Anderss.) and eastern gamagrass [*Tripsacum dactyloides* (L.) L.] have shown potential for use as vegetative hedges (Dabney et al., 1996; McGregor and Dabney, 1993; Ritchie et al., 1996).

Vetivergrass possesses the desirable plant characteristics (i.e., large, erect stems) for a vegetative hedge, but this subtropical plant is susceptible to winter kill in northern Mississippi (Snider, 1995). Thus, its use as a vegetative hedge is restricted to the southernmost region of the USA. Miscanthus, an ornamental grass cultivated for landscape enhancement, is propagated primarily from vegetative rootstock. Rootstock expense and labor for establishment, combined with the potential for it to become invasive may restrict its use in cropland (Hitchcock, 1951; R. Glennon, 1996, personal communication). Switchgrass and eastern gamagrass are two native warm season perennial grasses identified as candidates for stiff grass hedges (Dewald et al., 1995). Establishment of eastern gamagrass from seed has been a problem (Ahring and Frank, 1968) and inconsistent stands have been reported when seeded as a stiff grass hedge (Ritchie et al., 1996). Switchgrass is slow to establish and mature plants may reach heights of seven feet (Ball et al., 1991). Mowing to control

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plant height and biomass is necessary to prevent it from shading crops in rows near the hedge. Also, residue from unmanaged hedges may interfere with planting equipment (L. Kramer, 1996, personal communication).

Plants tested as a vegetative hedge have limitations. Therefore, data on other plants that may have potential is needed. Objective of our study was to evaluate ten plant species for potential use as vegetative hedges.

MATERIALS AND METHODS

This study was conducted from 1992-1996 at the USDA-Natural Resources Conservation Service (NRCS) Jamie L. Whitten Plant Materials Center (PMC) near Coffeeville, Mississippi. Three contour lines, 300 ft long, were arranged parallel across a field of Loring silt loam (Fine-silty, mixed, thermic, Typic Fragiudalfs) with a 6.8% slope. Spacing between contour lines was 63 ft. Within each respective contour line, ten, 30 ft by five ft plots were established.

Plots were roto-tilled and firmed prior to planting. Fertilizer, applied according to soil test recommendations, was incorporated during seedbed preparation. Plots were planted as a single perennial primary species or overseeded with either 'Pennlawn' red fescue (*Festuca rubra* L.) or redtop (*Agrostis alba* L.), which served as companion grasses (Table 1). Warm season plants were seeded or vegetatively propagated in a single row on eight inch centers in April-May 1992 and cool season grasses were either direct seeded or overseeded on 5 October 1992. Vegetative transplants were watered once after transplanting. Seed propagated plants were broadcast planted at four times the recommended rate and cultipacked. Efforts were made to obtain a complete stand of each primary and companion species. Herbicides were not used for weed control in this study. Mowing was used as an alternative weed control measure and was performed twiced annually with a rotary mower in May-June and September-October. Plant species were fertilized annually to maintain vigorous plants. Fertilizer rates varied but an average of 140-76-76 (N, P, K) was applied annually. A topographical survey was made on 14 July 1993 to obtain a base line elevation before fallowing between hedges. Survey data was collected by taking a cross section in the center of each hedge and perpendicular to the hedge with elevation readings at five ft intervals from 10 ft below to 20 ft above each hedge. A permanent benchmark was installed to provide a reference elevation for future surveys. Topographical surveys were made annually in August.

To accelerate erosion between hedges, the field was fallowed. It remained fallow except in the fall of 1994 and 1995 when a winter cover of wheat (*Triticum aestivum* L.) was planted. Four conventional hay bales were placed end-to-end and positioned perpendicular to the end of each hedge plot to prevent surface runoff from flowing parallel to the hedge, to separate plots and, to divert surface runoff into the hedges. Hay bales were removed and replaced each time the field was fallowed.

Percent stand was an annual estimate of the percent of the primary species. Plant vigor and weed population were subjective ratings (vigor - 1=best and 10=worst; weeds - 1=least and 10=most) recorded annually. Stems per ft^2 and stem diameter (inches) was collected in October 1996 from two random positions in each hedge. Stem diameter was determined by randomly selecting five live stems and measuring the diameter. Plant height and spread of unclipped hedges were determined by measuring the average height and canopy spread of each plant species from one replication in 1996.

Experimental design was a randomized complete block with three replications and data was analyzed using analysis of variance procedures.

Significant means were determined by least significant difference procedures (LSD) at the 5% level of probability (Gomez and Gomez, 1984).

Table 1. Plant species evaluated for potential use as vegetative hedges at Coffeeville, MS, 1992-1996.

Plant Species	PM[1]	Rate[2]	W/C[3]	N/I[4]
Arundo (*Arundo donax* L.)[5]	V	SS	W	I
'Pennlawn' red fescue[6] (*Festuca rubra* L.)	S	48	C	I
Eastern gamagrass [*Tripsacum dactyloides* (L.) L.][5]	V	MS	W	N
Pennlawn red fescue[6]	S	48	C	I
Dwarf switchcane [*Arundinaria gigantea* (Walt.) Muhl][5]	V	SS	W	N
'KY 31' Tall fescue (*Festuca arundinacae* Schreb)[6]	S	40	C	I
Vetivergrass (Sunshine)[5] [*Vetiveria zizanioides* (L.) Nash]	V	MS	W	I
redtop (*Agrostis alba* L.)[6]	S	24	C	I
Blackberry (*Rubus argutus* Link)[5]	V	MS	W	N
Pennlawn red fescue[6]	S	48	C	I
Pampasgrass (*Cortaderia selloana* J.A. & J.H. Schultes, Ascher. & Graebn.)[5]	V	MS	W	I
Pennlawn red fescue[6]	S	48	C	I
'Lometa' Indiangrass[5] [*Sorghastrum nutans* (L.) Nash]	S	40	W	N
KY 31 Tall fescue[5] (*Festuca arundinacae* Schreb.)	S	40	C	I
'Alamo' switchgrass[5] (*Panicum virgatum* L.)	S	20	W	N
Miscanthus (*Miscanthus sinensis* Andrss.)[5]	V	MS	W	I
Pennlawn red fescue[6]	S	48	C	I

1 PM=Planting method--S=seed, V=vegetative shoots; 2 Rate=Planting rate--SS=single shoot, MS=multiple shoots (2-3 shoots), number=lb/acre; 3 W/C--w=Warm season, c=Cool season; 4 N/I--N=native, I=introduced; 5=primary species, 6=companion species

RESULTS AND DISCUSSION

Redtop and red fescue were planted with most primary hedge species to provide temporary protection against gullying through the hedge until the primary specie established and to provide additional erosion control for the backslope. By 1995, the companion grasses had declined due to competition from taller species and weeds. Visual observations found both the companion grasses to be useful for preventing gullying through the hedge.

Vetivergrass had a significantly lower percent stand than the other species in 1993 and 1996 (Table 2). Winter damage in 1992-1993 and 1993-1994 caused a decline in stand. Snider (1995) reported that Sunshine vetivergrass was winter killed at Coffeeville. Percent stand of pampasgrass, indiangrass and eastern gamagrass declined from 1993-1996. Approximately one-half the stand of pampasgrass was winter killed in 1995-1996 due to an October 1995 mowing that loosened the roots of the plants, weakening them. This also attributed to a slow spring recovery. A decrease in stand of indiangrass and eastern gamagrass may be contributed to weed competition brought on by high fertilizer rates. Arundo, switchgrass, dwarf switchcane, blackberries, tall fescue and miscanthus had the greatest stand persistence.

Pampasgrass rated significantly higher in vigor than the other species in 1993, but declined sharply due to winter damage. Arundo, blackberries, tall fescue and dwarf switchcane showed a marked increased in vigor from 1993 to 1996. This notable increase is attributed to an increase in fertility and mowing management. Competition from goldenrod (*Solidago altissima* L.), Carolina nettle, (*Solanum carolinense* L.), smartweed (*Polygonum setaceum* Bald W.), ragweed (*Ambrosia artemisiifolia* L.) and native blackberry (*Rubus argutus* Link) was a problem in this study. Herbicides to control these problem weeds in vegetative hedges may be prohibited due to the agricultural crop and label restrictions.

Table 2. Percent stand, vigor and weed competition of ten plant species at Coffeeville, Mississippi, 1993 and 1996.

Plant species	%Std[1]		Vigor[2]		Weeds[3]	
	1993	1996	1993	1996	1993	1996
Arundo	87	88	4	7	5	6
Eastern Gamagrass	90	65	5	5	6	8
Dwarf Switchcane	90	98	5	8	4	3
Vetivergrass	38	1	4	3	9	10
Blackberries	93	98	6	8	2	6
Pampasgrass	100	53	10	3	1	7
Indiangrass	62	7	5	2	8	10
Tall Fescue	77	87	5	8	7	5
Switchgrass	100	88	8	7	3	5
Miscanthus	85	95	8	8	4	3
Mean	82	68	6	5	4	6
LSD (0.05)	21	27	1	2	3	2

1 %Std-percent stand; 2 Vigor rating (10=best 1=worst); 3 Weed rating (10=most 1=least).

Fertility and limited competition from primary species and companion grasses encouraged weed invasion (Table 2). Plant species with poor stands such as vetivergrass and indiangrass had a significantly higher weed population than species with good stands. Mowing was beneficial in controlling problem weeds but did not successfully eradicate them.

Stem density and stem diameter are important plant characteristics for trapping sediment and withstanding concentrated flow. Dunn and Dabney (1996) reported that a hedge's ability to resist failure is related to the product of stem density, moment of inertia, and modulus of elasticity. They found that modulus of elasticity in fresh grass stems increased with age and frequent mowing tended to increase stem density but reduce stem diameter. In this study, hedges were mowed twiced annually to control plant height and weeds, except in one replication in 1996.

Miscanthus produced significantly more stems per ft^2 than the other plant species (Table 3). Arundo produced the least amount of stems but was not significantly different than densities of eastern gamagrass, blackberry and pampasgrass. Stem production of miscanthus compared to Alamo switchgrass and arundo revealed a 56 and 740% increase, respectively. Since tall fescue was mainly vegetative growth, it was not measured. Vetivergrass and indiangrass was also excluded due to insufficient stands to collect reliable data.

Arundo had significantly larger stems than the other species (Table 3). Arundo's stem diameter was 83% larger than the average stem diameter of the other species. Stem diameter of eastern gamagrass was significantly larger than Alamo switchgrass and dwarf switchcane but was not significantly different than blackberry, pampasgrass and miscanthus. Vetivergrass, indiangrass and tall fescue was excluded from this measurement due to reasons mentioned above.

Mowing to control plant height, biomass, and spread of vegetation in vegetative hedges must be considered so as to limit the number of rows that may be affected by the hedge. Ritchie et al. (1996) reported a reduction in yield of soybean [*Glycine max* (L.) Merrill] and corn (*Zea Mays* L.) in rows near a miscanthus hedge. Shading and water use have also been accused of affecting crop yield in rows nearest the hedge but other factors including limited nutrients and deposition may contribute to reductions in yield (Lyles et al., 1984).

Table 3. Stem density, stem diameter, height and canopy spread of vegetative hedge species, Coffeeville, Mississipp, 1996.

Plant Species	StD[1]	SD[2]	Ht[3]	Can[4]
	-stems/ft	-inches-	-ft-	-ft-
Arundo	5	.55	11	16
Eastern gamagrass	8	.38	3	9
Dwarf switchcane	16	.22	4	8
Blackberries	6	.33	6	8
Pampasgrass	6	.35	6	8
Switchgrass	27	.23	6	12
Miscanthus	42	.28	6	10
Tall fescue [5]	--	--	1	6
Vetivergrass[6]	--	--	--	--
Indiangrass[6]	--	--	--	--
Mean	16	.36	5	9.5
LSD (0.05)	6.7	.15		

1 Stem density; 2 Stem diameter; 3 Height of unclipped plant (single replication); 4 Canopy spread of unclipped plants; 5 Vegetative production; 6 No measurements due to poor stands.

Plant height and canopy spread of unclipped species are presented in Table 3. Eastern gamagrass, tall fescue and dwarf switchcane were the lowest growing with minimal canopy spread as compared to arundo or switchgrass. Arundo was the tallest growing species and had the widest canopy spread. Blackberry, miscanthus, switchgrass and pamapasgrass were similar in height but switchgrass had the widest canopy spread. These species will require mowing management to control height and spread so as to limit their effect on crop yield in rows near the hedge. Arundo may be better suitable for other sediment control practices such as a vegetative debris basin.

Three consecutive years of collecting topographical surveys, at five feet above the hedge, revealed that blackberries accumulated the highest sediment depth but was not significantly different from the other plant species (Table 4). Sediment accumulation for vetivergrass and indiangrass was not presented because of poor stands. However, weeds such as goldenrod and ragweed that invaded these plots contributed to a relatively high sediment accumulation. For instance, sediment accumulation in vetivergrass and indiangrass plots was .48 and .42 ft, respectively. Ideally, a vegetative hedge would have limited weeds; however, weeds may play a role in filling voids in the hedge and improving sediment trapping.

Three year total sediment accumulation in the surveyed area above the hedges, averaged over the three, 300 ft hedges (300’ x 15’) was 41.5 tons. Since installation of vegetative hedges, a noticeable difference in landscape topography in the field is realized. In three years, benching from erosion below the hedge and sediment accumulation above the hedge has reduced field slope by 1.6 to 1.7%. Impact of vegetative hedges on landscape modifications in this field will be addressed in a future manuscript.

Table 4. Sediment accumulation at five feet above the hedge, Coffeeville, Mississippi,1993-1996.

Plant species	Sediment depth
	--ft--
Blackberry	.51
Pampasgrass	.48
Switchgrass	.46
Miscanthus	.47
Switchcane	.40
Tall fescue	.40
Eastern gamagrass	.33
Arundo	.32
Mean	.42
LSD (0.05)	NS[1]
%CV[2]	59

1 Not significant. 2 Coefficient of variation.

CONCLUSION

Ten plant species were evaluated for use as a vegetative hedge on the basis of stand persistence, vigor, weed competition, plant architecture, stem properties and sediment accumulation. Switchgrass, arundo, blackberries, dwarf switchcane, tall fescue and miscanthus exhibited favorable stand persistence and vigor. Vetivergrass and pampasgrass were severely winter damaged. Indiangrass did not persist. Miscanthus had the highest stem density. Arundo was the tallest species with the widest canopy spread and the largest stem diameter. Blackberry had the highest sediment accumulation and arundo had the least. Weeds were a problem in plots with poor stands but they were found to be effective in trapping sediment in absence of the primary species. Red fescue was useful as a companion grass in preventing gullying through the hedge until the primary specie established.

Switchgrass and miscanthus have shown in this study and in previous studies that they can be used as vegetative hedge. Dwarf switchcane, eastern gamagrass and blackberries have shown potential for use as a vegetative hedge. However, further field testing is needed to determine their ability to reduce surface runoff, trap sediment and overcome deposition in concentrated flow areas.

REFERENCES

Aase, J.K. and J.L. Pikul. 1995. Terrace formation in cropping strips protected by tall wheatgrass barriers. J. Soil Water Conserv. 50 (1):110-112.

Ahring, R.M. and H. Frank. 1968. Eastablishment of eastern gamagrass from seed and vegetative propagation. J. Range Management. 21:27-30.

Ball, D.M., C.S. Hoveland and G.D. Lacefield. 1991. Southern forages. Potash and Phosphate Institute, Atlanta, GA.

Dewald, C., J. Henry, S. Bruckerhoff, J. Ritchie, D. Shepard, J. Douglas, and D. Wolfe. 1996. Guidelines for the establishment of warm season grass hedge for erosion control. J. Soil Water Conserv. 51(1):16-20.

Dunn G.H. and S.M. Dabney. 1996. Modulus of elasticity and moment of inertia of grass hedge stems. Trans. ASAE 39(3):947-952.

Gomez, K.A. and A.A. Gomez. 1984. Statistical procedures for agricultural research. 2nd. ed. John Wiley and Sons, Inc., NY.

Hitchcock, A.S. 1951. Manual of the grasses of the United States. Revised by Agnes Chase. Misc. Pub. 200. USDA, Washington, DC.

Kemper, D., S. Dabney, L. Kramer, D. Dominick, and T. Keep. 1992. Hedge against erosion. J. Soil Water Conserv. 47(4):284-288.

Lyles, L., J. Tatarko, and J.D. Dickerson. 1984. Windbreak effects on soil water and wheat yield. Trans. ASAE 27 (1):69-72.

McGregor, K.C.,and S.M. Dabney. 1993. Grass hedges reduce soil loss on no-till and conventional till cotton plots. Proc. Southern Conserv. Tillage Conf. For Sustainable Ag. pp. 16-20.

Meyer, L. D., S.M. Dabney, and W.C. Harmon. 1995. Sediment-trapping effectiveness of stiff-grass hedges. Trans. ASAE 38(3):809-815.

Ritchie, J. C., W. D. Kemper, and J.M. Englert. 1996. Narrow stiff grass hedges for erosion control. J. Soil Water Conserv. Soc. (submitted).

Snider, J. A. 1995. Vetivergrass variety trials. Technical Notes. No. 4. Coffeeville PMC, MS.