Kika de la Garza Plant Materials Center

Kingsville, TX

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AN EVALUATION OF SALTBUSHES (ATRIPLEX SPP.) FOR RESTORATION OF ALKALINE AND SALINE SITES IN SOUTH TEXAS

INTRODUCTION

There is an estimated 600,000 acres in South Texas that exhibit complex saline and alkaline soil problems. These soils need plants that are adapted to these specific problems. Fourwing saltbush [Atriplex canescens (Pursh) Nutt.] has been utilized for restoration of oil well reserve pits with high salinities (EC 71-114dSm^{-1}) in west Texas (McFarland et al 1987). Fourwing saltbush is considered a valuable shrub for cattle, sheep and deer (Stubbendick et al 1982). It is also widely distributed, ranging from Canada to Mexico and from Texas to California (Correl and Johnston).

Armed saltbush [Atriplex acanthocarpa (Torr) Wats.] is another saltbush species found in Texas. It occurs from South Texas to Arizona (Jones 1982). Armed saltbush has been documented as having nutritious browse for cattle and deer (Garza and Fulbright 1988). Garza and Fulbright's study indicated that armed saltbush had higher crude protein levels than fourwing saltbush. Their study also revealed that armed saltbush had higher concentrations of sodium in its leaves than fourwing saltbush.

The objective of this study was to evaluate the survival and growth of armed saltbush compared to fourwing saltbush for restoration of alkaline and saline sites in South Texas.

MATERIALS AND METHODS

The study was conducted on a private ranch in Starr County and another private ranch in eastern Webb County. The climate of this area is characterized by hot summers and short mild winters (Starr County soil survey). Mean annual precipitation is 44 centimeters in Starr County and 50cm in Webb County. Peak precipitation occurs in May and September. The topography of the area is gently undulating with slopes averaging 3%. The soil at the Starr County site is a Montell saline clay with pH of 8.0. The soils at the Webb County site is a Catarina clay with a pH of 8.0.

Three experiments were established at these sites. Plantings were done in November of 1995 and February of 1996 at the Starr County site and in October of 1996 in Webb County.

Two accessions of fourwing saltbush and one accession of armed satlbush were evaluated. The cultivar “Santa Rita” fourwing saltbush was received from the United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) Arizona Plant Materials Center. Seeds from a native stand of fourwing saltbush in Texon, Texas, was received from the Texas Agricultural Experiment Station in San Angelo, Texas. The armed saltbush came from seeds from a native stand in San Benito, Texas.

STARR COUNTY SITE

At the Starr County site saltbush seedlings were grown in 4cm diameter by 21cm in depth plastic containers in a peat moss/vermiculite commercial soil mix in a 30% shade house for 3 months (Nov. 1995) and 6 months (Feb. 1996). Transplants were approximately 8cm tall at planting. All transplants were planted with a planting bar. A 15cm tall corrugated plastic tree shelter was wrapped around each transplant and staked into the ground. No artificial watering was applied to these transplants.

WEBB COUNTY SITE

At the Webb County site, saltbush transplants were grown from 5cm cuttings dipped in a commercial rooting powder of naphthaleneacetic acid and Thiram (NAA). Saltbush cuttings were grown in 4cm diameter by 21cm in depth plastic containers and in 5cm by 5cm by 38cm in depth paper containers in a commercial peat moss/vermiculite soil mix. Cuttings of “Santa Rita” fourwing saltbush were grown in a 30% shade house for five months. Cuttings of armed saltbush were grown in a 30% shade house for two months. Transplants were approximately 15cm tall at planting. All transplants were planted into holes made by a portable auger. A 15cm tall corrugated plastic tree shelter was wrapped around each transplant and staked into the ground. A small basin that was approximately 46cm in diameter and 7cm deep was formed around each transplant and filled with approximately 1,120 ml of water at the time of planting.

Experimental design was a randomized complete block with three replications of 5 transplants at each planting date. Planting dates were November 16, 1995, and February 6, 1996, at the Starr County site and October 23, 1996, at the Webb County site. Three soil samples were collected at each site at 6”, 12” and 18” intervals and evaluated for electrical conductivity (EC) (see table 1). Treatments of saltbush accession and rooting depths were evaluated based on survival and canopy volume using analyses of variance. Means were separated where significant using Tukeys test at a .05 level of probability.

RESULTS AND DISCUSSION

STARR COUNTY SITES

Armed saltbush had a significantly better survival rate than either of the fourwing saltbush collections twelve months and 26 months after planting in November of 1995 (see table 2) and nine months and 23 months after planting in February 1996 (see table 3). Furthermore, the armed saltbush plants outgrew the fourwing saltbushes from both planting dates. Armed saltbush had survival rates ranging from 93% to 100%. There were no appreciable differences in survival rates among the two fourwing saltbush collections. The four-wing saltbush survival rates ranged from 8% to 40%. There were no significant survival rate differences for the armed saltbushes planted in November, 1995, on salinities with electrical conductivity in mmhos/cm (EC) of 12.1 compared to the February, 1996, plantings on salinities with EC of 3.9. However, the fourwing saltbushes had lower survival rates from the February plantings despite being on lower salinity soil. Precipitation (table 4) was very low following planting in February, 1996. Mortality was probably more related to lack of rainfall than salinity levels for the fourwing saltbushes. High salinity levels with low rainfall appear to impact fourwing saltbush more severely than armed satlbush.

WEBB COUNTY SITE

Armed saltbush had a much better survival rate than “Santa Rita” fourwing saltbush nine months and fifteen months after planting in October of 1996 (table 5). Container size significantly impacted the survival rate of both species. Neither species had a surviving plant when the container rooting depth was 21cm. When the container size was 38cm the armed saltbush survival increased from 0% to 47%.

The salinity levels at this site were extremely high and they severely impacted plant survival. At the Starr County site where salinity levels at their highest were only at an EC of 12.1, armed saltbush had nearly a 100% survival rate. At the Webb County site with salinity levels at an EC rating of 73, armed saltbush only had a 47% survival rate. We also saw the combination effect of high salinity and low rainfall on armed saltbush at the Webb County site. Survival rate in early summer was 73%, but by winter following a hot dry summer survival was at 47%.

CONCLUSION

Establishment of plants on highly alkaline and saline sites requires adapted plants and techniques for optimizing soil moisture. In previous experiments, we tried planting saltbushes without the use of tree shelters. All our plantings were a failure. Tree shelters help to maintain soil moisture by reducing solar exposure and protecting the plant from desiccating winds. They also protect the plants from browsing by animals. Our results indicate that armed saltbush is more adapted than fourwing saltbush to the dry saline conditions of South Texas. Armed saltbush transplants with deep roots of 38cm should be planted in the fall utilizing tree shelters on dryland sites where salinity ratings are greater than EC 73. However, if water is available it may be more cost-effective to irrigate than to use labor-intensive deep transplants. Further evaluation is needed to determine EC levels for successful and cost-effective transplanting of both grass and shrub species under dryland and irrigated conditions as well as the potential for successful dryland and irrigated seedings.

TABLE 1

Salinity levels, electrical conductivity (EC) in mmhos/cm and sodium adsorption ratio (SAR), at the study sites.

STARR COUNTY SITE

NOVEMBER, 1995			FEBRUARY 1996		
DEPTH	EC	SAR	DEPTH	EC	SAR
0-6”	3.8	16.9	0-6”	1.3	5.8
6-12”	14.3	27.9	6-12”	1.9	12.1
12-18”	18.3	31.1	12-18”	8.4	24.8

WEBB COUNTY SITE

OCTOBER, 1996

DEPTH	EC	SAR
0.6”	85	96.9
6-12”	75	89.6
12-18”	47.5	80.3

TABLE 2

Survival rates and dimensions of saltbushes after planting on November, 1995 on a “moderately“ (EC 12.1) saline site in Starr County, Texas.

12 MONTHS AFTER PLANTING

	Survival rates*	Average dimensions	Volume (in^2)*
Santa Rita 4-wing saltbush	6 of 10 B	8” x 5”	40 B
Texon 4-wing saltbush	6 of 10 B	6” x 2”	12 B
720 Armed saltbush	10 of 10 A	13” x 18”	234 A

26 MONTHS AFTER PLANTING

	Survival rates*	Average dimensions	Volume (in^2)*
Santa Rita 4-wing saltbush	3 of 10 B	22” x 15”	330B
Texon 4-wing saltbush	4 of 10 B	17” x 8”	136B
720 Armed saltbush	10 of 10 A	22” x 47”	1034A

* Means with the same letter are not significantly different at the probability level of $P \leq 0.05$.

TABLE 3

Survival rates and dimensions of saltbushes after planting in February 1996 on a "slightly" (EC 3.9) saline site in Starr County, Texas.

9 MONTHS AFTER PLANTING

	Survival rates*	Average dimensions	Volume (in^2)*
Santa Rita 4-wing saltbush	4 of 15 B	12" x 3"	36B
Texon 4-wing saltbush	5 of 15 B	8" x 3"	24B
720 Armed saltbush	14 of 15 A	16" x 14"	224A

23 MONTHS AFTER PLANTING

	Survival rates*	Average dimensions	Volume (in^2)*
Santa Rita 4-wing saltbush	2 of 15 B	17" X 6"	102 B
Texon 4-wing saltbush	3 OF 15 B	14" X 12"	168 B
720 Armed saltbush	14 of 15 A	21" X 44"	924 A

* Means with the same letter are not significantly different at the probability level of $P \leq 0.05$.

TABLE 4

Monthly precipitation (inches) for closest weather stations to saline test plots.

	FREER		RIO GRANDE CITY	
MONTH	1996	1997	1996	1997
JAN	0.0	0.15	0.0	0.17
FEB	0.0	0.72	0.05	0.90
MARCH	0.17	4.37	0.0	2.87
APRIL	0.24	5.46	2.14	4.04
MAY	0.15	5.76	0.28	8.63
JUNE	0.37	6.95	0.0	6.62
JULY	2.30	0.53	0.92	0.0
AUGUST	3.72	1.57	4.07	0.0
SEPT	1.81	0.85	0.17	3.26
OCTOBER	0.0	0.87	1.90	3.61
NOV	0.83	1.76	0.43	
DEC	0.05	0.0	0.30	0.33
TOTAL	9.64	28.99	10.26	30.76

TABLE 5

Survival rates and dimensions of saltbushes after planting in October 1996 on "highly" (EC 73) saline site in Webb County, Texas.

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15 MONTHS AFTER PLANTING

	Survival rates	Average dimensions	Volume (in^2)
Santa Rita 4-wing saltbush at 38cm root-depth	1/15	9" X 4"	36
720 Armed saltbush at 38 cm root-depth	7/15	14" X 12"	168
All saltbushes at 21 cm root-depth	0/15		

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GRASS HEDGES FOR GULLY EROSION CONTROL

INTRODUCTION

Grass hedges are narrow strips (1-3 feet wide) of stiff, erect, densely growing grasses planted across the slope perpendicular to the dominant slope. These hedges function to slow water runoff, trap sediment and prevent gully development (Dabney et al. 1993). The hedges inhibit the flow of water because of their dense concentration of thick stems, thus slowing and ponding water and causing sediment to deposit in back of them (Meyers et al. 1994). Over time these deposits can develop into benched terraces (Aase and Pikul, 1995). These hedges function to diffuse and spread the water runoff so that it slowly flows through them without erosion. Grass hedges are resilient to failure because water passes over a broad area secured with perennial root reinforcement.

The objective of this study was to establish a series of grass hedge barriers and assess their ability to control gully erosion. Support and funding was provided by the Austin County Soil and Water Conservation District, the Texas State Soil and Water Conservation Board, and the United States Environmental Protection Agency.

MATERIAL AND METHODS

The study was conducted on a farm near Kenney, Tex., in Austin County. The treatment field is a severely overgrazed pasture with a 700 feet long gully with a 6 1/2 foot head-cut. The soils of the field are a Frelsburg clay with a 1 to 8 percent slope and a Latium clay with a 2 to 12 percent slope. In September of 1996 we crudely shaped the gully head to a 5:1 slope.

A baseline elevational survey was conducted in August, 1996, on 14 grass hedge lines. On September 16, 1997, vetiver grass was planted. The grass hedges range in length from 25 feet to 100 feet in length. The distance between the grass hedges varies from 13 feet to 74 feet with a vertical index from 1.7 feet to 2.5 feet. Slopes range from 2.8 percent to 16 percent.

Vetiver was planted as a single row across the basin depth, which ranged from 1.4 feet to 5.0 feet in height. Bareroot vetiver clumps of 4 stems were planted end-to-end across the basin 1/2 depth. The outside 1/2 depth was planted with 4 stem clumps at a three-inch interval. Vetiver was 9” tall with 4” roots. A trencher was used to produce a 6-inch wide trench. A 13-13-13 fertilizer was sprinkled in the trench at approximately an 80#/acre rate of actual nitrogen. Plants were placed in the trench and then backfilled. Straw bundles from 5 inches to 9 inches thick were placed on the downstream side across the 1/2 basin depth locations to prevent dislodging of the plants. No water was applied.

A second elevational survey of the site was performed on September, 16, 1996, right after planting, and another survey was conducted on July 30, 1997. The survey consisted of measurements at the ends of the grass hedges and at the 1/2 depth locations on either side of the grass hedges and in the middle. Measurements were also taken at 4 feet upstream, 4 feet downstream, and 20 feet upstream. A vegetational survey was conducted on May 12, 1997, and on September 18, 1997. Measurements were taken on percent survival, stem density (numbers per square foot), height (centimeters), base width (centimeters), and gaps between plants (number of spaces greater than 15 centimeters apart). Velocities (feet per second-ft/sec) and volume of surface runoff (cubic feet per second-cfs) were determined using the Natural Resources Conservation Service WWCALC engineering software program.

RESULTS AND DISCUSSION

HEDGE BARRIER STABILITY

Immediately after planting on September 18, 1996, an estimated ten year rainfall event (3.5” in 6 hrs) occurred that washed out several of the grass hedges (Table 1). Severe runoff broke the straw bundles and dislodged the plants. At high velocities, straw bundles staked through the middle will not stay secured. They must be staked and woven down with baling string. We resecured all the bundles on September 19, 1996, and they have remained secure throughout the study.

Grass hedge barriers 4,5,6,7, and 10 developed plunge pools because of the high velocity of the surface runoff (Table 2). This forced us to add concrete cylinders at these locations. We were afraid that the deep plunge pools would threaten the stability of the entire gully treatment.

Grass hedges 8 and 14 had velocities greater than grass hedges 4 and 7 which failed (Table 2). The difference between these hedges and the ones that failed were the length and steepness of upstream conditions and the narrowness of the channel downstream of the grass hedge.

Grass hedge 3 stayed stable with a hedge length of 30 feet and a slope greater than 10% for 60 feet upstream. Grass hedge 4 failed with an average slope greater than

10% for 80 feet upstream. The channel width for hedge number 4 was only 20 feet and narrowed to 15 feet directly below the barrier. The velocity as it approached hedge 5 was 7.7 feet per second (ft./sec.). This velocity on the bare soil below hedge 4 is what caused the plunge pool which required remedial treatment.

Grass hedge number 10 failed with a slope of 9% for 30 feet upstream. Grass hedge 10 had a channel width of only 15 feet that narrowed to five feet directly below the barrier. Again the velocity below the hedge was well over 7 ft./sec. and caused the plunge pool that nearly undermined the hedge.

Grass hedge 8 stayed stable despite a velocity of 6 ft./sec. and a channel width that was 15 feet both at the hedge and downstream of the hedge. The slope averaged less than 6% for over 80 feet upstream and the downstream hedge had a velocity of only 5.2 ft./sec. Grass hedge 14 also stayed stable with a velocity of approximately 6 ft./sec. The slope was roughly 7.5% and the channel width was 20 feet. Thirty feet upstream the slope was less than 4% and the velocity was less than 4 ft./sec. Downstream the slope flattened out and the velocity was less than 6 ft./sec.

It appears that grass hedges will be stable when constructed appropriately for velocities at 4 ft./sec. and volume less than 50 cubic ft./sec. Grass hedges will probably be stable at higher velocities up to 6 ft./sec. when the channel width is maintained at a consistent width at the hedge and downstream of the hedge. Optimum channel width for the grass hedges at our site was between twenty and thirty feet wide. Grass hedge length should be based on the width determined by the grass waterway calculation.

The limiting factor on velocity should be the soil velocity relationship. “Permissible velocities for channels lined with vegetation” and “Permissible velocity for vegetated spillways” in the SCS-TP-61 handbook provides a useful guide for this relationship (Table 3) and (Table 4). At our site, which had erosion resistant soils and slopes between 5-10%, the suggested permissible velocity would be 3.5 ft/sec. This is the permissible velocity suggested for native grass mixtures, and the suggested value for the bare soil, native plant composition that existed at our test site. At this time, we would not recommend exceeding the velocities established for specified seed mixtures for newly constructed sites. As a repair or secondary treatment for existing vegetated sites, we probably can use grass hedges at increased velocities of 1 to 2 ft./sec. above these levels.

VETIVER GRASS PERFORMANCE

Spot planting of vetiver grass was necessary after the September 18, 1996, rainfall event and again in April of 1997.

The results of the vegetation survey conducted on May 12, 1997, are presented in Table 5. Total survival of vetiver for the winter averaged 61 % across all the hedges. Numerous gaps between plants exceeded the 15 centimeter/6 inches threshold required for a successful hedge planting (Technote 1996). The results of the vegetation survey conducted on September 16, 1997, revealed a summer survival rate of 93% (Table 6). However, there were still spots where the gaps exceeded the 15cm threshold.

Vetiver grass performed better when planted in the spring versus the fall at this site. Competition from cool season vegetation and freezing temperatures had a detrimental impact on vetiver survival. Vetiver appears to prefer planting in the spring at a time when it is starting its period of rapid growth.

Vetiver mortality at some hedges was located at the lowest point of the barriers, indicating that high velocities may have been a factor. In the summer, most of the vetiver mortality was located at the outside edges where reduced soil moisture may have been encountered. Any growth of vetiver is remarkable at this site since it is a crudely shaped gully with very poor, hard clay subsoil. It is recommended that two rows of transplants be used to minimize gaps, reduce replanting, and ensure functionality of the grass hedge.

SEDIMENT MOVEMENT

Figure 1 shows sediment gains or losses at selected grass hedges during our elevational surveys. Grass hedge number 3 accumulated sediment from 1-2 inches across the basin except for the eastern end. Sediment accumulated despite a spotty vegetational stand. Most of the sediment trapped is probably attributable to the straw bundles. The straw bundles weather down to a height of approximately 2-3 inches which is what was accumulated at this hedge.

Grass hedge 11 had a variable elevational pattern. Sediment accumulated at about the same depth as hedge number 3 in the concentrated flow area despite a more solid grass barrier. However, the eastern end of this hedge lost over ten inches of soil due to a very steep side slope.

Grass hedge 7 accumulated from 2-3 inches across the hedge width. Hedge number 7 had a good solid grass stand.

Grass hedge 4 had a variable elevational pattern similar to barrier 11. There were vegetational gaps at this hedge at the outer edges. Where the hedge was solid, it accumulated over 6 inches of soil. The eight inch loss of soil came mostly from down cutting from steep side slopes that followed parallel to the hedge.

Where grass hedges have steep, bare side slopes, soil may be redistributed across the basin. It appears that where a good solid grass hedge is established soil will accumulate. However, further monitoring is necessary to verify this conclusion.

CONCLUSION

Grass hedges can help stabilize gullies when appropriately designed and constructed. Gullies should be surveyed, designed, and shaped similar to grass waterways. Velocities and volumes must be carefully calculated. Grass hedge barriers can add erosion control effectiveness on high velocity critical sites when combined with grass waterways by slowing and dispersing surface water runoff to prevent down cutting and channelization.

TABLE 1

Monthly precipitation (inches) for the closest weather station (Bellville) to the study site.

MONTH	YEAR	INCHES
Sept.	1996	9.83
Oct.	1996	1.67
Nov.	1996	2.86
Dec.	1996	2.65
Jan.	1997	4.81
Feb.	1997	6.10
Mar	1997	5.95
Apr	1997	5.03
May	1997	6.24
Jun	1997	4.85
Jul	1997	1.69
Aug.	1997	3.22
Sep	1997	3.57

TABLE 2

Velocity and Discharge of Surface Runoff at the Grass Hedges in Kenney, Texas.

GRASS HEDGE	DISCHARGE (cfs)	VELOCITY (ft/sec)	PLUNGE POOL (ft)
1	27	2.7	
2	27	2.5	
3	27	3.8	
4	35	4.9	2
5	40	7.7	1.7
6	40	9.6	2.1
7	40	5.4	2.0
8	47	6.1	
9	47	5.2	
10	47	7.0	1.8
11	47	4.5	
12	52	3.5	
13	52	3.5	
14	52	6.0	

TABLE 3:

Permissible velocities for channels lined with vegetation[1]
The values apply to average, uniform stands of each type of cover.

COVER SOILS	SLOPE RANGE[2]	PERMISSIBLE VELOCITY EROSION RE-SISTANT SOILS	EASILY ERODED
sec.	Percent	Ft. per. sec.	Ft. per.
Bermudagrass }......................	0-5 5-10 over 10	8 7 6	6 5 4
Buffalograss Kentucky bluegrass }................... Smooth brome Blue grama	0-5 5-10 over 10	7 6 5	5 4 3
Grass mixture }...................	[2] 0-5 5-10	5 4	4 3
Lespedeza sericea Weeping lovegrass Yellow bluestem Kudzu }................... Alfalfa Crabgrass	[3] 0-5	3.5	2.5
Common lespedeza[4] }.................... Sudangrass[2]	[5] 0-5	3.5	2.5

[1] Use velocities exceeding 5 feet per second only where good covers and proper maintenance can be obtained.
[2] Do not use on slopes steeper than 10 percent, except for side slopes in a combination channel.
[3] Do not use on slopes steeper than 5 percent, except for side slopes in a combination channel.
[4] Annuals--used on mild slopes or as temporary protection until permanent covers are established.
[5] Use on slopes steeper than 5 percent is not recommended.

TABLE 4:

Permissible velocity for vegetated spillways[1]

Vegetation	Permissible velocity[2] Erosion-resistant soils[3] Slope of exit channel pct 0-5 ft/s	Erosion-resistant soils[3] Slope of exit channel pct 5-10 ft/s	Easily eroded soils[4] Slope of exit channel pct 0-5 ft/s	Easily eroded soils[4] Slope of exit channel pct 5-10 ft/s
Bermudagrass	8	7	6	5
Bahiagrass				
Buffalograss Kentucky bluegrass Smooth brome Tall fescue Reed canarygrass	7	6	5	4
Sod-forming grass -legume mixtures	5	4	4	3
Lespedeza sericea Weeping lovegrass Yellow bluestem	3.5	3.5	2.5	2.5
Native grass mixtures				

[1]SCS-TP-61

[2]Increase values 10 percent when the anticipated average use if the spillway is not more frequent than once in 5 years, or 25 percent when the anticipated average use is not more frequent than once in 10 years.

[3]Those with a higher clay content and higher plasticity. Typical soil textures are silty clay, sandy clay, and clay.

[4]Those with a high content of fine sand or silt and lower plasticity, or non-plastic. Typical soil textures are fine sand, silt, sandy loam, and silty loam.

TABLE 5:

May 1997, Vetiver Grass Results from September, 1996, Planting at the Study Site in Kenney, TX.

BARRIER	PLANT SPECIES	PERCENT SURVIVAL	STEM DENSITY (#/SQ.FT.)	HEIGHT (CM)	BASE WIDTH (CM)	GAPS* (#>15CM)	LARGEST GAP (CM)
SITE A							
1	VETIVER GRASS	50	5	64	2	12	74
2	VETIVER GRASS	67	3	53	1	24	103
3	VETIVER GRASS	60	5	63	2	17	115
4	VETIVER GRASS	22	3	64	2	9	72
5	VETIVER GRASS	58	4	51	2	8	136
6	VETIVER GRASS	39	4	63	2	7	91
7	VETIVER GRASS	58	6	54	2	3	305
8	VETIVER GRASS	50	3	47	1	9	89
9	VETIVER GRASS	58	8	48	1	7	198
10	VETIVER GRASS	80	7	62	1	5	137
11	VETIVER GRASS	93	9	61	2	1	19
12	VETIVER GRASS	70	6	52	1	5	33
13	VETIVER GRASS	71	5	54	2	9	61
14	VETIVER GRASS	93	8	56	2	2	19

TABLE 6:

September, 1997, Vetiver Grass Results from September, 1996, Planting at the Study Site in Kenney, TX.

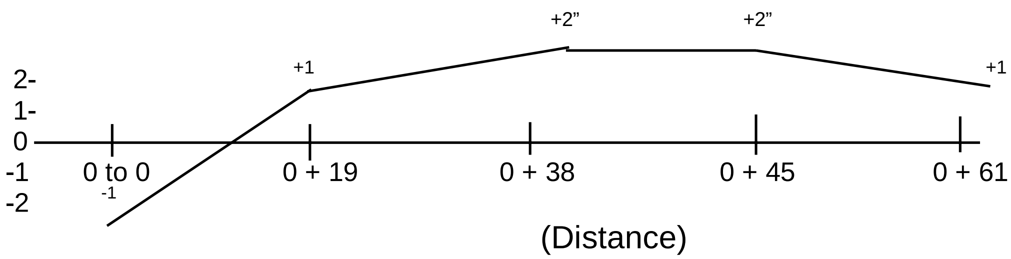
BARRIER	PLANT SPECIES	PERCENT SURVIVAL	STEM DENSITY (#/SQ.FT.)	HEIGHT (CM)	BASE WIDTH (CM)	GAPS* (#>15cm)	LARGEST GAP (CM)
SITE A							
1	VETIVER GRASS	89	0	7.0	4.3	6	25
2	VETIVER GRASS	89	3	79	8	6	91*
3	VETIVER GRASS	100	6	89	8	4	91
4	VETIVER GRASS	83	8	84	8	2	144*
5	VETIVER GRASS	93	8	87	8	2	37*
6	VETIVER GRASS	100	12	91+	10	2	23
7	VETIVER GRASS	80	3	82	7	0	
8	VETIVER GRASS	100	3	91+	7	3	30
9	VETIVER GRASS	100	15	91+	11	2	47
10	VETIVER GRASS	100	9	91+	8	6	49
11	VETIVER GRASS	92	4	87	7	0	-
12	VETIVER GRASS	100	3	89	6	1	27
13	VETIVER GRASS	86	2	84	7	0	
14	VETIVER GRASS	86	1	86	8	0	-

* Gaps were outside the concentrated flow area.

FIGURE 1

Sediment Gains or Losses (in inches) at Selected Grass Hedges at the Study Site in Kenney, TX. in September, 1997

TERRACE 3



TERRACE 4

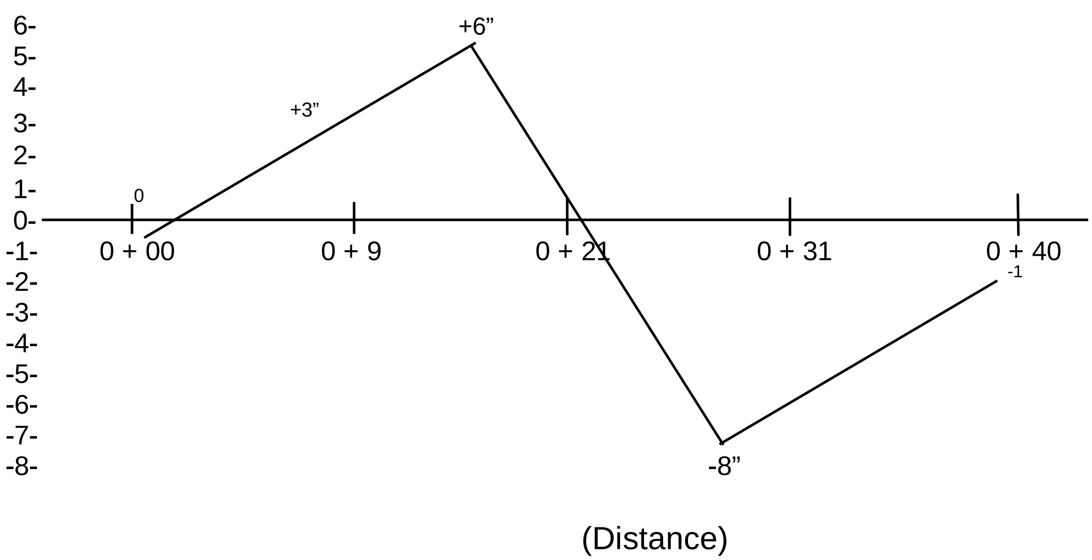
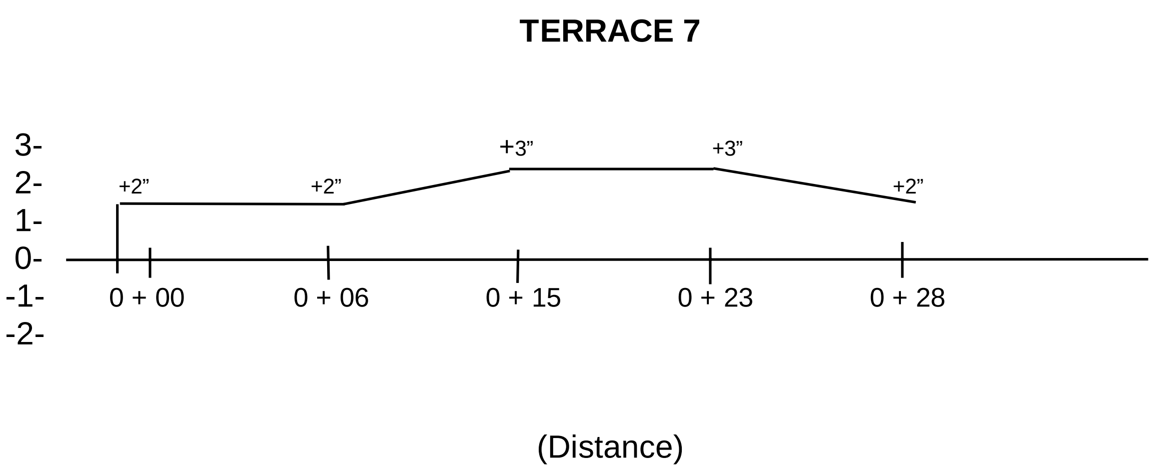
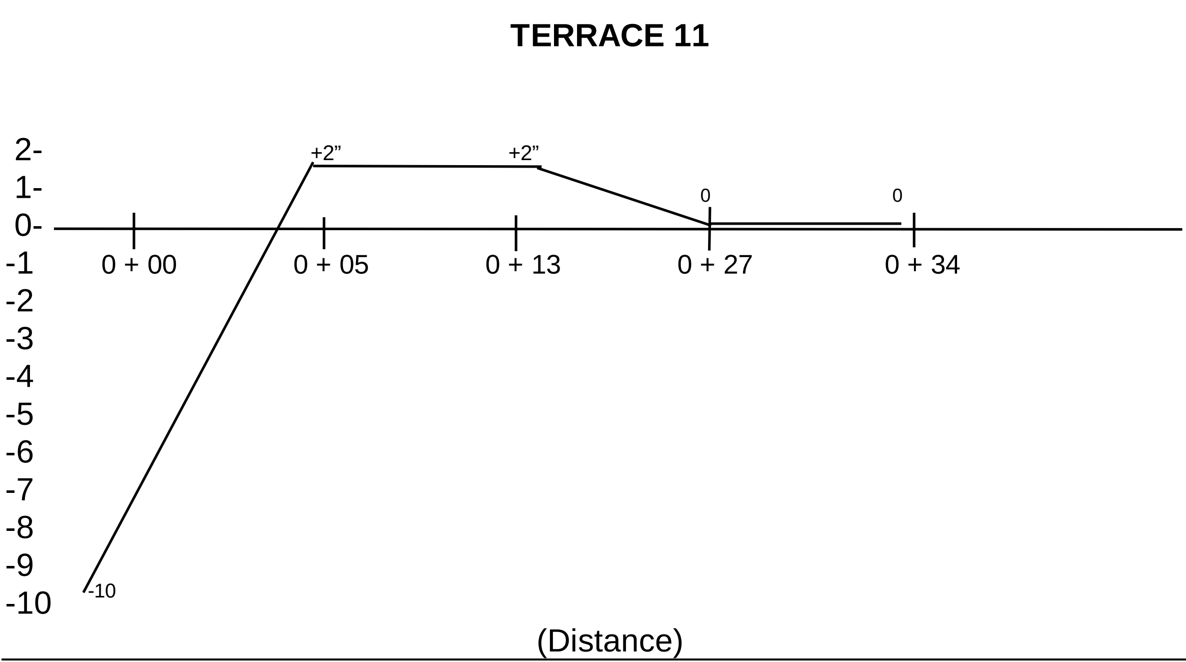


FIGURE 1 CONTINUED

Sediment Gains or Losses (in inches) at Selected Grass Hedges at the Study Site in Kenney, TX. in September, 1997





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Kika de la Garza Plant Materials Center

Kingsville, TX

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GERMINATION AND EMERGENCE IN FIVE ACCESSIONS OF WILDRYE

INTRODUCTION

Virginia wildrye *(Elymus virginicus*) and Canada wildrye (*Elymus canadensis*) are both native, cool season, perennial bunchgrasses which grow two to three feet in height. Both species reproduce by tillering and seed. Virginia wildrye can be found throughout the United States except for Nevada, California, and Oregon; whereas Canada wildrye is distributed throughout the United States except for Alabama, Georgia, Louisiana, South Carolina, and Tennessee (Hitchcock, 1971). Both species can be found scattered on shaded banks, along fencerows and in open woodlands (Gould, 1975). Virginia wildrye prefers moister soils, higher soil fertility, heavier soil textures, and is more shade tolerant than Canada wildrye (Phillips Petroleum Company, 1963). Virginia wildrye is very palatable and nutritious, and is readily eaten by all classes of livestock in the spring and fall when it is green (Phillips Petroleum Company, 1963). In the spring when it is green, Canada wildrye also has good forage value for cattle and horses; however, the forage value for sheep and wildlife is reported to be only fair. (Stubbendiek, Hatch, and Kjar, 1980). Stubbendiek, et al. also note that the forage value of Canada wildrye decreases sharply when the plant matures. Both species self-fertilize (Dewey, 1979), but have been known to hybridize and introgress (Brown & Pratt, 1960).

Two studies were conducted in the fall of 1997 at the Kika de la Garza Plant Materials Center in Kingsville, Texas. The first study was done to evaluate germination. The second study evaluated emergence. Both studies used the same five accessions of wildrye. In addition, the emergence study included a commercial variety, 'Beefbuilder' ryegrass, for comparison.

MATERIALS AND METHODS

The accessions of wildrye that were used in these studies are currently being evaluated at the Kika de la Garza Plant Materials Center in Kingsville, Texas. One Virginia wildrye accession (#845) was obtained from San Marcos, Texas. A second Virginia wildrye accession (#763) was obtained from Madisonville, Texas. Two other wildrye accessions (#971 & #957) were obtained from the East Texas Plant Materials Center in Nacogdoches, Texas. Finally, one Canada wildrye accession (#285) was originally obtained from Halletsville, Texas. This particular accession of Canada wildrye was chosen because it showed itself to have superior survival, foliage height, plant width, foliage density and other desirable agronomic characteristics after eight years of Initial Evaluation at the Kika de la Garza Plant Materials Center beginning in 1986. The Virginia wildryes #763 and #845 were similarly selected after eight years of Initial Evaluation, also conducted at Kika de la Garza Plant Materials Center. The ‘Beefbuilder’ ryegrass that was used in the planting study is a commercially available variety. It was used only for comparison purposes.

The Germination Study

Each germination test consisted of 50 untreated seeds of one accession evenly distributed on two sheets of blotter paper stacked one on top of the other, and placed in plastic boxes, with tight fitting lids. The blotter paper was moistened with de-ionized water, and remoistened with de-ionized water when necessary. Each test was replicated four times. Twenty plastic boxes, each containing one of the five wildrye accessions were placed in a randomized design on one of four shelves in a controlled environment chamber. The chamber was set to provide 16 hours of darkness and 8 hours of light in each twenty-four hour period. The temperature was set at 15ºC during the hours of darkness, and 30ºC during the hours of light. Samples were checked on a daily basis for 28 days starting on September 25, 1997. Shelf position was rotated daily. Seeds were considered to be germinated when the coleoptile and radicle extended one half the length of the seed or more. Percent of germination was the number of seeds germinated per box multiplied by two. Once seeds were considered germinated, they were removed from the plastic boxes and planted approximately ½” deep in 1”x 3” containers filled with potting soil mix. Emergence was watched and recorded.

The Emergence Study

For this study, 25 seeds of each wildrye accession and the ryegrass were planted in one of two soil treatments in 6- inch pots. Soil treatment #1 consisted of a 50/50 mix of potting soil and sterilized sand. Soil treatment #2 consisted of sterilized Victoria Clay from Block K of the Kika De La Garza Plant Materials Center. There were separate pots for each accession, each soil treatment, and each planting depth. Plantings were done at ½”, 1”, 1 ½”, and 2” depths. Pots were labeled by accession, planting depth, soil treatment, and replication number. The pots were then filled with the specified soil treatment to a 2” depth. Seeds were then arranged on the soil and covered by ½”, 1”, 1 ½”, or 2” of the same soil treatment, according to a preset mark on the inner wall of the pot. All pots were set in the greenhouse on a table with premoistened capillary matting so that all pots had equal access to water. Pots were placed on the table according to soil treatment, planting depth, and accession in a split-strip block design. The order of soil treatments, planting depths, and accessions were chosen randomly. The capillary matting was remoistened as needed. Pots were checked daily for new seedlings starting on November 26, 1997, the day after planting. A total count was made at the end of 45 days. There were two replications of each accession/planting depth/soil treatment combination. Replications one and three were given the clay soil treatment, while replications two and four used the sand/soil mix.

RESULTS

The Germination Study

Radicles were beginning to emerge from many of the seeds by day five. However, no seeds were classified as "germinated" until day six. On day six, all accessions but one (Wildrye #957) showed some seeds with both the coleoptile and the radicle extending at least ½ the length of the seed. This was determined visually; no measurements were made. Virginia wildrye #845 showed the highest percentage of early germination, followed by Virginia wildrye #763, and Canada wildrye #285. The two East Texas accessions were slower to germinate, possibly due to a difference in the harvest year (the two East Texas accessions, #957 and #971 were harvested in 1997; the other two Virginia wildrye accessions, #763 and #845, and the one Canada wildrye accession, #285, were all 1996 harvest). This year difference may have affected the total germination percentage. The 1997 harvested seed may need to "over-winter" to achieve its full germination potential. Treatment differences in the seed cleaning process may also have impacted the data. The two East Texas accessions were cleaned by hand, and were not debearded. The other three accessions were machine cleaned, and run through the debearder.

The results of this germination study were much better than anticipated. Three accessions (Virginia wildryes #763, #845, and Canada wildrye #285) achieved 80% germination or better in all replications. One accession (Canada wildrye #285) exceeded 90% germination in all replications, with 2 replications being 100% germinated. When averaged across replications, the Canada wildrye #285 achieved 96% germination. The Virginia wildryes #763 and #845 had 88% and 89% germination, respectively, when averaged across all replications. The two East Texas accessions did not perform quite as well. The wildrye #957 achieved an average germination rate of 74%, with all replications achieving better than 60% germination. Wildrye #971 was the poorest performer. Its lowest germination rate for a replication was 30% and no replication exceeded 60% germination. The average germination rate for this accession was only 47%. Again, differences in harvest year and seed cleaning treatment may have impacted germination. Further study using similarly cleaned seeds from the same harvest year should be pursued to see if differences in germination were due to seed year and /or seed treatment differences.

Statistical Analysis was conducted using SPSS for Windows. A one-way ANOVA was run to determine if replication differences in germination existed. No significant differences between replications were found. A one-way ANOVA was also run to determine if there were germination differences present between accessions. Results of the ANOVA showed that there were in fact significant differences in germination between accessions. Tukey's Test for Honestly Significant Difference was used to pinpoint specific differences. Wildrye #971 was found to have significantly poorer germination than any of the other accessions tested. In addition, wildrye #957 was found to have significantly poorer germination than Canada wildrye #285 (table 1).

The Emergence Study

Statistical Analysis was conducted using SAS. All statistical tests were run using both the actual emergence figures from the study and an emergence figure that was adjusted for germination. The adjusted emergence figure was calculated by dividing the actual emergence figure by the estimated germination rate for each accession. The purpose of the adjusted rate was to be able to look at emergence rates without germination functioning as a confounding variable. The germination rates used were based on the results of a 1997 germination study conducted at the Kika de la Garza PMC (see above). They are as follows: Virginia wildrye #763 - 88%, Virginia wildrye #845 – 89%, wildrye #957 – 74%, wildrye #971 – 47%, Canada wildrye #285 – 96%; and 'Beefbuilder' ryegrass – 98%.

A Factorial ANOVA was run for the factors, accession (ACC), planting depth (DEPTH), and soil treatment (TRT) using the actual emergence figures (GERM) as the dependent variable. The ANOVA was then repeated using the same factors, but with the adjusted emergence figure (ADJGERM) as the dependent variable. The error factors used for each main effect and interaction were adjusted as needed in accordance with the split-strip block design used. The results of both ANOVAs indicated significant main effects for accession and depth, and a significant 2-way interaction for treatment by accession. Tukey's Test for Honestly Significant Difference (Tukey's HSD) was run for the factor, depth, and also run using the 2-way interaction between accession and soil treatment as a combined factor. The adjusted error terms were also used for these tests. Tukey's HSD was done to help pinpoint specific areas of significant difference (table 2).

Treatment by Accession

Tukey's HSD was run for the combined variable soil treatment by accession (TBYA), using the GERM as the dependent variable. Results showed that Virginia wildryes #845 had significantly better emergence than all other accessions except the Virginia wildrye #763, when planted in clay soil. In addition, Virginia wildrye #763 showed significantly better emergence than wildrye #971, Canada wildrye

#285, and ‘Beefbuilder’ ryegrass when planted in clay soil. Also, wildrye #957 showed significantly better emergence than ‘Beefbuilder’ ryegrass and wildrye #971. When planted in sandy soil, all accessions outperformed wildrye #971, which was found to have significantly poorer emergence. ‘Beefbuilder’ ryegrass had significantly better emergence in sandy soil than all accessions, except Virginia wildrye #845. Finally, Virginia wildrye #845 outperformed wildryes #957 and #971.

When Tukey’s HSD was run using ADJGERM as the dependent variable, the ‘Beefbuilder’ ryegrass in clay soil was found to perform significantly poorer than all other accessions regardless of soil treatment, with the exceptions of Canada wildrye #285 and wildrye #971, both in clay soil. In addition, Canada wildrye #285 in clay soil performed significantly poorer than Virginia wildrye #845 in clay soil. When planted in sandy soil, no significant accession differences were found.

Planting Depth

When Tukey’s HSD was run for the factor DEPTH, it was found that there was significantly less emergence at the 1 ½” and 2” planting depths than there was at the ½” planting depth. Also, there was shown to be significantly poorer emergence at the 2” planting depth than there was at the 1” depth. This was true regardless of whether actual emergence or adjusted emergence figures were used for the dependent variable.

DISCUSSION AND CONCLUSION

Based on the results of the emergence study, significant differences in emergence were found for a soil treatment/accession interaction, and for planting depth. Wildrye #971 was found to perform significantly poorer than all other accessions in sandy soil. It was believed that this was due in part to that accession’s germination rate being significantly lower than the other accessions. This proved to be at least partly true. When the emergence figures were adjusted for germination, a difference still existed – but it was no longer statistically significant. Based on these results, if planting wildrye #971, more seed should be used to achieve the same seeding rate as the other accessions in order to account for the lower germination (and therefore a lower emergence) rate. In addition, the Virginia wildrye #845 performed significantly better than the Canada wildrye #285 in clay soil. This was true whether or not an adjustment was made for germination. Virginia wildrye #763 also showed significantly better emergence than the Canada wildrye #285 in clay soil, but this was only true if the adjustment for germination was not made.

Emergence differences for different planting depths were also found. It was believed that as planting depth increased, emergence would decrease. Tukey’s HSD supported this finding. However, significant differences in emergence were only found between emergence at the 2” depth and both the ½” and 1” depths, and between the 1 ½” and ½” depth. No significant differences were found between ½” and 1” depths. Based on this information, a ½” to 1” planting depth is recommended when planting wildryes and/or ryegrass.

Soil texture was also shown to have an effect on emergence. This emergence difference tends to manifest itself more often with some accessions than with others. For instance, when both accession and soil texture were considered ‘Beefbuilder’ ryegrass showed strong emergence in the sandy soil (mean emergence of 23.3750 seeds out of 25), yet it had a very poor emergence in clay soil (mean emergence of only 7 out of 25 seeds). Canada wildrye #285 also showed poorer emergence in clay soil than in sandier soil. This was found to be predominately true at deeper planting depths. It is recommended that you choose either the #845, #763 Virginia wildryes or the #957 wildrye with a preferred planting depth close to ½”, but no more than 1”, or the Canada wildrye #285 planted at a ½” depth, if the soil to be planted in is more clayey. In sandy soils, accession is not as much of an issue. Preferred planting depth is ½” to 1”; however, seedlings will emerge from as deep as 2” so there is a little more flexibility when planting.

TABLE 1.

GERMINATION PERCENTAGES FOR WILDRYES

Acc	Rep 1	Rep 2	Rep 3	Rep 4	Mean*
285	100	94	92	100	96.5^{a}
763	80	88	90	96	88.5^{ab}
845	90	88	86	92	89.0^{ab}
957	62	64	82	86	73.5^{bc}
971	30	48	58	54	47.5^{c}

* Means followed by the same letter are not significantly different at the 5% level of probability.

TABLE 2.

MEAN EMERGENCE[1] FOR WILDRYES

Accession	Actual Emergence		Adjusted Emergence[2]	
	SAND	CLAY	SAND	CLAY
285	17.8730^{bc}	10.3750^{cd}	18.6175^{a}	10.8075^{bc}
763	17.6250^{bc}	15.8750^{ab}	20.0288^{a}	18.0388^{ab}
845	19.3750^{ab}	19.3750^{a}	21.9113^{a}	21.7770^{a}
957	14.3750^{c}	13.0000^{bc}	19.4250^{a}	17.5663^{ab}
971	7.8750^{d}	7.3750^{d}	16.7550^{a}	15.6913^{abc}
BB	23.3750^{a}	7.0000^{d}	23.8525^{a}	7.1413^{c}

Planting Depth	Actual Germination	Adjusted[2] Germination
½”	17.8750^{a}	22.050^{a}
1”	16.0420^{ab}	19.274^{ab}
1 ½”	13.0420^{bc}	16.044^{bc}
2”	10.875^{c}	13.167^{c}

[1]Means in columns followed by the same letter are not significantly different at the 5% probability level.
[2]Emergence adjusted for germination

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Kika de la Garza Plant Materials Center

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FORAGE PRODUCTION STUDY OF WILDRYE ACCESSIONS IN SOUTH TEXAS

INTRODUCTION

Virginia wildrye *(Elymus virginicus*) and Canada wildrye (*Elymus canadensis*) are both native, cool season, perennial bunchgrasses which grow two to three feet in height. Both species reproduce by tillering and seed. Virginia wildrye can be found throughout the United States except for Nevada, California, and Oregon; whereas Canada wildrye is distributed throughout the United States except for Alabama, Georgia, Louisiana, South Carolina, and Tennessee (Hitchcock, 1971). Both species can be found scattered on shaded banks, along fencerows and in open woodlands (Gould, 1975). Virginia wildrye prefers moister soils, higher soil fertility, heavier soil textures, and is more shade tolerant than Canada wildrye (Phillips Petroleum Company, 1963). Virginia wildrye is very palatable and nutritious, and is readily eaten by all classes of livestock in the spring and fall when it is green (Phillips Petroleum Company, 1963). In the spring when it is green, Canada wildrye also has good forage value for cattle and horses; however, the forage value for sheep and wildlife is reported to be only fair. (Stubbendiek, Hatch, and Kjar, 1980). Stubbendiek, et al. also note that the forage value of Canada Wildrye decreases sharply when the plant matures. Both species self-fertilize (Dewey, 1979), but have been known to hybridize and introgress (Brown & Pratt, 1960). The objective of this study is to evaluate the potential of specific wildrye accessions for a cool-season forage for South Texas.

The two plots were planted in December 1997 and January 1998 at the Kika de la Garza Plant Material Center in Kingsville, Texas. One plot was seeded, and one utilized transplants set into bedded rows. The seeded planting (Wildrye Small Field Planting) consists of two accessions of Virginia wildrye and one accession of Canada wildrye currently being studied at the Kika de la Garza Plant Materials Center. The transplanted plot (Wildrye/Melic Plot) used the same three wildrye accessions from the seeded plot, and also included two wildrye accessions currently being studied by the East Texas Plant Materials Center in Nacogdoches, Texas, and two accessions of *Melic nitens*. In addition, ‘Beefbuilder’ ryegrass, a commercial variety of annual ryegrass, was used as a comparison standard.

MATERIALS AND METHODS

The Seeded Plot

The small field planting consisted of 16 plots that were six feet by twenty feet, surrounded by a ryegrass border to prevent an edge effect. Each plot was separated by a six-foot alley way. The plot was divided into four blocks of four plots each. Block order was randomized. Block 1 contained the four plots in the southeast corner. Block 2 was made up of the four plots in the northeast corner. Block 3 fell in the southwest corner, and Block 4 was in the northwest corner. The wildrye accessions and the ryegrass were randomized within each block. The seeds were broadcast into prepared beds by hand, and then pressed into the soil with a 5-foot cultipacker. Seeding rate for the wildryes was 40 pure live seed per square foot. The actual seed amount was calculated by multiplying the number of seed required for one plot (120 sq. ft.) by the percent of pure live seed for the particular accession. The ryegrass was seeded at a rate of 10 lbs. per acre. The soil type was Victoria Clay.

On June 10, 1998, ten 1 foot by 1 foot samples were clipped from each of the four plots within the four blocks of the Wildrye Small Field Planting located in Block E of the Kika de la Garza PMC in Kingsville, Texas. There were two accessions of Virginia wildrye (#763 and #845), one accession of Canada wildrye (#285), and 'Beefbuilder' ryegrass (BB) included in this study. All plots were broadcast seeded in December of 1997.

The ten sample locations were randomly selected by choosing grid locations with the help of a random numbers table and numbers picked from a hat. Samples sites were located within each plot and a 1 foot by 1 foot frame was placed in the designated location. Then percent of cover within the frame was estimated and all vegetation within the frame was clipped to a standard height of 4 inches using grass shears. Each sample was weighed and the green weight recorded. One sample from each plot was saved and dried in a drying room for ten days. Dry weight was then recorded, and the percentage of dry weight to green weight was calculated. An adjusted dry weight was calculated for each of the clippings taken. Seed heads were removed from the sample, and forage weight was calculated as well.

The Transplanted Plot

The Wildrye/ Melic Plot consisted of four replications of eight 15-foot sections of bedded rows, each containing 15 plants of a different accession. Locations of each accession within a replication were randomly selected. There was a five-foot wide alley between each replication, and a border row of seeded annual ryegrass on either side of the plot to control for an edge effect. Plants for this plot were grown individually in the greenhouse in seeded cones. They were transplanted by hand into their randomly assigned locations at one-foot intervals. They were irrigated immediately following planting and as needed throughout the growing season.

On June 8, 1998, ten plants plus one sample were clipped from each row in each replication of the Wildrye/Melic Plot located in Block D of the Kika de la Garza PMC in Kingsville, Texas. Plant accessions located in this plot included: two accessions of melic (#904 and #905), ‘Beefbuilder’ ryegrass, two accessions of Virginia wildrye (#763 and #845) and one accession of Canada wildrye (#285) being studied by the Kika de la Garza PMC, and two accessions of *Elymus spp*. that are being studied by the East Texas PMC (#957 and #971).

The ten plants were clipped at a standard height of four inches using hedge trimmers from either the north or south end of the row, excluding the end plant. The decision to clip either the north or south end of the row was made using a coin flip to ensure random selection. A representative plant was chosen from the remaining plants (excluding the end plants) to be the sample. The ten plants were bagged together and weighed green as one unit. The sample plant was kept separate and weighed green. It was then taken to a drying room for a period of two weeks, and then reweighed to establish a dry weight. The percentage of dry weight in relation to green weight was also calculated. Finally, an adjusted dry weight was computed for the ten plants bagged together. This adjusted bag weight was achieved by multiplying the original green weight for each bag by the percentage of dry weight for the sample.

RESULTS AND DISCUSSION

The Seeded Plot

Statistics were run using SPSS 8.0 for Windows. One-way ANOVAs were run using Block as the grouping variable and percentage of cover (Cvr), green weight (Grn), dry weight (Dry), and dry weight with the seed heads removed (Nohd). The process was repeated with accession (Acc) substituted as the grouping variable (Table 1). In addition, descriptives tables were run for all combinations of variables, and Tukey’s Test for Honestly Significant Differences (Tukey’s HSD) was run to pinpoint specific differences.

Block

A one-way ANOVA found no significant differences between blocks for any of the dependent variables.

Accession

Percent of Cover

The results of a one-way ANOVA revealed that there was a significant difference between accessions in the percent of cover per square foot. Tukey's HSD found that the 'Beefbuilder' ryegrass provided significantly more cover than any of the wildrye accessions. This difference was expected based on ocular estimation of plot cover.

Green Weight

Significant differences in green weight between accessions were also found with the use of a one-way ANOVA. Tukey's HSD showed that there was a significant difference in green weight between Virginia wildrye #763 and the 'Beefbuilder' rye grass, with the #763 having a significantly lower green weight than the ryegrass.

Dry Weight

A one-way ANOVA showed no significant differences in dry weights between the wildrye accessions. However, the ryegrass was found to have a significantly higher dry weight than all the wildrye accessions.

Forage Weight

The results of a one-way ANOVA revealed no significant differences in forage weight (dry weight with the seed heads removed) between wildrye accessions. However, the ryegrass was found to have a significantly higher forage weight than all the wildrye accessions.

Discussion

Although the wildryes showed significantly poorer cover at this point in time, it is expected that no significant differences will be found at the end of the next growing season. It is believed, based on our experience with the wildryes, that they become bushier once they are established and that first growing season data is an unreliable indicator of what the plants will produce when they regrow. In addition, the wildryes are prolific seed producers and have extremely good germination; therefore, many new plants can be expected the second year and beyond. Ryegrass, on the other hand, is an annual and must be reseeded each year, so the percent of cover tends to remain fairly consistent.

There were differences in green weight between the wildryes and the ryegrass (although only the #763 was significantly different), and there were significant differences in dry weight and forage weight between the wildryes and the ryegrass.

However, it is important to remember that this is only first season data. Once the wildryes establish themselves, plant production, and therefore forage weight, is expected to improve. The plot was seeded late in the planting season, and therefore the plants had less time to fully establish themselves. Furthermore, there is a lag time on growth potential for the wildryes versus the ryegrass while they establish a good root system.

The Transplanted Plot

Statistics were run using SPSS 8.0 for Windows. One-way ANOVAs were run using replication (Rep) as the factor variable with the two dependent variables: plant green weight (Bag) and adjusted bag dry weight (Bgw). In addition, a table of descriptives was run for each combination of variables. Tukey's Test for Honestly Significant Differences (Tukey's HSD) was run to pinpoint specific differences between accessions. The same tests were repeated using accession (ACC) as the factor variable (table 2.).

Replication

The one-way ANOVAs revealed no significant differences between replications for any of the dependent variables.

Accession

Bag

A one-way ANOVA found significant differences between accessions when Bag or total green weight was used as the dependent variable. Tukey's HSD showed the two accessions of melic had significantly less production than all other accessions in the plot. This was clearly evident in the field, as the melics have shown much less growth than the wildryes and the ryegrass. Also, #763 and #845 Virginia wildryes showed significantly poorer production than the #285 Canada wildrye and the #971 wildrye. In addition, the #957 wildrye and the 'Beefbuilder' ryegrass showed significantly poorer production than the #971 wildrye.

Bgw

A one-way ANOVA using Bgw or total dry weight as the dependent variable revealed that there were significant differences in adjusted bag weight between accessions. Tukey's HSD showed that the two melic accessions, #904 and #905, had significantly lower adjusted bag weights than all other accessions. In addition, #957 wildrye was found to have a significantly lower adjusted bag weight than #971 wildrye, 'Beefbuilder' ryegrass, and #285 Canada wildrye. Finally, #763 and #845 Virginia wildryes showed significantly lower adjusted dry weights than #285 Canada wildrye.

Conclusion

The differences in forage weight may be due at least partially to genus or species differences, rather than accession differences. For example, based on field observations, the melic species appear to have less leaf and stem growth, and the Canada wildrye appears to have more stem weight than the Virginia wildryes. In addition, differences in plant phenology may have an influence on the findings, since the accessions were at different stages of seed development. Added seed weight may be a factor in weight differences. The accessions from Kika de la Garza PMC were at full maturity, whereas the East Texas PMC accessions were only at boot or early seed head development stages.

Future evaluations will be based on winter (December) forage production and early spring (March) forage production to assess cool-season forage availability before warm-season forage is available.

TABLE 1.

MEAN CLIPPING DATA BY ACCESSION FOR THE WILDRYE SMALL FIELD PLANTING PLOT*

Accession	Green Wt. Plot Avg. (g)	Adj. Dry Wt. Plot (g)	Forage Weight Plot (g)
285	39.58[ab]	21.3705[a]	13.9288[a]
763	22.38[a]	13.3704[a]	8.6255[a]
845	33.63[ab]	21.3527[a]	13.7190[a]
BB	53.50[b]	37.7176[b]	29.7990[b]

* Means in columns followed by the same letter are not significantly different at the 5% probability level

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TABLE 2.

MEAN CLIPPING DATA BY ACCESSION FOR THE WILDRYE/MELIC ADVANCED EVALUATION PLOT

Accession	Green Wt. Bag (lbs)	Dry Wt. Bag (lbs)
285	6.825[cd]	3.925[d]
763	4.200[b]	2.625[bc]
845	4.325[b]	2.650[bc]
904	.400[a]	.130[a]
905	.650[a]	.268[a]
957	5.850[bc]	2.175[b]
971	8.200[d]	3.550[cd]
BB	6.100[bc]	3.575[cd]

* Means in columns followed by the same letter are not significantly different at the 5% probability level.

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A BIOENGINEERING SYSTEM FOR COASTAL SHORELINE STABILIZATION

INTRODUCTION

For many years, the Shoreline Erosion Committee of the Texas State Association of Soil and Water Conservation Districts has implemented shoreline erosion control projects with smooth cordgrass (Spartina alterniflora). However, many of these projects, where bluffs were encountered, failed to completely solve the shoreline erosion problem. Either the planting would not become established, or in some cases the bluff just continued to erode. With the development of geotextiles, there is the potential to implement low-cost shoreline projects that address these highly eroding bluff sites.

Geosynthetic turf reinforcement mats (TRM) provide a low-cost alternative to hard armor on eroding critical areas. The mats along with the root reinforcement of seeded or planted vegetation resist damage from wave energy and high velocity surface flows. On high-energy wave sites, cellular concrete blocks are an alternative to concrete and rip-rap. Both of these erosion control materials provide for the opportunity to install native salt tolerant plant species. These plants are not only aesthetically appealing but their roots and stems are a critical component of an effective long-term erosion control system.

In partnership with the San Patricio Soil and Water Conservation District we implemented such a project in October, 1997, under a grant from the Coastal Zone Management Program. We are evaluating turf reinforcement matting and cellular blocks while testing several plants such as marshhay cordgrass (Spartina patens), gulf cordgrass (Spartina spartinae), big sacaton (Sporobolus wrightii), marsh elder (Iva frutescens), wax myrtle (Myrica pusilla) and armed saltbush (Atriplex acanthocarpa) for adaptation and added environmental and engineering enhancement.

MATERIALS AND METHODS

The location is near the city of Portland, Texas along the Nueces Bay Shoreline. The site parameters when we started the project in July of 1997 were:

Soils: Monteola clay
Bluff: 0' to 8' in elevation
Bay Slope: 1:20, 5%
Fetch: 3 miles
Salinity: 25 ppt.

On July 1, 1997, we installed "Tensar" fence with three inch diameter size posts every ten feet as a wave barrier at approximately the mean tide level. It was secured to the post with 1" x 2" lathing and nailed at the top and bottom. "Vermilon" smooth cordgrass that was 18-24" tall, 1-2 stems and with 6" bare roots was planted as 4 rows 2' apart at 2" below to 12" above mean tide, ten feet toward shore from the Tensar wave barrier.

From August 25-28, 1997, we installed "PROTEC 420" cellular blocks and "North American Green C-350" TRM. We shaped the slope with an excavator at a 2.5:1 grade. We dug 1' below ground level for the toe and installed 3 blocks at 4:1 grade and then backfilled. We also dug 3' into the bank and installed three blocks at a 4:1 grade and then backfilled. All blocks were underlain with a nonwoven filter fabric. The blocks extended 48 feet in length and 3' in vertical height. The TRM was placed on the bank and extended for 152 feet in length and ranged from 0 feet to 8 feet in vertical height. The toe and the top of the bank was trenched to a 1 1/2 foot depth and the TRM was secured with either 8" staples or 6" (60d) nails with tin caps and buried. The TRM was secured every 18" with a 6" overlap of the mats.

Following a severe storm in October, 1997, which produced a 13" rainfall with high tide and winds providing waves 4-5' above mean tide, we had to make repairs. The corners where the cellular blocks ended were scoured out. We installed four inch "Terra cell" cellular confinement system underlain by filter fabric and overlaid with C-350 TRM at these locations. We also had to make some repairs to the TRM where the offshore wave barrier broke down, which caused some bank sloughing. We reshaped the slope and sandwiched the backfill between the old and new TRM.

On October 27, 1997, we planted an alternating sequence of a grass and a shrub. The grasses were gulf cordgrass (Spartina spartinae) and marshhay cordgrass (Spartina patens). The shrubs were marsh elder (Iva frutescens), armed saltbush (Atriplex acanthocarpa) and wax myrtle (Myrica pusilla). At 4 feet above mean tide, marshhay cordgrass was replaced with big sacaton (Sporobolus wrightii). Plants were chosen based on the published criteria found in Table 1.

Armed saltbush and big sacaton were chosen based on the author's personal experience and observations. The grass and shrub sequence was chosen to provide a root network of fibrous and tap roots to secure the bank slope. The plants were also chosen for abundant top growth to cushion the bank against wave energy. All plants were chosen to grow no taller than 2 meters so as not to restrict shoreline views.

All grasses at planting time were 9” tall with a 6-8” rooting depth and were grown for ten months from vegetative splits in either a plastic container or a 1” x 6” paper band that had a commercial soil mix. Wax myrtle and armed saltbush were 9” tall with a 6” rooting depth and were grown for 10 months in a plastic container or a paper band. The marsh elder were 18” tall with a 6” rooting depth and were grown for 12 months in a plastic container or a paper band. Wax myrtle was grown from seed and marsh elder and armed saltbush were grown from cuttings. Plants received no fertilizer at planting time and were planted into good soil moisture. A planting bar was used to puncture the TRM and plants were spaced every 18” and were backfilled with a 50:50 sand and commercial soil mix.

The cellular blocks were planted with the same species sequence. However, the marshhay cordgrass and the marsh elder were grown in 3”x3”x6” plant bands. We punched a hole in the filter fabric and planted into an opening of the blocks. A 50:50 sand and gravel soil mix was used for backfill and for fill of any unplanted openings of the blocks.

RESULTS AND DISCUSSION

Erosion Materials

The TRM was easy to install and has stayed stable since planting in late October 1997. At the two locations where the bank sloughed during the early October storm, the site has also stayed stable. We believe the bank sloughed at these two locations because of the breakdown at these sites in the offshore wave barrier. The estimated wave energy for material stability at this site based on our experienced conditions is at two feet above mean tide, when protected with an secure offshore wave barrier or a mature cordgrass stand. Without wave barrier protection, we would only recommend using the TRM at three feet or more above mean tide (Table 2). The cost of the material was $.36 a square foot (sq. ft.) which makes this erosion material very attractive.

The cellular blocks have stayed stable under all wave conditions. However, the corners where the blocks made a transition to TRM did not stay stable. Where we made repairs and used the “Terracell” cellular confinement system, it has stayed stable at the upwind transition from the cellular block to the TRM. However, the downwind corner that was tied into a 14 foot jutting bank has not stayed stable despite repeated treatments of TRM and “Terracell”. Waves continue to erode the nontreated slope, thus undermining this corner.

Installation of the cellular blocks was extremely difficult for us where we made changes in grade at the toe and at the top into the embankment. We recommend that where you are hand placing the blocks, you have a consistent, uniform grade. If you do have any changes in grade, consider using a cabled block system placed with an excavator. However, on small sites this will be more expensive. The cost of cellular blocks was $4.87 sq. ft., making this an expensive material that should be used only where other material is inadequate. The four inch "Terracell" cellular confinement system was a flexible material, making it easy to install. It has provided better stability then the TRM and is less expensive than cellular blocks at $1.15 sq. ft. Furthermore, on high shrink-swell clay soils, the cellular confinement system may give added protection against rilling and gullying of the bluff slope.

Vegetative Material

In February 1998, we surveyed the transplants for survival and found 40 dead plants out of 1400. No grasses were dead and most of the dead plants were at the shoreline of the cellular blocks, smothered by shoalgrass (Halodule wrightii). By April of 1998, the shoalgrass was 1-2 feet thick along the shoreline smothering the shoreline plants, especially at the deep corner of the blocks.

On July 9, 1998, we surveyed the plants for survival and growth (Table 3). The grasses have performed exceedingly well with all having survival rates over 90%. Both gulf cordgrass and marshhay cordgrass have grown well at this site and appear to be adapted to 11/2 to 2 feet above mean tide (Table 4). Marshhay cordgrass not only survived well but it extended runners from its rhizomes on 44% of the plants. Big sacaton had a 97% survival rate on the upper portions of the slope.

The shrubs did not perform as well as the grasses. Wax myrtle performed especially bad. It only had a 11% survival rate. This collection of wax myrtle came from a sandy site on Mustang Island and apparently was not adapted to the clay soils of this site. Where the bluff was a little bit sandy the wax myrtle performed better, with a 43% survival rate.

Marsh elder had overall a 72% survival rate. However, at those sites that were 2' above mean tide it had a 93% survival rate. The majority of its mortality occured where we planted it at the shoreline. Shoalgrass, which built-up to a 2 foot layer smothered many of these plants. Marsh elder also seemed to be sensitive to salt spray. It appeared in our April survey that many of the plants at the shoreline edge lost their leaves, apparently due to a high tide and salt spray. However, all these plants were resprouting from the branches. The native stands adjacent to this site are found at 11/2 to 2 feet above mean tide. Apparently the long term survival of these plants are good even if sensitive to salt spray. However, they may not tolerate it well when at a small transplant height. The native stands have plants that are 3-8' tall, well above most tidal spray and protected by a 20' section of smooth cordgrass. Since it is a major plant in the native shoreline community and has great shoreline stabilization characteristics with its tall canopy and deep woody roots, it requires additional monitoring.

Armed saltbush, which is not found very often along the shoreline, had an 89% survival rate. Armed saltbush is most frequently found on highly saline sites of inland south Texas. However, we have found plants along the shoreline of Hans Suter Park in Corpus Christi. This plant can produce many dense branches with a very wide canopy. It seems adapted to 3 feet above mean tide. We plan to continue to monitor this plant. However, we are cautious about its long term survival when its mature roots reach the saline water table.

CONCLUSION

It is recommended that smooth cordgrass be planted on sites where little shoalgrass is encountered and tidal slopes are less than 5%. Once the cordgrass is well established, bluffs less than 8' in elevation can be shaped and planted to adapted plant material. With the added toe protection, the bluff treatment has improved chances of success.

Where a smooth cordgrass stand is established, a combination of TRM and cellular confinement system with selected plant material should provide good shoreline stabilization. If smooth cordgrass cannot be established, then a bluff treatment that includes cellular concrete blocks for toe protection will be needed.

If the total length of a bluff site can not be treated, we would discourage any attempts at bluff shaping. However, on high value commercial or residential property where adjacent landowners are protecting their shoreline, we believe this system has promising value. We also think this system may have particular value for soil stabilization and wildlife habitat enhancement on man-made spoil islands along the Texas Gulf Coast.

TABLE 1

Establishment criteria for plants selected for shoreline stabilization in Portland, TX.

	Water Depth (inches)	Salinity Range (ppt)	Potential Plant Height (feet)	Potential Plant Width (feet)
Gulf cordgrass	-12" to 0+	0 – 18	2 - 3'	1'
Marshhay cordgrass	-4" to 0+	0 –16	2 - 3'	____
Big sacaton	____	____	4 -6'	1'
Marsh elder	-15" to 0+	2 –16	7'	6 -7'
Wax myrtle	-12" to 0+	0 – 4	4 - 5'	4 - 5'
Armed saltbush	___	___	2 -3'	5 -6'

Table 2

Recommended elevation for erosion control material based on our shoreline construction in 1997 at Portland, TX.

MATERIAL	ELEVATION (above Mean Tide)
TRM	3' +
Cellular Confinement System	1' +
Cellular Concrete Blocks	-0.5' - 3' +

TABLE 3:

Survival rates and dimensions of plants eight months after planting on October 27, 1997, in Portland, TX.

Species	Survival rates	Average Dimensions (inches) (height by width)	Number of Stems
Marsh elder	72%	22” x 13”	3.4
Wax myrtle	11%	6” x 4”	1.4
Armed saltbush	89%	11” x 21”	1.0
Gulf cordgrass	97%	16” x 3”	
Marshhay cordgrass	90%	19” x 3”	
Big sacaton	97%	12” x 2.5”	

TABLE 4:

Recommended elevation for planting based on our Shoreline Plantings on October 27, 1997, in Portland, TX.

SPECIES	ELEVATION (above Mean Tide)
Marsh elder	2’-3’+
Wax myrtle	not recommended
Armed saltbush	3’ +
Gulf cordgrass	2’ +
Marshhay cordgrass	1.5’ +
Smooth cordgrass	-1’/2 to 1+

Kika de la Garza Plant Materials Center

Kingsville, TX

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NATIVE MIX SMALL FIELD PLANTING SUMMARY

INTRODUCTION

Texas range seed mixes commonly include a mix of grasses and forbs. However, many of the commercial grass varieties included in these planting mixes are not native to Texas, and may inhibit establishment and growth of native forbs and other grass species that are planted nearby. Two-flower (*Chloris crinita)* and four-flower trichloris (*Chloris pluriflora)* are two warm-season perennial grasses native to Texas (Hitchcock, 1971). They are of particular interest because USDA-NRCS soil surveys have reported that two-flower and four-flower trichloris are co-dominant, climax species on numerous range sites in South Texas. Plains bristlegrass (*Setaria leucopila*) is an important warm-season, perennial forage species, which is native to Texas (Gould, 1975). It has moderate to high palatability for all species of livestock (Gay, Dwyer, Allison, Hatch, and Schickendanz, 1980). Buffelgrass (*Cenchrus ciliaris*) is an exotic commercial grass variety that has been widely used in Texas range planting mixes (Everitt and Gausman, 1984). However, a study by Nurdin and Timothy E. Fulbright (1990) found that buffelgrass “may produce phytotoxic chemicals that inhibit germination and growth of legumes planted in seeding mixtures” (p.466). Kleingrass (*Panicum coloratum)* is a native of Africa, which has been introduced to South and Central Texas (Gould, 1975). Two commercial varieties, ‘Selection 75’ and ‘Verde’, are commonly used in range and pasture mixes in Texas (Alderson & Sharp, 1994).

Native, perennial forbs are commonly used in Texas range plantings. Illinois bundleflower (*Desmanthus illinoensis*) is one of the most important native, perennial legumes currently used in Texas range planting mixes . It is high in protein, readily eaten by both livestock and wildlife, and is often used as an indicator of range condition (Ajilvsgi, 1984). Awnless bushsunflower (*Simsia calva*) is another forb native to Texas. In addition, awnless bushsunflower has been found to be a good source of protein for deer (Schweitzer, Bryant, & Wester, 1993). Other native, warm-season forbs have also been shown to provide a palatable food source for livestock and wildlife in Texas (Nelle, 1994). Orange zexmenia (*Zexmenia hispida*), also known as hairy wedelia (*Wedelia hispida)*, is a common, native, warm-season, perennial forb. It is easily cultivated, and is often browsed by deer, sheep, and goats (Ajilvsgi, 1984). *Aphanostephus riddellii*, commonly known as perennial lazy daisy, has been found to be one of the most highly preferred food sources for white-tailed deer (Arnold & Drawe, 1979; Everitt & Drawe, 1974). In fact, Everitt and Drawe’s 1974 study found perennial lazy daisy to be the most preferred spring food source of white-tailed deer, making up more than 12% of their early spring diet. Arnold and Drawe’s study in 1979 found perennial lazy daisy to be “the second most heavily preferred species” of white-tailed deer over the course of a year. The objective of this small field planting was to evaluate a warm-season, native grass alternative (for South Texas) to available commercial varieties, which will allow for a diverse mix of grass and forbs in rangeland plantings.

MATERIALS AND METHODS

Planting the Plots

Four mixes consisting of a grass and forb mix were compared in 20’ by 10’ plots. Each mix had four replications planted together in a block in order to guarantee some non-contaminated plots as time progresses. In addition, a fifth repetition of each mix was planted in random order in a four-plot combination block. All four mixes used the same forb combination, which consisted of .18 pounds of pure live seed per acre of perennial lazy daisy (Aphanostephus riddellii), .93 pounds of pure live seed per acre of prairie bundleflower (Desmanthus illinoensis, var. ‘Sabine’), 1 pound of pure live seed per acre of awnless bushsunflower (Simsia calva, var. ‘Plateau’), and 2 pounds of pure live seed per acre of orange zexmenia (Zexmenia hispida). In addition, Mix #1 used 2 pounds of pure live seed per acre of buffelgrass (Cenchrus ciliaris); Mix #2 consisted of 1 pound of pure live seed per acre each of plains bristlegrass (Setaria machrostáchya), accession # 434462 of two-flower trichloris (Chloris crinita), and four-flower trichloris (Chloris pluriflora); Mix #3 contained 1.5 pounds of pure live seed per acre of the two trichlorises; and Mix #4 had 1.7 pounds of pure live seed per acre of Kleingrass (Panicum coloratum, var. ‘Verde’) (Table #1).

The plantings were made on March 5, 1998, in blocks C and D at the Kika de la Garza Plant Materials Center in Kingsville, Texas. All plots were on Victoria Clay soil, and were cultivated prior to planting. Seeds were hand-broadcast, and then pressed into the soil, using a 5-foot cultipacker. Emergence was observed on a daily basis for 60 days after planting. Then observations were made weekly.

Spring Evaluation

On June 15, 1998, the plots were evaluated for the percent of cover provided by each of the planted species, and the percent of weed cover and bare ground. Data was collected by evaluating ten 1 foot x 1 foot square locations within each plot. A metal frame was used to mark each location. Locations were selected randomly, using a random numbers table and numbers drawn from a hat to represent the x-axis and y-axis locations on a grid of the plot. Ocular estimation was used to evaluate percent of cover provided.

Fall Evaluation

On December 1, 1998, the plots were re-evaluated for the percent of cover of each of the planted species and the percent of weed cover and bare ground. The plots were also evaluated for the number of each planted species and weeds per square foot. Data was again collected by evaluating ten 1 foot by 1 foot square locations within each plot. A metal frame was used to mark each randomly selected location. Ocular estimation was used to evaluate percent of cover. The number of plants of each species was counted.

RESULTS AND DISCUSSION

Spring Evaluation

No grass emerged in any of the plots with the exception of minimal kleingrass in plots containing Mix #4. The kleingrass was found to provide mean cover of only .5 percent. The failure of the grasses to emerge may be due to especially droughty conditions in Kingsville throughout the entire evaluation period (Table #2). In addition, the Victoria clay soil tends to form a heavy cap under dry conditions, further inhibiting emergence. With that in mind, the four forbs showed impressive establishment. All four forbs planted emerged and thrived despite droughty conditions and soil capping. All showed some reproductive growth as well. The bushsunflower provided 13.8 % of total plot cover, and seemed especially drought tolerant. The lazy daisy provided 3.4% of actual cover. This plant was particularly impressive in that many small plants became established, despite a seeding rate of only .18 lbs. of pure live seed per acre.   If there had been adequate seed available, we would have used a seeding rate of 1 lb. of pure live seed per acre.   The prairie bundleflower, which provided 2.82 % of actual cover, was also planted at a reduced seeding rate due to a lack of available seed. It was planted at only .93 lbs. of pure live seed per acre. Orange zexmenia, the fourth forb species provided 2.03% of total plot cover, while weeds provided 8.06 percent. The remaining 69.65 % was bare ground (Table #3).

Fall Evaluation

There was an increase in the emergence of kleingrass in the plots containing Mix #4.   It made up approximately 5 percent of the total plot cover, and averaged 0.18 plants per square foot. Most of the other species of planted grass never emerged, although one specimen of buffelgrass and one species of four-flower trichloris were noted. As noted in the previous paragraph, the failure of the grasses to emerge may be due to especially droughty conditions following planting, and capping of the heavy clay soil at the planting site.

Of the forbs, bushsunflower showed the highest percent of cover (25%), with an average of 2.14 plants per square foot. This was followed by orange zexmenia, with 11.47 percent of plot cover and an average of 1.1 plants per square foot. Lazy daisy made up 4.5 percent of total cover and averaged .57 plants per square foot. Prairie bundleflower averaged only .1150 plants per square foot and made up only .8 percent of the cover. Weeds made up 17.625 percent of total cover, and 35 percent of cover was bare ground (Table 3).

The condition of the plants at the time of evaluation is also an important factor to consider. When we evaluated the plots in the spring, plants from all four forb species used in this study were green, fresh, and lush. However, at the time of the fall evaluation, nearly all of the bushsunflower was at the end of its seasonal growth cycle, providing mostly older, less palatable vegetation for wildlife forage. The lazy daisy showed much new, green, tender growth, making it a more palatable wildlife food source at this time of year. The orange zexmenia and prairie bundleflower were only moderately fresh, showing mostly mature vegetative growth.

Changes in Plot Composition

There were several notable changes in plot composition from spring of 1998 to fall of 1998. First, only one of the planted species showed a decrease in percent of cover in the fall evaluation. Prairie bundleflower went from having 2.82 percent of total plot cover in the spring to a mere .8 percent of plot cover in the fall. This seems to indicate a poor survival rate for the prairie bundleflower. The only other decline in cover from spring to fall was that of bare ground, which decreased from 69.6 percent to 35.0 percent.

The other planted forbs all showed a fall increase in the percent of total plot cover. Bushsunflower led had an 11.2 percent increase in percent of plot cover. Orange zexmenia had a 9.445 percent increase in plot cover, while lazy daisy showed a 1.1 percent increase in plot cover. The percent of cover provided by kleingrass also increased from .5 percent in the spring to 5.6 percent in the fall, an increase of 5.1 percent.

Recommendations for Future Research

We were unable to evaluate the different grass-forb mixtures. Extremely droughty conditions and a heavy clay soil appeared to inhibit the emergence of the grasses. However, much useful information was gained on the forbs used in this study, all of which emerged, matured, and produced seed under extremely adverse conditions. With the exception of the prairie bundleflower, all the planted forbs showed an increase in percent of cover from spring to fall. It is our plan to replant this study in the spring of 1999.

TABLE 1.

SEED PURITY, GERMINATION RATE, AND PLANTING RATE FOR NATIVE MIX STUDY

Plant Type	Purity (%)	Germination (%)	Seed Adjustment Factor	Seed Rate /Acre(lbs) Mix #1	Seed Rate /Acre (lbs) Mix #2	Seed Rate /Acre (lbs) Mix #3	Seed Rate /Acre (lbs) Mix #4
2-flower Trichloris	96	90	.86	0	1	1.5	0
4-flower Trichloris	87	12	.10	0	1	1.5	0
Plains Bristlegrass	28	14	.04	0	1	0	0
Buffel Grass	92	87	.80	2	0	0	0
Orange Zexmenia	68	28	.19	2	2	2	2
Lazy Daisy*	87	03	.03	.18	.18	.18	.18
Bush Sunflower	81	75	.61	1	1	1	1
Prairie Bundleflower+	95	10	.10	.93	.93	.93	.93
Klein grass	-	-	.80	0	0	0	1.7

Plot size = 20' x 10' (200 sq.ft.) or .005 acres
There are five plots of each mix. Four reps for separate mix plot and one for the combined plot
* Seeding rate was reduced from 1 lb. of pure live seed per acre due to limited seed availability
+ Seeding rate was reduced from 3 lbs. of pure live seed per acre due to limited seed availability

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TABLE 2.

TEMPERATURE AND RAINFALL AVERAGES FOR KINGSVILLE, TEXAS* FOR THE SPRING OF 1998

Week of	Average Low Temperature (ºF)	Average High Temperature (ºF)	Average Weekly Temperature (ºF)	Amount of Precipitation (in.)
February 15,1998	51	74	63	1.2
February 22, 1998	53	78	66	< .01
March 1,1998	55	76	66	< .01
March 8, 1998	49	64	57	.68
March 15, 1998**	56	77	67	.60
March 22, 1998	61	82	72	0
March 29, 1998	58	84	71	0
April 5, 1998	56	83	70	0
April 12, 1998	66	82	75	0
April 19, 1998	54	84	69	0
April 26, 1998	62	89	75	.45
May 3, 1998	72	92	82	0
May 10, 1998	71	89	80	0
May 17, 1998	70	92	81	0
May 24, 1998	75	94	85	0
May 31, 1998	76	95	86	< .01
June 7, 1998	79	97	88	< .01
June 14, 1998	81	102	92	.15

* Data from NAS Kingsville
** Week that plots were planted

TABLE 3.

RELATIONSHIP OF PURE LIVE SEED TO PERCENT COVER

Species	Pounds/Acre of Pure Live Seed	Percent of Cover Spring 1998	Percent of Cover Fall 1998	Change in Percent of Cover 6/98-12/98	Avg. # of Plants Per Sq. Ft. Fall 1998
Bushsunflower	1	13.800	25.000	+ 11.200	2.140
Lazy Daisy	.18	3.400	4.500	+ 1.100	.570
Orange Zexmenia	2	2.030	11.475	+ 9.445	1.100
Prairie Bundleflower	.93	2.820	.800	- 2.020	.115
Buffelgrass (mix 1)	2	0.000	.005	+ .005	.001
Kleingrass (mix 4)	1.7	.500	5.600	+ 5.100	.180
Plains Bristlegrass (mix 2)	1	0.000	0.000	0.000	0.000
Four-Flower Trichloris (mix 2)	1	0.000	.005	+ .005	.001
Two-Flower Trichloris (mix 2)	1	0.000	.00	0.000	0.000
Four-Flower Trichloris (mix 3)	1.5	0.000	.00	0.000	0.000
Two-Flower Trichloris (mix 3)	1.5	0.000	.00	0.000	0.000
Weeds	-	8.060	17.625	+ 9.565	7.540
Bare Ground	-	69.650	35.000	- 34.650	-

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Kika de la Garza Plant Materials Center

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A GERMINATION STUDY OF NINETY-SIX ACCESSIONS OF PLAINS BRISTLEGRASS

INTRODUCTION

Plains bristlegrass is a warm-season, perennial grass that is native from South Texas to New Mexico, Colorado and Arizona, and down into central Mexico (Gould, 1975; Hitchcock, 1971). Its current scientific name is *Setaria machrostachya* (Correl & Johnston, 1996), although in the past *Setaria leucopila* and *Setaria texana* have also been included under this common name (Correl & Johnston, 1996; Gould, 1975). Plains bristlegrass is found on open dry ground and in dry woods (Hitchcock, 1971) and "on well drained soils along gullies, stream courses, and other areas occasionally with abundant moisture" (Gould, 1975, p.557). It provides moderate to high quality forage for all types of grazing livestock (Gay, Dwyer, Allison, Hatch, and Schickendanz, 1980), and makes up "an appreciable part of the forage on southwestern ranges" (Hitchcock, 1971, p.718). This species shows promise as a plant for range and wildlife use. The objective of this study was to seek out accessions of plains bristlegrass with good germination for further evaluation as a warm-season forage for south Texas. Future studies will examine factors such as plant hardiness, forage production, seed production, and other characteristics that would make plains bristlegrass desirable to include in South Texas range mixes.

MATERIALS AND METHODS

All of the accessions of plains bristlegrass used for this study were from Texas. They came from as far north as Dumas, as far west as El Paso, as far south as Raymondville, and as far east as Rosenberg. The majority of the ninetysix accessions studied were collected in 1982 and 1983, with three exceptions: accession #17041 which was collected in 1963, accession # 2615 which was collected in 1970, and accession #441267 which was collected in 1978.

The accessions were tested in four groups of twenty-four. Each germination test consisted of 50 untreated seeds of one accession evenly distributed on two sheets of blotter paper stacked one on top of the other, and placed in plastic boxes, with tight fitting lids. The blotter paper was moistened with de-ionized water, and remoistened with de-ionized water when necessary. Each test was conducted once. Twenty-four plastic boxes, each containing one of the twenty-four accessions assigned to a test group, were placed in a randomized design on one of four shelves in a controlled environment chamber. The chamber temperature was set to provide sixteen hours at 10ºc and eight hours at 30ºc in each twenty-four hour period. The chamber was kept in total darkness throughout the tests. Samples were checked on a daily basis for 21 days starting on June 26, 1998, for test group one, July 17, 1998, for test group two, August 7,1998, for test group three, and August 28, 1998, for test group four. Daily germination percentages were recorded and shelf position was rotated daily. Seeds were considered germinated when the coleoptile and radicle extended the length of the seed or more. Percent of germination was the number of seeds germinated per box multiplied by two. Once seeds were considered germinated, they were removed from the plastic boxes and discarded, unless germination for an accession exceeded forty percent. When this occurred, germinated seeds were planted in potting soil in plastic cones and grown outdoors in a shaded area for observation purposes.

RESULTS

Germination for plains bristlegrass occurred as early as four days into the test, and as late as twenty days, with the predominance of germination occurring between seven to sixteen days. A majority of the plains bristlegrass accessions tested showed no germination. Only one accession from Laredo, #29587, exceeded forty percent germination with a germination rate of 70%. Accession #38835 from Zavala County showed the second highest germination rate in the study with 34% germination. These were followed by two accessions that showed 20% germination: #29648 from Laredo and #29677 from Kenedy. Several accessions showed 10% germination or better, but poorer than 20% germination. These accessions include: #29582 from Crosbyton and #31331 from Hutchinson County (both 18%), # 29602 from Clarendon and #29679 from Tilden (both 16%), #29636 from George West (14%), and #29592 from Wellington and #38715 from Duval County (both 10%). Additionally, there were several accessions with less than 10% germination. Accessions #29605 from Val Verde County and #29635 from Hockley County both showed 6% germination. Four percent germination was shown by #29610 from Snyder, #29619 from Muleshoe, #38689 from Brownfield, and #38708 from Goliad County. Accessions #29591 from Spur, #29597 from Nolan County, #29611 from Hereford, #29613 from Amarillo, #29626 from Hutchinson County, #29667 from Cotulla, #31365 from Alpine, #31500 from Cottle County, #35730 from Collingsworth County, #38741 from Pecos, and #38755 from Throckmorton all showed 2% germination. For a complete list of accessions, see Table 1.

DISCUSSION AND CONCLUSIONS

A majority of the accessions studied showed poor or no germination. Since the criteria for further study was a germination rate of forty percent or better, only one accession from this study, #29587 from Laredo, will be evaluated further. This accession showed superior germination (70%), and it is hoped that this accession will exhibit other positive qualities such as good survival, hardiness, forage production and seed production that will render it a good accession of plains bristlegrass for inclusion in South Texas range mixes.

It should be noted that this study did have some limitations. First, all seed used in this study was more than 15 years old, which may have had an impact on seed viability. Second, only one replication of this study was done due to space, time, and seed amount limitations. Finally, much of the seed used in this study had been treated with an unknown fungicidal or insecticidal powder, which may have had some impact on germination as well.

List of Plains Bristlegrass Accessions with Seed as of 6/30/98

#	Accession Number	Year Collected	Location Collected	Germination %
1	17041	63	**S. TEXAS**	0
2	29581	82	MORTON	0
3	29582	82	CROSBYTON	18
4	29587	82	LAREDO	70
5	29589	82	ROSENBERG	0
6	29591	82	SPUR	2
7	29592	82	WELLINGTON	10
8	29597	82	NOLAN CO.	2
9	29602	82	CLARENDON	16
10	29607	82	HASKELL	0
11	29608	82	JAYTON	0
12	29609	82	MARTIN CO.	0
13	29610	82	SNYDER	4
14	29611	82	HEREFORD	2
15	29612	82	POST	0
16	29613	82	AMARILLO	2
17	29615	82	CLAUDE	0
18	29616	82	CANYON	0
19	29619	82	MULESHOE	4
20	29625	82	HARTLEY CO.	0
21	29626	82	HUTCHINSON CO.	2
22	29627	82	MATADOR	0
23	29630	82	DUMAS	0
24	29635	82	HOCKLEY CO.	6
25	29636	82	GEORGE WEST	14
26	29643	82	BIG LAKE	0
27	29644	82	CUERO	0
28	29646	82	LITTLEFIELD	0
29	29647	82	SILVERTON	0
30	29648	82	LAREDO	20
31	29654	82	SANDERSON	0
32	29655	82	MARFA	0
33	29656	82	VAN HORN	0
34	29657	82	FORT STOCKTON	0
35	29658	82	PECOS	0
36	29659	82	EL PASO	0
37	29660	82	EL PASO	0

38	29661	82	EL PASO	0
39	29663	82	VEGA	0
40	29664	82	RAYMONDVILLE	0
41	29667	82	COTULLA	2
42	29669	82	HEBBRONVILLE	0
43	29672	82	ZAPATA	0
44	29673	82	GOLIAD	0
45	29677	82	KENEDY	20
46	29678	82	TILDEN	0
47	29679	82	TILDEN	16
48	29934	82	CHILDRESS CO.	0
49	31318	82	QUANAH	0
50	31321	82	COLORADO CITY	2
51	31322	82	ABILENE	0
52	31331	82	HUTCHINSON CO.	18
53	31349	82	KNOX CO.	0
54	31365	82	ALPINE	2
55	31369	82	VERNON	0
56	31443	82	ECTOR CO.	0
57	31493	82	WILBARGER CO.	0
58	31496	82	FOARD CO.	0
59	31500	82	COTTLE CO.	2
60	2615	70	GEORGE WEST	0
61	35730	83	COLINGSWORTH CO.	2
62	38689	83	BROWNFIELD	4
63	38693	83	GOLDTHWAITE	0
64	38697	83	SPUR	0
65	38708	83	GOLIAD CO.	4
66	38711	83	KNOX CITY	0
67	38713	83	DUVAL CO.	0
68	38715	83	DUVAL CO.	10
69	38737	83	MULESHOE	0
70	38739	83	MARFA	0
71	38741	83	PECOS	2
72	38755	83	THROCKMORTON	2
73	38761	83	JAYTON	0
74	38762	83	ABILENE	0
75	38778	83	ASPERMONT	0
76	38788	83	WILBARGER	0
77	38789	83	HARDERMAN	0
78	38792	83	MATADOR	0

79	38793	83	PARMER CO.	0
80	38802	83	ALPINE	0
81	38815	83	POST	0
82	38818	83	MEMPHIS	0
83	38819	83	SAN ANTONIO	0
84	38820	83	WILLACY CO.	0
85	38827	83	JIM HOGG CO.	0
86	38829	83	DONLEY CO.	0
87	38830	83	HUTCHINSON CO.	0
88	38833	83	FRIO CO.	0
89	38835	83	ZAVALA CO.	34
90	43205	83	DEWITT CO.	0
91	43208	83	CHILDRESS CO.	0
92	441267	78	FORT STOCKTON	0
93	29586	82	LAREDO	0
94	29605	82	VALVERDE CO.	6
95	29622	82	ASPERMONT	0
96	38787	83	BAYLOR CO.	0

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Kika de la Garza Plant Materials Center

Kingsville, TX

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AN EVALUATION OF FOUR FORBS FOR INCLUSION IN RANGE SEEDING MIXES AND WILDLIFE FOOD PLOTS IN SOUTH TEXAS

INTRODUCTION

Texas range seeding mixes commonly include a mix of grasses and forbs. Native, perennial forbs are commonly used in these range plantings. They are also commonly used in wildlife food plots. Illinois bundleflower (*Desmanthus illinoensis*) is one of the most important native, perennial legumes currently used in Texas range planting mixes. It is high in protein, readily eaten by both livestock and wildlife, and is often used as an indicator of range condition (Ajilvsgi, 1984). Awnless bushsunflower (*Simsia calva*) is another forb native to Texas. It has been used as forage for sheep and goats (Soil Conservation Service – United States Department of Agriculture, 1988). In addition, awnless bushsunflower has been found to be a good source of protein for deer (Schweitzer, Bryant, & Wester, 1993).

Other native, warm-season forbs have also been shown to provide a palatable food source for livestock and wildlife in Texas (Nelle, 1994). Orange zexmenia (*Zexmenia hispida*), also known as hairy wedelia (*Wedelia hispida)*, is a common, native, warm-season, perennial forb. It is easily cultivated, and is often browsed by deer, sheep, and goats (Ajilvsgi, 1984). *Aphanostephus riddellii*, commonly known as perennial lazy daisy, has been found to be one of the most highly preferred food sources for white-tailed deer (Arnold & Drawe, 1979; Everitt & Drawe, 1974). In fact, Everitt and Drawe's 1974 study found perennial lazy daisy to be the most preferred spring food source of white-tailed deer, making up more than 12% of their early spring diet. Arnold and Drawe's study in 1979 found perennial lazy daisy to be "the second most heavily preferred species" of white-tailed deer over the course of a year.

Kika de la Garza Plant Materials Center in Kingsville, Texas, has conducted field evaluations using Illinois bundleflower, awnless bushsunflower, orange zexmenia, and perennial lazy daisy. Each species was evaluated for survival, plant hardiness, vegetative production, seed production, and other desirable characteristics. The purpose of this study was to evaluate each forb for potential inclusion in range seeding mixes and wildlife food plots for South Texas.

MATERIALS AND METHODS

The Four Forb Plot consisted of four replications of four 15-foot sections of bedded rows, each containing 15 plants of a different forb species. Locations of each species within a replication were randomly selected. There is a five-foot wide alley between each replication, and a border row of orange zexmenia transplants on either side of the plot to control for an edge effect. Plants for this plot were grown individually in the greenhouse in seeded cones. They were transplanted by hand into their randomly assigned locations at one-foot intervals in April of 1998. They were irrigated immediately following planting, and as needed throughout the growing season. Plants were observed several times a month, and survival, hardiness, vegetative production, and seed production were all recorded.

On December 1, 1998, all rows were evalauted for plant survival. In addition, height and width measurements were taken from five randomly selected sample plants from each row. The condition of the plants was also recorded at that time.

RESULTS

Plant Survival

Orange zexmenia had the highest survival rate of the four forbs included in the plot, with 100 percent survival for all four replications. Perennial lazy daisy had the second best survival rate. Two replications of lazy daisy had 100 percent survival, while the other two replications had 93 percent and 86 percent survival, giving perennial lazy daisy an average survival rate of 94 percent. The awnless bushsunflower and Illinois bundleflower had very poor survival. The awnless bush sunflower had only two surviving plants in one replication, leaving it with an average survival rate of only 3 percent. The Illinois bundleflower did even worse, having no surviving plants in the entire plot (Table 1).

Plant Size

Data on plant size was collected, not to compare species, but to provide an idea of the growth potential of each species in South Texas. Orange zexmenia has a rather shrubby growth form, and was the largest of the plants in the plot. It had an average height of 2.28 feet and an average width of 4.26 feet. Awnless bushsunflower was the next largest plant in the plot. The two surviving plants had an average height of 1.7 feet and an average width of 2.65 feet. Illinois bundleflower would have been the third largest plant in the plot; however, no data could be collected because there were no surviving plants. Perennial lazy daisy is a short wide herbacious forb, and the smallest of the forbs included in this study. It was found to have an average plant height of .9250 feet and an average plant width of 2.155 feet (Table 2).

Plant Condition

Plant condition for the Illinois bundleflower could not be recorded, as no specimens remained alive. The orange zexmenia and awnless bush sunflower were both at the end of their growth cycle, providing only stale, dry forage material at this time of year. The perennial lazy daisy was a pleasant surprise. It still had a lot of fresh green vegetative growth. Its ability to produce tender green forage at times when most other forbs are not, may be why it is such a highly preferred food source.

DISCUSSION

Much of the death loss in the awnless bushsunflower occurred in August of 1998. Most of the plants died suddenly, and upon examination it was noted that roots were spongy-textured. Kleberg County Agricultural Extension Agent, John Ford, confirmed the cause of death of the bush sunflower to be cotton root rot, a soil borne virus. By the beginning of September, 1998, only two awnless bush sunflower survived. A rancher would need to consider the susceptiblity to cotton root rot before including awnless bushsunflower in his range seeding mix. The other forbs in the plot appeared to be fairly resistant to the disease.

There was concern that the Illinois bundleflower would not be drought tolerant enough to survive the hot, dry, South Texas summer, but it surprised us by producing flowers and seed all the way through August. However, it began to die off during the heavy rains of September, 1998. By mid-October no surviving Illinois bundleflower plants remained. Although relatively drought tolerant, it appeared not to like extremely wet conditions following the long period of drought. Orange zexmenia, perennial lazy daisy, and the remaining awnless bushsunflower appeared to thrive under both wet and dry conditions.

Of the four forbs, orange zexmenia appears to be the hardiest of the species and also produced the most vegetation. It had 100 percent survival rate, and appears highly drought and wet tolerant. It produced multiple new seedlings near the existing plants. However, orange zexmenia tends to go dormant in early December. Perennial lazy daisy also had a good survival rate and appears to be tolerant of both wet and dry conditions. While it is a much smaller plant, it tends to produce new vegetative growth on a fairly continuous basis. It can be a good source of forage at times when other quality forage is scarce. It is also known to be a preferred source of food for white-tailed deer.

It is our recommendation that the characteristics of the individual range site be taken into account when choosing forbs to be included in a range seeding mix. A rancher may wish to consider Illinois bundleflower for inclusion in a range seeding mix if the planting site has well drained, sandier soils. Similarly, if the planting site has no history of cotton root rot, a rancher might consider using awnless bushsunflower in a wildlife food plot. However, based on the results of this evaluation, orange zexmenia and perennial lazy daisy were found to be most suited to South Texas conditions, and we would recommend their inclusion in both range seeding mixes and wildlife food plots in South Texas.

Table 1.

PLANT SURVIVAL BY SPECIES AND REPLICATION

Species	Replication	# Surviving	%Surviving
Awnless Bushsunflower	1	0	0
	2	0	0
	3	0	0
	4	2	13
	Total Plot	2	3
Illinois Bundleflower	1	0	0
	2	0	0
	3	0	0
	4	0	0
	Total Plot	0	0
Orange Zexmenia	1	15	100
	2	15	100
	3	15	100
	4	15	100
	Total Plot	60	100
Perennial Lazy Daisy	1	15	100
	2	13	86
	3	14	93
	4	15	100
	Total Plot	57	94

Table 2.

PLANT HEIGHT AND WIDTH BY SPECIES AND REPLICATION

Species	Replication		Height (ft.)	Width(ft.)
Awnless Bushsunflower	4	Mean	1.7000	2.6500
		N	2	2
		SD	.2828	1.7678
	Total Plot	Mean	1.7000	2.6500
		N	2	2
		SD	.2828	1.7678
Illinois Bundleflower			No Data Available	
Orange Zexmenia	1	Mean	2.1200	3.7200
		N	5	5
		SD	.1304	.2775
	2	Mean	2.3400	4.1000
		N	5	5
		SD	.2191	.4528
	3	Mean	2.1200	4.5800
		N	5	5
		SD	.3701	.6797
	4	Mean	2.2800	4.1650
		N	5	5
		SD	.2280	.4980
	Total Plot	Mean	2.2150	4.1650
		N	60	60
		SD	.2519	.5566
Perennial Lazy Daisy	1	Mean	1.0000	2.3800
		N	5	5
		SD	.2121	.6458
	2	Mean	.9600	2.1400
		N	5	5
		SD	.1342	.6198
	3	Mean	.9000	2.2200
		N	5	5
		SD	.1414	.2049
	4	Mean	.8400	1.8800
		N	5	5
		SD	.1140	.2490
	Total Plot	Mean	.9250	2.1550
		N	60	60
		SD	.1552	.4740

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