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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 (Stubbenick 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 saltbush 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 saltbush.

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		
<u>DEPTH</u>	<u>EC</u>	<u>SAR</u>	<u>DEPTH</u>	<u>EC</u>	<u>SAR</u>
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		
<u>DEPTH</u>	<u>EC</u>	<u>SAR</u>
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			
	<u>Survival rates*</u>	<u>Average dimensions</u>	<u>Volume (in²)*</u>
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			
	<u>Survival rates*</u>	<u>Average dimensions</u>	<u>Volume (in²)*</u>
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

	<u>Survival rates*</u>	<u>Average dimensions</u>	<u>Volume (in²)*</u>
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

	<u>Survival rates*</u>	<u>Average dimensions</u>	<u>Volume (in²)*</u>
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.

MONTH	<u>FREER</u>		<u>RIO GRANDE CITY</u>	
	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.

15 MONTHS AFTER PLANTING

	<u>Survival rates</u>	<u>Average dimensions</u>	<u>Volume (in²)</u>
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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