Establishing Alkali Sacaton on Harsh Sites in the Southwest

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Highlight: *Because of critical establishment requirements, seeds of alkali sacaton (*Sporobolus airoides *(Torr.) Torr.) must be planted when both soil moisture and probability of rain are high. Large seeds should be mulched to maintain moisture and darkness.*

Alkali sacaton (*Sporobolus airoides* (Torr.) Torr.) is a valuable plant on flood plains in the semidesert vegetation type of the Southwest (Aldon 1964). On badly eroded sites, remnant plants have effectively lowered sediment losses and provided valuable forage when managed properly (Aldon and Garcia, 1967). Establishing the plant on bare areas through reseeding has been difficult. Seeding has been attempted countless times by land managers with little success. Seed germination would be sporadic, and subsequent seedling mortality sometimes complete. Reasons for these difficulties became apparent during intensive investigations with the seeds and seedlings of this plant. From these investigations a series of steps was prepared outlining the establishment requirements for individual plants under ideal conditions. The validity of each step was tested in the field under difficult conditions.

Germination and Seedling Requirements

Knipe has established temperature stress, moisture, and after-ripening requirements, light, and imbibition effects, and the relationship of seed size to germination (Knipe, 1967; 1968; 1970; 1971a; 1971b). Seedling survival and growth under temperature and moisture stress and in a soil and agar medium, and methods of improving seedling survival, has also been evaluated (Aldon, 1969a; 1969b; 1970).

Alkali sacaton requires almost zero moisture tension to germinate, although large seeds can withstand some moisture tension (Knipe, 1969). Large seeds nearly double their air-dry weight during the first 4 hours under saturated conditions; they germinate better, faster, and emerge from deeper depths than small seeds (Knipe, 1970).

Optimum temperature for germination ranges from 27-32°C (Knipe, 1967). Temperatures of from 38-107°C for various periods of time did not affect germination of air-dry seeds (subsequent germination was above 90%) (Knipe, 1969). Unless scarified, seeds must after-ripen for several months before appreciable numbers will germinate.

Exposure to light for a few seconds delays germination for 24 hours, exposure for 9-13 hours delays germination 28 hours, and continuous exposure reduces germination of imbibed seeds by 40% (Knipe, 1971b).

Optimum growing conditions for alkali sacaton seedlings are 30°C and soil moisture at field capacity (Aldon, 1969a). If seedlings receive additional moisture within 5 or 10 days after planting, survival exceeds 90%. If forced to go longer before another wetting, seedling survival drops below 76%. After 5 days most seedlings have emerged from a 6 mm planting depth and have roots 5 cm long. By 15 days, roots are about 13 cm long and seedlings have three leaves.

Since soil is seldom saturated at most field planting sites, tests with possible substitute conditions (Aldon, 1969b; 1970) showed that: (1) seeds must be planted on moist soil with a 13 mm mulch when temperatures are around 30°C, (2) an agar plate helps reduce moisture tensions, and (3) plants should be watered after 5 days if no natural precipitation occurs (at least 6 mm). In Arizona, germination has been increased by concentrating rainfall in shallow pits.[1]

Based on the above information, we identified the succession of events needed for the establishment of alkali sacaton plants in the semiarid portions of New Mexico. It is substantially as follows: seeds are produced in the late summer and fall (October) from mature plants. They shatter and fall on surrounding areas. Winter and spring temperatures do not adversely affect the seeds. Below-optimum temperatures in winter, characteristically dry springs, and after-ripening requirements preclude early germination. After about 9 months of after-ripening (July), seeds will germinate easily. Late-afternoon summer convective thunderstorms begin in July. Large storms, 25 mm plus, cause local flooding and resultant sediment movement in arroyos and into flood plains. Seeds are moved by these flows, and deposited in saturated sediments. Overnight under dark conditions the seeds imbibe moisture. The next day, air and surface soil temperatures reach 32+°C and the seeds germinate. Once the thundershower systems begin in the Southwest, probabilities for weekly recurrence of storms increase (Gifford et al., 1967). Thus between 5 and 10 days later, another significant (7 mm plus) storm should occur, the soil is resaturated, and the seedlings have a good chance of survival. Up to 4 cm of

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[1] Personal communication with Robert D. Slayback, Manager, Plant Materials Center, Soil Conservation Service, U.S. Department of Agriculture, Tucson, Arizona.

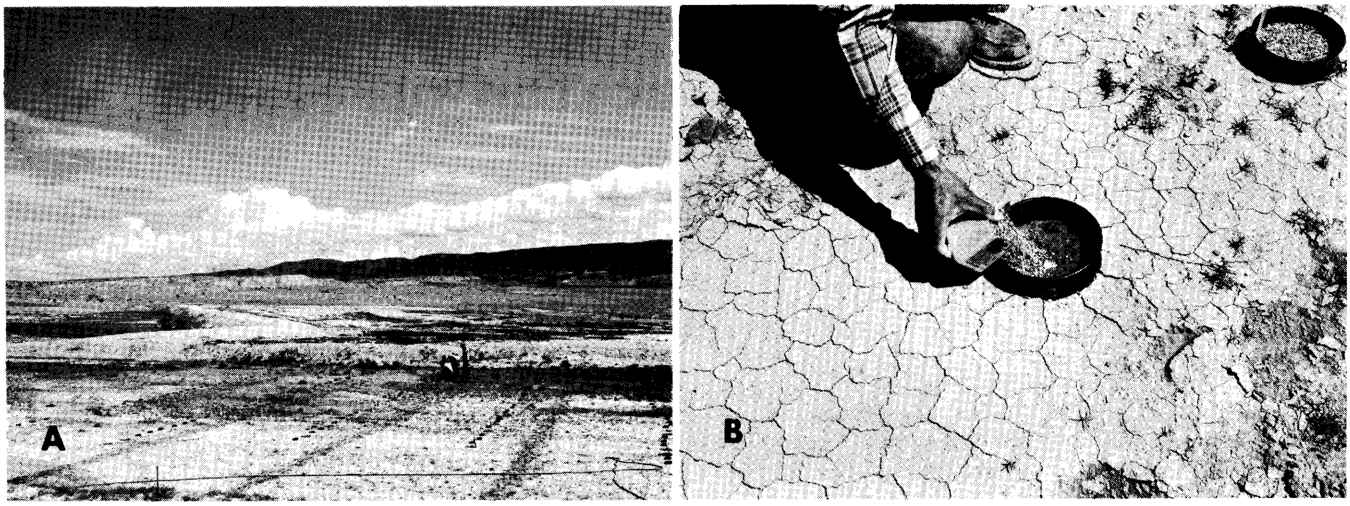

Fig. 1. A, *View of spillway site where tests were conducted; collars indicate replication of treatments.* B, *Closeup of harsh planting site.*

Fig. 2. *Alkali sacaton treatments:* A, *Typical treatment C survival after two growing seasons;* B, *Treatment E before planting;* C *Treatment E after two growing seasons (note sediment deposits on seedling).*

sediment can be deposited over the seedling and it will push through and live. Mature plants of alkali sacaton can withstand deposits of 23 cm of heavy-textured sediment with only moderate damage, and some large plants can survive under deposits of as much as 58 cm (Hubbell and Gardner, 1950).

Using these optimum conditions, we tested some field possibilities on a pilot basis on a harsh spillway site (Fig. 1) on the Rio Puerco drainage in New Mexico. Survival was counted after the second growing season to be certain establishment was successful.

Field Test Procedures

Six treatments were arranged

Table 1. Experimental design.

Treatment	Series designation A	B	C	D	E	F
Spot saturated initially	X	X	X	X		
Agar plate	X	X			X	
Mulch	X	X	X	X	X	X
Rewater after 5 days (mm)	50	6	50	6	6	6
Seeds in depression					X	X

randomly in a row plot and replicated five times in each of five blocks on a spillway site in late July, 1970 (Fig. 1). We waited until the summer thundershowers began to wet the site and could be expected to continue. Precipitation was measured on the site in a recording gage. A week prior to planting, 20 mm from two storms provided the desired wet soil conditions. Individual storms were measured during the first month after planting, and total weekly measurements were recorded thereafter. Soil and air temperatures were monitored on the site with recording thermometers. A sensor was placed 2.54 cm below the soil surface and covered with soil. Air temperatures were measured in a standard shelter 1.37 m above the soil surface.

Collars, 5 cm high, were placed around each planting spot (Fig. 1) and filled with water at planting time if necessary to be sure the spot was saturated. Ten large, 1-year-old alkali sacaton seeds were planted at each spot. The collars were labeled A, B, C, D, E, and F to designate the several watering regimes tried with combinations of agar plates and mulch (Table 1). Eighteen random 8-cm-deep soil samples were taken at planting time on the site, weighed, and oven-dried. Soil moisture determinations and drying curves were made from these samples (Aldon, 1972).

Results

On the 3rd day after planting, the site received a storm of 19 mm and rewatering was deemed unnecessary. By the 10th day an additional 49 mm was measured from two storms. Many of the agar plates were moved and covered with sediment. At other spots the vermiculite was covered with sediment. On the 13th day after planting, the area received 12 mm of rain.

Soil moisture averaged 14.1% by weight at planting time, which is 1 atm tension for this alluvial soil.

Surface soil temperatures between 1000 and 1700 hours averaged 33°C, and air temperatures during the first 5 days after planting averaged 25°C. The daytime soil temperatures were very close to optimum for germination.

Seedling emergence was noticed on the 5th day, but the large storm on the 8th and 9th days after planting caused sediment deposits of from 6 to 50 mm on the spots. On the 10th day it appeared that few seedlings were emerging, but many seedlings were again emerging by the 15th day. This 10-day delay is attributed to the sediment deposits, and further validates laboratory work on seedling emergence from deep sediment (Knipe, 1970).

Since rewatering was not needed, the treatments differ only in the use of agar, planting in a depression, and initial saturation. Survival was best where no agar or depression was used (treatments C and D, Table 2). The test was not confirmed for agar, which we thought would have resulted in highest survival.

Discussion

Seeds planted in depressions (treatments E and F) were not initially saturated and received 50+ mm of deposits (Fig. 2), which may account for the poor survival (Table 2). Beyond 44 mm deposition, seedling emergence is poor (Knipe, 1970). Collars protected many spots from excessive deposition.

At the end of the second growing season, 44% of the spots in treatments C and D were still supporting mature plants (Table 2). Total precipitation from the end of the first growing season to the end of the second growing season was 203 mm. From the end of the first growing season until August of the next year, the site received only 64 mm, a record low for the winter-spring period in this area.

The added burden of the extended drought lends support to the validity of the findings. Survival in treatments C and D was good (3 plants/spot) after the first growing season. Under more normal precipitation patterns we could expect second-year survival to be better.

Conclusions

Alkali sacaton is a valuable plant on flood plains in the semidesert type of the Southwest. Because it has exacting establishment requirements, however, the following agronomic steps are necessary for its establishment: (1) plant when soil moisture is at least 14% or higher (1 atm tension or less); (2) plant when probabilities for weekly precipitation are greatest and soil temperatures will be near 30°C; (3) use large seeds at least 1 year old; (4) saturate the planting site just prior to planting; (5) cover seeds with about 13 mm of mulch to keep them moist and dark; and (6) if storms at planting site do not deposit at least 6 mm of rain within the first 5 days, rewater to bring the soil to saturation.

Literature Cited

Aldon, E. F. 1964. Ground-cover changes in relation to runoff and erosion in west-central New Mexico. Rocky Mountain Forest and Range Exp. Sta., Fort Collins, Colo. U.S. Forest Serv. Res. Note RM-34, 4 p.

Aldon, E. F. 1969a. Alkali sacaton seedling survival and early growth under temperature and moisture stress. Rocky Mountain Forest and Range Exp. Sta., Fort Collins, Colo. U.S. Forest Serv. Res. Note RM-136, 4 p.

Aldon, E. F. 1969b. Alkali sacaton seedlings: germination and survival in an agar and soil medium. Rocky Mountain Forest and Range Exp. Sta., Fort Collins, Colo. U.S. Forest Serv. Res. Note RM-156, 3 p.

Aldon, E. F. 1970. Improving survival of alkali sacaton seedlings under adverse conditions. Rocky Mountain Forest and Range Exp. Sta., Fort Collins, Colo. U.S.

Table 2. Stocking[1] at the end of the first (1970) and second (1971) growing seasons.

Treatment	Avg plants/spot 1970	Avg plants/spot 1971	Stocked spots 1970	Stocked spots 1971	Percent stocked 1970	Percent stocked 1971
A	0.60 bc	0.16 b	7	2	28	8
B	.96 b	.16 b	10	2	40	8
C	3.64 a	1.32 a	19	11	76	44
D	3.04 a	1.16 a	17	11	68	44
E	.08 c	0 b	2	0	8	0
F	.40 bc	.08 b	4	2	16	8

[1] Any two means within columns not followed by the same letter are significantly different at the 0.05 level.

Forest Serv. Res. Note RM-177, 3 p.

Aldon, E. F. 1972. Critical soil moisture levels for field planting fourwing saltbush. J. Range Manage. 25:311-312.

Aldon, E. F., and G. Garcia. 1967. Summer deferred grazing can improve deteriorated semidesert ranges. Rocky Mountain Forest and Range Exp. Sta., Fort Collins, Colo. U.S. Forest Serv. Res. Note RM-95, 3 p.

Gifford, R. O., G. L. Ashcroft, and M. D. Magnuson. 1967. Probability of selected precipitation amounts in the western region of the United States. Nevada Agr. Exp. Sta. Reno. West. Reg. Res. Pub. T-8, n.p.

Hubbell, D. S., and J. L. Gardner. 1950. Effects of diverting sediment-laden runoff from arroyos to range and crop lands. U.S. Dep. Agr. Tech. Bull. 1012, 83 p.

Knipe, O. D. 1967. Influence of temperature on the germination of some range grasses. J. Range Manage. 20:298-299.

Knipe, O. D. 1968. Effects of moisture stress on germination of alkali sacaton, galleta, and blue grama, J. Range Manage. 21:3-4.

Knipe, O. D. 1969. Factors affecting the germination of alkali sacaton. PhD Thesis, Dep. Watershed Manage., Univ. of Ariz., Tucson.

Knipe, O. D. 1970. Large seeds produce more, better alkali sacaton plants. J. Range Manage. 23:369-371.

Knipe, O. D. 1971a. Imbibition of alkali sacaton seeds. J. Range Manage. 24:71-73.

Knipe, O. D. 1971b. Light delays germination of alkali sacaton. J. Range Manage. 24:152-154.