# Effects of Moisture Stress on Germination of Alkali Sacaton, Galleta, and Blue Grama [1]

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**Highlight**

**Seeds of alkali sacaton, galleta, and blue grama were germinated in media representing moisture tensions of 0, 1, 4, 7, 10, 13, and 16 atm. Alkali sacaton germination was most severely affected by moisture stress, which helps to explain, at least in part, why alkali sacaton plants are confined mainly to areas that are frequently flooded. In contrast, galleta and blue grama are less affected by moisture stress and, therefore, can become established and survive on the drier upland sites.**

Natural regeneration of the principal grass species in most parts of the Rio Puerco watershed area of west-central New Mexico is virtually nonexistent. The principal species of the area, alkali sacaton (*Sporobolus airoides* Torr.), galleta (*Hilaria jamesii* Torr.), and blue grama (*Bouteloua gracilis* [H.B.K.] Lag.) occur mainly as widely spaced vegetal islands. Observations over a period of several years have shown that seed production by these species is not lacking, yet large spots devoid of perennial plants remain intermixed with the islands of vegetation.

The ecology of alkali sacaton, galleta, and blue grama is being studied in an effort to determine what can be done to promote soil stabilization of the area. The present study is one phase of the overall ecological study. Its objective was to determine the effect of moisture stress on seed germination.

Several workers have used aqueous solutions of mannitol to limit moisture availability while studying the germination response of grasses to various levels of moisture tension. Helmerick and Pfeifer (1954), in tests with winter wheat, found that limiting moisture by use of aqueous mannitol-moistened blotters in petri dishes produced results similar to those obtained by use of the pressure membrane method. Powell and Pfeifer (1956), Dotzenko and Dean (1959), and Younis et al. (1963) have effectively tested drought hardiness by use of aqueous mannitol solutions. McGinnies (1960) and Knipe and Herbel (1960) used aqueous mannitol solutions to determine the effect of moisture stress on germination of several grass species. The effect of different levels of moisture tension on the germination of alkali sacaton, galleta, and blue grama apparently has not been investigated.

## Methods and Materials

Seeds used in the study were collected within the Rio Puerco watershed near the village of San Luis, 58 miles northwest of Albuquerque, New Mexico. The alkali sacaton seeds were collected in 1962, the galleta and blue grama seeds in 1965. Three-year-old alkali sacaton seeds were used, because recent tests have shown that this species requires an after-ripening period before appreciable germination can be expected.[3] The seeds were stored in cloth bags at room temperature.

The seeds were selected without regard to size or color, but only fully developed, undamaged seeds were used. The seeds were germinated in 4-inch-diameter petri dishes in a Stultz germinator programmed for 8 hr light at 86F and 16 hr darkness at 68F daily. The germination substrate was two thicknesses of standard blue germination blotter paper. Each species was replicated four times at moisture tension levels of 0, 1, 4, 7, 10, 13, and 16 atm. There were 100 seeds per replication. Levels of moisture tension were attained by saturating the blotters with aqueous mannitol solution prepared in accordance with the formula given by Helmerick and Pfeifer (1954). Since the osmotic tension of a solution varies with temperature, and since an alternating temperature regime was used, the concentration of mannitol was adjusted to give the desired tension at the intermediate temperature of 77F. Tap water was used for the 0 atm treatment.

Seedlings were counted daily from the second through the tenth day and at three-day intervals thereafter. The test was terminated after 32 days. Seeds that produced seedlings whose radicles and plumules exceeded 5 mm in length were counted as germinated. Molded and softened seeds were removed from the dishes as they occurred during the study. The final germination percentages were transformed by arcsin of square root of percentages for analysis of variance.

Seedling vigor was evaluated qualitatively on the fifth day after the start of the study. These evalu-

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[3] Germination percentages in the neighborhood of 20 to 30 the first year, 40 to 60 the second, and 70 to 85 the third year are characteristic of alkali sacaton. Germination percentages of galleta and blue grama range from 80 to 95 without benefit of after-ripening.

Table 1. Percent germination of three grass species at seven levels of moisture tension (atm) after 32 days. Each value is the mean of four replications of 100 seeds each.

| Moisture tension | Species | | |
|---|---|---|---|
| | Alkali sacaton | Galleta | Blue grama |
| 0.0 | 76.75 | 81.25a | 96.75a |
| 1.0 | 69.25 | 83.00a | 95.25a |
| 4.0 | 50.25 | 81.00a | 93.25a |
| 7.0 | 39.00 | 77.00ab | 92.50a |
| 10.0 | 18.50 | 72.25b | 74.50b |
| 13.0 | 7.50a[1] | 71.25bc | 72.75b |
| 16.0 | 3.00a | 65.50c | 42.25 |

[1]Any two means within species not followed by the same letter are significantly different (.05 level, Duncan's new multiple range procedure, Steel and Torrie, 1960).

ations were based on obvious size differences between controls and seedlings subjected to moisture tension treatment.

## Results and Discussion

Of the species tested, alkali sacaton was affected most by increases in moisture tension. Percent germination was significantly reduced by 1 atm moisture tension, and was further reduced by each 3 atm increase with the exception of 13 to 16 atm (Table 1).

Percent germination of galleta and blue grama was not significantly reduced until a moisture tension of 10 atm was reached. Both galleta and blue grama germinated as well at moisture tensions of 13 as at 10 atm, and galleta germinated equally as well at 16 as at 13 atm.

The rapidity of germination of galleta and blue grama was delayed by a moisture tension of 4 atm, and the rapidity of germination of alkali sacaton was delayed by a moisture tension of 1 atm. Delays in germination due to moisture tension were not analyzed statistically, but it is obvious that such effects were appreciable (Table 2).

Table 2. Time (days) required for alkali sacation, galleta, and blue grama to reach 90 percent of the total germination attained after 32 days at each of seven levels of moisture tension (atm).

| Moisture tension | Species | | |
|---|---|---|---|
| | Alkali sacaton | Galleta | Blue grama |
| 0 | 3 | 2 | 2 |
| 1 | 6 | 2 | 2 |
| 4 | 5 | 4 | 7 |
| 7 | 6 | 4 | 13 |
| 10 | 16 | 6 | 16 |
| 13 | 12 | 5 | 18 |
| 16 | 22 | 8 | 24 |

Moisture tension affected seedling vigor markedly. Moisture tensions in excess of 1 atm noticeably reduced vigor of alkali sacaton and blue grama seedlings (Fig. 1); tensions in excess of 4 atm noticeably reduced vigor of galleta seedlings.

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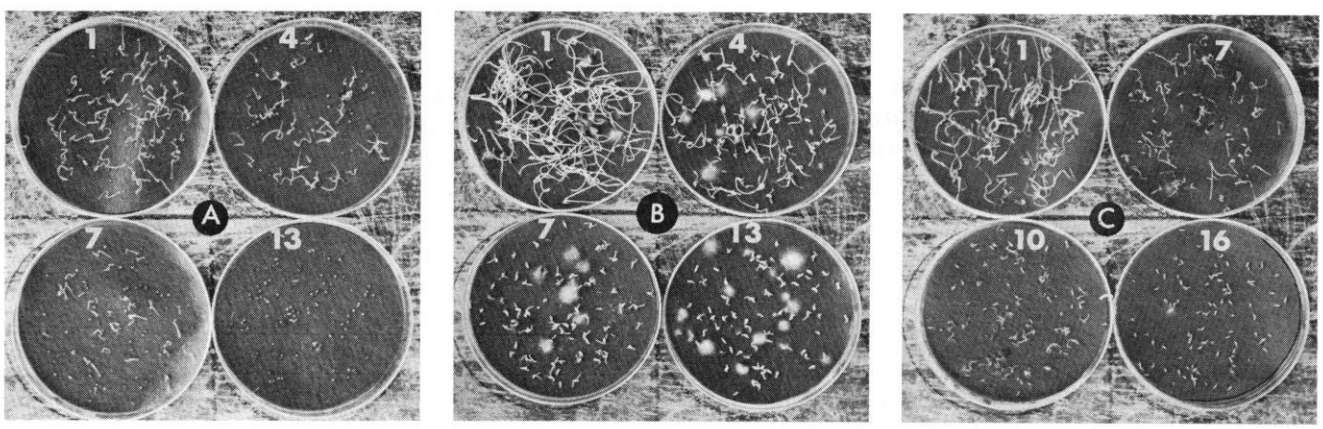


Fig. 1. Relative seedling vigor of *A*, alkali sacaton, *B*, galleta, and *C*, blue grama, after 5 days at various levels (atmospheres) of moisture tension.