Effects of Light and Temperature on Germination of Sideoats Grama

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Highlight: *Seed from three sources of sideoats grama (*Bouteloua curtipendula *(Michx.) Torr.) were planted on one- and two-way thermogradient plates to determine the effects of light, constant and alternating temperatures, and temperature duration on germination over a range of 10 to 40°C. The direction of the temperature gradients was switched on various 24-hour cycles consisting of the following combinations: 4-20, 8-16, and 12-12 hours. Dormancy was not broken by any set of alternating temperature combinations. Light did not promote the rate or completeness of germination. The seed from various sources differed in the totality of germination over the entire thermogradient plate. The best germination over the entire plate was obtained with the 12-12 hour cycle, followed in turn by the 8-16 hour cycle and finally the 4-20 hour cycle for seed source 63, 1969 seed. As the imbalance of time cycles increased, the exposure of seed to continuous extreme temperatures increased also, thereby lowering total germination. Optimum temperatures for maximum germination of each source differed depending upon year of seed production and duration of the specific temperature.*

Seed germination of sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.) is influenced by dormancy (Coukos, 1944), temperature (Toole, 1938), germination inhibitors (Sumner and Cobb, 1962; Major, 1972), and interactions between storage conditions and time (Coukos, 1944). The procedures recommended for germination by the Association of Official Seed Analysts (1970) are: (a) alternating temperature of 15 to 30° C, (b) 8 hours of light at the higher temperature, (c) the use of blotters moistened with 0.2% KNO_3 as the germination medium.

Previous research on germination of sideoats grama has been limited to a relatively few discrete constant or alternating temperatures. Development and description of the thermogradient plate (TGP) by Larsen (1971) provided a method to determine the optimum temperature for rapid and maximum germination of various seed. Larsen and Skaggs (1969) found that a constant 25° C was optimum for germination of crambe (*Crambe abyssinica* Hochst. ex R. E. Fries) seed using the TGP. Larsen et al. (1973) reported that dormancy affected the germination speed and pattern of rescuegrass (*Bromus cartharticus* Vahl.) on the TGP. They further reported that clipping the distal end of the pericarp increased germination of dormant seed.

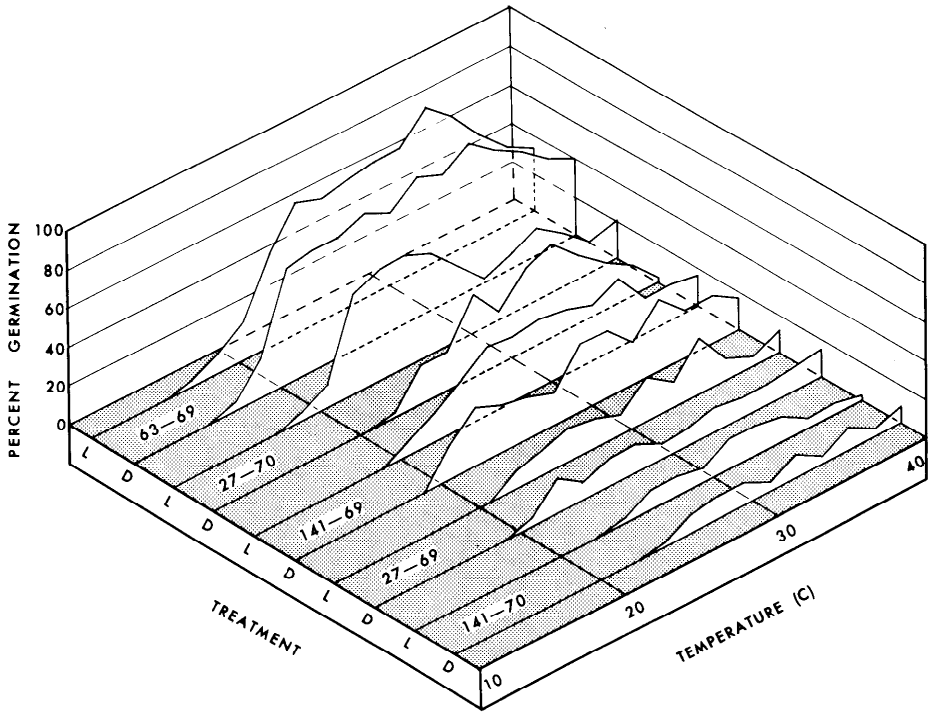

Fig. 1. *Effects of light and a range of constant temperatures (10 to 40°C) on germination of seed from different sources of sideoats grama. L = light. D = dark. 63-69 = source 63, seed produced in 1969. 27-70 = source 27, seed produced in 1970, etc.*

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Objectives of the present study were to determine the effect of light, constant and alternating temperatures, and the length of the alternating temperature cycle on the germination of sideoats grama and to determine if any combination of alternating temperatures and temperature durations would break seed dormancy.

Materials and Methods

Seed units of three seed sources of sideoats grama were produced as described by Major (1972) at the Plant Materials Center, Tucson, Arizona, in 1969 and 1970. The origins of each seed source were: (a) source 27, Texas–Texas P.M.C., PM-T-56, Orange Grove, (b) source 63, New Mexico–"Vaughn," Tucson P.M.C., lot 3196, and (c) source 141, Plant Introduction number 279525, from Argentina (Major, 1972). Spikes containing one or more caryopses were considered a seed unit or "seed."

Effects of light (100 ft-c at seed level, cool-white fluorescent and incandescent) and a range of constant temperatures from 10 to 40° C on germination were determined. The TGP was used in a one-way mode to establish the temperature gradient. Four replicates of 25 seed from each seed lot were planted at 15 different temperature positions on the TGP. Two TGP's were used, one covered with a black cloth and the other exposed to light for 8 hours daily. The experiment was repeated and data from similar treatments were combined.

The effects of light and a range of alternating temperatures of 10 to 40° C also were determined using the TGP in a two-way mode. The temperature gradient (10 to 40° C) was alternated on a 12-hour cycle. Light described above was alternated with dark on a 12-hour cycle. Two seed units of source 63, seed produced in 1969, were planted at each of 900 locations on the TGP and were spaced 2.54 cm apart in all directions.

The effects of time between temperature alternation and year of production were determined on each seed source in complete darkness. The TGP was used in the two-way mode. Temperature gradients (10 to 40° C) were established on two cycles; (1) 8 hours in one direction and 16 hours in one direction at a right angle to the 8-hour direction (8-16), (2) 4 hours in one direction and 20 hours in one direction at a right angle to the 4-hour direction (4-20). Seed were planted as previously described on the two-way TGP.

Two blotters were used in all experiments (in duplicate) as the medium for germination. Seed were considered germinated when one radicle per seed unit was at least 1 cm in length and the shoot visible. Germination counts were made 7

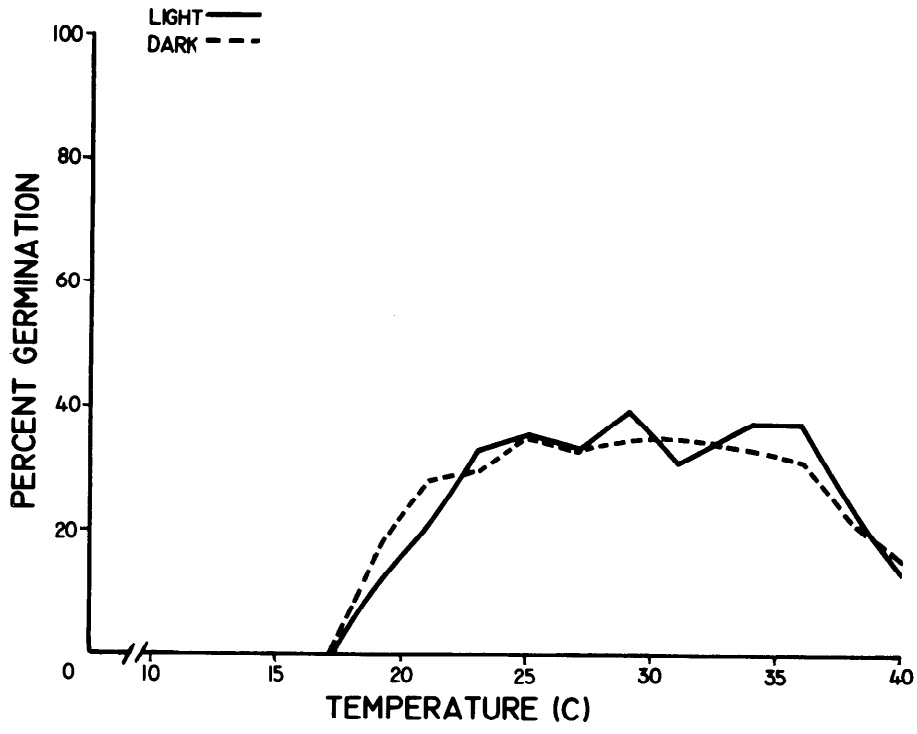

Fig. 2. *Effects of light and a range of constant temperatures (10 to 40° C) on germination of sideoats grama averaged over all seed sources.*

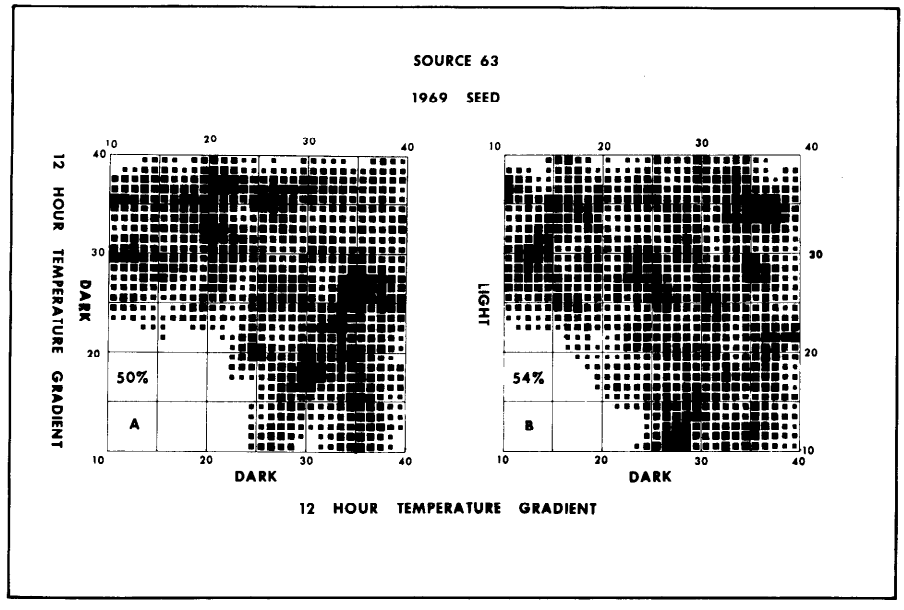

Fig. 3. *Effects of light and a range of alternating temperatures (10 to 40° C) on germination of seed from source 63, 1969 seed, of sideoats grama. The temperature gradients were alternated on a 12-12 hour cycle. The larger "squares" represent higher germination percentages (9 different sizes).*

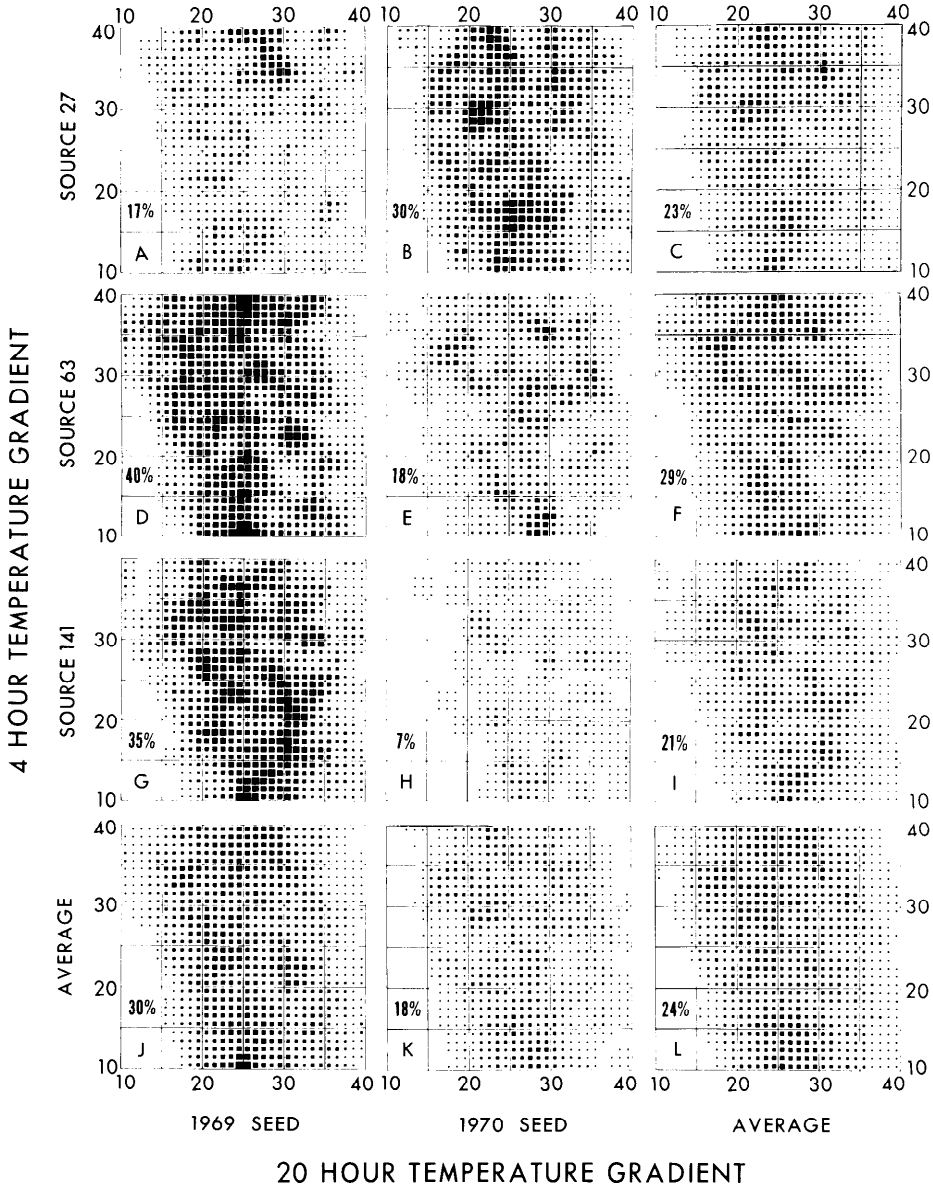

Fig. 4. *Germination pattern of sideoats grama seed on a two-way thermogradient plate in constant dark with a range of alternating temperatures of 10 to 40°C. The temperature gradients were alternated on a 4-20 hour cycle. The larger "squares" represent higher germination percentages (9 different sizes).*

days after planting. Moisture content of the blotters was maintained by watering when needed. A green safelight was used during watering to prevent a light reaction.

Intensity of germination diagrams (Larsen and Skaggs, 1969) were plotted for the two-way TGP data by using a moving average of each position with its adjacent 8 positions. Outside rows and columns were "weighted" by appropriate values. Larger "squares" on the intensity diagram represent a higher percentage germination.

Results and Discussion

Major (1972) classified source 27 as dormant and sources 63 and 141 as nondormant when germinated at the temperatures recommended by the Association of Official Seed Analysts (1970). However, seed produced in the same region in different years within sources exhibited different levels of dormancy. Major (1972) further showed that dehulling broke the dormancy and the seed germinated at the recommended temperature.

Seed from source 63, produced in 1969, showed less dormancy than seed from the other sources (Fig. 1). Differences between years of production were found for sources 27 and 141. At constant temperatures germination was not influenced by light (Figs. 1 and 2).

Light did not influence the completeness of germination of seed from source 63 when the temperature gradients were alternated on a 12-hour cycle (Fig. 3). Percentages in the lower left corner of each intensity diagram (Figs. 3, 4, and 5) represent the percent of seed that germinated for each seed source over the entire thermogradient plate. Results reported here on the influence of light on germination support previous research (Cole, 1971; Sumner et al., 1960; Toole, 1938) in that light is not a specific requirement for germination of sideoats grama.

Seeds were stored from time of harvest to the spring of 1972 at 5° C and a relative humidity of 15%. Coukos (1944) reported that dormancy in sideoats grama was prolonged at cool storage conditions. Effects of a range of alternating temperatures on two different alternating cycles are shown in Figs. 4 and 5. No specific alternating temperature combination or temperature duration appeared to break dormancy of this species. Germination occurred over a wide range of temperature combinations.

Maximum germination for sources 63 and 141 occurred with seed produced in 1969 (Fig. 4 d,g and Fig. 5 d,g), whereas, maximum germination of source 27 occurred with seed produced in 1970 (Fig. 4b, and Fig. 5b). Averages over all seed sources revealed that the seed produced in 1969 was less dormant than that produced in 1970 (Fig. 4 j,k and Fig. 5 j,k).

More seed germinated with the 8-16-hour alternating cycle (Fig. 5); and the 4-20-hour (Fig. 4) cycle reduced germination of all accessions at alternating temperatures above 35 and below 15°C of 20-hour duration.

Comparison of data for source 63, from Figs. 3, 4d and 5d, indicates that a 12-hour alternating cycle at the recommended temperature of 15-30 provides a more favorable environment for germination than an 8-16 hour cycle. Research with Kentucky bluegrass (*Poa pratensis* L.) showed that temperature alternation promoted germination in darkness when the daily period at 25° C is between 4 and 14 hours (Toole and Borthwick, 1971).

Maximum germination of seed from all sources when temperatures were alternated on a 4-20 cycle, occurred in the temperature range of 20 to 30° C for 20 hours independent of the temperature for the remaining 4 hours of the cycle (Fig. 4 j,k,l). This is contrasted with the much broader range of temperatures of maxi-

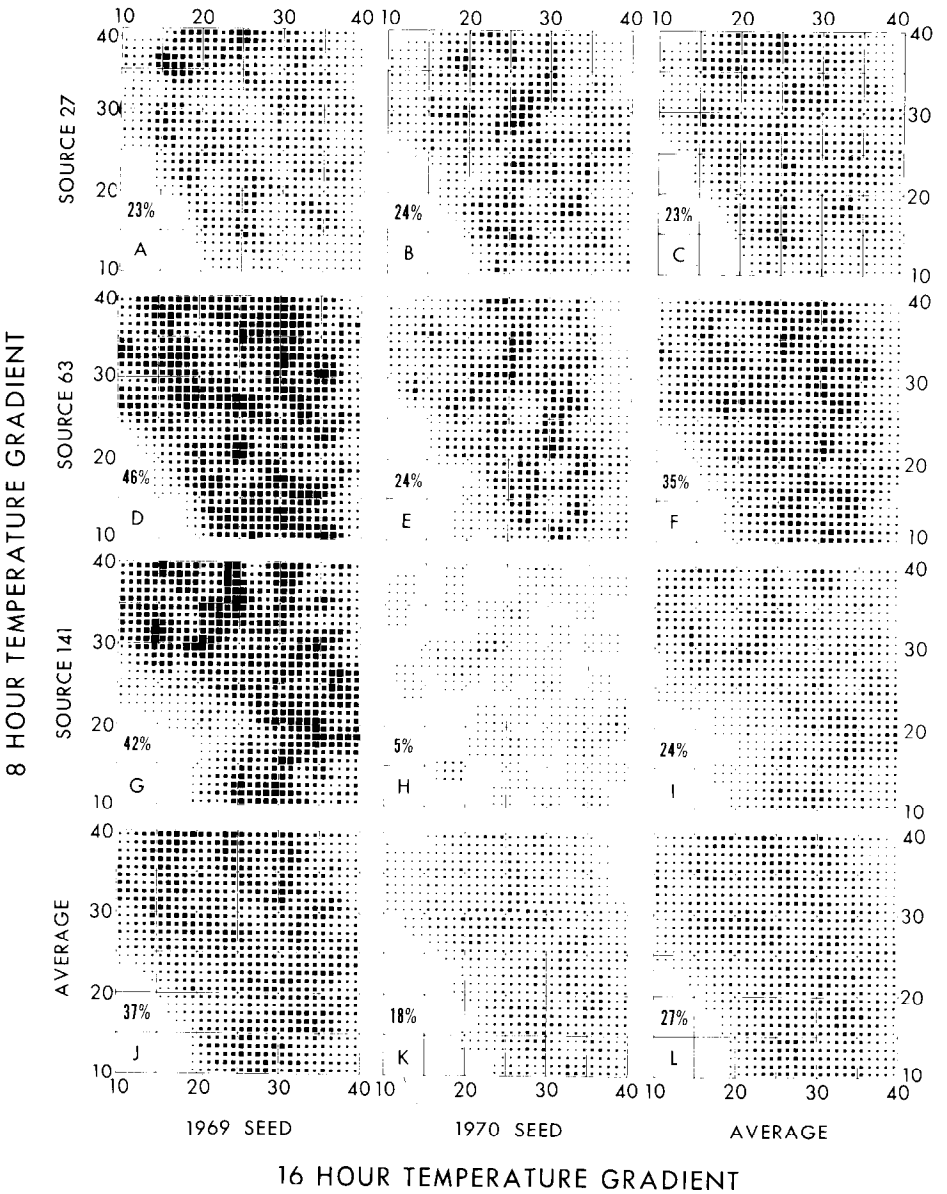

Fig. 5. *Germination pattern of sideoats grama seed on a two-way thermogradient plant in constant dark with a range of alternating temperatures of 10 to 40° C. The temperature gradients were alternated on a 8-16 hour cycle. The larger "squares" represent higher germination percentages (9 different sizes).*

mum germination with an 8-16-hour alternation (Fig. 5 j,k,l).

Regions of maximum germination for seed from each source differed in different years and duration of the specific temperature. An example is source 27, in which 1969 seed germination was maximized on a 4-20-hour cycle at temperatures of 35-30° C (Fig. 4a), respectively, and at an 8-16 hr cycle at temperatures of 35-15° C (Fig. 5a), respectively. Several other examples are apparent upon examination of the other seed sources and temperature cycles. Thompson (1970a) showed that maximum germination of different species of Caryophyllaceae occurred at different temperatures. He further reported that different seed sources of (*Silene secundiflora* Otth.) germinated over a broader range of temperatures as dormancy was reduced (Thompson, 1970b). The data reported here indicate that sources 63 and 141 germinated at a lower temperature than source 27 on both temperature alternation cycles (Fig. 4 and 5). This suggests that sources 63 and 141 may be better adapted to cooler climates or that they may have originated in different environmental conditions than source 27.

The recommended temperature (Assoc. Off. Seed Anal., 1970) resulted in less germination by seed from all seed sources than other temperatures which were more favorable. These data suggest that low temperatures for 16 hours may be either too low, or too long, or both. Increasing the low temperature to 20° C or changing to a 12 hour alternating cycle should provide a better environment for maximum germination.

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