Germination Characteristics of *Helianthus maximilianai* Schrad. and *Simsia calva* (Engelm. & Gray) Gray

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Abstract

Germination characteristics of Maximilian sunflower (*Helianthus maximiliana* Schrad.) and awnless bushsunflower {*Simsia calva* Engelm. & Gray) Gray were evaluated at water potentials of 0, -.25, -0.50, -0.75, and -1.0 MPa under alternating temperature regimes of 10/20, 15/25, and 20/30° C in controlled environmental chambers. Cumulative germination was greatest for both species at water potentials of 0 and -0.25 MPa in the 15/25° C temperature regime. Germination total and rate were depressed for both species in the 10/20° C regime. The 20/30° regime depressed total germination but increased germination rate. The adverse effects of more negative water potentials (-0.75 and -1.0 MPa) were more pronounced at low temperatures for awnless bushsunflower and high temperatures for Maximilian sunflower.

'Aztec' Maximilian sunflower (*Helianthus maximiliana* Schrad.) is an erect, perennial forb with one to several stems (1 to 2 m tall) and short rhizomes (Rechenthin 1972, Texas Agricultural Experiment Station 1979). This cultivar is adapted to the southern three-fourths of Oklahoma and all parts of Texas except the Trans Pecos region (Thornburg 1982, Wasser 1982). 'Aztec' is adapted to most soil types, except where prolonged saturation or salinity is a problem (Texas Agricultural Experiment Station 1979). Plants provide forage for livestock, cover and food for wildlife, and showy yellow flowers for landscape beautification (Rechenthin 1972).

Awnless bushsunflower {*Simsia calva* (Engelm. & Gray) Gray} is a multi-branched, spreading, perennial forb occurring on limestone and calcareous soils in Central Oklahoma and in the Coastal Prairie, Cross Timbers, South Texas Plains, Edwards Plateau, and Trans Pecos regions of Texas (Gould 1975, Soil Conservation Service 1980). Plants are readily grazed by sheep, goats, and deer, and to a lesser extent by cattle (Rechenthin 1972).

Both of these species could be used in mixtures to provide greater diversity for revegetation plantings on disturbed rangelands in the Southern Great Plains. However, a better understanding of their ability to germinate and develop under different environmental conditions must be obtained in order to effectively establish and manage them (Sutton 1975). The objective of this study was to investigate the effects of different temperature × water potential regimes on germination characteristics of 'Aztec' Maximilian sunflower and awnless bushsunflower.

Materials and Methods

Seed of 'Aztec' Maximilian sunflower and PMT-856 awnless bushsunflower were obtained from the Soil Conservation Service Plant Materials Center, Knox City, Texas. Seeds were harvested in 1981 and were stored for 5 months at 16°C and 40% relative humidity prior to germination trials. Lots of 100 uniformly sized seeds were dusted with Captan {CIS-N-(Trichlor-omethyl) thio)-4 -cyclohexene 0 1,2-dicarboximide} and placed on 1 piece of Whatman No. 1 chromatography paper in 13 × 13.5 × 3.5 cm plastic trays. The chromatography paper was supported by a 5-mm thick piece of polyurethane foam with 5 cotton wicks which extended into a 200-ml reservoir of solution. Solutions had water potentials of 0, -0.25, -0.50, -0.75, and -1.0 MPa, which were derived from 20,000 MW polyethylene glycol. Trays were wrapped with clear polyethylene film to reduce evaporation and stabilize the relative humidity. Trays were placed in controlled environmental chambers with night/day temperature regimes of 10/20, 15/25, and 20/30°C and 12-hour photoperiods. During the day period, a light intensity of 450 umol • m^{-2} • sec^{-1} was maintained at tray level. Germinated seeds were counted every other day over a 21-day period. A seed was considered to have germinated when it had at least 1 cotyledon exposed and a radicle greater than or equal to 5 mm in length (Copeland 1978).

The experiment was arranged in a completely randomized design with 3 replicates (trays) per treatment, and each treatment was replicated twice over time. Germination data were transformed with an arcsine transformation prior to statistical analysis by analysis of variance (Steele and Torrie 1960). The effects of substrate water potentials and alternating temperature regimes on germination percentages were analyzed by the use of a quadratic response surface (Evans et al. 1982).

Results and Discussion

Cumulative germination of Maximilian sunflower was greatest at substrate water potentials of 0 and -0.25 MPa in the 15/25°C temperature regime (Fig. 1). At the same substrate water potentials, germination decreased 7% as alternating temperatures were lowered to 10/20°C and 16% as alternating temperatures were elevated to 20/30°C. Germination remained at or above 60% in all 3 temperature regimes when substrate water potentials decreased to -0.50 MPa, but was significantly reduced when substrate water potentials decreased from -0.50 to 0.75 MPa and from -0.75 to -1.0 MPa.

Cumulative germination of awnless bushsunflower was greatest at the 0 MPa substrate water potential level in the 15/25°C temperature regime (Fig. 2). Germination remained at approximately 48% when substrate water potential decreased to -0.25 MPa in the 10/20°C and 20/30°C temperature regimes, and -0.50 MPa in the 15/25°C temperature regime. As with Maximilian sunflower, germination was significantly reduced in all 3 alternating temperature regimes when substrate water potentials decreased from -0.50 to -0.75 MPa and from -0.75 to -1.0 MPa.

Favorable planting dates can be selected on the basis of these temperature and moisture requirements for germination and a knowledge of seasonal temperature and moisture conditions of the area to be revegetated (Ashby and Hellmers 1955). Based on precipitation and dry period possibilities and soil temperatures in central Texas (Dugas 1983, 1984), optimum germination for both species occurs in March and April. Therefore, both species should be planted in early spring. Favorable microclimatic conditions prevailing in the immediate vicinity of the seed may override overall climatic factors and extend planting dates for both species (Mayer and Poljakoff-Mayber 1982).

Germination was initiated earlier, rate of germination was increased, and highest level of germination was reached at an earlier date with increasing temperature for both species (Fig. 3

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This research was supported in part by a grant from the Center for Energy and Mineral Resources, Texas A&M University, College Station 77843.
The authors gratefully acknowledge the USDA-SCS Plant Materials Center, Knox City, Texas, for providing seeds used in this study. Published with approval of the Director, Texas Agricultural Experiment Station, as TA-19669.
Manuscript accepted October 1, 1984.

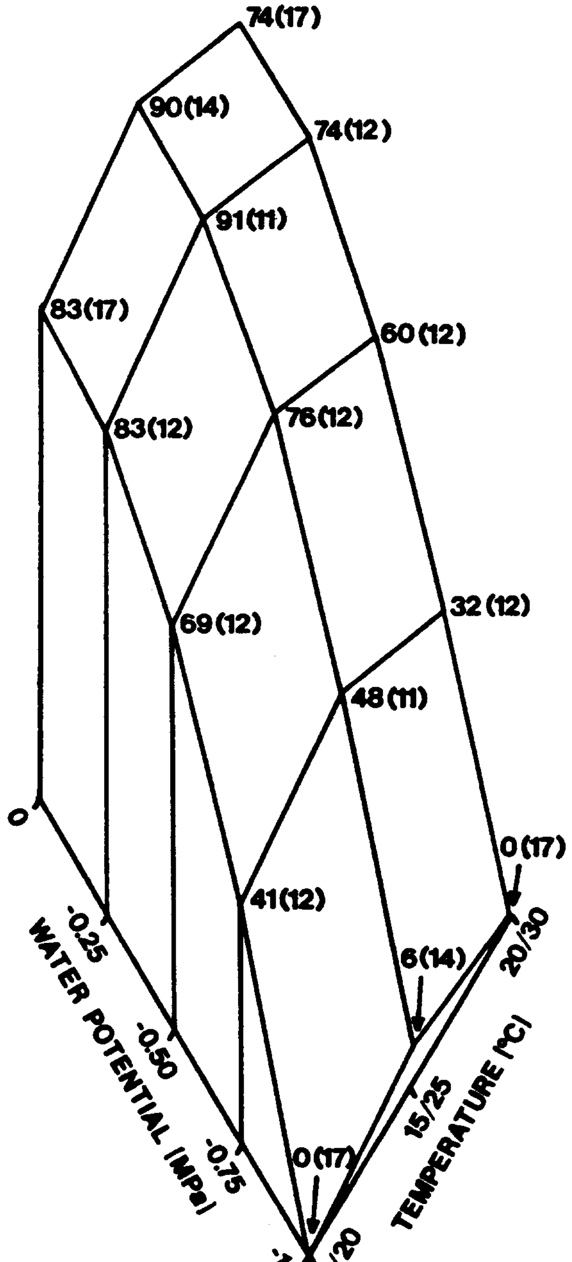

Fig. 1. *Quadratic response surface for cumulative germination percentage of 'Aztec' Maximilian sunflower seeds in relation to substrate water potentials and alternating temperature regimes. Values in parentheses are one-half the width of calculated confidence intervals.*

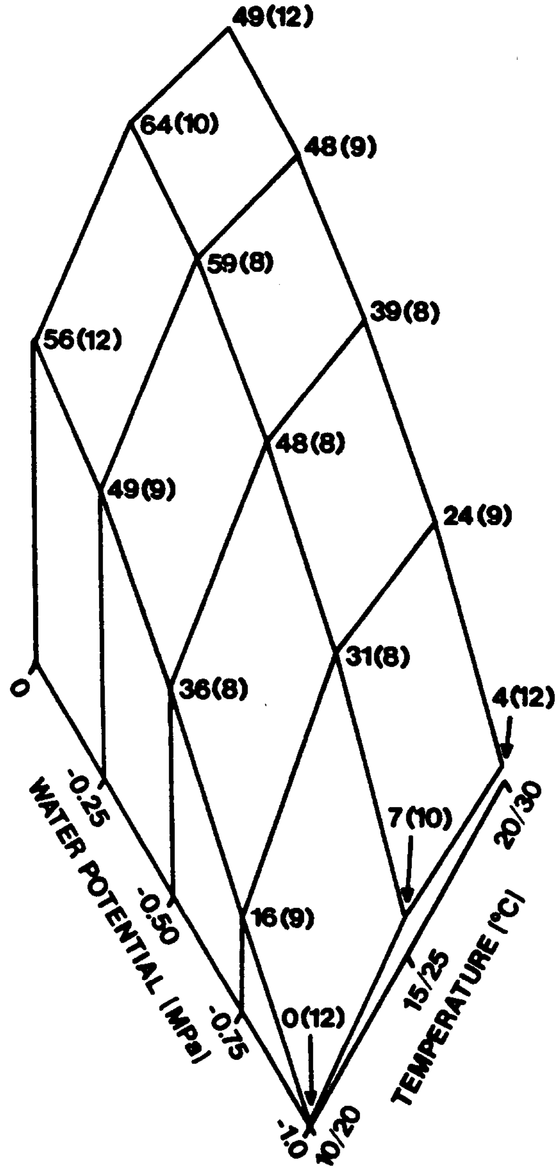

Fig. 2. *Quadratic response surface for cumulative germination percentage of awnless bushsunflower seeds in relation to substrate water potentials and altnerating temperature regimes. Values in parentheses are one-half the width of calculated confidence intervals.*

and 4). In the 10/20° C temperature regime, germination started at day 5 (an average of the 0, -0.25, and -0.50 MPa substrate water potentials) and continued through day 21 without reaching the highest ultimate level of germination. In the 15/25° C temperature regime, germination initiated at day 3 and leveled off after day 18. In the 20/30° C temperature regime, germination started at day 2 and reached the highest level of germination after day 10. Germination rates were negligible for both species at -1.0 MPa water potential in all 3 alternating temperature regimes.

The rates of germination and initial seedling growth can be critical factors in the success or failure of seeding operations on wildlands (Hillel 1972). Fast germination and establishment is desired because favorable temperature and moisture conditions last for only short periods of time under field conditions. Temperatures at the high end of the favorable range for germination shorten lag times and accelerate rates of germination, thus allowing germination to occur under transiently favorable water conditions (McDonough 1977). When averaged over substrate water potentials of 0, -0.25, and -0.50 MPa, Maximilian sunflower seeds attained 50% germination in approximately 12 days at 10/20° C (Fig. 3A). At 15/25 and 20/30° C approximately 10 and 8 days, respectively, were required for 50% of the seed to germinate (Fig. 3B and 3C). When averaged over the same substrate water potentials, awnless bushsunflower requires approximately 20, 11, and 9 days for 40% seed germination to occur at respective temperatures of 10/20, 15/25, and 20/30° C (Fig. 4A, 4B, and 4C).

Sorensen and Holden (1974) investigated the germination characteristics of other native species in the Asteraceae family that are found in Southern Great Plains. Under controlled environmental conditions (constant temperature of 21° C, complete darkness, and a continually moist filter paper substrate), common yarrow *(Achil-*

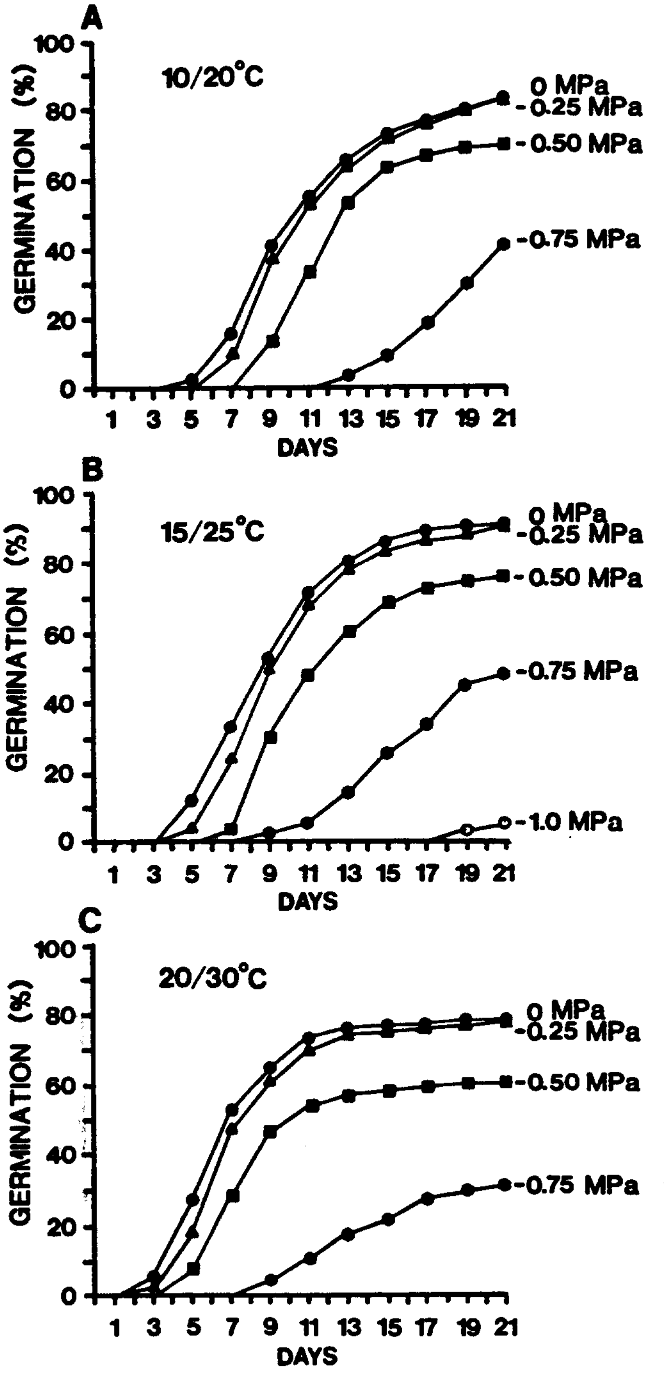

Fig. 3. *Percent germination of Maximilian sunflower seeds imbibed in five substrate water potentials in alternating temperature regimes of (A) 10/20° C, (B) 15/25° C, and (C) 20/30° C.*

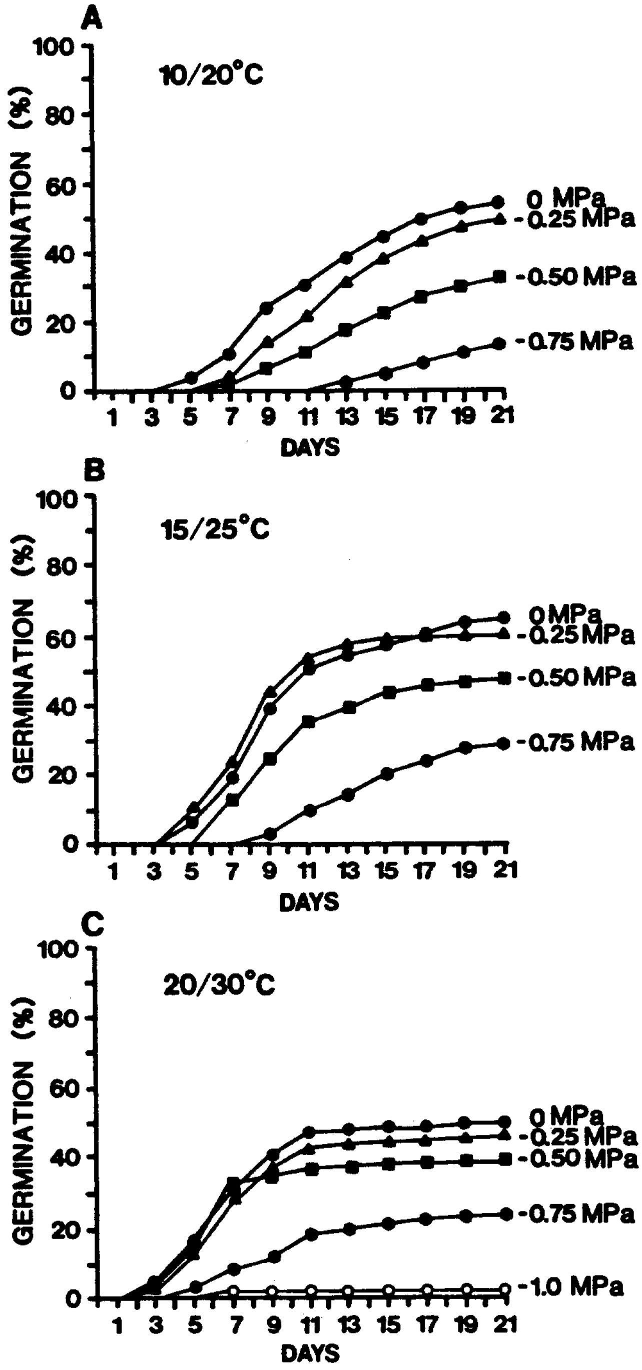

Fig. 4. *Percent germination of awnless bushsunflower seeds imbibed in five substrate water potentials in alternating temperature regimes of (A) 10/20° C, (B) 15/25° C, and (C) 20/30° C.*

lea millefolium) had 87% germination in 8 days, black sampson *(Echinacea angustifolia)* had 92% germination in 9 days, and silky aster *(Aster sericeus)* had 71% germination in 24 days. Seeds of these perennial species were considered germinated once the radicle protruded through the seed coat (Sorensen and Holden 1974). Common ragweed *(Ambrosia artemisiifolia)*, an introduced annual species in the Asteraceae family, was found to germinate readily at constant temperatures of 15, 20, and 25° C and alternating temperatures of 10/20 and 15/30° C following 15 weeks of cold stratification (Pickett and Baskin 1973). The ability to germinate readily at several temperature regimes aids in the establishment of this weedy species on disturbed sites in the Southern Great Plains.

Results from these laboratory tests may vary from results obtained under field conditions. At supraoptimal temperatures, germination of planted seeds may exceed germination in laboratory tests because soil cover has a strong modifying effect on both temperature extremes and on the development of water deficits (McDonough 1977). Conversely, germination under field conditions may be lower than in laboratory tests due to poor seed-soil contact, limited water flow properties of the soil (Sharma 1973), or competition from resident vegetation or other species in the seeding mixture. These studies do, however, provide guidelines for the proper timing of seeding in order to take advantage of favorable environmental conditions, and a means for comparing the germination performance of Maximilian sunflower and awnless bushsunflower to other native forb species tested under similar laboratory conditions.

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