Germination of Sweetgum in Response to Temperature, Moisture Stress, and Length of Stratification

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Abstract. Both total germination and rate of germination of sweetgum seed increased as temperatures were raised from 60–75 to 85–100°F. Increases in osmotic stress lessened total germination and rate of germination, and 15 atmospheres of stress completely inhibited germination. Raising the temperatures decreased the influence of osmotic stress, and lengthening the stratification time diminished both temperature and osmotic effects.

MATURE SWEETGUM (*Liquidambar styraciflua* L.) seed exhibits moderate dormancy that can be overcome by cold, moist stratification. Following stratification, sweetgum germinates readily over a wide range of temperatures, and an alternating regime of 60–85° has been recommended for germination tests of this species (Brunk and Hansbrough 1960). The effects of moisture stress on germination have been delineated for agronomic crops (Wiggans and Gardner 1959, Evans and Stickler 1961) and some conifers (Satoo and Goo 1954), but few data are available for hardwood species. The purpose of the present study was to evaluate the influence of stratification time, temperature, and moisture stress on the germination of sweetgum seed.

Methods

Seed from a single tree near Stoneville, Mississippi, was collected in October 1963 and stored dry at 36°F. Fifteen lots of 1,200 seeds each were drawn, and three replicates (lots) were randomly assigned to each of five stratification periods: 0, 2, 4, 6, and 8 weeks. Moist stratification was carried out in polyethylene bags at 36°F.

Following stratification, each lot was divided into 50-seed sublots, which were randomly assigned to moisture stress treatments (0, 1.0, 2.5, 5.0, 10.0, or 15.0 atmospheres) in each of four temperature regimes (60–75°, 70–85°, 75–90°, and 85–100°F).

Stress treatments were achieved by germinating the seed in covered petri dishes filled with 12 ml of appropriate osmotic solution, which was prepared with d-mannitol according to the formula used by Wiggans and Gardner (1959):

$$g = \frac{PVm,}{RT}$$

where g = grams of solute,
P = desired osmotic pressure in atmospheres,
V = volume in liters,
m = molecular weight of solute,
R =.0 825 atmosphere per degree per mole, and
T = absolute temperature.

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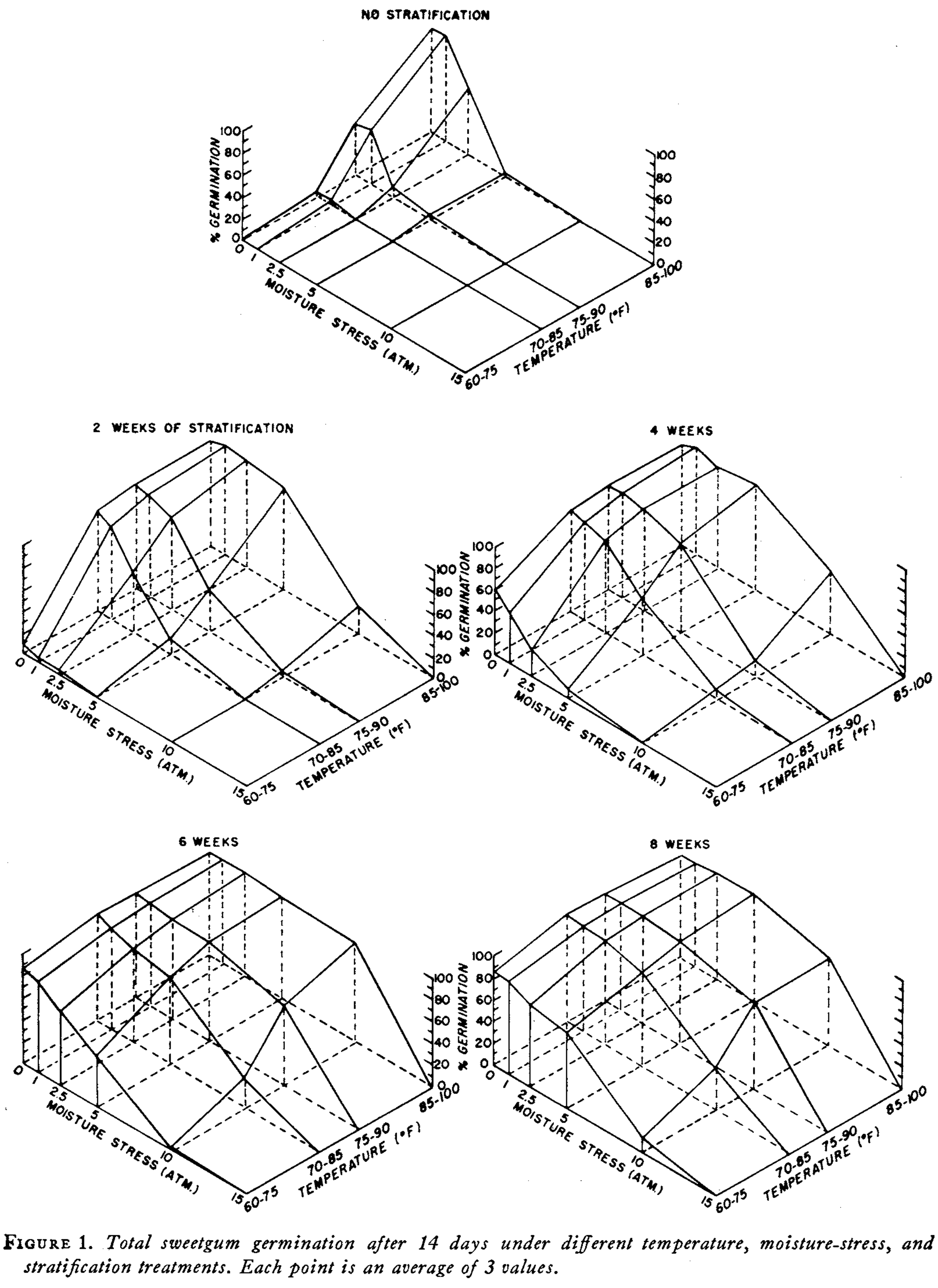

Figure 1. *Total sweetgum germination after 14 days under different temperature, moisture-stress, and stratification treatments. Each point is an average of 3 values.*

Calculations for preparation of the osmotic solutions were based upon median regime temperatures, i.e., 68°, 78°, 83°, and 93°F. Dishes were weighed to the nearest 0.1 g at the beginning of the tests, and distilled water was added daily to replace moisture lost through evaporation.

All seeds were surface-sterilized in mercuric chloride ($HgCl_2$:H_2O, 1:500) prior to placement in the dishes.

Temperatures were maintained within ± 2° F in laboratory germinators, and changes in temperature were created by moving dishes to appropriate cabinets. The dishes in each regime were exposed daily to 9 hours of the high temperature and 15 hours of the low. The only exposure of the seeds to light was when the dishes were removed for germination counts or to change germinators.

Germination was counted daily for 14 days, and germinated seeds were removed from the dishes. A seed was considered germinated when the emerging radical had pierced the seed coat. Arc-sin transformations of germination percentages at 14 days and germination peak values were analyzed. The germination peak value is the largest quotient obtained by dividing percent germination by the number of days elapsed since beginning of treatment (Czabator 1962).

Results and Discussion

Total germination in response to treatment is illustrated in Figure 1. The treatments affected rate of germination in an almost identical manner, except that germination rate was more sensitive to osmotic stress. Stresses even as low as 1.0 atmosphere reduced germination rate slightly. Treatment effects and all of their interactions were significant at the 1-percent level of confidence.

Both total germination and germination rate were increased by decreasing osmotic stress and increasing temperature. As temperature was increased, the osmotic effect was lessened, but at 15 atmospheres' stress no germination occurred at any temperature.

The data indicate that at favorable temperatures properly stratified seed will attain maximum germination under moisture stresses of up to 5 atmospheres, and acceptable germination (80 percent or more) at 10 atmospheres. Satoo and Goo (1954) reported similar results for coniferous species. The use of osmotic solutions to simulate soil moisture stress, however, may underestimate the effect of soil moisture stress (Collis-George and Sands 1962). Matric potential and osmotic potential, although identical in free energy status, do not necessarily have similar biological effects, and the anatomy of some seeds allows free entry of the osmotic solution (Manohar and Heydecker 1964). Furthermore, water uptake by seeds in soil can also be strongly influenced by the area of the seed in contact with water (Goo 1951).

Reduction of germination by moisture stress is commonly interpreted as the result of reduced moisture absorption, and the greater sensitivity to osmotic stress of germination rate as opposed to total germination supports this hypothesis. Further support stems from the fact that osmotic stress effects were lessened by increasing temperatures. It has been shown that seeds absorb more water as the temperature is increased (Crocker and Barton 1957).

Stratification lessened the inhibitory influence of osmotic stress and low temperature. Similar interactions between stratification time and temperature have been reported for several coniferous and broad-leaved species (Weiss 1926, Allen 1941, Black and Wareing 1955, Stearns and Olson 1958). For the seed used in this study, 6 to 8 weeks of stratification was best.

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