Thermal Regulation of Water Uptake by Germinating Honey Mesquite Seeds[1]

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Highlight

Ambient temperature regulated the rate and extent of water imbibition by germinating honey mesquite (*Prosopis glandulosa* Torr., var. *glandulosa*) seeds. Honey mesquite seeds required less water and less time for germination at 85 than at 100 or 70 F. Seeds at 70 F contained almost 3 times as much water as seeds at 85 F when germination first occurred although the rate of water uptake (mg/seed/hr) was reduced considerably. Decreasing moisture availability to 8 atm influenced the rate of water absorption by seeds more at 85 and 100 F than at 70 F.

Honey mesquite (*Prosopis glandulosa* Torr., var. *glandulosa*) occurs on some 80 of the 107 million acres of Texas rangelands. It is established in regions ranging from semiarid to sub-humid on a wide array of soils varying in origin, texture, nutrient level and moisture availability. Much research effort has been devoted toward development of control measures. However, less effort has been concentrated on factors determining the ecological range of honey mesquite. An understanding of germination, seedling establishment and plant growth may elucidate methods of controlling and preventing the reinvasion of honey mesquite. Since available moisture and temperature influence development of individual plants and vegetation communities, investigation of these climatic variables may facilitate understanding the ecological behavior of a plant species. This report emphasizes the role of temperature in rehydration of honey mesquite seeds from inactive embryonic tissues to emergence of the radicle from the testa.

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Materials and Methods

Honey mesquite seeds for these studies were collected near Spur, Texas in 1967 and 1968. The seeds germinated in excess of 95% following scarification. The technique and apparatus used in these studies have been previously described by Scifres and Brock (1969). Honey mesquite seeds were germinated on cheesecloth saturated with distilled water in 90-ml glass vials. A glass tube, held in place with a plastic cap, was placed in the center of each vial to allow gas exchange. All openings, except the end of the glass tube, were sealed with lanolin paste. The vials were submersed in water baths at temperatures of 70, 85 or 100 F. One hour was allowed for equilibration of the vials.

The air-dry weight of 10 honey mesquite seeds was determined before the seeds were placed in each germination vial. Three vials were placed in each of the temperature regimes. For determination of weight change, the honey mesquite seeds were carefully removed from the vials and quickly and gently blotted dry with tissue paper. Weights were determined hourly for the initial 6 hr. Weights were also recorded at 8, 10, 12 and 24 hr after initiation of the study. Time lapse from removal to replacement in the water baths rarely exceeded 5 minutes. The seeds were also weighed at the first sign of germination (when the radicle extended 2-mm from the testa). The study was repeated four times and data averaged.

A similar study was conducted utilizing cheesecloth saturated with a mannitol solution in the vials. The mannitol solution was formulated to achieve a moisture tension of 8 atm as described by Powell and Pfeifer (1956). The experiment was conducted twice and the data averaged.

The increase in fresh weight over any time period **t** from the dry weight was assumed due to imbibition of water. Phillips (1968), in studies of water diffusivity of crop seeds, assumed the available moisture at the seed-water source interface to be constant throughout the germination period. In the present studies a similar assumption, that the volume of free space between the testa and embryo did not interact with temperature and influence water movement into the embryo, was made. Phillips (1968) discussed in detail the theory underlying manipulation of this type of data. The amount (mg) of water imbibed after a given time interval **t** is denoted **A(t)**. The amount of water imbibed by the time of "first germination" is denoted **A(tg)**. Imbibition curves were developed by considering the ratio **A(t)/A(tg)** as a function of time.

Results and Discussion

Only 11 hr were required for germination of honey mesquite seeds at 85 F in distilled water (Figs. 1 and 2). The average dry seed weight was about 42 mg and 44 mg of water had been imbibed at germination. The average rate of imbibition was about 4.0 mg/seed/hr.

There was no difference in imbibition rate of honey mesquite seeds at 85 and 100 F for the first 8 hr (Fig. 1). Germination occurred after 18 hr

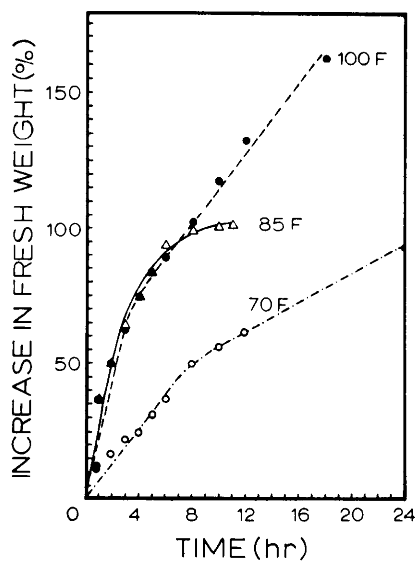

FIG. 1. Increase in weight of honey mesquite seeds in distilled water at 100, 85 and 70 F at various time intervals for the initial 24 hr following wetting.

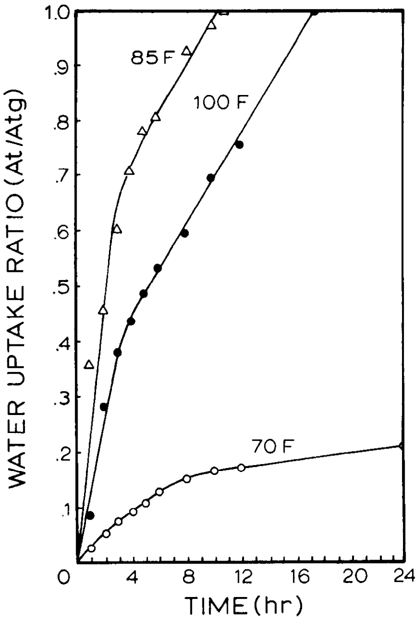

Fig. 2. Thermal regulation of imbibition by honey mesquite seeds per unit time (At) based on the total water uptake for first germination (Atg) as a function of time.

Table 1. Ratio of water uptake at 2, 4 and 6 hr (At) to the amount of uptake at first germination (Atg) of honey mesquite seeds under 0 and 8 atm osmotic pressure at 70, 85 and 100 F.

Germination temperature (F)	Osmotic pressure (Atm)	Water uptake ratios at various times (hr) after wetting[1]		
		2	4	6
70	0	0.03	0.08	0.11
	8	0.02	0.05	0.09
85	0	0.47	0.72	0.82
	8	0.13	0.26	0.33
100	0	0.28	0.45	0.54
	8	0.08	0.13	0.23

[1] Differences in mean ratios must exceed 0.13 for significance ($P < 0.05$).

at 100 F and each seed had imbibed an average of 69 mg of water. Therefore, imbibition of water for germination of honey mesquite seeds was less efficient at 100 than at 85 F (Fig. 2).

Germination did not occur until 42 hr at 70 F when each seed had imbibed an average of 121 mg water. The slow rate of water imbibition (about 2.8 mg/seed/hr) and the extended time required for germination indicated that 70 F was the least efficient temperature for the imbibition of water by honey mesquite seeds.

Honey mesquite seed germination in a solution with an adjusted 8 atm moisture stress resulted in reduced rate of water imbibition and total amount of water imbibed at 85 and 100 F. However, reduced moisture availability had little affect on imbibition at 70 F (Table 1). This probably indicates the effect of the lower temperature on the physiological processes responsible for imbibition. Theoretically, the kinetic energy of the water and activity of the embryonic tissues was reduced at 70 F. Water adsorbed by the testa was probably responsible for the weight change.

The reduction in rate of imbibition at 8 atm osmotic pressure was greater at 100 as compared to 85 F (Table 1). The drying effect of the higher temperature probably limited the amount of water adsorbed on the testa and lowered the uptake ratio. Secondly, reduced physiological activity of the embryo at the high temperature may account for reduced imbibition.

These data indicate that the influence of temperature on honey mesquite seed germination (Scifres and Brock, 1969), may be explained by reduction in rate and extent of imbibition of water during the initial few hours of the germination process. Although reductions in available water are important, temperature is most influential in regulating efficient use of water by germinating honey mesquite seeds. Physiological activity of honey mesquite seed tissues is apparently favored more at a temperature of 85 F than of 70 or 100 F, and, assuming available water is not critical, may regulate germination.

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