tion in the job of improvement and management of rangelands. Range resource problems, to the extent that they are soil problems, can be brought closer to solution by 1) a program of soil surveys guided and directed by specific management objectives, 2) development of systematic relationships from soil survey data that will increase the use of available soil survey information and facilitate understanding of soils by resource managers, and 3) filling the voids in the range soils research program to bridge the gap between accumulating soil information and application of that knowledge to critical range problems.

**Literature Cited**


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**TECHNICAL NOTES**

**Temperature and Moisture Stress Affect Germination of Gutierrezia sarothrae**

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**Highlight**

Germination of broom snakeweed seed was found best at 60-70 °F temperatures and was inversely related to moisture stress.

Broom snakeweed (Gutierrezia sarothrae (Pursh) Butt. & Rusby), an undesirable half-shrub, is frequently the heaviest understory herbage producer in the southwestern pinyon-juniper type (Arnold et al., 1964). Reduction or elimination of this noxious plant generally increases production of usable forage (Jameson, 1966). Successful reduction may depend on knowledge of life history. Consequently, this study was designed to measure some effects of temperature and moisture stress on snakeweed germination.

Snakeweed seeds (three replications of 25 each) were germinated in the laboratory. Moisture stresses of 0.2, 1.2, 2.4, 6.0, and 12.0 atm were attained by prescribed amounts of aqueous solutions of mannitol (Helmerick and Pfeifer, 1954). Distilled water was used as a moisture stress control (0 atm). Temperatures of 40, 50, 60, 70, 80, and 90 °F were tested. Seed germination was determined for about 2 weeks following incubation.

Seeds germinated best at 60 and 70 °F; germination decreased and took longer above and below these temperatures (Figs. 1 and 2). Seeds did not germinate at 40 and 90 °F.

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2 Forest Service, U.S. Department of Agriculture, Flagstaff, Arizona, in cooperation with Northern Arizona University; central headquarters maintained at Fort Collins, in cooperation with Colorado State University.
Germination was inversely related to moisture stress; 95% of the seed germinated in the control, while none germinated at 12 atm (Fig. 1). Although no direct translation can be made, these laboratory trials may serve as an indicator of broom snakeweed germination responses under normal field conditions.

A Spring-Actuated Maximum Temperature Indicator

WILLIAM B. FOWLER


Highlight

Studies of range restoration problems required determination of seasonal variation of maximum air temperatures near the soil surface. More accurate sampling of this important environmental factor is now possible with responsive, easily read, maximum temperature indicators, operating between 38 and 62 C.

Measurement of maximum temperature with temperature-sensitive wax products has been frequently reported. Recently, Hallin (1968) described their use in measuring maximum surface temperatures on cutover lands in the Oregon Cascade Range. Shearer and Hammer (1968) described the use of these waxes to indicate soil temperatures at different depths during prescribed slash burning.

Use of these waxes depends on the ability of the observer to determine that the melting point of the wax has been reached. Change in surface texture of a mark made with a specified wax crayon or actual melting of a wax bead or pellet signifies the presence of an above-melting-point temperature. In situations where an observer is not present, the problem frequently arises of assessing the appearance of the resolidified wax mark or pellet which may not have been appreciably changed by the melting process. In these cases, inclusion of surface materials or deformation of the wax pellet suggests above-melting-point temperatures, but changes in surface characteristics or color are a poor index. Normally, sizable pellets of dissimilarly colored waxes are used for indicators. In field studies, differential heating by the sun of the wax itself may occur due to these varying wax colors.

In a current study of the problems of forest-associated range rehabilitation in eastern Washington, knowledge of the maximum air temperature near the soil surface was required. Although a wax-based indicator appeared suited to this study, solution of some of these customary measurement problems with a more readable, accurate, and inexpensive indicator was attempted. A simple spring wire carrier with a uniformly reflective overcoat of an attached wax drop was found to be a satisfactory compromise. Figure 1 shows two of these indicators, one having been exposed to a temperature in excess of the wax melting point.

In production of these indicators, 1

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