

Measurement of Seed Responses to Environment^{1,2}

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Highlight

The objective of this work was to develop a method for evaluating seed responses to field environments. Seeds placed in soil in the field were brought into the laboratory for germination tests under controlled conditions. Hastening of germination, an indicator of seed responses to environment, was determined by subtracting the number of days required for samples placed in soils in the field to reach 50% germination from the days required for air-dry control samples to reach 50% germination. A temperature of 5 C provided a more sensitive test for measuring hastening of germination than 10 or 20 C. Measurements of environment and of seed responses to environment will help explain why seeds sometimes fail to germinate on harsh rangeland sites.

Environmental conditions during the interval from planting to germination may be critical in the establishment of perennial grasses on harsh rangeland sites. Yet, we know little concerning responses of seeds to extreme and fluctuating temperature and moisture conditions during this period. We lack this type of information because suitable methods for measuring these responses have not been available.

This paper describes a method for measuring hastening of germination and discusses how it may be used in evaluating responses of seeds to environment. The method is adapted from the work of Keller and Bleak (1968).

The concept of hastening of germination suggests that planted seeds do not remain quiescent until the time germination can be observed. Instead, it suggests that during periods of favorable environment they carry on numerous biochemical reactions which eventually lead to cell division, cell enlargement, and the protrusion of root and shoot. Thus, hastening of germination is an integrated measure of how far seeds have progressed toward germination.

Materials and Methods

Seeds of Nordan crested wheatgrass (*Agropyron desertorum* (Fisch. ex Link) Schult.) were treated with 20 mg of thiram (tetramethylthiuram disulfide) per g dry weight to inhibit microbiological growth.

In a laboratory test, samples of 100 seeds were placed on two layers of moist seed-germinating blotter paper in petri dishes and incubated at 5, 10, or 20 C in a germinator. The

objective was to determine the best temperature for measuring hastening of germination.

In a field study, samples of seeds were enclosed in flat cotton screen bags and placed in moist soil at a depth of 2.5 cm. Seeds were removed periodically from the field, promptly placed on moist blotter paper in petri dishes, and germinated at 5 C. Control samples consisted of seeds from air-dry storage, germinated under the same conditions as seeds from the field. Germinated seeds (both root and shoot visible) were removed from petri dishes and counted daily.

Results and Discussion

In the laboratory test, seed samples reached 50% germination in 18.4, 11.5, and 4.4 days at 5, 10, and 20 C, respectively (Fig. 1). Cumulative percent germination over the range of 10 to 70% increased linearly with time. Visually fitting a line to the points eliminated some of the daily variation in the number of germinated seeds. The slope of the line was only slightly greater at 20 C than at 10 and 5 C.

Cumulative percent germination of individual samples taken from the field on different dates is shown in Figure 2. The average cumulative percent germination for eight control samples is also shown in Figure 2. In this case, the control samples reached 50% germination in 18.1 days. Hastening of germination or days gained was calculated by subtracting days to 50% germination for individual field samples from average days to 50% germination for control samples.

At 5 C, the interval from planting to the beginning of germination in the field often represents hastening of germination values ranging from 0 to 12 days (Fig. 2), but at 20 C these values range from 0 to 3 days. Therefore, germination of seeds at 5 C provides a more sensitive test for detecting small differences among seed samples than 10 or 20 C. However, when experiments include species that germinate poorly at low temperatures, it may be more appropriate to conduct the tests at 10 C.

In fall and spring experiments with eight replications, a comparison of days gained on different sampling dates (Duncan's Multiple Range Test, 1% level) indicated Shortest Significant Difference values of 0.7 to 0.9 days. Since crested wheatgrass seeds that have been in soil in the field may germinate (at 5 C) 0 to 12 days ahead of controls, hastening of germination can serve as a sensitive indicator of seed responses to environment.

We have encountered several problems in measuring hastening of germination. In long term experiments, temperature may drift in the facility used for the germination tests. Placing a set of control samples in the germinator at weekly intervals makes it possible to correct for small drifts in temperature.

Another problem relates to the distance between experimental sites and laboratory facilities. Field and control seed samples in petri dishes may be packed with bottles of ice in an insulated chest and transported several hundred miles with good results.

A third problem is that all seeds in a sample may not respond in the same way to environment. In other words, the slope of the germination curve (Fig. 2) for control samples may sometimes be greater than the slope of the curve for field samples. In this case, some seeds from the field

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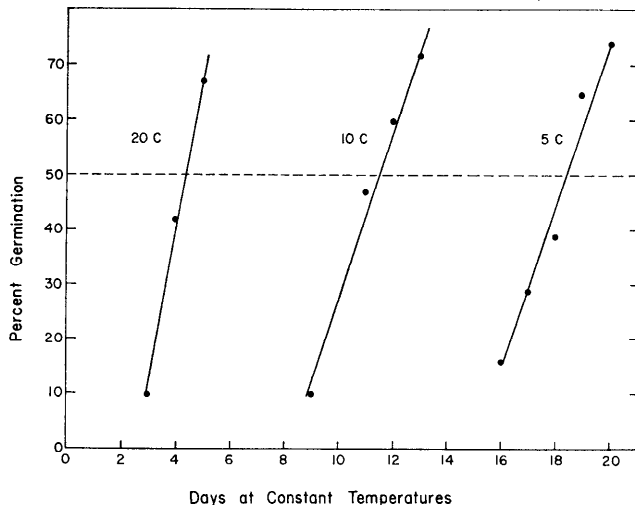


FIG. 1. Cumulative percent germination of crested wheatgrass seeds incubated at constant temperatures of 5, 10, and 20 C. Points are averages of five replications of 100 seeds.

may germinate well ahead of control seeds and others only slightly ahead of control seeds. Thus, when 50% (or some other percentage) is used for calculating days gained, one must realize that the values reflect how only part of the sample has responded to environment. In some experiments, the effects of environment may be illustrated best by plotting germination curves as in Figure 2.

Measurements of hastening of germination have several applications. They may be correlated with the progress of specific biochemical reactions and thus aid in discovering mechanisms of cold and drought tolerance in germinating seeds (Wilson, 1971). These measurements may also be correlated with environmental variables, providing models for explaining or predicting seed responses to environment. Hastening of germination values can give a day-to-day indication of how seeds are responding to fluctuating environ-

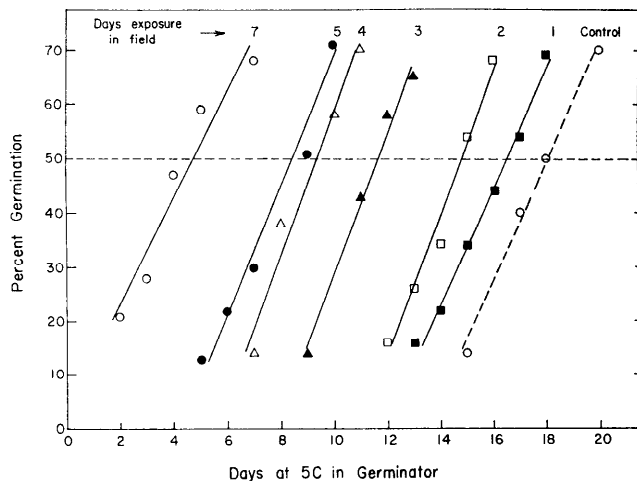


FIG. 2. Cumulative percent germination of crested wheatgrass seeds taken from the field 1 to 7 days after planting. The control consisted of seeds from air-dry storage germinated under the same conditions as samples from the field. Average germination of eight replications is shown for the control, and germination of a single replication is shown for field samples. By the seventh day of exposure, 6% of the seeds had germinated in the field.

ments and to environments that are too harsh for seeds to germinate (Wilson, in press).

Literature Cited

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