Effects of Wetting and Drying on Germination of Crested Wheatgrass Seed[1]

MICHAEL L. MAYNARD AND DILLARD H. GATES

Research Associate, University of Arizona, Tucson, and Range Management Specialist, Oregon State University, Corvallis.

Seeding establishment is a major problem in revegetating arid lands. When a seeding does not become established, the blame is often placed on some environmental factor, with little thought of the other possible causes of failure.

If the problem of seeding failures is to be resolved, a better understanding of the factors influencing the success or failure of a seeding is necessary. Despite the available information on germination and seedling establishment, the response of Nordan Crested wheat grass *(Agropyron desertorum* (Fisch) ex Link Schult.) seeds to various cycles of wetting and drying under controlled conditions was unknown before these investigations. Since wetting and drying periods are natural phenomena in range seeding, additional information is needed to further explain their effects on germination and seedling establishment. Moisture variation was selected for this study since it is thought to be one of the primary factors influencing germination and seedling establishment.

Literature Review

Literature on seed testing and the responses of germinating seeds to various environmental phenomena is voluminous. Crocker and Barton (1953) stated that seed soaking accelerated the metabolic processes preparatory to germination, and that this acceleration was accompanied by oxygen absorption, carbon dioxide release, and diminishing of the food reserves. They further stated that the effect of soaking depended upon the mount, kind, and temperature of the water or solution used; the length of the soaking period; aeration; size of the seeds; and density of the seed mass.

Plummer (1943) found that for the most uniform and rapid emergence of shoots under favorable moisture conditions in the greenhouse, ¼ inch was the most desirable planting depth for twelve range grasses. He also found that total root development prior to summer drought was directly associated with initial success or failure. Species with slow root development were extremely difficult to get started, while species which developed roots quickly were more easily started.

Kidd and West (1919) reported that although soaking appeared to be a simple treatment, the immediate and subsequent effects of soaking seeds in water were complex. These effects differ widely according to the conditions under which seeds are soaked. During the natural uptake of water preceding germination, the whole physiological system of the seeds is set in motion. They further stated that when seeds were immersed in water, the conditions were abnormal. This was shown by the fact that germination was inhibited. However, it is definitely known that when considerable exosmosis of essential soluble food-reserves occurs, the oxygen supply to the seed is decreased and carbon dioxide accumulates in the seed.

Griswold (1936), working with 42 species in Utah, found that the effects of alternate moistening and drying varied with seeds of individual species. She noted that the time of drying in relation to the stage of development of the germinating seed was a most important factor and that the rate of drying influenced its effects.

Rosenquist and Gates (1961) found that seeds of several range grasses were greatly affected by extreme temperatures during the period immediately following planting. Germination was reduced or inhibited if seeds were subjected to a temperature of 115° F. within six days after planting.

Procedures

This study was conducted in a controlled environment growth chamber to minimize environmental effects. The 12 hour daytime temperature was 86° F. and the night time temperature was 53° plus or minus one degree.

Approximately 10,000 seeds of Nordan crested wheatgrass, were given a preliminary treatment by scattering them over blotter paper in large trays, moistening and placing in the growth chamber. Blotters and seeds were initially moistened with water containing 5 ppm of a mercuric compound to control pathogens. Seed trays were covered with a transparent plastic film to prevent moisture evaporation. After 24 hours the covers were removed to allow the seeds to dry. The seeds remained uncovered for 24 hours. Then the seeds were again moistened and covered. Seeds were kept moist until the radicles began to emerge.

When the radicles reached a length of approximately 2 mm., 200 seeds were selected for each of the 16 treatments. These were divided into four replications of

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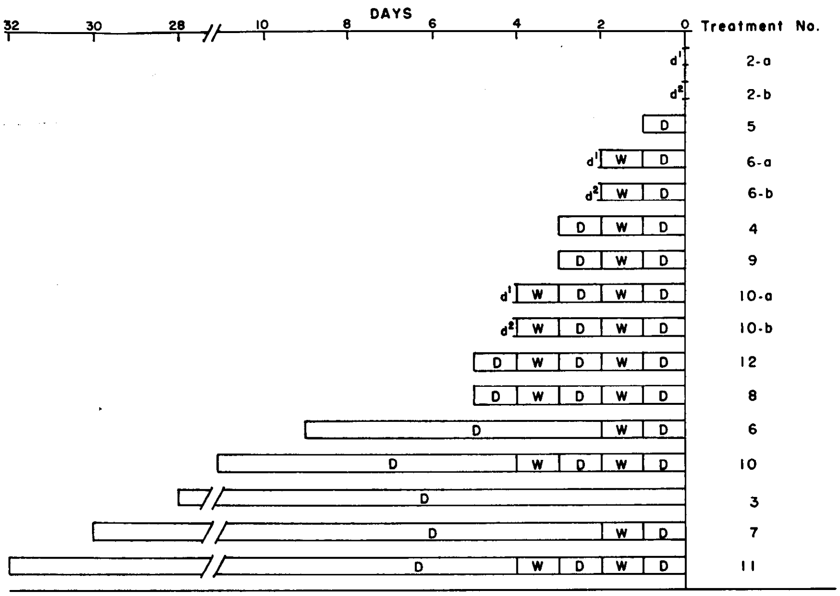

D designates drying periods, either 1 day, 1 or 4 weeks; d^1 is a 4 hour drying period at 100° F.; d^2 at 130° F.
W designates a wetting period of 1 day. All seeds were wetted at start and end of the wetting and drying treatments.

FIGURE. 1. A graphic representation of the treatments following the preliminary treatment.

50 seeds each. The seeds were then put on moist filter paper in petri dishes and returned to the growth chamber. The various lots of seeds were then subjected to additional treatments (Figure 1). All seeds remained in the growth chamber throughout the study.

Two criteria were selected for evaluating response of the seeds to the various treatments: percentage germination, determined from seeds which had developed both radicles and coleoptiles, and days required for 10 per cent of the radicles to reach a length of 20 mm.

Results And Discussion

Germination percentages varied from a low of 0 for treatments 3 and 6-b to a high of 43 for treatments 9 and 10-a (Table 1). Analysis of variance indicated that the germination means differed sufficiently to be significant at the 0.01 level of probability. The highest germination from the seeds of treatment 9 and 10-a (43 per cent) was significantly different from germination of the seeds of treatments 11, 6, 6-a and 5, which had mean germination percentages of 8, 16, 15, and 21 respectively. (Table 1)

It appears that drying for 4 hours at 130° F. could not account entirely for the failure of seeds in treatment 6-b to germinate. Seeds in treatments 2-b and 10-b were subjected to the same high temperatures, but had germination percentages of 23 and 24 respectively. No explanation for this apparent discrepancy is readily discernible. However, the lethal effects of treatment 6-b may have been due to high temperature destruction of an enzyme present at the particular stage of development (3rd day) but which was not present in treatments 2-b (1st day) and 10-b (5th day).

Drying at 100° F. for 4 hours in treatment 10-a gave a higher percentage germination than treatment 10 and 10-b, which had 32 and 24 per cent, respectively. This might indicate that an intermediate amount of heat could increase the germination of crested wheatgrass seeds.

Days required for 10 per cent of the radicles to reach 20 mm. varied from a low of 11 for treatment 7 to a high of 30 for treatment 10-b (Table 1). Treatment 2-b required 24 days for the radicles to reach 22 mm. Treatment 6-b failed to germinate. This might indicate that drying for 4 hours at 130° F. is too severe for maximum germination and radicle elongation.

Analysis of variance indicated that the association of treatments with days required for 10 per cent of the radicles to reach 20 mm. was significant at the 0.01 level of probability.

Seeds in treatments 3, 7, and 11 were all dried for 4 weeks. Seeds of treatment 3 received one less wetting and drying cycles than seeds of treatment 7. Seeds of treatment 11 received one more than 7. Seeds in treatments 7 and 11 required 11 and 18 days for the radicle to reach 20 mm., while seeds of treatment 3 failed to germinate. This would again suggest that at a certain point in its development the embryo is very susceptible to extreme or unfavorable conditions of heat or desiccation. Within a few hours after this point, the seed is again able to withstand these treatments. How long seeds can survive the effects of drying was not determined from this study.

Seeds in treatments with the highest germination percentages tended to develop radicles sooner than those in treatments with low germination percentages. The differences in vigor could be related either to the effects of these treatments as pre-treatments or to the effects of the treatments on the expenditure of food reserves.

In ranking the means for comparisons by the multiple range test, adjacent means were statistically different if they were separated by a minimum of 11 days (Table 1). This test showed that radicle development in treatment 10-b (30 days) was statistically slower from that under treatments 7, 9, 12, and 10-a, which required 11, 15, 15,

Table 1. Germination percentages and days required for 10 percent of the radicles of crested wheatgrass seeds to reach 20 millimeters.

Treatment Number	Germination Percent[1]	Time Days[1]
2-a	30 abc	22 ab
2-b	23 abcd	24 ab
3	0	....
4	34 ab	19 abc
5	21 bcd	20 abc
6	16 cd	20 abc
6-a	15 cd	25 ab
6-b	0	....
7	22 abcd	11 c
8	30 abc	17 bc
9	43 a	15 bc
10	32 abc	19 abc
10-a	43 a	16 bc
10-b	24 abcd	30 a
11	8 d	18 abc
12	40 ab	15 bc

[1] Any two means not followed by the same letter are statistically different at the 0.01 level of probability.

and 16 days respectively, for the radicles to reach 22 mm.

The relations of rate of radicle elongation to germination percentage was measured by correlation analysis. This analysis of the data produced a positive correlation coefficient of 0.86 and indicated a significant relationship between germination percentage and the average number of days required for 10 percent of the radicles to reach 20 mm. Apparently, rapid germination and radicle elongation were measures of seed vigor. Treatments which reduced the rate of germination also depressed rate of radicle elongation.

Summary and Conclusions

During the fall of 1960 and the spring of 1961, the effects of wetting and drying cycles on the germination of crested wheatgrass seed under closely monitored conditions were studied. Temperatures were 86° and 53° F. during the day and night, respectively, and were alternated on a 12-hour basis.

Seeds were subjected to various wetting and drying treatments. The drying periods were for 24 hours, one week, and four weeks. Though most seeds had the treatments continued after the radicle had developed, some did not.

Treatment response was determined from total germination and time required for 10 percent of the radicles to reach 22 mm.

Despite extreme variability of the experimental results, some trends were evident. It appears that the following conclusions can be drawn:

1. Seeds of crested wheatgrass can tolerate extreme moisture fluctuation, remain viable, and produce vigorous seedlings.
2. In many cases, various wetting and drying treatments increased seed germination.
3. When allowed to develop a radicle approximately two mm. long and then dried for one or four weeks, some seeds still developed into vigorous seedlings when water was subsequently applied.
4. Germinating seeds of crested wheatgrass can withstand drying temperatures as high as 130° F. and remain viable.
5. Severe and prolonged wetting-drying treatments reduced vigor of germinating seeds.
6. It appears that critical stages in their physiological processes make seeds of crested wheatgrass readily susceptible to extremes of desiccation. These perods of susceptibility may last for only a few hours.
7. A pre-planting treatment involving some of the cycles used in this study may have promise as a means of increasing germination of crested wheatgrass in range seedings.

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NOTICE

The membership is invited to participate in the compilation of a range glossary by the Range Term Glossary Committee. Undoubtedly, several unpublished glossaries of a local or regional level exist throughout the Nation. If a member has access to an unpublished glossary and has authority to do so, he is invited to submit it to the Committee. Members who wish to submit specific terms and definitions are requested to do so.—Don Huss, Chairman.