Germination of Downy Brome from Southern Kansas, Central Oklahoma, and North Texas

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Abstract

Mature downy brome (*Bromus tectorum* L.) seeds collected in Texas, Oklahoma, and Kansas in mid-June did not germinate at summer temperatures even when supplied with adequate moisture. The after-ripening of seeds for 3 months produces germination of 50% or more in most populations, as does subjecting fresh seeds to November temperature regimes. These results are similar to those reported for downy brome seeds from eastern Washington, central Idaho, and central California in which fresh seeds are dormant. They differ from those reported for seeds from Montana, northern California, northern and western Nevada, southern Idaho, and northern Utah in which fresh seeds germinate at high percentages. Dormancy of fresh seeds from the Southern Great Plains delays downy brome germination until the fall season at which time rainfall and other climatic conditions are more favorable for its survival.

Key Words: *Bromus tectorum*, winter annuals, climate

Downy brome (*Bromus tectorum* L.) is a Eurasian annual grass which has become widely established on rangelands, in cultivated fields, and in waste places since its introduction to the United States in the mid-nineteenth century (Mack 1984). In the high plains and intermountain west it has replaced native species and provides an important grazing source for livestock during the winter months (Klemmedson and Smith 1964). In winter wheat fields of Texas, Oklahoma, and Kansas downy brome is a serious and costly pest because of competition with the crop during its growing season and because its seeds contaminate the grain at harvest time. The problem arises because of the high viability of the seeds and its apparent adaptation to the same growing conditions which are favorable to the germination and growth of winter wheat.

A number of studies have been conducted on downy brome seed germination and dormancy. A review of much of the earlier work is provided by Klemmedson and Smith (1964), including work on phenology, seed germination, and viability. Warg (1938) reported high percentages of germination in freshly harvested seeds from Montana as did Hull and Hansen (1974) in fresh seeds from southern Idaho and northern Utah and Young et al. (1969) in fresh seeds from northern Nevada and California. Other workers reported delayed germination in seeds from eastern Washington and western Idaho (Hulbert 1955) and from central California (Laude 1956).

These studies suggest a degree of variability in the germination mechanism of downy brome, which may provide adaptations for survival in the variety of climatic types in which it is found. Studies of downy brome from the Subtropical Humid climate type have not been reported. It has been observed in central Oklahoma that downy brome does not begin to appear in lawns and fields until fall in spite of the occurrence of rains in mid- and late summer which provide sufficient moisture to support germination. This suggests that seeds are dormant immediately after maturation and that a shortage of moisture is not the cause of the delay in germination. From this observation it seems evident that studies of seed germination from a climatically different part of the range of downy brome would provide useful information as to its adaptability. The present study was undertaken in an attempt to discover how downy brome seeds respond to environmental conditions in the Southern Great Plains.

Methods and Materials

A preliminary experiment was done in 1983 with seeds collected in mid-June of that year from a stand of downy brome growing in Norman, Oklahoma (N83). Germination was observed under the following conditions: (1) in a greenhouse chamber with temperatures limited to the range of 21–32° C; (2) in an environmental chamber at a constant temperature of 5° C; (3) in an environmental chamber with alternating temperatures (13° C night, 24° C day) simulating mean October temperature conditions in central Oklahoma; and (4) in an environmental chamber with alternating temperatures (5° C night, 16° C day) simulating mean November temperatures. The first set was initiated on 1 July 1983 and repeated 4 times at monthly intervals. "Aging" referred to below is dry storage in closed containers at ≈ 25° C. For each treatment, 3 replicates of 50 seeds each were placed in petri dishes on 2 sheets of Whatman #41 filter paper, moistened with distilled water, and placed in the conditions specified above for 60 days. Seeds were not allowed to become dry. Seeds were inspected daily and germinated seeds (those with coleoptile or radicle emerged) were counted and removed.

In mid-June 1985, seeds for a subsequent experiment were collected from the same Norman, Okla., stand (N85); Gainesville, Texas (GT); Emporia, Kans. (EK); Salina, Kans. (SK); and Haviland, Kans. (HK). Germination was evaluated under the following conditions: (1) under simulated central Oklahoma November temperatures (No. 4 above); and (2) in an environmental chamber with alternating temperatures (22° C night, 34° C day) to simulate mean July temperatures in central Oklahoma. Other conditions of the experiment were as described above for the 1983 experiment.

The study was repeated in order to obtain better control over temperature conditions by using environmental chambers for all the experiments. Seeds were collected again from the original populations in order to assess the range of differences between different populations.

Mean germination time (Bonner 1983) and mean germination percentages were calculated for each set of 3 samples. Mean germination time (MGT) was not calculated for any sample with less than 5% germination. Results were tested for normal frequency distribution, and a Kolmogoroff-Smirnoff test on germination responses was done to determine significant differences between treatments and between dates of initiation (Sokal and Rohlf 1981). "Significant differences" referred to below are those at a probability level of 0.05 or less.

Results and Discussion

1983 Experiment

Fresh seeds (those in which the experiment was initiated less than 1 month after maturity) failed to germinate under high-temperature (greenhouse) conditions. Seeds germinated in progressively greater numbers from the second through the fifth month under the high temperature regime. MGT declined steadily with time, although germination times for the fourth and fifth months were not significantly different.

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Germination rates were 94–98% with no significant difference between treatments or months in all 5 months for simulated October and November temperatures (Table 1). Germination of seeds older than 1 month occurred significantly faster than in fresh seeds under both the October and November temperature regimes.

Seeds maintained at a constant temperature of 5° C germinated at rates of 67–85%, with no significant differences between months. Mean germination times of 18–21 days were not significantly different from month to month, but were significantly different from the 3–5 day MGT's of the 2 simulated fall temperature regimes after 2 or more months of aging (Table 1).

Table 1. Mean germination percentages for downy brome seeds subjected to simulated July temperatures, as affected by successive months of aging. Nonsignificant subsets (p>0.05) are connected by lines. Abbreviations: N83 = Norman, OK 1983; N85 = Norman, OK 1985; GT = Gainesville, TX; SK = Salina, KS; HK = Haviland, KS; EK = Emporia, KS.

	Provenance					
Month	N83	N85	GT	SK	HK	EK
One	0	3	5	0	0	1
Two	40	3	0	2	0	3
Three	63	27	91	24	21	27
Four	91	62	57	59	5	63
Five	96	69	33	53	3	50

1985 Experiment

Mean germination percentages under simulated July temperatures are given in Table 1. Germination percentages were below 5% in all populations of the 1985 collection when aged less than 2 months and germinated under summer temperatures. After 3 months or more of aging, germination was significantly higher in most of the populations, although the HK collection never exceeded 21% germination at the high temperatures. The N85, SK, and EK populations had significant increases in germination after 3 and 4 months of aging with no significant change in the fifth month, while the GT and HK seeds reached a peak in the third month followed by significant declines. The only probable difference between the N83 and N85 collections is that the 1983 collection had significantly increased germination in the second month while germination did not increase significantly until the third month in the 1985 collection. Statistically significant differences in the fourth and fifth month were invalidated by unplanned low temperatures for those months in the 1983 experiment.

MGT's for simulated July temperatures are given in Table 2.

Table 2. Mean germination time (days) for downy brome seeds subjected to simulated July temperatures, as affected by successive months of aging. Nonsignificant subsets (p>0.05) are connected by lines. Mean germination time was not calculated for samples with less than 5% germination (indicated by dashes).

	Provenance					
Month	N83	N85	GT	SK	HK	EK
One	—	—	—	—	—	—
Two	38	—	—	—	—	—
Three	30	35	31	28	51	34
Four	8	18	31	17	—	15
Five	4	15	34	21	—	14

Many of the collections in the first 2 months had germination percentages too low for calculation of meaningful germination times. There was a trend toward shorter germination times in the N85, SK, and EK collections, and no significant change with time in the GT and EK collections. The short germination times for months 4 and 5 in the N83 collection were probably stimulated by the occurrence of unplanned cool temperatures.

Germination percentages for the seeds subjected to simulated November temperatures are given in Table 3. The N83, N85, and GT collections had no significant increase in germination with aging, with all replicates reaching 95% germination or higher under the cooler temperatures. The SK and EK collections had significantly lower germination in seeds aged less than 1 month, while the HK seeds reached their highest germination percentages with fresh seeds. No significant differences were noted between the N83 and N85 collections, all of which had germination percentages >97%.

Table 3. Germination percentages for downy brome seeds subjected to simulated November temperatures, as affected by successive months of of aging. Nonsignificant subsets (p>0.05) are connected by lines.

	Provenance					
Month	N83	N85	GT	SK	HK	EK
One	97	98	95	68	92	47
Two	96	99	95	99	67	100
Three	97	99	100	98	85	94
Four	99	100	97	98	84	92
Five	99	99	98	99	79	99

MGT's for seeds in simulated November temperatures are given in Table 4. N85 and GT seeds had no significant change in MGT with age under the cool temperatures, while the N83 and all the Kansas seeds had a significant reduction in MGT with age. The Norman, Okla., collections from the 2 different years had significantly different MGT in the first 2 months. All collections reached a MGT of 5 to 6 days (no significant differences) after 5 months of aging.

Table 4. Mean germination time (days) for downy brome seeds subjected to simulated November temperatures, as affected by successive months of aging. Nonsignificant subsets (p>0.05) are connected by lines.

	Provenance					
Month	N83	N85	GT	SK	HK	EK
One	22	7	9	29	15	38
Two	16	6	8	13	14	18
Three	6	6	8	9	10	12
Four	5	5	6	6	8	9
Five	5	5	6	5	6	6

The differences in germination response in seeds of the same species from a relatively small geographic area can be attributed to both genetic factors and environmental factors. According to Mayer and Poljakoff-Mayber (1975) environmental factors to which the parent plant is exposed during seed formation and ripening can affect subsequent germination response of the seeds, but these factors are secondary to genetic control of germination behavior.

Fresh seeds of a number of species have been found to require very specific temperature regimes for germination, which requirements tend to disappear during storage (Mayer and Poljakoff-Mayber 1975). Downy brome in the Southern Great Plains seems to fit into this category, since fresh seeds require cool temperatures for high germination rates and older seeds will germinate well over a broad temperature range.

Conclusions

The data which were gathered from these studies of downy brome seeds from Texas, Oklahoma, and Kansas confirm the observation that fresh seeds were dormant early in the season at the time of ripening in June and will not germinate at that time under summer temperature regimes even when adequate moisture is available to support germination. By late summer dormancy begins to disappear, so that by September a significant percentage of seeds will germinate if an adequate supply of moisture is available. The percentage of seed germination under high temperatures continues to increase through October and November to 50% or more in some populations (GT, N83, N85, EK and SK), while MGT decreases through the later days of the year. At the same time, high percentages of seeds will germinate in July and August when exposed to the colder temperature regime that is characteristic of November in the Southern Great Plains. These germination percentages exceed 90% in the later months of September, October, and November in some populations.

Delayed germination of seeds from plants in the Southern Great Plains provides downy brome with an advantage in its survival in the Subtropical Humid (Trewartha 1968) climate type, where heavy summer rains may occur, but which are usually followed by periods of hot dry weather. Dormancy which is broken by aging and cold temperatures delays germination until the fall when seasonal rains are more likely to support growth and development of the grass. In most consistently dry regions of the western United States where moisture is insufficient to support germination in mid-summer, dormancy of freshly matured seeds may be of little value in the survival of the species although some populations do have dormancy. In the more humid parts of its range, dormancy of seeds which mature in May and June at the time of wheat harvest provides downy brome with an adaptive mechanism for survival. Thus the germination, growth, and maturation of downy brome corresponds with these same phases of wheat development in fields of which it has become a serious pest.

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