CHAPTER 4

Field Emergence and Dormancy of *Bromus pectinatus* Thunb.

ABSTRACT

Investigations were conducted on the field emergence pattern, and after-harvest laboratory germination of *Bromus pectinatus* Thunb. At Njoro, Kenya, in 1983, a relationship between precipitation and emergence of *B. pectinatus* was observed. There was a large initial flush of *B. pectinatus* in May, after the onset of the long rains, which was followed with a second, smaller, flush with the onset of the second half of the long rains in July. There was no emergence of *B. pectinatus* during the dry season. The lack of emergence during the dry season is suggested to be due to seed dormancy present in the caryopsis and induced by the lemma and palea. In seeds where the lemma and palea were removed partial germination occurred immediately after harvest, and the percentage germination gradually increased as storage time increased. In seeds where the lemma and palea were left on germination did not occur until after 9 months in storage. After 10 months in storage the presence of the lemma and palea on the seed had no influence on *B. pectinatus* seed germination.

INTRODUCTION

The National Plant Breeding Station (NPBS) Njoro, Kenya, where the following investigations were carried out, has a semi-humid climate with two main seasons. The wet season from March to September and the dry season from October to February. The season of effective rainfall, the wet season, or the "long rains", has a bimodal pattern of rainfall with peaks in April and August. June is usually the dryest month of the wet season. There is usually little effective rainfall during the dry season, except for the "short rains" of November.

The germination behavior of *B. pectinatus* needs to be synchronized with the seasons to provide a maximum chance for survival. *B. pectinatus* seedlings which emerge during the dry season would not receive enough moisture for growth to maturity. There would need to be some dormancy mechanism which would restrict *B. pectinatus* from germinating during the dry season but would allow adequate germination of *B. pectinatus* during the long rains after the crops have been sown.

Innate dormancy is very common in *Bromus* species. Innate dormancy, of up 5 months after harvest, has been observed in *B. mollis* and *B. rubens* (Laude, 1956), *B. secalinus* (Steinbauer and Grigsby, 1957a), *B. japonicus* (Baskin and Baskin, 1981; Hulbert, 1955), *B. tectorum* (Hulbert, 1955; Laude, 1956; Steinbauer and Grigsby, 1957a), *B. rigidus* (Hulbert 1955; Laude, 1956) and *B. brizaeformis* and *B. commutatus* (Hulbert, 1955).

Roberts and Potter (1980) observed in several weed species that once the spring flush occurred, seedling emergence was primarily influenced by the pattern of rainfall. Should *B. pectinatus* germinate completely with the onset of the long rains, or germinate in several flushes with defined peaks, control through management techniques would be possible.

This paper reports the results of observations on the field emergence pattern, in relation to rainfall, of *B. pectinatus* and relates this emergence pattern with the after harvest laboratory germination of *B. pectinatus* kept in storage.

MATERIALS AND METHODS

After-Harvest Germination of *Bromus pectinatus* Thunb.

Spikelets were hand stripped from mature panicles of *B. pectinatus* on September 16, 1982, at the NPBS, Njoro. The spikelets were air dried, placed in an air tight glass jar, and stored in an office drawer.

At 28 day intervals, beginning September 23, 1982, and ending January 19, 1984, seeds were removed from the jar and germinated in petri dishes, in the uncontrolled physical environment of an office drawer. Each petri dish was 9 cm in diameter and contained 2 sheets of Whatman Number 1 filter paper moistened with 5 ml of distilled water. Twenty dehulled, or hulled, seeds were placed uniformly into each petri dish. Dehulled seeds had the lemma and palea carefully peeled of the seed exposing the caryopsis. Hulled seed was the unmodified seed.

Every 7 days throughout the germination trial, the seeds were counted and removed from the petri dishes. Occasionally, as required, 1 to 2 ml of distilled water was added to the filter paper to maintain adequate moisture for continued germination. After a germination interval of 28 days the trial was discontinued and the next trial was initiated.

Petri dishes were arranged within the drawer in a completely randomized design with 8 replicates. Data was analysed using the least significant difference test at the 1% significance level following analysis of variance. Only those differences found significant by this test were considered meaningful.

Field Emergence Pattern of *Bromus pectinatus* Thunb.

Five 1 m^2 quadrats, were positioned at random in a *B. pectinatus* infested field at NPBS, Njoro. The field was previously in maize and was disc ploughed and tandem disc harrowed in early January before the quadrats were marked out.

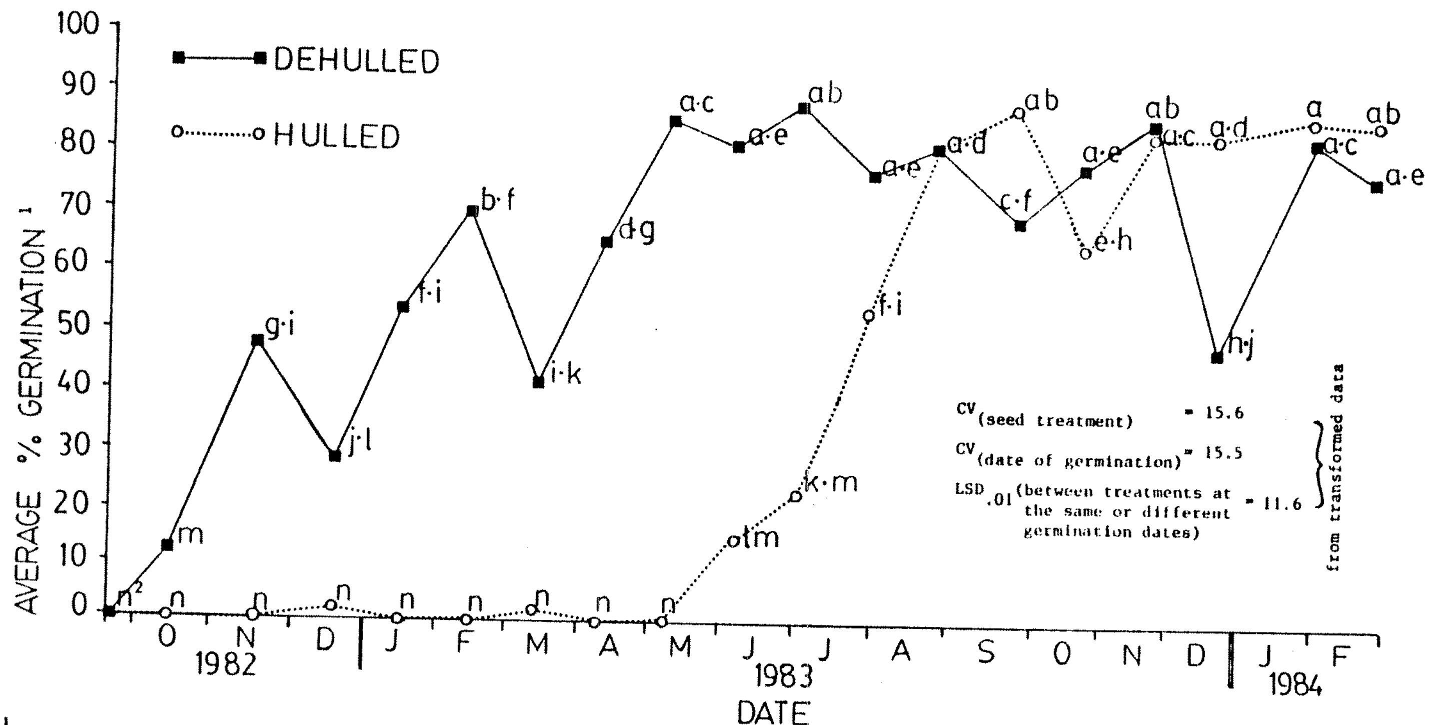
The quadrats were sprayed with paraquat at a 1 kg/ha rate at the start of the experiment (January 17, 1983) and throughout the year after each quadrat inspection. During the inspections, which occurred every 4 to 5 weeks, the number of emerged *B. pectinatus* plants were counted. Application of paraquat after each inspection killed all emerged plants in the quadrat area.

Meteorological information was collected near this site during the study period. The precipitation and temperature records were plotted along side the emergence record to determine if there is a relationship between emergence and climatic conditions.

RESULTS AND DISCUSSION

After-Harvest Germination of *Bromus pectinatus* Thunb.

The hull of a *B. pectinatus* seed is important in inhibiting germination through physical and/or chemical means. Dehulled seeds of *B. pectinatus* germinated immediately after harvest, whereas hulled seed did not germinate until after 9 months of storage (Figure 11). The caryopsis itself also contributed to the germination inhibition. In dehulled seed there was only partial germination immediately after



[1]Average of 8 replicates, 20 seeds each.

[2]Points on the graph followed by the same letters do not differ significantly ($P \leq .01$) by the least significant difference test on the arc sin $\sqrt{X}$ transformed data.

Figure 11. After harvest germination of hulled and dehulled Bromus pectinatus Thunb. stored under laboratory conditions.

harvest (13%), but this percentage germination gradually increased over the following 7 months.

The reduced germination of freshly harvested seed is most likely due to innate dormancy induced primarily by the lemma and palea and partially by some factor in the caryopsis itself. The innate dormancy is not likely due to incomplete seed development. Incomplete development has been found to be unimportant in the viability of other *Bromus* species. Hulbert (1955) with *B. tectorum* and Gill (1938) with *B. mollis*, observed that early collected seeds (green) of these plants had high viability.

The reduced germination of freshly harvested seed may be an enforced dormancy, due to unfavorable temperatures for germination. Over the course of the experiment the office drawer temperature fluctuated between 18 and 21 C and this temperature range may have been too high for germination of freshly harvested *B. pectinatus* seeds. It has been observed in *B. tectorum* and in *B. secalinus* that temperatures 15 C, and less, were best for germination of freshly harvested seeds, while more mature seed would germinate at higher temperatures (Hulbert, 1955; Steinbauer and Grigsby, 1957b).

Regardless of whether the seeds were hulled or dehulled, germination after 18 months in storage was at least 77 per cent (Figure 11). *B. pectinatus* can remain viable in dry storage for at least 18 months. Steinbauer and Grigsby (1957a) found that seeds of *B. secalinus* germinated 91% after 8 years of dry storage in sealed containers. Hulbert (1955) found florets of *B. tectorum* stored for 11.5 years in a paper sack in a laboratory were still viable (96%).

In nature, soil microorganisms, leaching and cultivations may remove the hull and any inhibitors from the seed. The pattern of germination of the dehulled seed may be more representative, than that of hulled seed, of what would occur in the field. The germination pattern of hulled seed is important in that it represents the maximum innate dormancy interval in *B. pectinatus* under the conditions of this experiment.

Field Emergence Pattern of *Bromus pectinatus* Thunb.

Soil moisture had an overriding influence on *B. pectinatus* seedling emergence. At Njoro, in 1983, *B. pectinatus* did not emerge until after the onset of the "long rains" in April (Figure 12). This large initial flush ended in June (low precipitation) and a second smaller flush started with the onset of the second part of the long rains in July. The second flush was smaller than the first and the seedling emergence gradually declined with time even though precipitation was adequate. The reduction in the number of plants which emerged, and gradual decline of emergence, in the second flush may be explained as either depletion of the seed bank or induction of a secondary dormancy into some seeds by the June drought. The second flush ended in September and *B. pectinatus* seedlings did not emerge during the last two months of 1983.

The observed relationship between emergence of *B. pectinatus* and precipitation is in agreement with the observation of Jain (1982) for other *Bromus* species. He observed that dormancy in *B. mollis*, *B. rigidus* and *B. rubens* was highly correlated with the rainfall pattern at their collection sites. He also observed that in *B. mollis* there was a direct relation between the amount of dormancy and the probability of a

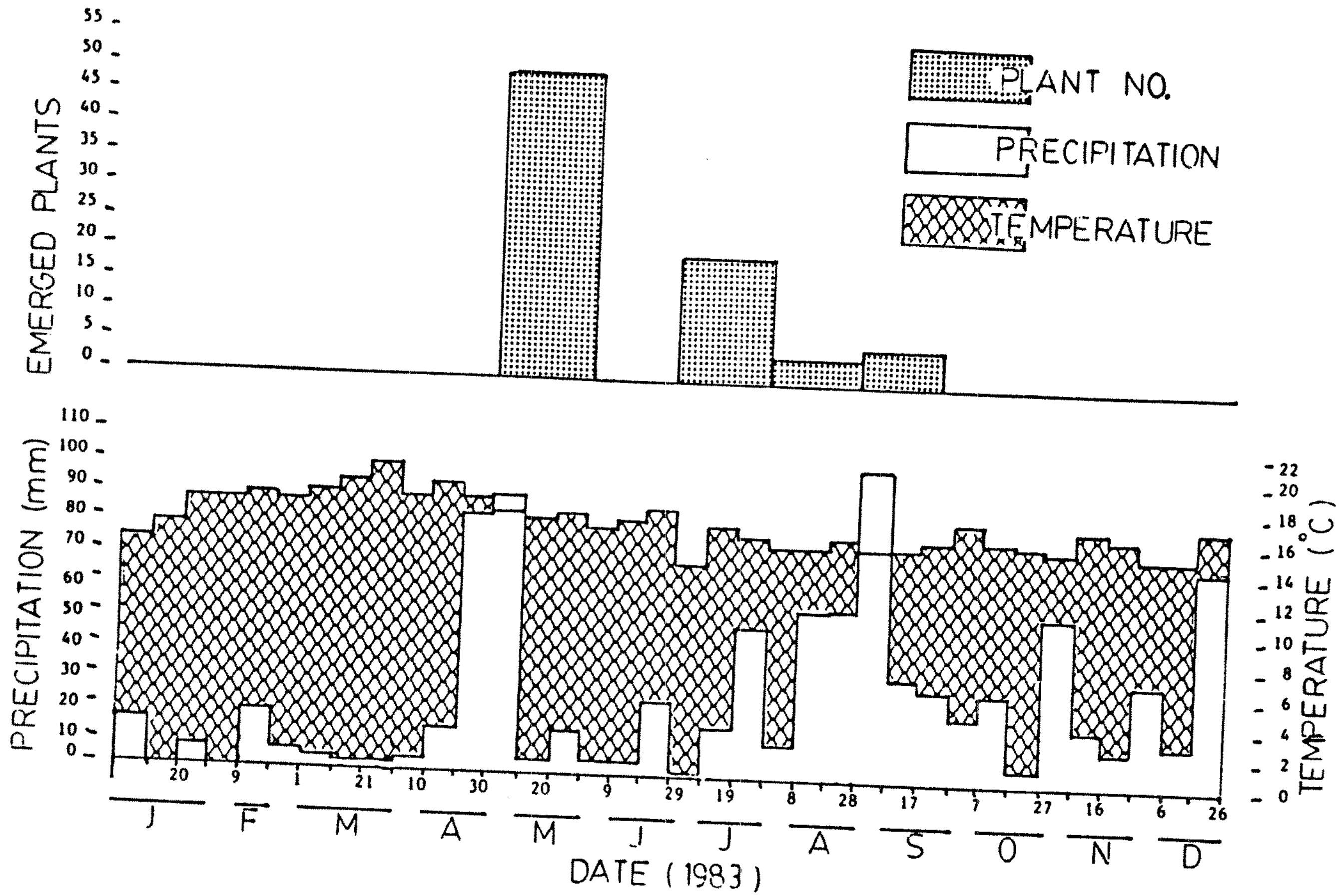


Figure 12. Field emergence pattern of Bromus pectinatus Thunb. at the NPBS, Njoro, and relation to 10 day average precipitation and temperatures during 1983.

summer rainfall.

There was no relationship between temperature and the emergence of *B. pectinatus* (Figure 12). *B. pectinatus* is a plant of tropical origin (Clayton, 1971) and would therefore would not evolve a seasonal emergence pattern based on the relatively small tropical seasonal fluctuations. At Njoro, daily temperature fluctuations were much greater than the seasonal fluctuations. It has been demonstrated that the distribution of native *Bromus* species is often determined mainly by temperature (Hartley, 1973; Tieszen *et al.*, 1979).

Due to the distinct seasonality of precipitation in Kenya it would be to the survival advantage of *B. pectinatus* to time emergence to occur when there is adequate moisture for growth through to maturity. These studies indicate that seed dormancy is responsible for timing emergence in *B. pectinatus*.

Hulled seeds did not germinate until May (Figure 11) and field emergence did not begin until May (Figure 12). Dormancy is likely to be responsible for the lack of germination of hulled seed. It is also likely that seed dormancy was also responsible for inhibiting emergence, through the dry season, in the field. It is also possible that conditions during the dry season were just too dry, and/or the soil temperature just too hot, for emergence of *B. pectinatus*.

Scarification may be important in germination of *B. pectinatus*. Dehulled seeds began germinating sooner after harvest than did hulled seeds (Figure 11). Seedlings of *B. pectinatus* emerged continuously through the long rains, in at least two flushes. Harper (1977) states that seeds that require abrasion do not have only a sudden flush but break dormancy at different times.

The emergence of *B. pectinatus* throughout the growing season, not as one flush, may have been the result of a heterogeneously mature seed source. Once *B. pectinatus* reaches the reproductive phase panicles emerge successively over the plants remaining life. Early emerged plants are shedding seed while other plants and panicles are being initiated. Seed will readily disarticulate from mature spikelets except for the basil seed in each spikelet, which often remain attached. *B. pectinatus* is shedding seed continuously from the time the first panicle on the earliest plant matures, till the plants are killed by cultivation or dessication. The seedbank of *B. pectinatus* will therefore be of heterogeneous maturity and even with a uniform innate dormancy interval *B. pectinatus* seed would emerge throughout the growing season.

B. pectinatus seeds may persist in the seed bank for longer than a year. In the germination study only seeds which appeared well developed were germinated and yet the maximum germination within the 18 month germination period was only 88% (Figure 11). The lack of complete germination implies that there is an innate dormancy in some seeds which persists longer than the 18 months of the germination study. So even though in Figure 12 it appears that most seeds germinated and emerged within the first year after release, some seeds (as much as 12%) may persist in the soil for a longer period.

The occurrence of a large initial flush of *B. pectinatus* is useful towards its control. Application of selective herbicides after this flush, say in June, would effectively reduce the *B. pectinatus* population in a field. Nonetheless, the existence of continuous germination through the wet season, and the possibility of some seed persisting for more than a year, means that control of *B. pectinatus* will be a long term process, involving careful considered management.