Effects of a Wet-Dry Seed Treatment on the Germination and Root Elongation of "Whitmar" Beardless Wheatgrass under Various Water Potentials

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Abstract

Seeds of Whitmar beardless wheatgrass (*Agropyron spicatum* f. *inermis* Beetle) were allowed to imbibe water at 20° C for 24 hours, followed by air-drying at room temperature for 24 hours. Seeds were then placed in slanted-plate containers held at 20° C to measure germination and root elongation under water potentials of -0.3, -7.5, and -15 bars. Seed treatment significantly accelerated germination and root elongation under a water potential of -0.3 bars, with some acceleration occurring at -7.5 bars. Treatment did not accelerate growth activity under a water potential of -15 bars.

The loss of available forage on many lower elevation rangelands due to agricultural development, water impoundment, municipal and industrial expansion, as well as highway development, has increased the grazing pressure on the less accessible areas. These areas are often steep and rocky, which limits revegetation, in many cases, to broadcast seeding. On many such semiarid rangelands in the West, inadequate moisture and competition from aggressive annuals hinder the establishment of perennial forage grass seedlings. In addition, bird and rodent depredation of broadcast seed can be an important factor in the success or failure of these operations (Goebel and Maguire 1976; Nelson et al. 1970). Successful establishment of broadcast seeded Whitmar beardless wheatgrass (*Agropyron spicatum* f. *inermis* Beetle) has been demonstrated in fall reseeding along the Snake River breaks in southeastern Washington where seeds were protected from bird depredation (Goebel and Maguire 1976). Therefore, if seed germination could be accelerated following broadcast seeding, the probability of successful establishment could be enhanced.

Alternate wetting and drying preplanting seed treatments have been shown to accelerate seedling emergence in several grasses (Keller and Bleak 1968; Bleak and Keller 1972, 1974). The beneficial effect of such treatments is more pronounced as the soil moisture content is reduced (Keller et al. 1970; Chippendale 1934). The response of seeds to an alternate wetting and drying treatment varies with the species (Griswold 1936; Bleak and Keller 1972; Chippendale 1934).

This paper reports the effects of an alternate wetting and drying seed treatment on the germination and root growth of Whitmar beardless wheatgrass under water potentials of -0.3, -7.5, and -15 bars.

Materials and Methods

Seed of Whitmar beardless wheatgrass used in this experiment was produced by the SCS Plant Materials Center at Pullman, Washington, in 1972. Seed germination originally tested at 84% after 14 days at 20° C.

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The seeds were treated by placing them in petri dishes for 24 hours on two layers of blotter paper soaked with distilled water. They were kept at 20° C and received 8 hours of light during treatment. The seeds were then allowed to air-dry at room temperature in the laboratory for 24 hours. The temperature and relative humidity in the laboratory during the experiment were 21.2 ± 2.2 C° and $33 \pm 8\%$, respectively.

After drying, seeds were placed in slanted-plate containers, which allowed evaluation of germination, as well as measurement of root growth with a minimum amount of disturbance to the seeds. The slanted-plate containers consisted of covered plastic boxes which held 8 plastic plates. These plates were tilted at 9 degrees from vertical. Mannitol solution 1.2 cm deep, was placed in the bottom of each container. Solutions of D-mannitol were prepared using the formula provided by Helmerick and Pfeifer (1954) to simulate water potentials of -0.3, -7.5, and -15 bars. This range of water potentials was chosen on the basis of previous work by McGinnies (1960).

Twenty-five equally spaced seeds were placed in a narrow groove across each plate one-fourth of the way down from the top. A single layer of blotter paper, when moistened with the appropriate mannitol solutions, adhered to the back of each plate. The blotter paper provided moisture to the seeds and held them in place.

Each of three containers held seeds under a different water potential. In each container, four plates of treated seed and four plates of untreated seed were used. All containers were kept in a germinator at 20° C where they received 8 hours of light during each 24-hour period.

Germination percentage and root elongation were recorded at 24-hour intervals over a period of 9 days. A visible seminal root and coleoptile were used as the criteria for germination. Root measurements were taken on the first five developing seedlings on each plate.

Tests of significance for cumulative germination percentages and root length used the binomial confidence limits and the least significant difference, respectively.

Results

Cumulative germination percentages for treated and untreated seeds are shown in Figure 1. At a water potential of -0.3 bars, treated seeds began to germinate about 1 day ahead of the controls. On the fourth through the seventh day, the germination percentage for treated seeds was at least 17% higher than that of the untreated seeds. Germination at 9 days was also higher for treated seeds, but not significantly.

No significant differences between treated seeds and the controls were observed at a water potential of -7.5 bars. Treated seeds began to germinate 1 day earlier than the controls, but the controls showed a greater, although nonsignificant, germination percentage on the ninth day.

Fig. 1. Cumulative germination percentage for treated and untreated seeds of Whitmar beardless wheatgrass at three water potentials during a 9-day period. Treated seeds failed to germinate at -15 bars. For each day, percentages within each water potential labelled with different letters are significantly different at the 5% level using binomial confidence limits. Percentages without letters are not significantly different.

At a water potential of -15 bars, treated seeds failed to germinate. Thus, treatment was of no advantage in hastening germination under a water potential of -15 bars.

Mean root lengths are presented in Figure 2. At a water potential of -0.3 bars, root growth was initiated one day sooner by treated seeds. Roots from treated seeds were significantly longer than those of the controls on the second through the eighth day. Roots from treated seeds were also longer on the ninth day, but not significantly.

No significant differences were found between mean root lengths of treated seeds and those of the controls at a water potential of -7.5 bars. However, treated seed initiated root growth one day sooner. Roots from treated seeds were longer than those of the controls until the eighth day.

Discussion

Our data show that as the water potential decreased to -15 bars, germination was delayed and proceeded at a reduced rate. This was observed by McGinnies (1960) for several cool-season grasses. For our data, this was true for treated seeds as well as the controls. Root growth followed a similar trend under decreasing water potential. This effect was likely due to an inhibition of gibberellic acid-induced α -amylase synthesis by the mannitol solution similar to that noted by Jones (1969) in barley (*Hordeum vulgare*) aleurone layers.

It appears that the effect of an alternate wetting and drying seed treatment is highly dependent upon the temperature at which seeds are incubated following treatment. Chippindale (1934) reported that seeds of several cool-season grasses which had been exposed to moisture and then dried showed a greater acceleration of germination over the controls when they were allowed to germinate at 7° C than at 22° C. Wilson (1972) observed that seeds of Nordan crested wheatgrass (*Agropyron desertorum*) which had been kept in cotton screen bags in moist soil had increased germination rates over

Fig. 2. Mean root length for treated and untreated seeds of Whitmar beardless wheatgrass at three water potentials during a 9-day period. For each day, means within each water potential labelled with different letters are significantly different at the 5% level using the L. S. D. Means without letters are not significantly different.

the controls that ranged from 0 to 12 days when seeds were germinated at 5° C, and values ranging from 0 to 3 days when germinated at 20° C. Therefore, it seems probable that a greater acceleration of growth activity would have been noted under water potentials of -0.3 and -7.5 bars if seeds had been germinated at lower temperatures.

During the wetting phase of treatment, seed germination is being initiated. Some of the early metabolic processes that appear to be started during this period include synthesis of adenosine triphosphate, uridine diphosphate hexose, hexose phosphate, uridine triphosphate (Wilson and Harris 1966), and α -amylase (Wilson 1971).

Air-drying of seeds following exposure to moisture did not result in the breakdown of α -amylase (Wilson 1971). However, uridine diphosphate hexose and adenosine triphosphate were broken down when previously moistened seeds were exposed to a water potential of -400 bars (Wilson et al. 1970).

The results of this study indicate that an alternate wetting and drying seed treatment may be a valuable aid in improving and success of revegetation efforts in areas limited to spring broadcast seeding. The accelerated growth activity demonstrated by treated seeds should make them more competitive with aggressive annual vegetation, as well as making them less susceptible to bird and rodent depredation where water potentials are not much below -7.5 bars.

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