Germination Requirements of Scarlet Globemallow[1]

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Highlight

Seed germination percentages of scarlet globemallow can be increased by acid and mechanical scarification. However, the highest germination rate was produced with diethyl dioxide. All treatments interacted with temperature conditions. Alternating temperatures, particularly 12 hour periods at 15 and 22 C, were most favorable in attaining relatively high germination percentages.

Scarlet globemallow *(Sphaeralcea grossulariaefolia* (H. & A.) Rydb.) is an important perennial forb component of Shadscale Zone vegetation in the Great Basin (Billings, 1951). Few other species of comparable life form have persisted as well under the heavy grazing characteristic of this region. A major reason for this persistence is delayed dissemination of seed until favorable conditions for germination occur (Kearney, 1935). The indehiscent part of the carpel is known to hold the seed until the reticulate wall has disintegrated. Literature lacks any information, however, on how environmental factors influence germination once the seed is disseminated. The following research was conducted since such information is necessary if this species is to be used in revegetation programs.

Materials and Methods

Native seed collected near the campus of Utah State University, Logan, was stored for 10 weeks at 5 C. All fruits were reduced to individual carpels by rubbing them between two sheets of ribbed rubber. For each experiment, seeds were randomly divided into lots and uniformly spread over sterile filter paper in petri dishes.

Plexiglass germinators with individually time-clock controlled heat sources were operated in a walk-in controlled-temperature room.

Seeds were considered to have germinated when the radicle had elongated 0.5 cm. Responses were recorded for 19 days; a period found adequate by pilot experimentation.

Percentage germination was computed directly and by subtracting the number of hard coated and empty seeds from those initially treated. The number germinated was then divided by this new denominator. This procedure was necessary, in most tests, because of large numbers of seeds with empty carpels or heavy seed coats. Otherwise values of positive responses were depressed too much for optimum data analysis. Values quoted are on this latter basis.

Since preliminary tests indicated that no germination occurred when the filter paper of the plates was merely moistened with distilled water, the effects upon the seed coat of mechanical scarification, acid scarification and diethyl dioxide were first investigated.

Mechanical Scarification: Four replications of 100 seeds were scarified by high speed rotation in a sandpaper lined container for 5, 15 or 25 seconds. The seed was then placed in germinators with alternating 12-hour periods at 15 and 22 C.

Acid Scarification: The possibility of embryo damage from mechanical scarification may be obviated by the immersion of seeds in sulfuric acid. Effects of concentrated sulfuric acid were tested by placing four 100 seed units each in the acid for periods of 15, 25 or 35 minutes. One set was germinated on filter paper disks saturated with distilled water, an identical set of treated seeds was germinated with tap water as the medium.

Diethyl Dioxide (Dioxan) Treatment: Seeds of some species do not germinate because the seed coats prevent water penetration. To test whether or not a non-wetting substance was contained in the seed coats of scarlet globemallow, 3 replications of 100 seeds each were immersed in dioxan for 1, 2, 3, or 4 hours. Dioxan is a paraffin solvent which mixes easily with water and substitutes readily for the water in plant tissues without causing plasmolysis (Sass, 1940). After treatment all seed lots were placed in germinators with alternating 12-hour periods at 15 and 22 C.

Potassium Nitrate: The use of KNO_3 as a germination stimulant is well known (Toole et al. 1955). Three 100 unit replications of seeds were scarified for 25 min. with concentrated sulfuric acid at room temperature and then allowed to imbibe water for 24 hours. Then a 0.2% solution of KNO_3 was substituted as the germinating medium.

Temperature Effects: There are minimum levels, as well as maximum temperatures, at which germination is inhibited in various species. The following set of germination temperature regimes were tested with four 100 seed replications of acid-scarified seed: constant 8, 15, or 22 C, and alternating 12-hour periods at 15 and 22, 15 and 27, or 15 and 32 C.

Light Effects: Continuous light can inhibit seed germination of arid-zone species, and germination may increase as the dark period is lengthened (Koller, 1957). We tested the effect of alternating light as compared to total darkness. The 400 seeds per treatment used in this test were acid-scarified at room temperatures for 25 min., washed in distilled water and then placed on water-saturated filter paper at 4 C for 24 hours.

After the pretreatment period, those petri dishes containing seed to germinate in total darkness were placed in a black-walled can, containing a petri dish full of water to maintain a saturated atmosphere. The cans were not opened until the end of the germination period.

The dark treatment cans plus those petri dishes to be exposed to alternating light and darkness were placed in three germinators set at constant temperatures of 8, 15 and 22 C. A 150-watt clear-glass incandescent lamp approximately 5 ft above the germinators furnished light.

Viability Tests: A random sample of 250 seeds was allowed to imbibe distilled water for 12 hrs, and placed in the dark on filter paper saturated

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with 2, 3, 5-triphenyl tetrazolium chloride. (Porter et al., 1947).

Results and Discussion

Mechanical Scarification: As scarification time increased, germination percentage decreased. Average germination was 47.4% for the 5 sec. treatment, 10.5% for 15 sec. and 8.0% for 25 sec. This trend may have been caused by increasing damage to embryonic tissue or weakened seed coats which permitted abnormal appearance of cotyledons before the radicle.

Acid Scarification: Germination percentage for these treatments was very erratic in all instances, showing few definitive trends. Germination ranged from approximately 30 to 40% for all treatment combinations. Germination increased with time of immersion when tap water was used. Germination was significantly higher with distilled water. Immersion in the acid up to 35 min. did not decrease germination rates.

Diethyl Dioxide (Dioxan) Treatment: Average germination for the four treatments was 36.7, 51.5, 48.2, and 67.1% for the 1, 2, 3, and 4 hour treatments, respectively. This progressive increase seems to indicate that a non-wettable agent is a primary factor responsible for cases of reduced germination in this species. Results of this treatment compared with those of the previous two experiments showed that: (1) germination was quicker and more uniform, (2) percent germination was higher than for the mechanically or acid-scarified seed lots, and (3) no abnormal germination occurred.

Potassium Nitrate: KNO_3 treatment increased average germination by 9% over that of the controls treated only with tap water. As used in these experiments in combination with acid scarification, the germination was below that obtained when dioxan was used alone.

Temperature Effects: Germination percentages of acid-scarified seed increased as constant temperatures were increased at intervals of 8, 15 or 22 C. Average percentages were 4, 10, and 12% respectively. Fluctuating temperature regimes were generally more conducive to germination than constant temperatures. The most favorable thermoperiodic treatment was alternating 12-hour periods at 15 and 22 C. Such treatment gave an average germination of 34.3% for the four 100 seed replications, whereas the 15 and 27 C treatment yielded 22.5% and the 15 and 32 C regime 18.6% germination. Thus, germination percentages decreased as the maximum temperature of the alternating regime increased.

Light Effects: Germination percentages were low (2 to 12%) in this test, probably due in part to the constant temperature regimes imposed. No significant differences in germination response were attributable to the light treatments imposed.

Viability Tests: An average of 85.7% of seed (hard-coated and empty seeds not subtracted) tested imbibed red color, allowing interpretation of that percentage viability. Of this sample, 58.0% of the seeds possessed hard seed coats and 13.6% were empty. The tetrazolium test showed 95.2% of the hard seeds to be viable. That seed in none of the other tests approached the apparently potential level of germinability is probably due to the high proportion of seeds with either a hard or heavily impregnated seed coat.

Summary and Conclusions

Our results show that germination percentages of scarlet globemallow can be enhanced, particularly by treatments with diethyl dioxide. Sulfuric acid and mechanical scarification also increased germination, but, in both of these methods more care must be exercised to prevent injury to the seed. Potassium nitrate had only negligible effect as a germination stimulant.

All treatments interacted with temperature conditions. Alternating temperatures, particularly 12-hour periods at 15 and 22 C, were found to favor relatively high germination percentages.

Contrary to the general rule of continuous light inhibition of seed germination of arid zone species, scarlet globemallow showed no differential response in exposure of seeds to light or total darkness.

The generally low level of germinability of scarlet globemallow seeds is believed to be due to the hard seed coats that are heavily impregnated with a non-wettable substance.

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