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## **Seed Dormancy in *Artemisia tridentata* Nutt. Subspecies *vaseyana* Rydb.**

### **Abstract**

Dormancy in achenes of *Artemisia tridentata* Nutt. subspecies *vaseyana* Rydb. (mountain big sagebrush) is partially relieved by light, gibberellic acid, or acid scarification and is almost completely relieved by removal of the pericarp. Dormancy in this subspecies is interpreted in terms of the balance between embryo growth and pericarp resistance to this growth.

### **Introduction**

Achenes of big sagebrush (*Artemisia tridentata* Nutt.), when undistinguished into subspecies, have generally been considered to be nondormant because various investigators have obtained intermediate- to high-germination percentages by holding the imbibed achenes at temperatures of about 20°C with no special treatment except illumination (Andersen, 1968). A germination study of achenes collected from individual plants of three subspecies of big sagebrush showed that a 50-day stratification treatment gave significant improvement in the subsequent germination at higher temperatures of all collections of subspecies *vaseyana* Rydb. only—germination ranged from 16 percent without stratification to 94 percent following a stratification treatment.<sup>2</sup> The study reported here was done to clarify the mechanism of dormancy in this subspecies, as reported below.

### **Materials and Methods**

Achenes were collected in 1971 from plants of subspecies *vaseyana*, distinguished on the basis of its morphology (Winward, 1970), on sagebrush-grass range near Dubois, Idaho. Extraneous debris and empty and aborted achenes were removed by sieving and winnowing and the cleaned achenes were stored in sealed jars in a coldroom, until used in experiments 4 to 7 months after collection. Germination tests were run on filter paper moistened by distilled water and contained in 9 cm petri dishes at temperature alternations of 20/10°C (8 hours/16 hours in Lab-Line growth chambers). In all treatments except dark controls and continuous illumination, 8-hour photoperiods (1100 lumens/m<sup>2</sup> of cool white fluorescent light at bench level) coincided with the

<sup>1</sup> Stationed in Logan, Utah, at Forestry Sciences Laboratory, maintained in cooperation with Utah State University.

<sup>2</sup> W. T. McDonough and R. O. Harniss. Seed germination in three subspecies of big sagebrush. Manuscript in preparation, Intermt. Forest & Range Exp. Stn., Ogden, Utah 84401.

higher temperature of the alternation. For the light treatments, the dishes were stacked in metal cans equipped with transparent, snap-on lids. The dishes were systematically changed in position daily during inspections for germination. For the treatment in constant darkness, the dishes were stacked in metal cans with opaque, snap-on lids.

There were approximately 50 achenes per dish and four dishes for each treatment which included: constant darkness; 8- and 24-hour photoperiods; imbibition in 100, 250, and 500 ppm gibberellic acid (GA<sub>3</sub>); scarification in concentrated sulfuric acid for 5, 10, and 15 seconds followed by a ½ hour wash in running tap water; leaching in running tap water for 8, 16, and 24 hours; and removal of the pericarp by pressing against the cotyledonary end of the achene with a probe after 8 hours of imbibition. The thin, enveloping layer of endosperm tissue separated with the pericarp; thus, this last treatment resulted in isolation of the embryo.

Germination tests were ended after 30 days and the results were evaluated by variance analysis and studentized range tests at the 5 percent level of significance. Perceptible growth of the radicle was considered to be normal germination, and such growth of the cotyledons was considered to be atypical. Separate counts were kept of each type.

Gravimetric determinations of imbibitional water uptake were made on four additional sets of 50 achenes in the air-dry state and after 16 hours' contact with water-moistened filter paper in darkness. The achenes were blotted surface-dry before the second weighing.

### Results

Normal and atypical germination percentages and the ratios of atypical to total germination under the various treatments are given in Table 1. Where several application levels were involved (GA<sub>3</sub>, scarification, leaching) the one giving the highest per-

TABLE 1. Effects of various treatments on germination.

Treatment	Germination (%) <sup>1</sup>		
	Normal	Atypical	Atypical/Total
Constant darkness	2 <sup>a</sup>	5 <sup>a</sup>	.71
8 hour photoperiods	12 <sup>b</sup>	3 <sup>a</sup>	.20
24 hour photoperiods	14 <sup>b</sup>	4 <sup>a</sup>	.22
16 hour leach	17 <sup>b</sup>	5 <sup>a</sup>	.23
5 second acid scarification	23 <sup>c</sup>	16 <sup>b</sup>	.41
500 ppm GA <sub>3</sub>	26 <sup>c</sup>	3 <sup>a</sup>	.10
Pericarp removed	95 <sup>d</sup>	0 <sup>c</sup>	—

<sup>1</sup> Germination percentages within a column having the same letter in superscript do not differ significantly at the 5 percent level.

centage is listed. Light had a limited promotive effect on normal germination over dark controls, but continuous light gave no advantage over 8-hour photoperiods. The leaching pretreatment had no promotive effect. Acid scarification and GA<sub>3</sub> resulted in additional germination; however, isolation of the embryo yielded nearly complete germination (Table 1).

Rates of germination (not determined in dark controls), expressed as days required to reach one half of the final percentage, ranged from 8 to 12 days, except after pericarp removal when only one day was required.

Imbibitional water uptake by achenes amounted to a 77 percent increase in fresh weight.

Atypical germination did not differ significantly among treatments except for the high value following scarification, and it did not occur after pericarp removal (Table 1), which resulted in approximately simultaneous growth of the radicle and cotyledons. When atypical germination was expressed as a proportion of total germination, it was highest in constant darkness and with scarification, and lowest with GA<sub>3</sub>.

#### Discussion

Growth of the isolated embryos was rapid and nearly complete; therefore, enforcement of dormancy must reside in the pericarp and/or endosperm. These enveloping tissues may enforce dormancy by: (a) releasing an inhibitor of embryo growth (Koller, 1972); (b) restraining embryo growth mechanically when other factors are operating to reduce growth (Koller, 1972; Villiers, 1972); or (c) hindering the uptake of water or diffusion of respiratory gases (Villiers, 1972).

Action of a water-soluble inhibitor seems unlikely in view of the ineffectiveness of the leaching treatments in the promotion of germination. Mechanical restraint of embryo growth in achenes held in constant darkness is a more probable mode of action because treatments that increase germination—stratification, light, GA<sub>3</sub>—are known to promote embryo growth (Koller *et al.*, 1962; Villiers, 1972). Acid scarification, also effective in increasing germination, acts primarily to weaken the structure of the pericarp. That this treatment was only moderately effective in increasing germination was probably due to injury to the radicles of many achenes. Impermeability to water is not a factor because achenes imbibed in darkness take it up readily. Resistance to gaseous diffusion (e.g., oxygen) was not investigated but, if it is involved, it would act as another possible inhibitor of embryo growth.

In summary, the data suggest that the determinant in the germination of achenes of this subspecies is in the balance between the pressure exerted by the radicle and the resistance of the pericarp; thus, an increase in the former and/or a decrease in the latter will increase the probability of germination. Under natural conditions, the combined effects of winter stratification on the promotion of growth of the embryo and erosion of the pericarp by weathering and by the action of soil micro-organisms probably insure prompt and nearly complete germination by the time of snowmelt in spring.

Treatments that increase normal germination also reduce atypical/total germination, except for the acid treatment that probably resulted in damage to the radicle of many embryos, thus distorting the ratios. The radicle has a localized apical meristem and region of cell elongation close to the inner surface of the pericarp, compared to the diffuse plate meristem and cell enlargement regions of the cotyledons (Esau, 1960). It is not known whether atypical germination results from less pericarp resistance at the cotyledonary end of some achenes or from greater pressure exerted by the growing cotyledons compared to the radicle.

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