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Seed Germination of Alaska Iris, *Iris setosa* ssp. *interior*

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Abstract. **Seeds of Alaska iris, *Iris setosa* Pall. ssp. *interior* (Anders.) Hult., were collected from wild stands near Fairbanks and subjected to the following treatments: 0 or 125 days of stratification; 24-hr soak in water or 1000 mg·liter^{-1} gibberellic acid (GA_3); alternating (25°/10°C) or constant (21°) temperatures; and germination in darkness or light. After 7 days, germination was best (95.0%) with stratified seeds that were soaked in GA_3 and germinated at constant temperatures in the dark. A greenhouse study in which stratified seeds were soaked in water or GA_3, sown in a commercial peat and vermiculite seed germination mix, and germinated beneath clear or black plastic confirmed that germination was highest (64.4%) and most uniform (83.3% filled container cells) with the combined treatments of GA_3 and darkness.**

Seeds of Alaska iris do not germinate immediately upon harvest. Seeds require a period of cold stratification ranging from 120 to 150 days at 4°C, but germination rarely exceeds 40%. This germination pattern is similar to other *Iris* species and hybrids in which dormancy may persist for several months, followed by intermittent germination over several years. (2, 3, 9, 11, 12, 15). Dormancy is reported to be caused by a dormant embryo (9), a water-soluble inhibitor in the endosperm (3, 4, 8, 12, 14), and/or mechanical inhibition of embryo growth (5, 14).

Several methods have been used to improve germination percentages of iris seeds, including cold stratification (9, 10, 12), leaching (3, 12), chipping or removal of the seedcoat (5, 12, 15); sowing immature seeds (2, 6), heat treatment (7), and embryo excision (9, 11–13). With the exception of embryo excision, these methods have not consistently improved germination percentages. None of these treatments has been reported previously with the Alaska iris to my knowledge. The purpose of this experiment was to test various treatments including cold stratification, light, gibberellic acid, and temperature to determine possible methods of improving germination of the Alaska iris.

Seed capsules of Alaska iris were collected on 22 Aug. 1985 from wild stands growing near Fairbanks. Capsules were air-dried for 24 hr to facilitate removal of the seeds; seeds were then stored dry at 4°C for 2 weeks. One-half of the seeds were stratified in peat at 4° for 125 days, while the remainder were stored dry at 4° until further treatment. Both stratified and unstratified seeds were soaked in tap water (pH 6.5) or 1000 mg·liter^{-1} gibberellic acid (GA_3) for 24 hr at room temperature, rinsed in water, and then placed on moistened filter paper in petri dishes. One-half of the dishes were enclosed in aluminum foil to exclude light, and all dishes were placed into clear plastic bags to retard evaporation. Dishes were placed in a growth chamber at 21° constant temperature. Light was provided for 16 hr each day using a mixture of 40-W cool-white fluorescent and 25-W incandescent lamps with a radiant flux of 55 W·m^{-2} measured 33 cm below the lamps using a LI-COR Model LI-185B Quantum/Radiometer/Photometer. Previous experiments had shown that nondormant seeds germinate rapidly in 3 to 5 days with little or no additional germination after 7 days. Consequently, germination was recorded as radicle emergence from the seedcoat after 7 days of treatment. The entire experiment was repeated under alternating temperatures of 25° (day) and 10° (night) for 16 and 8 hr, respectively. Both experiments were conducted as a completely randomized design with three replicates per treatment and 50 seeds per replicate.

In order to test selected treatments under greenhouse conditions, seeds from a different wild stand near Fairbanks were collected on 1 Sept. 1985. Seeds were stratified in peat at 4°C for 125 days and then soaked in 1000 mg·liter^{-1} GA_3 or water. Three seeds per cell were sown ≈5 mm deep in six-celled plastic containers filled with a commercial peat and vermiculite seed germination mix (≈45 cm^3 of mix per cell). Containers were watered and enclosed in individual black or clear plastic bags, which then were placed randomly on a bench in the greenhouse. A minimum air temperature of 21° was maintained. Thermocouples were inserted at random beneath the plastic to a medium depth of 5 mm in order to determine any temperature differences between plastics. Since medium temperatures did not differ by more than 3° between plastic treatments, temperature was not considered further as a major treatment effect. Sunlight was supplemented with a 16-hr photoperiod from 6:00 AM to 10:00 PM using 400-W high-pressure sodium lamps at 48 W·m^{-2} measured to 1.6 m below the lamps. After 10 days, all containers were removed from the plastic bags. After an additional 30 days, the percent seedling emergence from the medium was recorded. Data were analyzed using analysis of variance for four factors with treatment containers replicated 12 times in a completely randomized design. Where appropriate, data were subject to arcsin transformation prior to analysis.

Unstratified seeds failed to germinate regardless of constant or alternating temperatures, GA_3 or light treatments, and consequently the data were omitted from further treatment comparisons. In a comparison of the stratified seeds, the GA_3 treatment significantly improved germination at constant temperatures in both light and dark (Ta-

Table 1. Effects of light, GA_3, and constant or alternating temperatures on seed germination of Alaska iris in a growth chamber.

	Germination (%)[z]			
	21°C		25°/10°	
Treatment	Mean	SE	Mean	SE
Light				
GA_3 soak	53.6	2.4	23.3	6.2
Water soak	33.3	6.2	25.0	8.2
Dark				
GA_3 soak	95.0	8.5	35.0	4.1
Water soak	30.0	7.1	35.0	4.1
Significance				
Light/dark	*		NS	
GA_3/water	**		NS	
Treatment interaction	**		NS	
GA_3/water × Light	*			
GA_3/water × Dark	**			
Light/Dark × GA_3	**			
Light/Dark × Water	NS			

[z]Radicle emergence after 7 days.
NS,*,**Not significant and significant at P = 5% and 1%, respectively.

Table 2. Effects of GA_3 or water soak and clear or black plastic on germination of Alaska iris seeds sown in a peat and vermiculite mix.

	Seedling emergence (%)[z]		Empty container cells (%)	
Treatment	Mean	SE	Mean	SE
Black plastic covering				
GA_3 soak	64.4	13.8	16.7	11.5
Water soak	50.5	12.1	30.6	14.9
Clear plastic covering				
GA_3 soak	57.0	13.6	29.7	13.7
Water soak	38.1	10.2	59.8	15.9
Average treatment effects				
Between plastics				
Black	57.5**		23.6**	
Clear	48.0		44.4	
Between water and GA_3 soak				
GA_3 soak	60.7**		22.9**	
Water soak	44.2		45.1	

[z]Shoot emergence from medium after 30 days.
**Treatment pairs within columns significant at 1%.

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ble 1). Germination also was improved by the dark treatment, but was the best with a combination of GA_3 and darkness. Differences between light and dark germination in water-soaked seeds were not significant.

Germination at alternating temperatures never exceeded 45% for any treatment replicate, and differences among treatments were not significant (Table 1). Although it appeared that a constant temperature was preferable to alternating temperatures, the 8 hr of low temperatures per day may have delayed germination so that maximum germination and treatment effects were not evident after the 7-day germination period.

Results of the greenhouse experiments were similar to the growth chamber tests in that GA_3 significantly improved seedling emergence of stratified seeds (Table 2). Emergence also was improved by covering the flats with black plastic, but there was no significant interaction between the two main treatments. Since all seeds were sown at an ≈5-mm depth, all seeds in flats covered with either clear or black plastic received a reduced light treatment, which could explain the lack of interaction evident in the previous experiment and the similar germination percentages recorded for GA_3-treated seeds in both plastic treatments.

The uniformity of seedling emergence is reflected in the percentage of empty cells per container (Table 2). Stratified seeds that were soaked in water and germinated in the clear plastic bags showed no seedling emergence in more than half of the container cells. Based on the percentage of empty cells for this treatment, an average of 7.4 seeds per cell would have to be sown in order to approach 100% filled cells. In contrast, the stratified, GA_3-treated seeds that were germinated beneath black plastic had only 16.7% empty cells, and would require an average of 3.6 seeds per cell. The remaining two treatments would require an average of 4.3 seeds per cell.

Both experiments demonstrated that germination is improved significantly by soaking the stratified seeds in 1000 mg·liter^{-1} GA_3 and germinating them in darkness. Reports of GA_3 treatments using the *Iris* spp. have been limited. Abdalla and McKelvie (1) reported that *I mellita* Janka seeds failed to germinate when they were soaked in 500 mg·liter^{-1} GA_3 and then held at 23°C. Seeds soaked in GA_3 and stratified at 1.5° for 4 weeks before being transferred to the higher temperature also did not germinate. The GA_3 treatment in both *I. setosa* and *I. mellita* apparently does not replace the chilling requirement of unstratified seeds. The 4-week chilling period probably was too short to overcome dormancy in the *I. mellita* seeds.

Few reports document the response of iris seeds to darkness. Guppy (7) found that 46.6% of *I. pseudacorus* L. seeds germinated after 6 months in the greenhouse in containers of water that were covered to exclude light. No seeds germinated in the light at room temperature or in the greenhouse, or in the dark at room temperature. Randolph (11) recommended culturing excised embryos first in darkness at 28° to 30°C for 3 to 5 days, followed by a gradual increase in light until seedlings were transferred to a shaded greenhouse. Both of these studies indicate a positive effect of darkness on germination. The experiments with *I. setosa* showed that darkness does not influence germination of unstratified seeds nor is it an obligate requirement of stratified seeds. Darkness does improve germination percentages, particularly when combined with GA_3 treatment. This combination of stratification, GA_3 and darkness provides a less cumbersome method than embryo excision for obtaining high germination percentages for commercial producers and plant breeders.

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Apparent Effect of Zinc Treatment on the Growth Rate of Pecan Production and Yield

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Abstract. **Rosette was the major pecan [*Carya illinoensis* (Wangenh.) C. Koch] production problem prior to the discovery, in 1932, that the disorder was a symptom of Zn deficiency. A comparison of pecan production during the 10-year period prior to 1933 and the 10-year period following 1933 was made to determine the apparent effect of the use of Zn on the growth rate of pecan production from orchards in native and non-native pecan areas. Following the discovery of the cause of rosette, the rate of pecan production increased in non-native but not in native areas. The differential response is proposed to have been due primarily to less severe Zn deficiency in orchards in native than non-native areas. Alternatively, correction of Zn deficiency would have been less likely in native area orchards because of the general ineffectiveness of soil applications of Zn on calcareous soils.**

Pecan rosette, which eventually was discovered to be caused by Zn deficiency, was reported as early as 1902 (20). By 1914, rosette had been observed on pecans growing from Texas to the Atlantic Coast and from Florida to Virginia. By 1919, rosette was the most serious problem of the pecan industry (19). By 1932, hundreds of hectares of pecans were abandoned in the southeastern United States (1). At first, rosette was thought to be a disease (20, 23), but research by Orton and Rand (20) proved this not to be the case. These workers found that transplanting healthy trees into soils from rosette-

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