Germination of Alaska-Cedar Seed

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Seeds of Alaska-cedar (Chamaecyparis nootkatensis *D. Don) were tested for germination following combinations of warm and cold stratification. For nursery sowing, good germination can be achieved using 60 days of warm stratification followed by 90 days of cold stratification. Extending stratification periods beyond these times may result in seed loss from seed germination during stratification and from seed molds. Unstratified seed sown in greenhouses in late summer will germinate well the following spring if greenhouse temperatures are lowered during fall and winter to meet cold stratification requirements.* Tree Planters' Notes 44(1):21-24; 1993.

Alaska-cedar *(Chamaecyparis nootkatensis* D. Don) occurs from Prince William Sound in Alaska to the mountains of Oregon and northwestern California (Viereck and Little 1972). Alaska-cedar reaches its best development on the islands of southeast Alaska and in British Columbia, where it is also known as yellow-cedar or yellow cypress.

The wood is highly valued because it is resistant to attack by insects and decay fungi. It has been used for boat construction, decking, window framing, and other construction uses where the wood is exposed to the weather. Native Americans have used the wood and bark for many purposes and continue to use the wood for carving and bark for weaving.

In southeast Alaska, the best development of Alaska-cedar occurs on moderately productive sites at elevations of 150 to 475 m (500 to 1,500 feet). It is also found on poorly drained or on shallow sites with low productivity. On more favorable sites it is unable to compete with western hemlock. *(Tsuga heterophylla* (Raf.) Sarg.), Sitka Spruce *(Picea sitchensis* (Bong.) Carr.), and western redcedar *(Thuja plicata* Donn.). Timber harvest in southeast Alaska over the last 30 years was concentrated in high-volume, low-elevation stands, generally with a low Alaska-cedar component. With the designation of wilderness and more complex land-use designation patterns, timber harvest now occurs in a variety of stands. These changes, and greater demand for Alaska-cedar wood, have resulted in increased harvest of stands where Alaska-cedar is a major component.

Regeneration requirements of Alaska-cedar are poorly understood. Seedlings are uncommon in the understory and on regeneration sites following logging of stands that previously contained Alaska cedar. If Alaska-cedar is to be a component of second-growth stands, artificial regeneration will be required on many sites.

Alaska-cedar seeds are difficult to germinate. Germination is usually poor and may be delayed for up to a year. Seeds sown in the spring may not germinate until the following year. Stratification recommendations for Alaska-cedar seeds are poorly developed. Bensen (1969) achieved 10% germination using a 58-day warm period followed by a 30-day cold period. Harris (1974) summarized early germination test and results of nursery sowings and suggested other variations of warm periods followed by cold periods might be needed to optimize germination.

Our earliest attempt to grow Alaska-cedar at the B. F. Heintzleman Nursery at Petersburg followed a November 1983 seed collection. Although initial germination was low, seeds germinated well the following spring after a winter at temperatures above freezing (average minimum daily temperature). We found that seed viability was good and that seedlings could be produced if stratification requirements were met.

Because experience with nursery sowing suggested that seed germination could be increased with extended warm stratification followed by cold stratification, and since similar results were reported for other nursery sowings (Harris 1974), this study was initiated to test the effect of various combinations of warm and cold stratification treatments on seed germination of Alaska-cedar.

Methods

In October 1985, Alaska-cedar cones were collected from 25 to 30 trees at an elevation of 335 to 365 m (1,100 to 1,200 feet) on Mitkof Island in southeast Alaska. Seeds were extracted from the cones and stored at -18 /C (0 /F). After 2 weeks, the seeds were removed from storage and warmed to room temperature. Then, the seeds were placed in a polyethelene bag and soaked in water for 24 hours. Excess water was drained from the bag and the seeds were put into warm stratification.

For warm stratification, seeds were placed in a room where temperatures fluctuated between 13 to 24 /C (55 to 75 /F). At the start of warm stratification (0 days), and at 30-day intervals from 30 to 240 days, samples of the seeds in warm stratification were transferred to separate polyethelene bags and placed into cold stratification at 1 to 2 /C (34 to 36 /F). For each sample, germination was tested for the seeds at 30-day intervals in cold stratification from 30 to 240 days. Thus, there were 72 treatment combinations-nine levels of warm stratification, each with eight levels of cold stratification.

Seeds removed from cold stratification at the appropriate times for testing were placed onto moist potting soil in covered plastic trays. Each treatment was replicated three times, using 100 seeds per-replication. Trays containing seeds were placed in an incubator at 24 /C (75 /F). The trays were examined every 2 or 3 days and the number of germinated seeds was recorded. Seeds were considered to have germinated when the seed coat lifted above the soil. Germinated seeds were removed from the trays as they were counted and the test ended after 28 days.

The study was installed as a randomized complete block experiment with three replications. Because all treatments were not be tested at the same time, one replication of each treatment was assigned to each of three levels in the germination chamber. Location of each treatment within a repcations was assigned randomly to one of nine locations, the maximum number of treatments being evaluated at any time. Data were subjected to an analysis of variance. Main affects were compared using Duncan's multiple range test at the 0.05 level of significance (Snedecor and Cochran 1967).

In addition to these laboratory tests, starting in November 1985, a 4-cubic-inch Styroblock with 240 cavities was sown each month for a year (until October 1986) with unstratified seed taken from cold storage. Sown Styroblocks were placed in a production greenhouse to test whether greenhouse conditions could meet stratification requirements for Alaska-cedar seeds. This portion of the study was not replicated. From August 1986 through November 1986, greenhouse temperatures varied with outside temperatures. No heat was added, but temperatures were kept below 27 /C (80 /F) on sunny days. From December 1986 through February 1987, temperatures were kept above freezing but not allowed to exceed 7 /C (45 /F). By March, seedlings grown for reforestation were lifted and temperatures in the greenhouse were kept above freezing but allowed to rise during the day. Temperatures in the greenhouse were kept at 24 /C (75 /F) during the first 3 weeks of April 1987. After that, day temperatures were maintained at 24 to 27 /C (75 to 80 /F) and allowed to cool to 13 /C (55 /F) at night. The percentage of seed germinating in the greenhouse was scored on March 1, 1987, before greenhouse temperatures had begun to rise and again on March 21, 1987, after 3 weeks of warm temperatures that favored germination.

Results

Laboratory germination. Germination of seeds following stratification was affected by the length of time in warm and cold stratification (table 1). Warm stratification for 30 to 150 days significantly increased germination over that of untreated seeds. Germination over all cold treatments was highest, about 58%, with warm treatments of 60 to 120 days, after which germination percentages decreased due to mold development on the seeds. After 150 days in warm stratification, no seed germinated regardless of cold stratification treatment.

Length of cold stratification increased germination percentages through 90 days for all levels of warm stratification (table 1). After 90 days of cold stratification, germination percentages decreased as length of cold stratification increased. This decrease can be explained, to some extent, by the onset of seed germination during cold stratification when cold stratification was in excess of 90 days. Even though those germinated seeds were excluded mathematically from the calculation of germination percentage during the germination phase, removal of seeds that germinated during stratification reduced the number of seeds with germination potential in the test samples. This resulted in germination percentages being lower than would have occurred had the seeds not germinated in stratification. The highest numerical germination was 69% for the treatment with 60-day warm stratification followed by 90-day cold stratification; with no warm stratification, germination percentages increased with increased cold stratification. Also, at

*Table 1 -Germination of Alaska-cedar seed after 30 to 240 days of warm stratification followed by 30 to 240 days of cold stratification**

Days warm stratification	Percent germination: 30 days cold	60 days cold	90 days cold	120 days cold	150 days cold	180 days cold	210 days cold	240 days cold	Mean warm days
0	0	1	0	0	1	4	6	10	3 a
30	16	52	66	57	52	47	53	28	47 c
60	37	64	69	68	67	60	54	55	59 e
90	49	61	68	65	57	50	60	56	58 e
120	48	57	61	60	62	58	52	52	56 d
150	11	11	15	13	11	12	13	12	12 b
Mean cold days	27 a	41 cd	47 f	44 a	42 d	28 a	40 c	34 b	

Means within columns followed by a common letter are not significantly different. Means within rows followed by a common letter are not significantly different (P < 0.05).
*Seeds germinating during stratification are not included.

150 days of warm stratification, there were only small differences in germination at any level of cold stratification (range, 11 to 15%).

Greenhouse germination. Seeds sown monthly from November 1985 to October 1986 into Styroblocks and placed into the greenhouse germinated poorly through March 1, 1987 (table 2). Germination was somewhat higher with the earlier sowings but did not exceed 10% (for example, January 1986). No germination occurred in sowing after July 1986. During the months of December 1986 through February 1987, greenhouse temperatures were too low for germination. After March 1, 1987, greenhouse temperatures increased and ungerminated seeds began to germinate. Germination continued through March 21, 1987, when seedlings and recent germinants were counted. Highest germination was 83% for the September 1986 sowing and lowest (17%) for the March 1986 sowing.

Table *2-Greenhouse germination of unstratified Alaska-cedar seed sown monthly from November 1985 to October 1986*

Date sown	Percent germination: March 1, 1987	March 21, 1987
November 85	4	57
December 85	6	51
January 86	10	34
February 86	4	32
March 86	5	17
April 86	9	52
May 86	2	47
June 86	4	62
July 86	1	55
August 86	0	67
September 86	0	83
October 86	0	31

Germination percentages for March 1, 1987, show the germination that occurred without a warm stratification period followed by a cold stratification period. By March 1, 1987, stratification requirements were met but greenhouse temperatures were too low for seed germination. With increased greenhouse temperatures after March 1, stratified seed germinated through March 21, 1987.

Germination for the other sowings ranged from 31 to 67%.

Discussion

Germination of Alaska-cedar seeds requires a period of warm stratification followed by a period of cold stratification for a high percentage of the seeds to germinate. Seeds with no warm stratification germinated poorly even after 240 days of cold stratification. Some seeds with extended warm stratification and no cold stratification will germinate. However, warm stratification of more that 120 days' duration can result in loss of seed viability due to storage mold.

Monthly sowing of unstratified seed in the semi-operational greenhouse trial gave results similar to those from the controlled germination study. Seed germination was delayed in the greenhouse until both warm and cold stratification requirements were met, at least 60 days of warm stratification followed by 90 days of cold stratification (table 2). The September 1986 sowing produced the highest level of germination. Most likely, seed germination in the earliest sowing-November 1985 through February 1986-was delayed for over a year until these requirements were met. The low germination rate for the March 1986 sowing and the variation in germination among sowing dates may be due, in part, to dislodging of seeds from the containers by irrigation spray. The main finding of the greenhouse germination study is that with temperature modifications, Alaska-cedar seeds can germinate at similar levels as in the laboratory.

Conclusions

Nursery managers growing Alaska-cedar seedlings must use stratified seed to ensure good germination. Seed can be sown in late summer and placed into greenhouses where warm and cold stratification requirements will be met, or they can be sown in spring with stratified seed. Good results can be expected with 60 days of warm stratification followed by 90 days of cold stratification. Some variation in the warm stratification period around 60 days should not greatly affect germination as long as the cold stratification period is at least 90 days. Seeds held in warm stratification beyond 90 days may begin to germinate in stratification and seeds held beyond 120 days may begin to mold.

The poor success in regenerating Alaska-cedar in second growth stands in southeast Alaska can be explained in part by its seed characteristics. Seed production of Alaska-cedar is never abundant when compared to Sitka spruce, western hemlock, and western redcedar, its chief associates. Seeds from these species require little or no stratification for germination, giving them an advantage in quickly occupying sites following logging. Only a small percentage of Alaska-cedar seed will germinate the first year after seed dispersal. The remainder of the seeds will need another year to meet their stratification requirements. During this time, the seed numbers may be consumed by birds and rodents or killed by fungi. Until methods are developed to ensure adequate natural regeneration, artificial regeneration will be required if Alaska-cedar is to be well represented in second-growth stands in south east Alaska.

Literature Cited

Benson, D. 1969. Seed test data. Macon, GA: USDA Forest Service, Eastern Tree Seed Laboratory.

Harris, A.S. 1974. *Chnmaecyparis.* In: Schopmeyer, C.S., tech. coord. Seeds of woody plants of the United States. Agric. Handbk. 450. Washington, DC: USDA Forest Service: 316 320.

Snedecor, G.W.; Cochran, W.G. 1967. Statistical methods. Ames: Iowa State University Press. 593 p.

Viereck, L.A.; Little, E.L. 1972. Alaska trees and shrubs. Agric. Handbk. 410. Washington, DC: USDA Forest Service. 265 p.

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