

**GERMINATION OF *PINUS GERARDIANA* SEEDS FOLLOWING STORAGE AND STRATIFICATION**

*Pinus gerardiana* Wall., known as chilgoza or Himalayan edible pine, grows in natural stands in northwestern India, northern West Pakistan, and eastern Afghanistan (4). It occurs at elevations between 6,000-12,000 feet (1,800 -3,600 m) in scattered groups on dry, rocky sites. It has little importance as a timber tree. The seeds-which are very large (15-25 mm long), rich in oils, and edible - constitute a staple article of local food and are also exported. Seeds are long, cylindrical, with a rudimentary wing, and do not retain viability long (5).

This species and its close relative lacebark pine, *P. bungeana* Zucc., constitute a small subsection (Gerardianae) in the taxonomic classification of pines. *Pinus gerardiana* has needles 5- to 10-cm long with a single vascular bundle, which is characteristic of the white (haploxylon) pines. Each fascicle has three needles, however, which is unusual in the white pines, and has a basal sheath (at least for 1 year) as in the hard (diploxylon) pines. Wood of this species has ray tracheids with dentate walls, a characteristic of the diploxylon pines, and a heartwood polyphenol composition different from other white pines. Chemically and taxonomically, chilgoza and lacebark pines are intermediate between the white and hard pines (8).

Chilgoza pine seeds stored for 3 years at -10° C yielded 60 percent germination with no pretreatment. Stratification of frozen seeds yielded only 6 percent germination. Seeds stored at + 4° C were not viable.

*P. gerardiana* is reported to withstand considerable drought and cold, as well as rather high summer temperatures. For these reasons it may be a good candidate for adaptability tests in the Great Plains. Past attempts to cultivate it in Britain have not been successful, but possibly techniques can be improved. This note reports on the germination of *Pinus gerardiana* seeds after approximately 3 years storage at two temperatures followed by two treatments prior to sowing.

**Methods**

Seeds used in this experiment were collected by M. Hamid Ali, Special Duty Wildlife Officer at Quetta, Baluchistan, and transmitted to us by Dr. G. M. Khattak, Chief Conservator of Forests, Peshawar, Pakistan.

Cones were collected October 22, 1971, from nine trees in natural stands in one area located 31.3° North latitude, 70.9° East longitude, and 6,500 feet (2,000 m) elevation near Sharav Kund, West Pakistan. Seeds were extracted, cleaned, treated with HCN gas, certified free of insects, and sent via American Embassy and the U.S. Department of Agriculture to Wooster, Ohio, where they were X-rayed. Seeds were received in Lincoln July 26, 1972, placed in paper seed envelopes, and stored at + 4° C. On November 10, 1972,

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each of the nine seed lots was divided into two equal parts; one was stored in paper envelopes at -10° C, while the other was returned to +4° C storage. There were roughly 80 to 115 seeds in each of the nine lots, and of the approximate 900 total seeds received, the X-ray showed only 26 empty.

Nearly 3 years later, September 24, 1975, half of the refrigerated lots and half of the frozen lots were stratified in wet sand at +4° C for 15 days. The recommended cold stratification after storage (storage temperature not specified) is 0 to 30 days at 1° to 5° C in a moist medium (9). All seeds were sown October 9, 1975, in vermiculite in flats and placed in the greenhouse where temperatures ranged from 16° to 32° C (60° to 90° F). Thus, there were four treatments: (1) frozen-stratified, (2) frozen-unstratified, (3) refrigerated-stratified, and (4) refrigerated-unstratified. Germination counts were made daily for 30 days, and number of cotyledons recorded at end of experiment.

**Results and Discussion**

None of the seed stored at +4° C germinated. Germination of frozen-stratified seeds was 6 percent, compared to 60 percent for the frozen-unstratified seeds (table 1). About two-thirds of all germination occurred during the first 15 days. A cutting test on a

**Table 1.—Germination<sup>1</sup> of *Pinus gerardiana* seeds after 3 years storage at below freezing temperatures<sup>2</sup> followed by stratification and no stratification**

Tree lot no.	Frozen (–10° C)					
	Stratified			Unstratified		
	Sowed	Germinated		Sowed	Germinated	
	No.	No.	Percent	No.	No.	Percent
1	26	1	( 4)	27	7	(26)
2	21	1	( 5)	21	8	(38)
3	22	2	( 9)	22	17	(77)
4	28	6	(21)	28	26	(93)
5	22	1	( 5)	22	9	(41)
6	25	1	( 4)	25	19	(76)
7	24	0	( 0)	24	17	(71)
8	24	1	( 4)	24	11	(46)
9	25	0	( 0)	25	16	(64)
Total	217	13	( 6)	218	130	(60)
Mean <sup>3</sup>			( 6)			(60)

<sup>1</sup>Germination percentages 30 days after sowing.

<sup>2</sup>No seeds stored at above freezing temperature (+ 4° C) germinated.

<sup>3</sup>Paired test:  $t = 8.18$ . Difference is significant at .001 level.

sample of nongerminated seeds from all four treatments revealed that they were full; many were mushy, however, and growth of fungi was evident on the seed coats.

We did not measure moisture content of seeds before placing them in storage, but judged them to be sufficiently dry for storage because they had been subjected to air drying for approximately 9 months. Under those conditions, sub-freezing temperature sustained the viability of chilgoza pine seed during storage for nearly 3 years in paper envelopes. Use of sealed containers would probably have given better results (2).

Storage above freezing in unsealed containers proved unsuitable. This substantiates the research by Barton (2) and Jones (7), who point out that rising seed moisture content in unsealed containers results in seed deterioration, particularly in above freezing storage where relative humidity reaches 95 percent.

Stratification of frozen seed reduced germination to only 10 percent of that obtained without stratification. Similar results were observed with Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) seed (3). They found that

stratification reduced germination percentages of "low viability" Douglas-fir seed by approximately one-half. Stratification increased fungus growth (*Aspergillus* spp., *Trichoderma viride*, and *Penicillium* spp.), and application of 25 percent Thiram further reduced germination in both stratified and unstratified lots. Allen (1) found the amount of processing influenced germination of stratified Douglas-fir seed. Stratified seeds which underwent prolonged tumbling during cleaning and dewinging had lower germination than stratified seeds from the same lot which underwent little tumbling. Mechanical damage caused by overprocessing weakened the seed, and stratification under these conditions proved detrimental.

Stratification of stored seeds can be used as a test to determine their vitality. Heit (6) recognized the value of such a test with corn, beans, and peas as well as conifer seeds. Information derived from a sample test is useful before sowing an entire seedlot. In our study, the decreased germination of frozen seeds when stratified leads to the conclusion that the vitality of our seedlots was low. Some loss of vitality may have occurred in the first year when seeds were in transit and possibly subjected to extremely high temperatures.

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be sown in Douglas-fir styroblock-8 plugs. Replicated outplantings will be established on a wider range of sites including thick duff, compacted landings, disturbed mineral soil, and more road-fills and slides. Systematic sampling for foliar nutrient analyses is, also contemplated.

I encourage you to try this promising approach. I would appreciate hearing of your experiences with legumes in general and containerized trials in particular.

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Number of cotyledons per seedling averaged 9.8. One of the lots had a range of 7 to 12, but most of them ranged from 8 to 11.

Our recommendations for storage and pretreatment of chilgoza pine seeds are as follows:

1. Long-term storage (after air drying at room temperature) should be approximately -10° C.
2. After subfreezing storage, test a small sample for vitality by comparing germination of stratified versus unstratified seed.
3. If germination is reduced by stratification, sow seedlot from frozen storage without pretreatment.

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