

Storage Studies on Seeds of Chir Pine (*Pinus roxburghii* Sargent)

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ABSTRACT The freshly collected seeds of chir pine were put in storage for 20 months at room temperature, $5\pm 1^\circ\text{C}$, $0\pm 1^\circ\text{C}$ and $-5\pm 1^\circ\text{C}$ in polythene bags, canvas bags and glass jars to determine the seed longevity. The seeds stored at $5\pm 1^\circ\text{C}$ temperature in glass jars proved to be the best for maintaining 79.5 per cent germination up to 16 months. The seeds stored at $-5\pm 1^\circ\text{C}$ temperature in canvas bags was least effective in prolonging seed germinability.

Keywords: *Pinus roxburghii*, storage, temperature, containers, longevity.

Pinus roxburghii Sargent commonly known as chir pine is one of the most important pine species of India growing between 450-2300 m and covering an area of 6728 sq. km. Seeds of chir pine (*Pinus roxburghii*) belongs to true orthodox type category [1]. Such type of seeds can be stored for relatively long periods at lower temperatures if moisture contents are reduced to below ten per cent. In spite of regular production of seed every year, good seed year generally occur after 2-3 years. This has necessitated the storage of seeds in various storage conditions to facilitate sustained supply of quality seeds every year for afforestation programme. The present investigation was thus carried out to find out suitable temperature and container for seed storage of chir pine.

MATERIALS AND METHODS

The experiment was conducted at Dr. Y.S. Parmar University of Horticulture and Forestry, Solan in Himachal Pradesh. The experimental site, both seed collection area and laboratory, is located at $30^\circ 51'$ north latitude, $76^\circ 11'$ east longitude with an altitude of 1100-1250 m above sea level. The study area experiences 1000-1300 mm precipitation annually.

The seeds were collected from middle aged good seed bearers of chir pine trees in the month of March

and stored immediately in the laboratory of Department of Silviculture and Agroforestry. Prior to storage, the seeds were subjected to water flotation test and those sank were taken for storage. These were dried to a moisture content of 15.5 per cent before storing. The seeds were stored at four different temperatures viz. room temperature (T_1), $5\pm 1^\circ\text{C}$ (T_2), $0\pm 1^\circ\text{C}$ (T_3) and $-5\pm 1^\circ\text{C}$ (T_4) in three different containers namely polythene bags (C_1), canvas bags (C_2) and glass jars (C_3). Observations were taken at four months intervals starting from 8th month of storage up to 20 months for germination percentage, germination energy (Percentage of germination at peak) and germination value ($GV = PV \times MDG$; where PV = Peak Value of germination and MDG = Mean Daily Germination) [2]. The germination study was carried out by sowing 100 seeds per replication in trays containing wet germination blotter paper (TP) kept in a seed germinator at $25\pm 1^\circ\text{C}$ and data was subjected to statistical analysis [3]. The experiment consisted of twelve treatments with three replication laid out in split plot design where main plot was storage temperature and subplot was storage container.

RESULTS AND DISCUSSION

The freshly collected fully developed seeds when subjected to germination tests revealed high

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Table 1. Effect of storage period (months), temperature and containers on germination parameters of *Pinus roxburghii* seed.

Treatments	Germination (%)					Germination energy (%)					Germination Value				
	8 month	12 month	16 month	20 month	8 month	12 month	16 month	20 month	8 month	12 month	16 month	20 month	8 month	12 month	20 month
Temperature (°C)															
T ₁ (room temp)	89.26 (73.06)	84.44 (68.61)	55.55 (48.23)	24.04 (29.32)	59.61 (50.58)	55.84 (48.39)	35.95 (36.80)	15.53 (23.16)	40.26	36.37	16.20	3.06			
T ₂ (5±1°C)	96.11 (82.55)	92.22 (75.44)	71.11 (57.79)	30.30 (33.86)	64.15 (53.24)	60.92 (51.33)	46.37 (42.91)	19.38 (26.08)	42.86	39.50	25.46	4.61			
T ₃ (0±1°C)	93.33 (77.97)	91.11 (75.29)	68.00 (55.60)	28.40 (32.18)	62.93 (52.53)	60.12 (50.87)	43.79 (41.41)	19.28 (25.28)	42.53	39.46	22.12	3.86			
T ₄ (-5±1°C)	77.22 (62.33)	63.33 (53.26)	46.74 (42.85)	31.05 (32.85)	51.83 (46.06)	41.77 (40.20)	29.77 (32.22)	19.76 (25.56)	34.05	27.05	16.15	7.12			
S.Ed±	4.49	2.33	1.30	0.74	1.77	1.13	0.88	0.64	0.58	1.16	0.80	0.22			
C.D 0.05	10.99	5.71	3.19	1.81	4.33	2.75	2.16	1.57	1.42	2.84	1.95	0.55			
Containers															
C ₁ (Polythene bag)	91.25 (75.58)	87.92 (70.59)	58.12 (49.85)	27.32 (31.46)	61.05 (51.42)	58.79 (50.09)	37.61 (37.72)	17.63 (24.77)	41.95	39.42	18.98	4.34			
C ₂ (Canvas bags)	77.28 (65.75)	70.42 (58.40)	48.74 (43.84)	21.72 (27.40)	52.06 (47.05)	47.02 (42.62)	31.59 (33.60)	14.14 (21.84)	35.46	31.63	16.48	3.49			
C ₃ (Glass jars)	91.81 (76.21)	95.00 (80.04)	74.18 (69.1)	36.30 (36.91)	61.69 (51.80)	63.43 (52.81)	37.72 (43.69)	22.95 (28.45)	42.35	42.17	24.48	6.15			
S.Ed±	2.40	2.62	1.76	0.90	1.43	1.18	1.12	0.69	1.57	1.06	0.96	0.22			
C.D. 0.05	5.09	5.56	3.74	1.90	3.03	2.51	2.38	1.45	3.32	2.24	2.03	0.47			

Arc sine transformed values in parenthesis

Table 2. Interaction effect of storage period (months), temperature and containers (TXC) on germination parameters of seed.

T x C	Germination (%)				Germination energy (%)				Germination Value			
	8 month	12 month	16 month	20 month	8 month	12 month	16 month	20 month	8 month	12 month	16 month	20 month
T ₁ C ₁	88.89 (70.74)	75.00 (60.32)	51.92 (46.11)	22.57 (28.34)	59.40 (50.43)	49.50 (44.71)	33.75 (35.50)	14.58 (22.43)	40.58	32.25	15.03	2.81
T ₁ C ₂	91.67 (76.26)	85.00 (67.41)	50.72 (45.41)	21.91 (27.90)	61.64 (51.74)	55.99 (48.45)	32.38 (34.67)	13.99 (21.95)	41.58	36.53	14.70	2.75
T ₁ C ₃	88.89 (74.33)	93.33 (78.10)	64.00 (53.18)	27.65 (31.71)	59.80 (50.70)	62.03 (52.00)	41.72 (40.22)	18.03 (25.10)	40.17	40.32	18.88	3.60
T ₂ C ₁	94.94 (78.52)	96.67 (81.39)	69.15 (56.44)	29.46 (32.84)	63.20 (52.66)	64.07 (53.18)	44.96 (42.10)	19.15 (25.92)	42.11	40.83	24.59	4.46
T ₂ C ₂	98.33 (75.24)	88.33 (73.55)	64.74 (53.60)	27.58 (31.67)	62.55 (52.28)	58.19 (49.73)	42.09 (40.45)	17.93 (25.03)	41.77	38.08	23.06	4.17
T ₂ C ₃	98.33 (85.70)	91.67 (73.79)	79.45 (63.32)	33.85 (35.56)	66.32 (54.53)	60.50 (51.07)	52.05 (46.18)	21.05 (27.26)	45.00	31.59	28.74	5.22
T ₃ C ₁	96.67 (81.39)	88.33 (73.86)	68.00 (55.62)	28.40 (32.19)	63.78 (53.02)	63.47 (53.82)	44.02 (41.56)	18.38 (25.37)	43.08	41.47	22.18	3.87
T ₃ C ₂	91.67 (76.26)	90.00 (75.70)	62.56 (52.36)	26.13 (30.71)	61.67 (51.79)	59.40 (50.47)	39.82 (39.10)	16.63 (24.03)	42.00	39.45	20.31	3.55
T ₃ C ₃	94.45 (79.36)	86.67 (69.24)	73.44 (59.01)	30.67 (33.63)	63.28 (52.73)	57.50 (49.33)	47.52 (43.58)	19.84 (26.45)	42.42	37.44	23.85	4.15
T ₄ C ₁	78.33 (63.60)	60.00 (50.85)	43.42 (41.21)	28.84 (32.47)	52.52 (46.67)	39.60 (38.96)	27.69 (31.72)	18.39 (25.37)	35.25	25.77	14.13	6.23
T ₄ C ₂	71.67 (58.07)	50.00 (45.00)	16.95 (24.00)	11.26 (19.33)	47.80 (43.73)	33.22 (34.57)	12.04 (20.18)	8.00 (16.32)	32.25	21.38	7.85	3.49
T ₄ C ₃	94.45 (76.85)	98.33 (85.70)	78.95 (63.34)	53.04 (46.74)	59.96 (50.75)	62.97 (52.53)	49.58 (44.76)	32.90 (35.00)	42.32	34.00	26.46	11.6
S.Ed	1.59	3.84	3.53	1.79	1.29	2.94	2.24	1.37	1.68	3.16	1.91	0.45
C.D 0.05	3.37	8.15	7.48	3.81	2.74	6.23	4.75	2.91	3.57	6.70	4.06	0.95

Arc sine transformed values in parenthesis

germination (98.00%), germination energy (68.80%) and germination value (45.40 units). The results of the effect of storage temperature and container on seed germinability have been presented in Table 1. The perusal of the data in Table 1 indicates that the storage temperature had a pronounced influence on germination parameters of seed. Among the four storage temperatures, the temperature of $5\pm 1^\circ\text{C}$ excelled over its counterparts showing maximum germinability of seeds. After eight months of storage of seeds it was observed that germination was 96.11 per cent, germination energy 64.15 per cent and germination value 42.86 units. The viability of seeds can be maintained up to sixteen months of storage at $5\pm 1^\circ\text{C}$ storage temperature where seeds recorded 71.11 per cent germination, 46.37 per cent germination energy and 25.46 units germination value. Thereafter, there was drastic decrease in germination parameters up to twenty months of storage. The seeds stored at $0\pm 1^\circ\text{C}$ (T_3) temperature proved to be equally effective in maintaining seed germinability up to sixteen months of storage.

The better storability of seeds at $5\pm 1^\circ\text{C}$ storage temperature may be ascribed to the slow rate of biological processes at this temperature compared to room temperature. Bonner [4] found that storage of *Quercus shumardii* acorns in polythene bags at a temperature little above 0°C is considered to be most promising for long term storage. The other reason for better storage performance at $5\pm 1^\circ\text{C}$ temperature is probably due to loss of least moisture in it in comparison to other storage temperatures. These results are in harmony with the earlier findings [5, 6 and 7]. The minimum germinability of seeds at $-5\pm 1^\circ\text{C}$ (T_4) temperature may be attributed to the chilling damage or freezing injury as the seeds had initial moisture content above 5 per cent which is considered maximum for low temperature storage. The loss of seed germinability could also have been due to the breakdown of lipids at below freezing temperature and the subsequent production of free radicals that inactivated enzymes, proteins and nucleic acid. Inactivation of these essential substances leads to the disruption of cell membranes and consequent loss of viability [8]. Similar results have also been reported [9 and 10].

The three different types of storage containers viz. polythene bags (C_1), canvas bags (C_2) and glass jars (C_3) demonstrated a marked bearing on the germinability of seeds (Table 1). The glass jar storage was found to be most effective, registering highest value for per cent germination, germination energy and germination value whereas, canvas bag storage

was noticed to be least effective exhibiting the lowest value for all the germination parameters. The seeds stored in the glass jar (C_3) registered maximum per cent germination (91.81%), germination energy (61.69%) and germination value (42.35 units) after eight months of storage. The minimum values were observed in canvas bag storage. The germinability of seeds can be maintained up to sixteenth months of storage in glass jar where they recorded 74.18 per cent germination, 37.72 per cent germination energy and 24.48 units germination value. Thereafter, there was much decrease in germinability attributes up to 20 months of storage.

The better performance of glass jar (C_3) may be ascribed to the proper preservice of moisture in it which prevents contamination by fungi and other micro-organisms. The glass jar prevents increase in moisture content which leads to better germinability over its counterparts. These results are in conformity with the earlier findings [11, 12]. The intermediate performance of polythene bags (C_1) may be ascribed to the slight exchange of gas and moisture as they are not completely impermeable to the moisture and gases. Similar results with polythene bag were found earlier [13, 14]. The poor germinability of seeds stored in canvas bag (C_2) may be attributed to the fluctuation in seed moisture content and temperature during storage which reduces the seed longevity. Almost identical findings were also reported for other species [15, 16]. The deterioration in seed longevity during storage may be attributed to the changes in the physiological state of seeds particularly the respiratory metabolism [17].

The interaction effect of storage temperature and container ($T \times C$) are presented in Table 2. It indicates that the seeds stored at $5\pm 1^\circ\text{C}$ in glass jars excelled over other treatments combinations by registering 98.33 per cent germination, 66.32 per cent germination energy and 45.00 units germination value after 8 months of storage. The seed longevity can be maintained up to 16 months under this condition with 79.45 per cent germination, 52.05 per cent germination energy and 28.74 units germination value. The seeds stored at $-5\pm 1^\circ\text{C}$ in glass jars proved to be equally effective in maintaining seed longevity up to 16 months of storage. At the end of storage experiment, they proved its supremacy over other combinations by registering 53.04 per cent germination and 32.90 per cent germination energy suggesting that the seeds of chir pine can be stored for longer duration at $-5\pm 1^\circ\text{C}$ temperature in glass jars. The minimum values in all the germinability attributes were observed in seeds stored at $-5\pm 1^\circ\text{C}$ temperature in canvas bags.

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