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ALTITUDINAL VARIATION IN DIFFERENT SEED SOURCE OF *PINUS WALLICHIANA* UNDER TEMPERATE CONDITIONS OF KASHMIR

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ABSTRACT

Seed source studies are desirable to screen the naturally available genetic variation to utilize the best material for maximum productivity and for further breeding programme. A study on "Altitudinal variation in Seed Source of *Pinus wallichiana* was under taken with altitudinal range viz., A_1; 1,600-2000 masl (Kehmil Forest Division), A_2; 2000-2400 masl (Lidder Forest Division), A_3; 2400-2800 (Pirpanchal Forest Division) and A_4; 2,800-3200 masl and above (Sindh Forest Division) for the study. The highest dimensions of cones of *Pinus wallichiana* in relation to cone length (17.16$\pm$0.37cm), cone diameter (5.25$\pm$0.015 cm), cone weight (118.53$\pm$0.42 g), seeds per cone (133.28$\pm$0.25), scales per cone (141.58$\pm$0.44), seed weight (86.9$\pm$0.10 g) and germination per cent (86.9$\pm$0.10) were recorded at lower altitude 2000-2400 masl and the minimum values at altitudinal range of 2400-3200 masl. Seedling characters (cm) viz., (Hypocotyl length (4.83$\pm$0.01), radical length (3.31$\pm$0.01), number of cotyledons (11.48$\pm$0.05) and total seedling length (8.14$\pm$0.01) under laboratory conditions differed significantly ($p \leq 0.5$) among different altitudes and recorded maximum for lower altitudinal range (1600-2600 masl). The study concluded that an altitudinal range between 1600-2400 m is better for collection of *Pinus wallichiana* cones at maturity for large scale seed extraction for mass production of quality seedlings.

KEY WORDS
Germination
Radical length
Cone length
Cone weight

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INTRODUCTION

The forests form one of the major national assets; so much is dependent on their existence and considered to be economic safety especially in developing countries by providing larger proportion of employment and livelihood security (FAO, 2010). These resources are under tremendous pressure due to careless, indiscriminate and massive clearance of forest for agriculture and other social benefits leading to deforestation. The reckless deforestation due to population growth along with the living standards would lead to many environmental issues (Nair *et al.,* 2010).The depletion of biodiversity matters primarily to the people living close to the earth who mainly depend on bioresourcesof their locality for their livelihood. The biodiversity has always been a bank to such ecosystem men who as prudent customers show obligatory involvement to maintain a substantial balance of bioresources in their account through optimum sustainable utilization in harmony with the laws of nature (Mukherjee, 2013). Concerted efforts are being made continuously to reverse deforestation and reclaim the land degraded by deforestation. This will require large number of of plants, which ultimately depends upon seed and its quality.*Pinuswallichana* "A.B. Jackson" is a tall evergreen tree with spreading or drooping branches, found in the Himalayas from Kashmir to Bhutan at altitudes ranging from 1,800 to 3,700 m (Anonymous, 1976). In the western Himalayas at altitudes between 1,800 and 2,500 m the tree is gregarious, often forming extensive pure crops, owing to its capacity to come up in dense even aged masses. The blue pine timber is next to deodar in commercial importance. The timber finds many uses; it is used for internal fittings of residential houses, such as planking, door and window frames, panels and furniture. Genetic improvement in a particular species is through the development of a sound scientific breeding programme, based on the available genetic variability and application of appropriate breeding method to utilize the existing variability. Provenance studies in forest trees are very important as it helps in identifying the best and highly adaptable provenance. In fact forest tree improvement programme starts with the scanning of provenance/ seed source capable of providing best adapted trees (Suri, 1984).). The success in threatened Guggal Shrub species (*Commiphora wightii)* plantation programme, its mother plant with a good vigor and fecundity in seed orchards need to be identified as future source of seeds to raise healthy seedlings and quality planting material (Sinha *et al.,* 2014). Besides seed source studies are also desirable to screen the naturally available genetic variation to utilize the best material for maximum productivity and for further breeding programme (Shiv Kumar and Banerjee, 1986). Seed sources studies have been conducted by good number of authors on a number of species e.g. *Pinus caribea* (Venator, 1974*), Eucalyptus globules*labill (Kirkpatrick, 1975*), Acacia mangium* (Salazar, 1989) and *Pinus greggi* (Dvorak *et al., 1999*)**,** *Pongamia Pinnata* (Vasantha Reddy *et al.,* 2007), *Veteria indica* (Jagadish *et al.,* 2014).Keeping the significance of provenance study in view a study was undertaken on Altitudinal variation in seed source of Pinus*wallichiana* under temperate conditions of Kashmir. These findings have significant relevance for identifying better seed source when there is need for large scale seed collection for mass production of quality seedlings for the restoration or aforestation/ reforestation programmes.

MATERIALS AND METHODS

The experiment was conducted in the state of Jammu and Kashmir situated between 32° 17′ and 37° 6′ North latitude and 73° 26′ and 80° 36′ east longitude. The four sites were selected for the study situated at North Kashmir, Central Kashmir and South Kashmir. The altitude range of 1,600-2000 masl (Kehmil Forest Division), 2000-2400 masl (Lidder Forest Division), 2400-2800 (Pirpanchal Forest Division) and 2,800-3200 masl and above (SindhForest Division) were referred to as altitude A_1, A_2, A_3 and A_4 respectively and were selected for study of altitudinal variation in seed sources of the species. The fresh mature cones were collected from each selected provenances in month of September at lower altitudes (1600-2400 m), while at higher altitudes (2400-3200 m) the cones were harvested in the October from selected trees and also collected from comparison trees to avoid the dominance of prolific seeders. The collected cones were subject to sun drying and the extraction of seeds was done manually.

The cone characteristics were studied by taking 40 cones randomly per replication each source and replicated three times. The average length of selected cones for each site was measured in centimeters by measuring tape up to one decimal for their length, While as the cone diameter up to two decimal places by the help of digital vernier caliper. The average cone weight was taken by using top pan balance for each source. The specific gravity was determined by Floating test or water displacement method (Barnett, 1979) as follows:

$$\text{Specific gravity} = \frac{\text{Green cone weight}}{\text{Weight of volume of water displace by same green cone}}$$

The number of seed per cone was recorded by manual extraction of seeds from 20 cones of each site and replicated four times. Seed weight of 100 seeds was recorded using eight replications of 100 seeds each with the help of sensitive top pan balance and was finally transformed into 1,000 seed weight by multiplying the seed weight of 8 replicates by 1.25. Scales were also counted manually in replicated manner.Seed length (mm), seed width (mm) and seed thickness (mm) parameters were measured by digital caliper by taking 200 seeds per source replicated four times. Seed volume (cm^3) of 1000 seeds was determined by water method (Pandye, 1991) and replicated 8 times to minimize the error. The germination test was conducted in glass Petri plates on top of a germination paper. Four replicates of 100 seeds each were used for the test. Germination percent was recorded by the formula:

$$\text{Germination per cent} = \frac{\text{Number of Seeds germinated}}{\text{Total number of seed sown}} \times 100$$

The moisture content of seeds extracted from harvested cones was expressed in percentage on fresh weight basis was determined by the following formula

$$\text{Moisture per cent} = \frac{\text{Fresh seed weight - Dry seed weight}}{\text{Fresh seed weight}} \times 100$$

The hypocotyl length (cm) and radical length (cm) of 10 seedlings were recorded using scale up to two decimal places at the end of the germination test and replicated thrice. Numbers of cotyledons were also counted at the time of emergence of seedling in petri plates. The total seedling length (cm) was computed with the help of a scale. The total length of seedling (length of hypocotyls + length of radical) was multiplied by total germination percent (Bhattacharya *et al.*, 1991) to determine the vigour index of the species.

Vigour index (VI) = Total seedling length x germination per cent

RESULTS AND DISCUSSION

The highest dimensions of cones of *Pinus wallichiana* in relation to cone length (17.16±0.37cm), cone diameter (5.25±0.015), cone weight (118.53±0.42) seeds per cone (133.28±0.25), scales per cone (141.58±0.44) were recorded at lower altitude A_2 (2000-2400 m), which was at par with A_1altitude (Table 1). The minimum values for these parameters were obtained at higher altitudinal range of 2400-3200 m and above. The specific gravity at all the altitudes ranged between 0.85±0.00 to 0.92±0.00 at maturity. This could also be attributed to the fact that cone size and cone weight often increase with geographic changes that are associated with the increase in the length of growing season, for example, decreasing latitude (Langlet, 1938 ,Sziklai, 1969). Similarly, Mughal and Thapliyal (2006) in his study reported that cone length and weight increased from north to south in *Cedrus*

Table 1: Altitudinal variation in cone characters in *Pinus wallichiana* at maturity

Altitude	Cone length (cm)	Cone diameter	Cone weight (gm)	Cone specific gravity	No. of seeds per cone	No. of scale per cone
A1	16.59±0.29	5.20±0.009	103.37±0.27	O.92±0.00	103.56±0.50	129.97±0.42
A2	17.16±0.37	5.25±0.015	118.53±0.42	0.98±0.006	133.28±0.25	141.58±0.44
A3	14.22±0.41	4.25±0.001	64.31±0.22	0.86±0.007	91.17±0.13	94.19±0.13
A4	12.63±0.21	4.21±0.002	68.56±0.18	0.85±0.001	77.12±0.15	90.69±0.44
C.D(p≤0.05)	0.97	0.02	0.84	0.01	0.87	1.10

Altitude A_1: Kehmil Forest Division Kupwara (1600-2000 masl); Altitude A_2: Lidder Forest Division Phalgam (2000-2400 masl); Altitude A_3: Pirpanchal Forest Division Dooghganga range (2400-2800 masl) and Altitude A_4: Sindh Forest Division Sonamarg (2800-3200 and above masl

Table 2: Altitudinal variation in Seed characters of *Pinus wallichiana* at maturity

Altitude	Seed weight 1000 seeds (gm)	Germination %	Seed moisture content (%)	Seed length (mm)	Seed width (mm)	Seed thickness (mm)	Seed volume 8000(cc)
A1	73.1±0.08	73.46±0.56	18.27±0.02	10.05±0.01	5.38±0.05	3.35±0.03	26.54±0.22
A2	86.9±0.10	78.91±0.22	17.82±0.04	9.83±0.19	5.15±0.10	3.28±0.03	22.38±0.13
A3	37.1±0.08	67.72±0.17	18.99±0.00	9.52±0.10	4.75±0.05	3.01±0.09	20.77±0.20
A4	33.5±0.10	56.94±0.36	17.57±0.56	9.09±0.02	4.44±0.08	2.89±0.09	20.03±0.26
C.D. (p≤0.05)	0.27	1.09	0.82	0.30	0.24	0.18	0.60

Altitude A_1: Kehmil Forest Division Kupwara (1600-2000 masl); Altitude A_2: Lidder Forest Division Phalgam (2000-2400 masl); Altitude A_3: Pirpanchal Forest Division Dooghganga range (2400-2800 masl) and Altitude A_4: Sindh Forest Division Sonamarg (2800-3200 and above masl)

Table 3: Altitudinal variation in seedling characteristics of *Pinus wallichiana* under laboratory conditions

Altitude	Hypocotyl Length (cm)	Radical Length (cm)	No. of cotyledons	Total seedling length (cm)	Vigor index
A1	4.40±0.06	3.14±0.01	11.48±0.05	7.54±0.07	493.70±12.93
A2	4.83±0.01	3.31±0.01	11.13±0.02	8.14±0.01	572.51±13.95
A3	3.73±0.00	2.44±0.01	10.40±0.05	6.17±0.02	257.28±5.60
A4	3.16±0.01	2.86±0.01	10.27±0.03	6.01±0.20	290.89±4.57
C.D(p≤0.05)	0.10	0.042	0.10	0.11	29.65

Altitude A_1: Kehmil Forest Division Kupwara (1600-2000 masl); Altitude A_2: Lidder Forest Division Phalgam (2000-2400 masl); Altitude A_3: Pirpanchal Forest Division Dooghganga range (2400-2800 masl) and Altitude A_4: Sindh Forest Division Sonamarg (2800-3200 and above masl

deodara. The length of cones is directly proportional to the number of seeds. Seed germination percent increase as the fruit matures. This is a result of loading the seeds with carbohydrates fats and proteins which proceed gradually across the season to observed increase in germination percentage from 0.5 to 32.14 percent in seeds of fir (*Abies pindrow*) when collected in August to October. These results also get support from a number of workers like Singh and Kachari (2006) in *Pinus kesiya*, Mughal and Thapliyal (2006) in *Cedrus deodara*

Seed characters of *Pinus wallichiana* at maturity

The highest dimensions for seed weight were recorded at lower altitudinal ranges (1600-2400 m). It was maximum (86.9±0.10 g) at A_2 altitude and minimum 33.5±0.10 at A_4 altitude Similarly, the analysis regarding germination per cent revealed (Table 2) significant variation among seed sources (Altitudes) at p≤0.5 level of significance ranging from 35.0 ±0.10 to 86.9±0.10. The highest germination percent of 86.9±0.10 per cent was recorded at A_2 altitude and minimum 35.0±0.10 at A_4 altitude. The seeds extracted from mature cones (Table 2) from all the four altitudes at maturity revealed statistically significant differences at (p≤0.05) among themselves in different seed parameters viz., seed length, width, thickness, and seed volume. The seed length values ranged from 9.09 to 10.05 mm, it was maximum (10.05 mm) at A_1 altitude which was at par with 9.83±0.19 at A_2 altitude. Lowest value (9.09 mm) for seed length was recorded at A_4 altitude. Similarly, the maximum seed width (5.38±0.05 mm) was recorded at A_1 altitude which was at par with (5.15±0.10 mm) at A_2 altitude. However, lowest value (4.44±0.08 mm) for seed width was recorded in A_4 altitude. Seed thickness varied from 2.89 to 3.35 mm again the maximum seed thickness was observed at Lower altitudinal range of 1600-2400 m A_1 (3.35 mm) and A_2 (3.28 mm). However, lowest seed thickness was observed in A_4 altitude with a value of (2.89 mm). Similarly, seed volume differed significantly among seed source altitudes (Table 2) with values ranging from 20.03 to 26.54 cc. The maximum seed volume was recorded in A_1 (26.54 cc) followed by A_2 (22.38 cc) and (20.77 cc) in A_3 altitude respectively. However, lowest value (20.03 cc) was observed in A_4 altitude. Seed size may vary due to both internal (maternal, hereditary) and external (environmental) conditions operating at the time of seed development (Harper *et al.*, 1970). This differential development might have an adaptive advantage in local edapho-climatic conditions. In the present study, the above mentioned characters were significantly different between the altitudes which was in conformity with the studies of Sinduveerendra and his associates (1999), who also reported significant variation in seed parameters viz., seed length, width, and weight of *Santalum album* provenances. Also the present study was in agreement with the studies of Gera *et al.*, (1999), Argen (1989), Mughal and Thapliyal (2006) and Mukherjee, (2005) on chir pine respectively. Variation in *Pinus wallichiana* seed sources with respect to their seed traits could be due to the fact that this species grows over a wide range of climatic conditions. The larger seed size and weight has been generally observed to produce faster germination and initial growth. The relationship was also noticed in different *Pinus wallichiana* seeds sources with lower seed weight exhibited poor germination (Singh, 1998). Similarly, the seeds with large size have higher seed characterization and biochemical constituents in *Calophyllumino phyllum*, which in turn was reflected in the germination parameters (Ajeesh *et al.*, 2014). Larger seeds germinate faster and more completely than smaller ones probably due to more endosperm nutrient pool (Kandya, 1978). Jagadish *et al.* (2014) ,reported that in case of *Vateria indica* different seed sources as well as individual trees within each seed source influenced seed germination parameters.

Seedling characteristics of *Pinus wallichiana* under laboratory conditions

Significance differences were observed among altitudes in seedling characteristics under laboratory condition (Table 3). Seeds collected from different altitudes differed significantly with respect to hypocotyl length, radical length, number of cotyledons, total seedling length and vigour index. The hypocotyl length ranged from 3.16 to 4.83 cm. It was recorded maximum at A_2 altitude (4.83 cm) followed by 4.40 and 3.73 cm at A_1 and A_3 altitudes respectively. The maximum radical length of (3.31cm), seedling length (8.14 cm), vigour index (572.51) was also recorded for A_2 altitude. Minimum hypocotyl length (3.16cm), Seedling length (6.01 cm), radical length (2.44) and Vigour index (257.28) were recorded at higher altitudes (2400-3200 masl). Perusal of analyzed data in table-3 revealed that number of cotyledons showed significant differences between with values from 10.27 to 11.48. Present study revealed that the growth parameters having strong positive relationship with seed size, weight and seed vigour that regulate germination and subsequent plant growth. Seeds of lower altitudes under laboratory conditions showed better performance in terms of hypocotyl length, radical length, number of cotyledons, total seedling length and vigour index. The results are in conformity with Chauhan and Raina, (1980) in *Pinus roxburghii*. Physiologically efficient cotyledons play a major role in seedling growth, development and establishment (Marshall and Kozlowski, 1976). The altitudes with highest number of cotyledons are more vigorous and they perform very well in both in the laboratory and nursery conditions. The importance of cotyledonary photosynthesis for normal seedling development has been established for some woody gymnosperms (Kozlowski and Borger, 1971); Sasaki and Kozlowski, 1968, 1970) as well as herbaceous plants (Lovell and Moore, 1970). Reduced photosynthesis in *Pinus recinose* cotyledons inhibited expansion of primary needles (Sasaki and Kozlowski, 1970).The cotyledons are highly correlated with a large number of different seed and seedling characters.

REFERENCES

Anonymous 1976. The wealth of Indian raw materials. *CSIR,* New Delhi. **VIII:** 78-83.

Ajeesh, R., Jijeesh, C. M., Vidyasagaran, K. and Vikas, K. 2014. Impact of seed weight on germination parameters of calophylluminophyllum l.: a potential biodiesel tree species of coastal region. *The Bioscan.* **9(3):** 1087-1091.

Argen, J. 1989. Seed size and number in *Rubus chamaemorus*: between habitat variation and effects of defoliation and supplement pollination. *Ecology.* **77(4):** 1080-1092.

Barnett, J. P. 1979. An easy way to measure cone specific gravity. **In**: Karrfalt, R.P., comp. Proceedings of the seed collection work shop, 1979, Department of Agricultural Forest Services *State and private Forestry*. pp. 21-23.

Bhattacharya, A. K., Lakhri, A. K. and Basu, R. N. 1991. Improvement of germinability of eucalyptus spp.by pregermination treatments. *Indian Forester*. **117:** 661-663.

Chauhan, P. S. and Raina, V. 1980. Effect of seed weight on germination and growth of chir pine *(pinusroxburghii sergeant). Indian Forest* **16(1):** 53-59.

Dvorak, W. S., Kietzka, J. E. and Donahue, J. K. 1996. Three year survival and growth of provenances of *Pinus greggi* in the Tropics and sub tropics. *Forest Ecological Management.* **83(1-2):** 131-132.

Food and Agriculture Organization 2010. *Global Forest Resources Assessment* 2010, FAO, Rome

Gera, M., Gera, N. and Ginwal, H. S. 1999. Seed source variation in germination and early growth among ten indigenous populations of *Dalbergia sisso. The Indian Forester.* **125(12):** 1190-1197.

Harper, J. K., Lovell, P. H. and Moore, K. G. 1970. The shape and sizes of seeds. *Annual Research Ecology System.* **11:** 327-356.

Jagadish, M. R., Venkata Reddy, Y. B., Venkata Naidu, M. J., Vachana, H. C., Devakumar, A. S. and Patil, C. S. P. 2014. Seed source variation in germination behaviourof *VateriaindicaLinn. International J. Science and Nature.* **5(2):** 231-234.

Kandya, A. K. 1978. Relationship among seed weight and various growth factors in *Pinus oocarpa* Schiede seedlings. *Indian Forestar.* **104:** 561-567.

Kirkpatrick, J. 1975. Geographical variation in *Eucalyptus globules*. Austrilan Govt. Publishing Ser. Canberra, Forestry and Timber Bureau. *Bulletion* No. **47:** 65.

Kozlowski, T. T. and Borger, G. A. 1971. Effect of temperature and light intensity early in ontogeny on growth of *Pinus resinosa* seedlings. *Canadian J. Forest Re*search. **1:** 57-65.

Langlet, O. 1938. Proveninsforsok med olikatradslag (Provenance test with various wood species). Satrycksvenskas kogsvards foreningens *Tidskrift* **i-ii:** 225-278.

Lovell, P. H. and Moore, K. G. 1970. A Comparative Study of cotyledons as assimilatory organs. *J. Experimental Botany.* **21:** 1017-1030.

Marshall, P. E. and Kozlowski, T. T. 1976. Compostional changes in cotyledons of woody angiosperms. *Canadian J. Botany.* **54:** 2473-2477.

Mughal, A. H. and Thapliyal, R. C. 2006. Cone and seed maturity indices in *Cedrus deodara* (D. Don, G. Don). *Indian J. Forestry.* **29(2):** 167-174.

Mukherjee, A. 2013. Bioresource conservation: traditional knowledge India. *The Ecoscan.* **3(Special issue):** 57-63.

Mukherjee, S. 2005. Studie on provenance variation in cone, seed and seedling characteristics of *Pinus roxburghii* Sarg. *Ph. D, Thesis, FRI Deemed University, Dehra Dun, India.*

Nair, P. K. R., Nair, V. D., Kumar, B. M. and Julia, M. S. 2010. Carbon sequestration in agroforestry systems. In. Donald sparks, eds: Advances in agronomy, Burlington Academic press. **108:** 237-307.

Pandye, B. K. 1991. Variability in salasodine content in *Solanum khasianum* Clarke as affected by soil PH and avalible NPK under natural conditions.M.sc thesis, Dr.Y.S.Parmar university of Horticulture and Forestry Solan (H.P) p. 158.

Salazar, R. 1989. Genetic variation of 16 provenances of *Acacia mangium* at nursery level in Turrialba Cost Rica. *Common Wealth Forest Review.* **68(4):** 263-72.

Sasaki, S. and Kozlowski, T. T. 1970. Effect of cotyledons and hypocotyls photosynthesis on growth of young pine seedlings. *New Phytolo*gy **69:** 493-500.

Sasaki, S. Kozlowski, T. T. 1968. The role of cotyledons in early development of pine seedlings. *Canadian J. Botany.* **46:** 1173-1183.

Shiv Kumar, P. and Banerjee, A. C. 1986. Provenance trial of *Acacia nilotica, J. Tree Science.* **5(1):** 53-56

Sindhuveerendra, H., Ramlakashmi, S. and Mallesha, B. B. 1999. Variation in seed characteristics in provenances of Sandal. *The Indian Forester.* **125(3):** 308-312.

Singh, O. 1998. Seed maturity indices in silver fir (*Abies pindrow*). *Indian Forester.* **124(3):** 243-246.

Singh, O. and Kachari, J. 2006. Seed maturity indicies in khasi Pine. *Research Notes.* **132:** 12.

Sinha, N. K., Kumar, S., Santra, P., Raja, P. and Mertia, D. S. 2014. Temporal Growth performance of Indian Myrrh (*Commiphora wightii*) raised by seedlings and cuttings from same genetic stocks in the extremely arid Thar Desert of India. *The Ecoscan*. **8(3&4):** 241-244.

Suri, S. K. 1984. Analytical study of teak Provenance test in North Raipur Division of Madyapradesh. *The Indian Forester*. **110:** 345-363.

Sziklai, O. 1969. Preliminary notes on variation in and seed morphology of Douglas fir *Pseudotsiga menziestil* (Mirb.) Franco 2nd World Consultation on Forest Tree Breeding. *FAO-FTB*. p. 619.

Vasantha Reddy, K. V., Pradeep Kumar., H., Siddaraju., C. M., Rajesh Gunaga., P., Madiwalar, S. L. and Patil, S. K. 2007. Seed source variation for seed and seedling traits in Pongamia pinnata (L.) PIERRE: An important bio-fuel yielding tree species. *My Forest*. **43(1):** 61-68.

Venator, C. R. 1974. Hypocotyl length in *Pinus caribae* seedlings: A quantative genetic variation parameter. *Silvae Genetica*. **23:** 130-132.

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