

PROVENANCE VARIATION IN *PINUS ROXBURGHII* SARG.

Altaf Hussain*

Summary

Comparative provenance trial of Chir pine (*Pinus roxburghii* Sarg.) was established in August, 1976 at Pir Sohawa, Margalla hills, Islamabad to evaluate their growth performance.

Comparative height growth in the nursery and field trials indicated that the provenances ranking have completely changed. The slowest growing provenance (Lehtrar) in the nursery obtained top ranking in the field.

The growth results indicated significant differences between the nine provenances for height and diameter. Lehtrar provenance is the most vigorous amongst all the provenances. Provenances originated from Batrasi, Dadar and Ghoragali are the best in diameter and height growth under local climatic conditions at Pir Sohawa, Islamabad.

Introduction

Amongst coniferous tree species of Pakistan, *Pinus roxburghii* is an important commercial timber and firewood species. Selective cutting in the past under contractor system of harvesting resulted in the existing minus stands in most of the localities. Owing to its high rate of afforestation success, weather resistance and soil binding benefits, it is extensively used in the afforestation programmes. During the years 1996-98 an area of 46,469 ha is planned to be planted in NWFP alone. The seed requirement is estimated to be about 32,000 kg to achieve the planting targets (Siddiqui and Tahir, 1993).

The supply of high quality seed is central to the success of improved tree planting stock. It costs just as much to establish trees

*

Assistant Forest Geneticist, Pakistan Forest Institute, Peshawar.

from poor seed as it does from seed of the highest genetic potential. However, the difference in wood quality, volume and economic return can be far greater.

There is a need to select, establish, manage and conserve good seed sources. This process should be carried out with the evaluation of each seed source so far utilized and should proceed to search for possible new sources.

Genetic improvement trials of *Pinus roxburghii* were undertaken more than twenty year ago in Pakistan. Morphological and physiological variations in *Pinus roxburghii* have been described in the literature. Siddiqui (1983, 1985) reported variations in height and diameter growth characteristics in various local provenances. Similarly difference in height growth were observed in national provenance trials in India (Uniyal *et. al.*, 1989). Ghosh *et. al.* (1982) reported significant variation in height growth among various provenances tested in sub-tropical zone of India.

Results of comparative performance of various provenance of pine species indicated marked differences in height and diameter growth between different provenances of each species including *P. roxburghii*. On the basis of differences in various provenances of *P. roxburghii* the authors suggested intensive provenance trials and selection in *P. roxburghii* (Ghosh *et. al.*, 1981).

The result of genetic structure and differentiation at isozyme level have also indicated marked differences regarding the distribution of allelic variation, heterozygosity, gametic diversity and total differentiation within and among natural populations of *P. roxburghii* (Hussain, 1995).

The main objective of the study is provenance testing to determine the extent and pattern of variation between provenances of chir pine and to choose the best available types for afforestation and further breeding work for better growth and wood quality.

Materials and Methods

In order to initiate a provenance study of chir pine, seed collection was carried out from individual trees from 9 localities during April, 1975. The description of the provenances planted in the experiment is given in Table. 1. The test site is, located at Pir Sohawa, Margalla hills, Islamabad. It lies at $33^{\circ} 43'$ latitude and $73^{\circ} 05'$ longitude at an elevation of about 1200 m. Average annual precipitation is about 953 mm; most of which is received during monsoon. The soil of the test site is sand stone and limestone.

After extraction and cleaning of seed, a mixture was prepared for each locality by mixing equal number of seeds from all trees of a locality. The seed of each provenance was sown in July, 1975 at PFI nursery. Germination percentage and height growth of seedlings was recorded to compare the growth of various provenance in the nursery. Planting of one year old seedlings of nine provenances of *Pinus roxburghii* Sarg. was carried out at 2 x 2 m spacing between the plants and 4 x 4 m between the replications for ease of identification of each replication.

Table 1. List of provenances with meteorological data planted at Pir Sohawa, Islamabad.

Sl. No.	Provenances	Forest Division	Latitude	Longitude	Altitude (m)	Mean annual Rainfall (mm)	Mean temperature (°C)	
							max	min
1	Lehtrar	Rawalpindi	$33^{\circ} 47'$	$73^{\circ} 26'$	1050-1200	1540	33.3	11.7
2	Dadar	Hazara	$34^{\circ} 31'$	$73^{\circ} 6'$	1200-1600	1700	25.6	13.0
3	Batrasi	Hazara	$34^{\circ} 20'$	$73^{\circ} 12'$	1160-1380	1700	16.7	7.2
4	Ghoragali	Murree	$33^{\circ} 55'$	$73^{\circ} 32'$	1020-1885	1600	36.7	-1.1
5	Kotli	Rawalpindi	$33^{\circ} 47'$	$73^{\circ} 32'$	1000-1800	1540	33.4	11.9
6	Danoi	Rawalpindi	$33^{\circ} 52'$	$73^{\circ} 42'$	920-1500	1540	28.9	14.4
7	Panoggali	Kotli A.K	$33^{\circ} 31'$	$73^{\circ} 46'$	1200-1500	1500	-	-
8	Nikial	Kotli A.K	$33^{\circ} 32'$	$73^{\circ} 54'$	1250-1470	1550	-	-
9	Bazkhan	Hazara	$34^{\circ} 20'$	$73^{\circ} 12'$	1070-1600	1700	25.6	13.0

Randomized complete block design with four replications was used with varying number of plants of each provenance in each plot depending upon the availability of plants of each provenance. A total of 2,220 plants were planted during August, 1976.

Height and diameter growth were recorded in December, 1992 when the plantation attained an age of above 16 years. The computation of growth measurements were performed using the Statistical Analysis System (SAS Institute Inc. 1987).

Results and Discussion

Germination percentage and mean height recorded at one year of age in the nursery indicated that provenance Batrasi gave the highest germination percentage (84%) and average height (32.9 cm). Provenance ranking on the basis of height growth at nursery stage is given in Table 2.

Table 2. Nursery data of one year old *Pinus roxburghii* Sarg. provenances and ranking on the basis of height growth.

Provenance	Germination (%)	Max. height (cm)	Min. height (cm)	Mean height (cm)	Ranking
Batrasi	84.0	46.0	18.0	32.9	1
Danoi	64.2	41.0	18.0	31.9	2
Panoggali	30.4	41.0	22.0	30.8	3
Bazkhan	14.9	45.0	13.0	30.6	4
Nikial	35.4	48.0	16.0	30.4	5
Kotli	60.2	41.0	10.0	29.4	6
Dadar	81.4	40.0	10.0	28.7	7
Ghoragali	66.4	25.0	15.0	27.5	8
Lehtrar	82.5	40.0	9.0	27.3	9

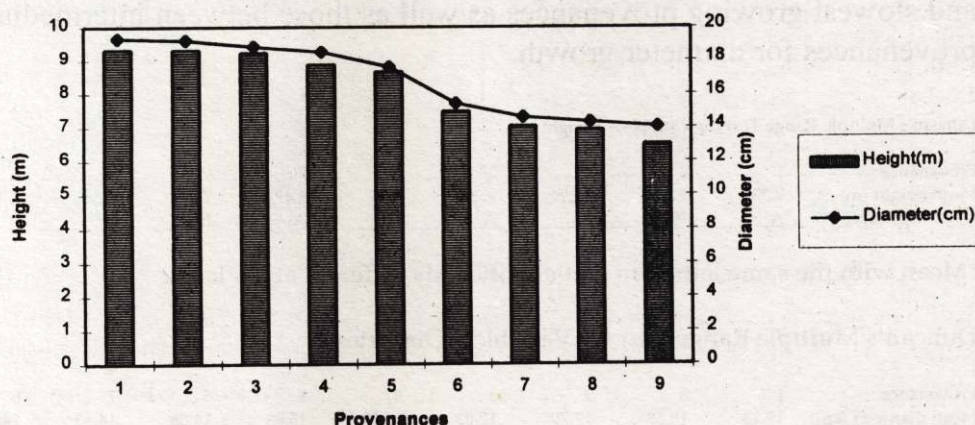
The average height, diameter and ranking of 9 provenances in the field is given in Table 3 and graphically represented in Fig.1. The data show considerable variation in growth characteristics. Growth comparison of various provenances at nursery stage and in the field revealed that order of performance of all the provenances has completely changed with the passage of time. The slowest growing provenance of Lehtrar in the nursery outperformed in the field and ranked at the top. Provenance Ghoragali ranked at number 8 out of 9 provenances at one year of age but was second fastest growing provenance in the field as far as height growth is concerned. The change in ranking of seed sources in the nursery and field have also been reported in *Pinus strobus* by King *et. al.* (1969). The change in the performance of various provenances in

the field can mainly be attributed to soil and climate conditions prevailing at the experimental site.

Table 3. Ranking of provenances on the basis of height (m) and diameter (cm) growth at 16 year age.

Provenance	Mean height (m)	Ranking	Provenance	Mean diameter(cm)	Ranking
Lehtrar	9.33	1	Lehtrar	19.13	1
Ghoragali	9.30	2	Batrasi	18.88	2
Batrasi	9.29	3	Dadar	17.79	3
Dadar	9.20	4	Ghoragali	17.03	4
Kotli	8.86	5	Bazkhan	16.33	5
Panoggali	8.47	6	Nikial	15.03	6
Bazkhan	7.48	7	Kotli	14.86	7
Nikial	7.36	8	Panoggali	14.65	8
Danoi	6.93	9	Danoi	14.30	9

Fig. 1. Height and diameter growth differences in 9 provenances of *Pinus roxburghii*



Analysis of variance for height and diameter growth showed highly significant differences between provenances. F-values are given in Table 4.

Table. 4. F-values of analysis of variance

Source of variation	Height (F-Values)	Diameter (F-Values)
Provenances	8.17 **	23.91 **
Replication	1.24 NS	0.60 NS
Error	-	-

** = Significant at (P=0.01)

NS=Non-significant

DUNCAN's Multiple Range Test was also performed to determine the differences between the provenances for height and diameter growth characteristics. Test for height indicated two groups of provenances. First group comprises of Lehtrar, Ghoragali, Batrasi, Dadar, Kotli and Panoggali and second group consists of Baz Khan, Nikkial and Danoi. The differences within the groups are non-significant but the difference between the provenances of the two groups are significant at 5% level.

The analysis also showed significant differences between fastest and slowest growing provenances as well as those between intermediate provenances for diameter growth.

Duncan's Multiple Range Test for Variable = Height

Provenance	1	4	3	2	5	7	9	8	6
Mean height (m)	9.33	9.30	9.29	9.20	8.86	8.47	7.48	7.36	6.93
Duncan grouping*	A	A	A	A	A	A	B	B	B

*Mean with the same letter are non-significantly different at 5% level.

Duncan's Multiple Range Test for Variable = Diameter

Provenance	1	3	2	4	9	8	5	7	6
Mean diameter (cm)	19.13	18.88	17.79	17.03	16.33	15.03	14.86	14.65	14.30
Duncan grouping*	A	A	B	B	C	D	D	E	E

* Mean with the same letter are not significantly different at 5% level.

The difference in height growth of provenance Lehtrar at No.1 and slowest growing provenance Danoi at No.9 is almost 26%, whereas

the difference in diameter growth of fastest and slowest growing provenances is 25%. Thus a substantial increase in wood volume production could be expected from fastest growing provenances.

Enough is known about provenance variation in *Pinus roxburghii*. Selection and breeding operations require sound provenance results. Almost universally, the evaluation and selection of provenances and plus trees has been on the basis of growth rate and form (Davidson, 1977). Kageyama *et. al.* (1978) reported that height, straightness, internode length and branch angle are under genetic control as indicated by total variance. On the basis of present results, it is recommended that seed stand/zones of chir pine (*Pinus roxbureghii*) may be selected in most differentiated and vigorous populations like Lehtrar, Ghoragali, Batrasi and Dadar for future afforestation programme. The results could also be applied for future breeding programmes like selection and establishment of seed orchards of *Pinus roxburghii*.

References

- Davidson, J. 1977. Breeding tropical eucalypts. In Proc. Joint IUFRO workshop on progress and problems of Genetic Improvement of Tropical Forest Trees, April 4-7. Brisbane, Queensland, Australia. pp 941-956.
- Ghosh, R.C., B. Singh and K.K. Sharma. 1981. Suitability trial of different species and provenances of pine in the Doon Valley of India. Ind. Forester. 197(3): 135-150.
- Ghosh, R.C. , B. Singh. K.K. Sharma, and U.D. Dhauniyal. 1982. Performance of chir pine in comparison to *Pinus caribaea*, *P. patula* and *P. kesiya* in the sub-himalayan zone. Ind. Forester. 108(1): 29-38.
- Hussain, A. 1995. Untersuchung zur genetischen Kontrolle von Isoenzyme-Polymorphismen und zur genetischen struktur von *Pinus roxburghii* Sarg. Ph.D. Thesis, Georg-August Universität, Göttingen, Germany. 174p.

Kageyama, R.Y., M. Ferreira., F. Betrolani and N. Nicelielo. 1978. Genetic variation between thirteen provenances of *Pinus oocarpa* Schiede plante din 1972 at Agudos (Sao Paulo, Brazil). In. Proc. Joint IUFRO workshop on progress and problems of Genetic Improvement of Tropical Forest Trees, April 4-7, 1977. Brisbane, Queensland, Australia. pp 588-592.

King, P.J and H. Nienstaedt. 1969. Variation in Eastern White pine seed sources planted in the Lake States. *Silvae Genetica*. 18: 83-86.

SAS Institute Inc. 1987. SAS Application guide version 6.03. SAS Institute Inc. Cary, NC. USA.

Siddiqui, K.M. 1983. Provenance trial of chir pine. National Programme of Tree Improvement and Introduction. Ann. Res. Rept. 58p.

Siddiqui, K.M. 1985. Provenance trial of chir pine. National Programme of Tree Improvement and Introduction Ann. Res. Rept. 57p.

Siddiqui, K.M. and M.T. Laeeq. 1993. Tree seed requirement in Pakistan. *Pak. J. Forestry*. 43(4): 189-197.

Troup, R.S. 1921. The Silviculture of Indian Trees. Oxford University Press. Vol III. pp 1036-1095.

Uniyal, D.P., M.S. Rawat, and R.K. Vakshasya, 1989. National provenance trial of *Pinus roxburghii*. Some early observations. Provenance Research Institute of Forest Genetics and Tree Breeding, Coimbatore, India.

Vidakovic, M. 1969. Genetics and Forest Tree Breeding. UNDP-FAO Pakistan National Forestry Research and Training Project. 203p.

Wright, J.W. 1962. Genetics of Forest Tree Improvement. F.A.O. Rome, Italy. 399p.

Wright, J.W. 1976. Introduction to Forest Genetics. London: Academic Press. 463p.