GROWTH AND HERITABILITY ESTIMATES AMONG SIX-YEAR-OLD THREE GEOGRAPHIC SOURCES OF SHISHAM (*DALBERGIA SISSOO* ROXB.) IN PAKISTAN

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Summary

Half-sib progenies of *Dalbergia sissoo* Roxb. tested at Peshawar gave significant differences among geographic areas. The broad-sense heritability at 6-year-age for diameter was 0.83 indicating that the trait is heritable. Further possibilities of selection and genetic improvement in the species are discussed in irrigated plantations of Pakistan.

Introduction

Shisham (*Dalbergia sissoo* Roxb.) is the most important and extensively planted species in the plains of Pakistan. It was introduced on a large scale in the country almost a century back under irrigated conditions. It has been planted on road and railway sides, canal banks and cultivated fields. Shisham is one of the most useful timber and firewood species and its major use also lies in furniture and construction. There is a considerable need for initiating tree improvement work, particularly for grwoth rate, stem form and wood quality. Variations in stem form consist of crookedness and forking and greater variations also occur in growth and wood quality characteristics. A major part of any forest tree breeding and improvement programme is based on the selection of superior phenotypes and the degree of transmission of desirable characters to the offsprings. The superiority of the selected phenotypes is due to genotype-environment interaction.

As a first step in improvement, a number of candidate plus trees were selected and marked in various ecological zones of Pakistan by the Forest Genetics Branch, Pakistan Forest Institute, Peshawar. Half-sib progeny tests were initiated in 1967–1969. Preliminary results indicated that stem crookedness in shisham is under higher genetic control. Heritability of crookedness for Daphar irrigated plantation was found to be 42% and that of Pirawala 65% (Vidakovic and Ahsan, 1970). Heritability of height-growth on the other hand varied from 6.3% to 11.1% and that of diameter from 0.3% to 1.2% in three irrigated plantations of shisham in Punjab (Vidakovic and Siddiqui, 1968). The low heritability values in height and diameter on the basis of parent-offspring relationship could be attributed to be due to environmental effects specially the irrigation water and management practices used in plantations. Half-sib progeny tests established in the past had given only limited information regarding variability and heritability in the species. It was thus suggested that a number of progeny tests may be established to have more reliable information on the inheritance of important characters in shisham (Ahsan, 1970).

Material and Method

Phenotypically good trees on the basis of growth and stem form were selected in the plantations of Changa Manga, (Punjab), Chichawatni (Punjab) and Mardan (NWFP) in 1977.

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The geographic and climatic data of the localities are given below:

Sl. No.	Localities/ seed origin	No. of trees selected	Latitude / Longitude	Altitude (m)	Mean annual rainfall (mm)	Temperature range (°F)	Remarks
1	Changa Manga	12	31° 01′ / 73° 56′	220	334	21–121	Irrigated
2	Chichawatni	17	30° 45′ / 71° 31′	160	187	37–110	Irrigated
3	Mardan	25	34° 12′ / 72 03	300	487	26–121	Non-Irrigated

Fig. 1. Seedling Seed orchard of Shisham (*Dalbergia sissoo*) at P.F.I. Peshawar.

The indivudual tree seed was collected, cleaned and seed of 54 progenies was sown in March/April, 1977 at PFI nursery in raised beds at Peshawar. Further selection at nursery stage was also carried out before planting in April, 1978. The selection of seedlings at nursery stage was done on the basis of overall mean + 2 standard deviation taking into consideration stem straightness. Forked and weak seedlings were straight away rejected. Root-shoot cuttings of 20 cm length were made and field planting of the selected stock was carried out at PFI Campus, Peshawar during the second week of April, 1978 by including all original 54 progenies in 9 replications in 4–tree plot in each block (Fig. 1). The RCB design was followed and planting was done at 2x2 m spacing. Irrigation, weeding and other cultural treatments in the experimental area were kept as uniform as possible throughout the period of investigations. The latitude and longitude of Peshawar is $34^{o}.01'$ and $71^{o}.34'$ respectively with an altitude of 350 m. The range of mean annual temperature is 51–91 ^{o}F with mean annual rainfall of 350 mm.

Six-year-old growth data on diameter was recorded in November, 1984 and used for further statistical analysis. Values of F, co-efficient of variance, least significant difference and broad-sense heritability were worked out to find the extent and pattern of variation among three distinct geographic areas.

Results and Discussion

The results of the 6-year-old shisham trial consisting of 3 distinct geographic seed sources indicated that the average diameter of the trees originating from Chichawatni, Changa Manga and Mardan were 7.1, 7.0 and 6.4 cm respectively. The standard deviation for all the locations did not show much dispersion as it ranged between 2.4–2.7. The co-efficient of variation also ranged between 34–38 (Table 1). These preliminary results have shown that generally the trees originating, from Chichawatni are significantly different from Mardan. Similar observations have been endorsed by Hussain and Abbas (1974) while preparing the volume table for the irrigated plantations of shisham in Punjab. These authors selected Chichawatni, Daphar, Khanewal and Changa Manga for their studies. A comparison of diameter/height relationship of only two localities namely Chichawatni and Changa Manga have shown that this relationship was highest for Chichawatni as compared with Changa Manga for all the diameter classes.

The F-ratio was also significantly different in the present studies (Table 2). The LSD test indicated that Chichawatni was significantly better than Mardan at 5% p-level. Based upon MSS values, broad sense heritability was worked out after Roulund and *et al* (1985). The h^2(b.s) in the present investigations was 0.83 indicating that the trait is highly heritable. Comparing these results with Harahap and Soerianegara (1977) on 25-year-old clonal trial of *Tectona grandis*. the results of present investigations are similar with these authors. The heritability values for diameter in *Tectona grandis* was 0.71. Similarly higher heritability values for diameter in 15-year-old clonal trial of Norway spruce (*Picea abies*) was 0.75, Roulund *et al* (1985). On the other hand low heritability value on the basis of parent-progeny relationship in shisham was reported by Vidakovic and Siddiqui (1968). These authors gave h^2 values ranging between 0.3 – 1.2% for three irrigated plantations of Punjab. The authors attributed the low heritability values to be due to parent-progeny age differences, environmental factors and management

practices in the irrigated plantations. Based upon present investigations there seems to be greater scope to bring about further genetic improvement in the species in the irrigated plantations of the Punjab.

Table 1.–Mean Dimeter, Co-Efficient of Variability and Least Significant Difference of three Provenances of Shisham (*Dalbergia sissoo*)

S. No.	Localities	Mean diameter (cm)	Standard deviation	CV (%)	LSd at 5% level
1	Mardan	6.4	2.4	36.0	6.4
2	Changa Manga	7.0	2.7	34.0	7.0
3	Chichawatni	7.1	2.4	38.0	7.1

Table 2.–Analysis of Variance, Variance Components and Estimation of heritability for Diameter of the Replicated Shisham Trial at Peshawar

Source of variation	df	SS	MSS	F-Value	Variance components
Provenances/Clones	2	3.54	1.77	4.66*	Ve + rVc
Replications	8	19.51	2.44	6.42*	Ve + CVr
Error	16	6.12	0.38	–	Ve
Total	26	29.17	–		

Legends:

C = Clones
r = Replications
Ve = Variance due to error
Vr = Variance due to replications
Vc = Variance due to clones

Estimation of heritability (h^2): $\frac{}{b.s}$

* Significant at 5% p-level

$$h^2_{(b.s)} = \frac{V_c}{\frac{Ve}{r} + V_c}$$ (After Roulund and *et al*; 1985)

$$V_c = \frac{1.77}{9} = 0.20$$

$$h^2_{(b.s)} = \frac{0.20}{0.04 + 0.20}$$

$$h^2_{(b.s)} = \frac{0.20}{0.24}$$

$$h^2_{(b.s)} = 0.83$$

Conclusions

Although the number of geographic areas included in the present studies are less, yet some useful conclusions may be drawn from the investigations. The establishment of seed production areas in Chichawatni seem to be quite useful in afforestation programmes. Increasing the number of provenances in calculating the provenance differences and heritability values might yield useful information about the species. The establishment of provenance trials in different ecological zones are preferred over progeny trials in shisham.

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