Variability, Heritability and Genetic Gain in Cone and Nut Characters of Chilgoza Pine (Pinus gerardiana Wall.)

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Summary

Genetic parameters for 9 characters on the cone and seed of 15 plus trees of *Pinus gerardiana* Wall. were estimated in Kinnaur (North-West Himalaya). Information on variability, heritability and expected genetic gain were calculated for all individual characters. Seed weight exhibited high heritability and maximum genetic gain. It is due to additive gene effect. Correlation of coefficients were obtained highly significant and positive for all the characters under study.

Key words: *Pinus gerardiana*, variability, heritability, genetic and phenotypic coefficient of variation, genetic gain, cone, nut (seed).

Introduction

Chilgoza (*Pinus gerardiana* Wall.) is well known in dry fruit trade and its fruit is highly valuable as an edible nut. In India, it is very much restricted in dry temperate region of North-Western Himalayas between an altitude of 1600m to 3000m above mean sea level (Dogra, 1964). It is mainly distributed in district Kinnaur of Himachal Pradesh which is situated between 77°45'00" and 79°00'35" E longitudes and between 31°05'50" and 32°05'15"N latitudes (Chib, 1978). The larger proportion of nut production (180 tonnes per year) comes from Kinnaur alone and remaining requirement of this nut is met through import from Afghanistan (Karwaskara, 1981). There is lot of scope to domesticate and improve this crop through establishment of clonal seed orchard and control breeding for the enhancement of nut production both in quality and quantity (Singh, 1990, 1992).

In chilgoza pine, the cone and nut characters are of economic importance for the importance of the crop. In order to assess the variability whether it is heritable or environmental, the present study was carried out to ascertain the genetic variability, heritability and genetic gain present in the cone and nut of 15 plus trees of chilgoza pine selected from wide range of occurrence in Kinnaur.

Materials and Methods

15 plus trees selected in Kinnaur were used for this study. 15 cones per tree were taken at random from selected plus trees in 1990 for recording observations on nine characters viz., cone length, cone breadth (from middle of the cone), cone weight, number of seeds per cone, seed weight per cone, seed length, seed breadth (from middle of the seed), seed thickness and seed weight (100 seeds). The mean value of 25 seeds of each in 4 replications were used for statistical analysis (*Table 1*). The combined analysis of variance and coefficient of variation were calculated for all the traits (Gardner, 1963). The genotypic and phenotypic coefficient of variation, and correlation coefficient for 9 characters were calculated as suggested by Comstock and Robinson (1952), Johnson *et. al.* (1955) and Namkoong (1979).

The broad sense heritability (ratio of total genetic variance to phenotypic variance) is appropriate in predicting genetic gain from selection. A common formula for predicting gain (ΔG) from selection is $\Delta G = ih^2\sigma P$ where 'i' is the intensity of selection i. e. 5% = 2.06 in the present study and σP is the square root of the phenotypic variance (Falconer, 1966).

Results and Discussion

The magnitude of variability in various characters is given in *table 1*. It clearly shows that high genetic variability exists in the material. The maximum range of variability was exhibited by seed weight per cone and minimum in seed thickness. The estimates of phenotypic, genotypic

Table 1. — Analysis of variance for different characters in chilgoza pine.

Characters	Range	Mean	S.E.	'F' Value	C.D.
Cone length(cm)	12.56-18.20	15.48	00.45	10.99**	01.74**
Cone breadth(cm)	07.58-10.90	08.5	00.33	08.89**	01.25**
Cone weight(gm)	345-859	573.00	32.55	14.05**	124.48**
No. of seeds per cone	64.80-103.80	87.73	05.26	03.97**	20.11**
Seed wt. per cone	26.80-62.00	40.03	02.97	08.23**	11.37**
Seed length(mm)	18.09-24.78	21.49	00.25	84.01**	00.95**
Seed breadth(mm)	06.47-07.84	07.02	00.09	18.59**	00.34**
Seed thickness(mm)	05.41-06.65	05.78	00.06	30.50**	00.24**
Seed weight(gm) (100 seeds)	38.06-62.22	45.24	01.80	24.70**	04.88**

**) Significant at 1% level of probability and environmental variances as well as the coefficients of phenotypic and genotypic variation of different characters are shown in *table 2*. The relative amount of variation in different characters can be formed by comparing the coefficients of phenotypic and genotypic variation of each character. In general, both the coefficients of phenotypic and genotypic variation were of comparable magnitude for all the characters. The heritability estimates (broad sense) were found highest in seed length (93.7%) followed by seed thickness (85.7%), seed weight of 100 seeds (82.57%), seed breadth (77.78%), cone weight (72.30%), cone length (58.13%) and number of seeds per cone (37.30%). The expected genetic gain by selecting the 5% best as percent of mean was found to be maximum for seed weight per cone (29.47%) and minimum in seed thickness (11.47%). Seed weight in both per cone and 100 number of seeds provide a sufficient amount of genetic variability as it is evidenced from GCV and PCV estimates in combination with heritability. Johnson *et al.* (1955), Singh and Uppal (1977) and Volker *et al.* (1990) reported that heritability estimates along with estimates of expected genetic gain is more useful than the heritability itself in predicting the resultant effect for selecting the best genotypes for a given trait. The results of the present study also established the fact that the high heritability did not always mean high genetic gain. It happens due to non-additive gene effects. The characters like seed weight, seed length had a very high genetic gain together with high heritability which indicates that high heritability obtained in these characters is due to additive gene effects (Panse, 1957; Keller and Linkens, 1955; Misra and Saini, 1988). Correlation coefficients was found highly significant positive for all the characters in study (*Table 3*). The present study suggests that the seed weight, seed length and cone size should be given the top priority for the improvement of this crop.

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Table 2. — Variance, coefficient of variation, heritability and genetic gain in chilgoza pine.

Characters	Phenotypic variance	Genotypic variance	Environmental variance	C.V.	G.C.V.	P.C.V.	Heritability	Genetic gain	Genetic gain as per cent of mean
Cone length	03.12	02.08	01.04	06.52	09.31	11.41	66.66	01.98	12.80
Cone breadth	01.29	00.75	00.54	08.52	10.08	13.24	58.13	01.01	11.79
Cone weight	19181.52	13867.51	05314.01	12.72	20.54	24.16	72.30	70.56	12.31
No. of seeds per cone	221.32	82.55	138.77	13.42	10.40	16.96	37.30	12.95	14.76
Seed weight per cone	108.45	64.11	44.34	16.63	20.00	26.02	59.11	11.80	29.47
Seed length	04.76	04.46	00.30	02.55	09.82	10.15	93.70	05.10	23.73
Seed breadth	00.18	00.14	00.04	02.84	05.33	06.04	77.78	00.87	12.39
Seed thickness	00.14	00.12	00.02	02.42	05.94	06.43	85.71	00.66	11.47
Seed weight (100 seeds)	47.01	38.82	08.19	06.32	13.77	15.15	82.57	12.30	27.18

Calculated for a selection intensity of 2.06 = 5% best

Table 3. — Correlation coefficient in chilgoza pine.

Characters	Cone length	Cone breadth	Cone weight	No. of seeds per cone	Seed wt. per cone	Seed length	Seed breadth	Seed thick -ness	Seed weighing (100 seeds)
Cone length	- -	.998**	.993**	.994**	.989**	.998**	.998**	.998**	.995**
Cone breadth	- -	-	.992**	.993**	.989**	.997**	.998**	.998**	.996**
Cone weight	- -	-	-	.983**	.988**	.989**	.987**	.988**	.989**
No. of seeds per cone	- -	-	-	-	.990**	.993**	.995**	.993**	.989**
Seed wt. per cone	- -	-	-	-	-	.988**	.985**	.986**	.994**
Seed length	- -	-	-	-	-	-	.997**	.998**	.995**
Seed breadth	- -	-	-	-	-	-	-	.999**	.994**
Seed thickness	- -	-	-	-	-	-	-	-	.995**
Seed weight (100 seeds)	- -	-	-	-	-	-	-	-	-

**) Significant at 1%

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An Attempt to Identify the Origin of Pinus brutia Ten. Plantations in Israel by Needle Resin Composition[1])

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Abstract

Identification of seed sources of plantations of *Pinus brutia* TEN. subsp. *brutia* from imported seed, was attempted by determination of the needle resin composition. The results were compared with the resin composition of various identified seed sources in provenance trial plots. The seed sources present in trial plots were grouped by cluster and discriminant analysis procedures mainly into low -and high -altitude western Anatolian groups and an eastern Anatolian group, with the Iraq, Cyprus and Crete provenances occupying isolated positions.

There is reason to believe that plantations established in the 1930s and 1940s were of Greek origin, whereas some of those established in the 1960s and 1970s were in part of Turkish origin.

Key words: Pinus brutia, resin composition, provenances.

Introduction

The range of *Pinus brutia* TEN. subsp. *brutia,* the eastern vicariad of *Pinus halepensis* MILL., extends from the Greece Aegen Islands through Turkey to Lebanon and northern Iraq (CRITCHFIELD and LITTLE, 1966). The subspecies was introduced into Israel in the late 1920s (HETH, 1968), but only recentely it is widely used in afforestation projects; at present, out of an area of man-made conifer forests of approximately 60,000 ha, *P. brutia* plantations extends over some 10,000 ha. Reliable knowledge on the seed origin of the plantations is almost nonexistent. According to available data, most of the seed used in the last 40 or 50 years appears to have been imported from Greece. Cyprus and Turkey, but locally collected second-generation seed is being used increasingly (Y. REVES, personal communication). Seed was imported at a rate of 10 kg to 20 kg each year, which means that the seed crop of at least 70 trees was used here yearly in the reforestation projects. It is therefore of interest to identify, if possible, seed sources well adapted to local conditions in order to utilize more fully the potential for growth of brutia pine, since the tree is clearly superior to the still widely used Aleppo pine (*P. halepensis*) owing to the straight shape of the bole and its resistance to the pine bast scale *Matsucoccus josephi* BODENH. et HARPAZ, the major (and often lethal) pest of *P. halepensis* (MENDEL, 1984).

Determinations were made of the needle resin composition in local plantations of *Pinus brutia* TEN.; the results were compared with the resin composition determined in trees from various registered seed sources growing in provenance trial plots established in 1976 in conjunction with the IUFRO-FAO project 4 bis. This method was chosen because analysis of monoterpene composition was shown to be useful for assessing possible geographic origins (SQUILLACE et al., 1980).

To sample a large number of trees and obtain statistically valid results, it proved expedient to investigate the resin composition of needles rather than of the cortex or xylem, although this involved a repeat analysis of various seed origins in the provenance trials (SCHILLER and GRUNWALD, 1987).

Materials and Methods

1. Plant material

Needle samples were collected in the autumn from all the trees growing in trial plots planted in 1976 at 3 sites: on Mt. Carmel at Ramat ha'Nadiv (32°32'N, 34°56'E); in the Judean Foothills near Nahshon (31°50'N, 34°58'E); and in the Judean Mountains at ha' Qedoshim forest (31°47'N, 35°05'E). The 14 provenances under trial at the three locations are shown in *table 1* and *figure 1.* The total number of trees sampled was 232, with 7 to 20 trees per provenance.

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