

**PROPAGATION, SELECTION AND ESTABLISHMENT OF CLONAL SEED  
ORCHARD OF CHILGOZA PINE (*PINUS GERARDIANA* WALL.)**

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**Introduction**

*Pinus gerardiana* Wall. known as Chilgoza or Neoza is most important tree cash crop among fine *Pinus* species reported from the country. Its distribution is restricted to dry inner valleys of North-West Himalayas between 1600 to 3300 metres elevation. The main source of Chilgoza nut (seed) in India is Sutlej Valley of District Kinnaur in Himachal Pradesh. The total area under this crop is around 2500 ha including the plantations raised by State Forest Department and the annual yield of nut varies from 150-180 tonnes per year (Tandon, 1965). It forms predominant vegetation starting from Tapri upto Dabling along the river Sutlej and the best growth is noticed at an altitude of about 2600 m (Dogra, 1964).

By the increasing demand of nut in dry fruit trade of the country, it is now back bone of the livelihood of tribal people of Kinnaur. At the same time the depletion of the crop area and its density is directly linked with no or very meagre natural regeneration due to reckless lopping of branches for the extraction of each and every possible cone even in extreme inaccessible sites. Since the right of harvest of the Chilgoza had been given to local inhabitants that is why there

is no check on its way of extraction by State Forest Department.

*Pinus gerardiana* is very sparsely studied. Chandra and Mahindru (1976) reported the results of air layering. The artificial regeneration of Chilgoza pine was studied by Singh *et al.* (1973). Singh (1989, 1990) reported on its clonal propagation and effect of different factors on the success of tender shoot cleft grafting respectively. However, not much work has been done in the genetic improvement of this species except the studying the phenotypic variations of Chilgoza (Kumar, 1986). In order to bring *Chilgoza pine under clonal cultivation* at part to other fruit crop in dry temperate Himalaya, the efforts have been made on its propagation, selection of plus trees (clones) and the transplanting of grafted plants in an experimental clonal seed orchard at Regional Research Station, Sharbo, Kinnaur. The average annual rainfall at the station was about 500 mm and average temperature varies from 10°C to 35°C during the month of January to July.

The present paper deals with its clonal propagation, selection of plus trees, analysis of variance, coefficient of variation, phenotypic coefficient of variation, genotypic

coefficient of variation, heritability, genetic gain for eight characters and the methodology of raising clonal seed orchard of Chilgoza pine.

#### Material and Methods

*Vegetative Propagation* : The tender shoot cleft grafting was done in February 1989 and February 1990. The method was followed as described by Dorman (1976). The seedlings of 2-3 years age old raised in polythene bags of 45×15cm size were procured from Forest Range Nursery, Kalpa for the present study. The experiment was laid out in randomized block design with three replications having 40 plants in each replication. The observations on success percentage were recorded when the grafts started bearing new leaves whereas the percentage of survival was noted in December 1989 and 1990 respectively.

*Selection of plus trees and analysis of phenotypic and genotypic variability for cone and nut characters* : 20 plus trees were selected in 1989 from different parts of Kinnaur based on five characters viz. height, diameter, crown size, number of cones and seed weight of 100 seeds. The marking of superior (plus) trees was done to only those trees which had given better result for each character to the average of neighbouring five trees termed as candidate trees for the comparison. In 1990, fifteen cones per tree were collected from selected plus trees for further analysis of eight cone and nut characters comprising fresh cone weight, cone length, cone breadth (middle), number seeds per cone, seed weight, seed length, seed breadth (middle) and seed thickness. The mean value of 25 seeds of each plus tree

in four replications were used for statistical computation (Table 2). The components of variance and coefficient of variation were calculated. The genotypic coefficient of variation, phenotypic coefficient of variation, heritability genetic advance for eight characters were calculated (Burton and Da Van, 1953; Johnson *et al*, 1955 and Namkoong, 1979).

*Establishment of experimental clonal Seed Orchard* : 30 grafted plants of three plus trees namely Sharbo, Kalpa and Khawangi were transplanted in December, 1989 in orchard by removing the polythene bags carefully without damaging the root system of the plant. The size of pits was kept 1×1 m and spacing 7 × 7m was given plant to plant. The pits were filled up with earth, forest soil, cow dung (5-7 kg per pit) and fertilizer (N.P.K) in the ratio of 70:35:70 gm per pit. The forest soil was used in the pits as to inoculate mycorrhiza for the better growth of the plants (Mukherjee and Rehill, 1962). The average height and collar diameter of grafts were 13 cm and 04 mm respectively during transplanting out in field. The basins (thali) were prepared of one meter diameter. The proper care was taken for watering (twice in week) specially for six months May to October. The pine needles and local weed were used for mulching in the basin of plants.

#### Results and Discussion

*Vegetative Propagation* : The report of Singh (1989) established the fact that tender shoot cleft grafting had given best result in mid of February. The success of grafting was recorded 70% and 60% whereas the grafts

**Table 1***Selection of Plus Trees*

(The measurement is shown as plus tree upon average of five candidate trees for respective character).

Place (Trees Selected)		Height (m)	Diameter (DBH in cm)	Crown size (m <sup>2</sup> )	Number of cones	Seed weight (gm) (100 seeds)
1		2	3	4	5	6
Sharbo	Plus	25.00	69.50	45.00	160	51.00
	Av.	23.40	59.00	40.50	95	40.70
Khawangi	Plus	24.50	73.80	49.55	175	56.00
	Av.	20.80	60.50	38.70	120	45.12
Kalpa	Plus	22.70	66.00	46.80	150	58.60
	Av.	19.00	58.77	40.00	108	47.00
Powari	Plus	25.00	70.00	48.55	165	59.00
	Av.	21.00	62.75	41.50	115	47.85
Bogtu I	Plus	26.00	75.00	50.50	160	57.50
	Av.	22.50	64.45	41.00	110	46.00
Bogtu-II	Plus	23.75	70.35	45.59	145	56.00
	Av.	19.80	61.00	39.75	100	44.00
Bogtu III	Plus	24.50	71.00	42.80	155	54.65
	Av.	21.00	62.15	35.60	98	41.75
Brua	Plus	22.45	60.00	40.00	140	46.80
	Av.	18.75	51.50	31.00	90	40.33
Kilba-I	Plus	25.75	68.90	47.00	148	54.66
	Av.	22.55	56.50	33.00	110	38.00
Kilba-II	Plus	23.00	65.00	45.39	155	55.00
	Av.	19.00	58.87	34.77	115	40.50
Kilba-III	Plus	21.50	58.17	39.50	138	48.50
	Av.	19.00	53.25	35.00	90	39.75
Shongtong	Plus	23.50	60.00	43.95	150	57.00
	Av.	18.44	55.28	35.77	101	41.83
Karcham	Plus	21.15	58.11	39.50	137	46.85
	Av.	17.67	53.55	33.80	90	39.90
Skibba-I	Plus	23.10	63.50	47.40	155	57.00
	Av.	18.50	55.55	36.75	115	41.85
Skibba-II	Plus	22.67	61.22	49.00	169	58.11
	Av.	17.50	56.15	37.00	105	43.95
Akpa	Plus	21.75	57.65	44.75	160	56.12
	Av.	16.55	52.50	33.67	90	40.88
Chirang Khad	Plus	24.45	62.00	52.11	165	57.50
	Av.	18.66	56.58	38.68	110	42.00

(Contd ..)

1		2	3	4	5	6
Holdo Nallah	Plus	22.75	60.00	47.00	156	57.00
	Av.	17.60	52.50	39.00	95	41.39
Pangi	Plus	21.55	65.00	41.21	129	49.58
	Av.	17.60	59.50	37.94	86	38.80
Ralli	Plus	22.80	67.70	40.77	115	48.00
	Av.	18.90	61.00	36.50	80	32.45

Table 2

*Phenotypic Variability in Cone and Nut characters*

Name of Plus Trees & origin	Cone length (cm)	Cone breadth (cm)	Cone weight (gm)	No. of seeds per cone	Seed wt. per cone (gm)	Seed length (mm)	Seed breadth (mm)	Seed thickness (mm)
Sharbo (PG-1)	13.76	7.58	485	88.20	36.20	18.09	6.81	5.43
Shongtong (PG-2)	15.72	7.90	572	88.40	36.20	20.85	6.99	5.50
Holdo Nallah (PG-3)	16.16	8.68	608	85.80	42.40	23.87	6.92	6.01
Kilba-I (PG-4)	14.54	8.06	533	78.20	32.60	19.14	6.72	5.54
Kilba-II (PG-5)	15.44	7.60	517	93.60	45.40	23.26	6.81	5.53
Kalpa (PG-6)	14.16	8.06	516	96.80	38.20	19.18	7.01	5.86
Khawangi (PG-7)	18.20	10.90	859	99.60	62.00	24.50	7.68	6.65
Powari (PG-8)	17.96	10.10	738	103.80	50.00	24.78	7.84	6.12
Skibba-I (PG-9)	16.54	9.00	650	75.40	42.00	22.16	7.12	6.12
Skibba-II (PG-10)	12.56	7.98	345	64.80	26.80	19.60	6.73	5.58
Akpa (PG-11)	14.16	7.84	496	88.20	37.60	21.35	6.47	5.41
Chirang Khad (PG-12)	15.96	8.38	573	86.20	37.20	22.13	7.01	5.85
Bogtu-I (PG-13)	15.44	8.56	474	99.60	44.80	19.25	6.75	5.42
Bogtu-II (PG-14)	16.22	8.90	675	77.40	30.00	21.25	7.23	5.84
Bogtu-III (P-15)	15.22	8.78	554	90.00	39.00	22.89	7.01	5.98
Range	12.56	07.58	345	64.80	26.80	18.09	6.47	5.41
	18.20	10.90	859	103.80	62.00	24.78	7.84	6.65
Mean + SE	15.48	08.56	573	87.73	40.03	21.49	07.02	05.78
	±00.45	±00.33	±32.55	±05.26	±02.97	±00.25	±00.09	±00.06
S.D.	01.01	00.73	72.90	11.78	06.66	00.55	00.20	00.14
'F' test	××	××	××	××	××	××	××	××
	10.99	07.89	14.05	03.97	08.23	74.01	18.59	30.50
C.D. at 1%	1.74	1.25	124.48	20.11	11.37	00.95	00.34	00.24

×× — Significant at 1% probability.

showed 65% and 50% survival in 1989 and 1990 respectively. The success and survival of the grafts were decreased in 1990 perhaps due to sudden and heavy snowfall and intermittent rains in last week of February and March. However, such fluctuations in result can be controlled if the grafting would be done in glasshouse.

*Selection of plus trees and analysis of phenotypic and genotypic variability for cone and nut characters:* Of 20 plus trees selected in Kinnaur, 15 plus trees were finally taken in the present study (Table 1). The plus tree which had attributed more than 42 m<sup>2</sup> crown area, 140 cones and 50 gm weight of 100 seeds were further screened for the study of 8 economic characters on cone and nut.

The analysis of variance (Table 2) revealed highly significant variability for all the characters under study. It clearly shows that high genetic variability exists in the material. The range of variation for each

character showed a good variability for almost all the characters.

As per Table 3, the coefficient of variation was observed maximum in seed weight per cone and minimum in seed thickness. Phenotypic as well as genotypic coefficient of variation were found high for seed weight per cone followed by number of seeds per cone, cone weight, cone breadth, cone length, seed length, seed thickness and seed breadth. Further, all the estimates of genotypic coefficient of variation was less in magnitude than that of phenotypic coefficient of variation indicating environmental effects on these characters.

Heritability estimates (broad sense) were observed to be maximum in seed length (93.70%) and minimum in number of seeds per cone (37.30%). However, in most of the characters, the heritability was recorded to be high except in number of seeds per cone (Table 4). The expected genetic gain was found to be highest for seed weight per cone

**Table 3**  
*Estimates of components of variance and coefficient of variation for eight characters in Chilgoza pine.*

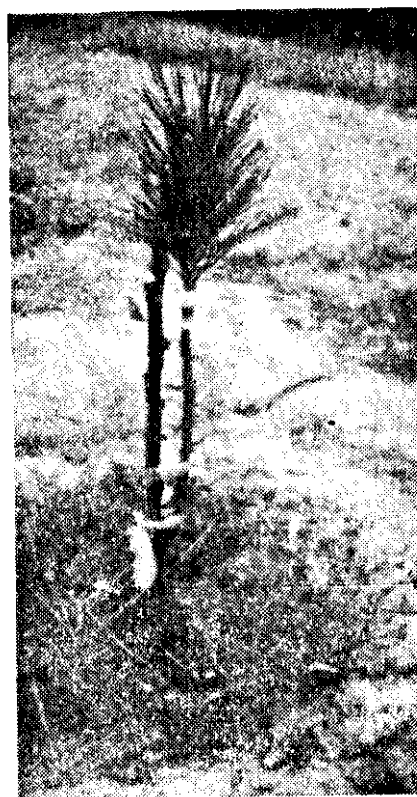
Characters.	Phenotypic variance	Genotypic variance	Environmental variance	C.V.	G.C.V.	P.C.V.
Cone length	03.12	02.08	01.04	06.52	09.31	11.41
Cone breadth	01.29	00.75	00.54	08.52	10.08	13.24
Cone weight	19181.52	13867.51	05314.01	12.72	20.54	24.16
Number of seeds per cone	221.32	82.55	138.77	13.42	10.40	16.96
Seed weight per cone	108.45	64.11	44.34	16.63	20.00	26.02
Seed length	04.76	04.46	00.30	02.55	09.82	10.15
Seed breadth	00.18	00.14	00.04	02.84	05.33	06.04
Seed thickness	00.14	00.12	00.02	02.42	05.94	06.43

**Table 4**  
*Heritability and genetic advance of eight characters in Chilgoza pine.*

Characters	Heritability (%)	Genetic advance	Genetic advance as per cent of mean
Cone length	66.66	01.98	12.80
Cone breadth	58.13	01.01	11.79
Cone weight	72.30	70.56	12.31
Number of seeds per cone	37.30	12.95	14.76
Seed weight per cone	59.11	11.80	29.47
Seed length	93.70	05.10	23.73
Seed breadth	77.78	00.87	12.39
Seed thickness	85.71	00.66	11.47

(29.47%) and lowest in seed thickness. Seed weight provide a sufficient amount of genetic variability as it is evidenced from GCV and PCV estimates in combination with heritability. GCV alone is not a correct estimate to know the heritable amount of variation present in the species for a given trait. It should be considered together with heritability estimates to obtain the best picture of the amount of genetic advance to be expected from the selection (Burton and Da Vane, 1953). High heritability estimates are useful in making selection of superior phenotypes (plus trees) on the basis of phenotypic performance of quantitative characters. Johnson *et al.* (1955) reported that heritability estimates along with expected genetic gain is more useful than the heritability itself in predicting the resultant effect for selecting the best genotypes. The results of present study (Table 4) clearly proves that it is not necessary that high heritability should always yield high genetic gain (Singh and Uppal, 1977). Keeping in mind the above facts and results of the study, the attention should be paid upon selection of seed weight and cone size for

**Fig. 1**



A ramet in the orchard of Chilgoza pine at Regional Research Station, Sharbo, Kinnaur (H.P.)

evolving high yielding genotypes by adopting suitable breeding procedure.

*Establishment of experimental clonal seed orchard:* The average height and collar diameter was recorded 22.5 cm and 6.75 mm respectively in December 1990 (Fig. 1) 7 plants were dried perhaps due to sudden rain

and snowfall which resulted over flooding of water and silt in March, 1990. The grafting will be done in large scale in February, 1991 by using superior genotypes for quality and quantity nut production (Table 3 and 4). Thereafter more area will be brought under seed orchard.

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#### SUMMARY

Clonal propagation was standardized in Chilgoza pine. 20 plus trees were selected from 15 different places of Kinnaur in Himachal Pradesh. Information on variability, heritability and expected genetic gain (genetic advance as percent of mean) were obtained for eight cone and nut characters. In general, heritability estimates were quite high for most of the characters. Seed weight per cone provides lot of variability, high heritability and maximum genetic gain (29.47) followed by seed length and number of seeds per cone. Seed weight per cone should be given top priority for selecting the high yielding genotypes. Experimental clonal orchard was established by using three plus trees.

चिलगोजा (पाइनस गेरार्डियाना वालि०) के कृन्तक बीज उद्यानों का प्रवर्धन,

प्रवरण और स्थापना

एन०वी० सिंह

सारगँश

चिलगोजा के कृन्तक प्रवर्धन को प्रतिमानित किया गया। हिमाचल प्रदेश में किन्नौर क्षेत्र के 15 विभिन्न स्थानों से श्रेष्ठ वृक्ष चुने गए। 8 शंकुओं और अष्टिफलों की विभिन्नीयता, पित्रागम्यता और प्रत्याशित आनुवंशिक लाभ (माध्य से आनुवंशिक वृद्धि प्रतिशत रूप में) की जानकारी इकट्ठी की गई। सामान्यतः अधिकांश लक्षणों में पित्रागम्यता के अनुमान काफी उच्च रहे। प्रति शंकु बीज का भार से ही विभिन्नीयता, उच्च पित्रागम्यता और अधिकतम आनुवंशिक लाभ (29.47) की वृद्धत सी जानकारी मिल जाती है जिसके बाद बीज की लम्बाई और प्रति शंकु बीजों की संख्या आने हैं। प्रति शंकु बीजों का भार का अधिक प्राप्तिदायक समग्रिक चुनने के लिए सर्वाधिक प्राथमिकता देनी चाहिए। तीन श्रेष्ठ वृक्ष लेकर संपरीक्षात्मक कृन्तक उद्यान

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