CLONAL EVALUATION ON POPLAR (*POPULUS DELTOIDES* BARTR.) IN EASTERN UTTAR PRADESH. II - ESTIMATES OF GENETIC PARAMETERS IN FIELD TESTING

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Introduction

Poplar (clones of *Populus deltoides*) occupies a very distinguished position in the agrarian economy of North-Western part of Indian plains and foothills because of its growth, multifarious uses and viable commercial returns. It is suitable for various wood based industrial purposes and can be vegetatively grown wherever irrigation facilities and sandy loam soils are available under different agroforestry models. Poplar wood has been able to met the demands of wood based industries as an alternative source of wood in the country. By and large poplar is cultivated in the areas lying above 28°N latitude and most of the research work is confined pertaining to these areas. There are number of reports available on clonal performance of poplar specially in Tarai region of Uttar Pradesh, Haryana and Punjab (Jha *et al.*, 1991, 1993; Chaturvedi, 1992; Chandra and Joshi, 1994; Misra *et al.*, 1995; Sidhu, 1994, 1996; Khanna *et al.*, 1996; Kumar *et al.*, 1999). A few attempts have also been made on introduction trial of Poplar in non-traditional areas which has given an insight for further clonal testing (Eastern Uttar Pradesh - Singh and Misra, 1995; Rawat *et al.*, 2001; Madhya Pradesh - Puri *et al.*, 2001; Maharashtra - Ballal *et al.*, 2001; Bihar - Anon., 2000).

In India, till date more than 500 clones of Poplar have been introduced and tested in a very limited region. Some of them performed very well thus introduction and regular clonal development has helped by increasing yield per tree in short rotation (6-8 years).

Keeping in view the ever increasing demand of Poplar wood and the interest of farmers in Poplar culture, selected promising clones developed by various research organisations in the country and abroad as well, are being tested in a number of locations under All India Coordinated Research Project on Poplar Improvement (Kumar *et al.*, 1999; Singh, 1999). The ongoing work on Poplar improvement will

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extend the genetic base of Poplar plantations in traditionally growing areas on the one hand and spreading of Poplar cultivation in other potential areas of Eastern Uttar Pradesh, Northern Bihar, Tarai region of West Bengal and North-Eastern States on the other. At the same time, site specific clones of Poplar for partly degraded soils of northern plains of the country and suitable pockets in other States like Madhya Pradesh, Maharashtra, Karnataka, would be identified for undertaking further plantation (Land and Singh, 1998; Singh *et al.*, 1999; Singh *et al.*, 2001).

New introduction, selection and breeding programme could extend further more southern limit of latitude of Poplar production (Pryor and Willing, 1965; Frampton and Foster, 1993; Newman, 1997; Singh *et al.*, 1999; Singh *et al.*, 2000). In order to compare the nursery performance of different clones, a field experiment on clonal testing was undertaken to find out the variability, genetic component of variance, heritabilities and genetic gains. This is perhaps the first ever attempt in India to analyse the genetic components of variance for growth characteristics of Poplar clones in the field.

Material and Methods

Cuttings of different clones of Poplar were planted in January 1998 for raising saplings (ETPs) at Ramshahpur, IFFDC Ltd., Sultanpur U.P. Location/site, soil analysis and other related details of clones were given in earlier paper (Rawat *et al.*, 2001). The ETPs were treated with fungicide and insecticide as per standard package of practices before out-planting. The field plantation of 50 clones was completed at Ramshahpur, Sultanpur (U.P.) during first week of February 1999 in randomised complete block design with four replications in four tree plot. The planting was done in the pits of 45 cm x 45 cm x 100 cm size at 4 m x 4 m spacing. Soil amendment was added in the pits as per the guidelines provided by Forest Soil and Land Reclamation Division, F.R.I., Dehra Dun (4 kg gypsum + 2 kg rice husk + 10 gm zinc sulphate + 10 gm iron sulphate + 50 gm urea + 120 gm single super Phosphate + 25 gm M.O.P. + 15 gm themet + 5 kg FYM). The dug out soil was thoroughly mixed and drenched with 0.1% chloropyriphos against termite attack. G3, G48 and S7C15 were treated as check clones. Field performance of different clones is shown in Fig. 1.

The data was recorded on each ramet of all 50 clones in the month of December every year for six characters viz. Survival percentage, plant height, diameter, number of branches, crown diameter and volume. The data was statistically analysed and genetic parameters were calculated at the age of 2 years i.e. one third of commercial rotation after Burton and De Vane (1953) and Falconer (1981). This procedure conforms with estimates of broad sense heritability in clonal material by Wilcox and Farmer (1967), Mohn and Randall (1971), Randall and Cooper (1973) and Farmer *et al.* (1988).

Results and Discussion

Analysis of variance of the 50 clones at the age of two years for six growth characters viz. survival percentage, plant height, diameter at breast height, number of branches, crown diameter and volume were found statistically significant (Table 1). The survival percentage ranged from 50.00 (63-N) to 100.00 (25-N, 38-N and PD-1) whereas average survival for

Table 1

Field performance of 50 Poplar clones at Ramshahpur IFFDC Ltd. Sultanpur (U.P.)

Sl. No.	Clone	Survival (%)	Plant height (m)	DBH (cm)	No. of Branches	Crown Dia. (cm)	Volume (m^3)
1	2	3	4	5	6	7	8
1.	UD-8806	66.66 (8.02)*	7.86	6.81	11.91	218.88	0.0456
2.	WSL-45	62.50 (7.86)	8.51	6.10	10.66	195.83	0.0348
3.	S7C20	91.66 (9.55)	8.31	7.39	15.25	173.05	0.0484
4.	UD-55	91.66 (9.55)	8.30	7.88	14.02	224.16	0.0551
5.	42-N	91.66 (9.55)	7.90	7.41	12.83	297.50	0.0469
6.	82-42-5	75.00 (8.53)	6.37	4.80	8.00	88.12	0.0146
7.	23-N	83.33 (9.10)	8.75	7.86	15.58	168.05	0.0549
8.	41-N	58.33 (7.44)	7.52	6.69	11.08	135.83	0.0336
9.	S4C2	75.00 (8.57)	8.97	7.42	13.27	226.94	0.0579
10.	UD10007	83.33 (9.02)	8.70	8.03	16.75	207.08	0.0745
11.	126/86	83.33 (9.10)	9.05	8.41	12.31	183.47	0.0686
12.	S7C2	66.66 (8.13)	7.06	6.18	10.97	141.38	0.0314
13.	UD 9605	87.50 (9.33)	8.12	6.75	12.12	133.33	0.0376
14.	UDH 1002	66.66 (7.88)	9.08	9.56	18.12	172.22	0.0968
15.	37-N	75.00 (8.57)	8.71	8.53	15.13	195.00	0.0843
16.	38-N	100.00 (10.00)	9.41	9.04	14.00	306.25	0.0823
17.	UDH 1001	91.66 (9.55)	8.77	8.36	14.50	189.44	0.0624
18.	22/86	91.66 (9.55)	9.15	7.64	10.94	174.02	0.0552
19.	D-121	83.33 (9.02)	7.91	6.83	11.83	147.08	0.0387
20.	UD 9116	91.66 (9.55)	9.84	9.80	18.55	246.66	0.1052
21.	UD 9020	91.66 (9.55)	9.70	8.65	17.61	289.16	0.0829
22.	34-N	75.00 (8.57)	8.76	8.85	14.41	184.86	0.0786
23.	40-N	87.50 (9.33)	10.16	10.82	20.45	314.58	0.1195
24.	82-26-5	66.66 (8.13)	7.11	5.97	13.25	120.41	0.0262
25.	421-2	66.66 (8.16)	8.03	5.72	9.25	68.75	0.0262
26.	S7C15	62.50 (7.86)	9.20	8.66	16.41	133.33	0.0702
27.	25-N	100.00 (10.00)	9.48	9.90	17.66	354.16	0.1009

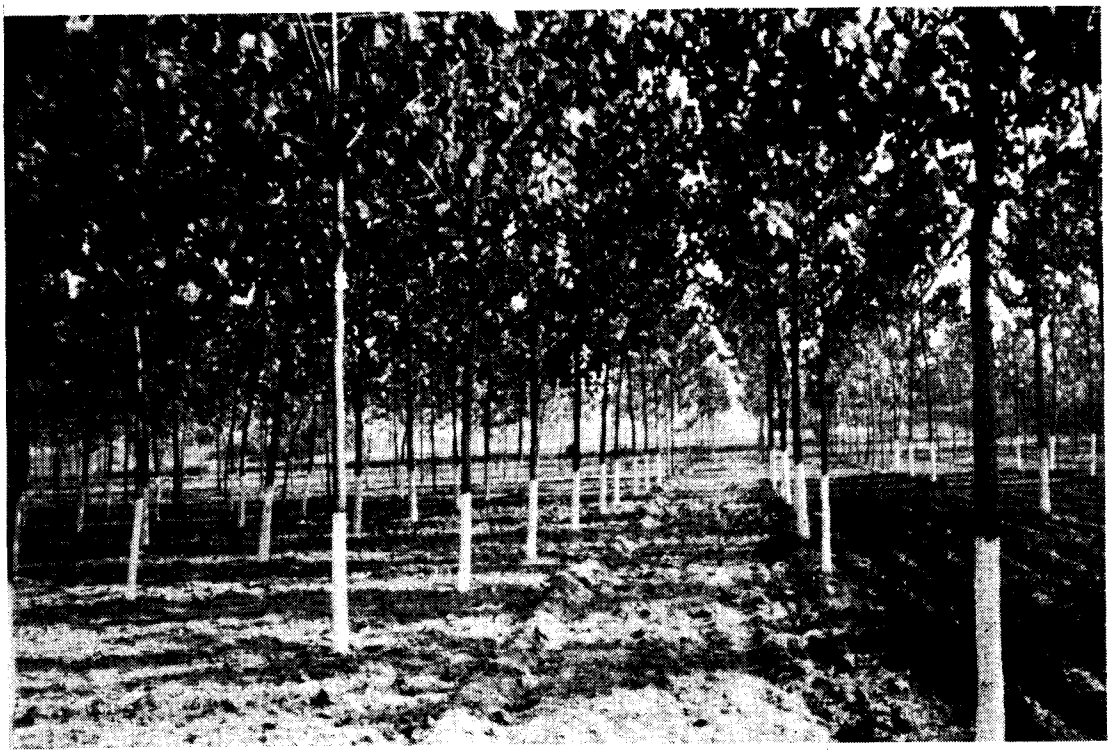
Contd...

1	2	3	4	5	6	7	8
28.	UD 902	83.33 (9.10)	8.86	8.71	18.10	299.86	0.07112
29.	UD 10009	83.33 (9.10)	8.49	8.85	13.13	186.11	0.0699
30.	UD-10005	91.66 (9.55)	8.43	7.11	11.41	206.94	0.0469
31.	UD-36	83.33 (9.10)	9.32	8.63	16.27	239.72	0.0704
32.	S7C8	83.33 (9.10)	8.29	6.53	13.30	141.11	0.0412
33.	UD5502	91.66 (9.55)	8.81	8.58	12.25	238.19	0.0673
34.	Kranti	75.00 (8.57)	8.45	8.27	11.63	169.72	0.0619
35.	63-N	50.00 (7.07)	10.06	10.05	16.25	212.50	0.1016
36.	36-N	91.66 (9.55)	8.16	7.97	17.16	173.75	0.0571
37.	43-N	75.00 (8.57)	8.25	6.89	13.38	186.80	0.0409
38.	L-200	91.66 (9.55)	8.16	7.00	12.75	146.25	0.0435
39.	G48	75.00 (8.57)	9.28	9.11	13.94	238.33	0.0781
40.	L34	91.66 (9.55)	8.04	6.79	10.91	159.86	0.0375
41.	G3	83.33 (9.10)	6.60	5.83	8.61	92.22	0.0234
42.	PD-1	100.00 (10.00)	8.31	8.09	13.41	159.16	0.0584
43.	90-12	75.00 (8.57)	8.11	8.16	10.41	176.39	0.0712
44.	26-N	91.66 (9.55)	8.94	8.66	13.91	272.91	0.0707
45.	UD-6500	91.66 (9.55)	9.13	8.32	17.16	239.86	0.0660
46.	Bahar	91.66 (9.55)	9.25	8.83	15.80	250.83	0.0730
47.	L-49	75.00 (8.57)	9.33	9.10	13.72	175.00	0.0774
48.	UD-6502	91.66 (9.55)	7.54	7.48	10.58	175.00	0.0451
49.	S7C1	83.33 (9.10)	7.99	6.26	11.97	199.58	0.0334
50.	UD4709	91.66 (9.55)	9.24	8.66	11.94	222.56	0.0696
Mean±SE		82.16 (9.02) ±0.83	8.53 ±1.02	7.84 ±1.44	13.57 ±3.54	1.98.50 ±88.57	0.0598 ± 0.0019
Range		50.00 - 100.00	6.37 - 10.16	4.06 - 10.82	8.00 - 20.45	28.75 - 354.18	0.0146 0.1195
CD at 5%		1.63	2.00	3.39	6.95	173.99	0.0137

*Value expressed in parenthesis is transformed value

the plantation was recorded 82.16 per cent. Plant height varied from 6.37 m (82-42-5) to 10.16 m (40-N) closely followed by 63-N (10.06 m), UD 9116 (9.84 m). Diameter was found maximum in 40-N (10.82 cm) closely followed by 63-N (10.05 cm), UDH 1002 (9.56 cm) and the minimum value was noticed in 82-42-5 (04.80 cm).

Fig. 1



Two years old plantation at Ramshahpur, Sultanpur (U.P.)

As regard the number of branches, highest number (20.45) was recorded in 40-N followed by 18.55 in UD 9116 and 17.66 in 25-N and the lowest value (08.00) was worked out in 82-42-5. Crown diameter (spread) was ranging from 68.75 cm (421-2) to 354.16 cm (25-N). Maximum volume was observed in 40-N (0.1195 m^3) followed by UD 9116 (0.1052 m^3), 63-N (0.1016 m^3) and minimum value (0.0146 m^3) registered in 82-42-5.

The genetic parameters as furnished in Table 2 revealed that genotypic and phenotypic coefficient of variation ranged from 05.35 and 10.29 in survival percentage to 32.15 and 47.61 in volume respectively. In present findings the heritability estimates in broad sense were used to obtain the heritable portion of variation. It was calculated on individual plant basis as well as clone means basis. Minimum heritability (13.08%) was found in crown diameter followed by (in ascending order) number of branches (19.44%), plant height (22.14%), survival (26.99%), diameter (28.57%) and volume (39.51%). The expected genetic gain was observed to be highest for volume (30.28) and lowest value in plant height (5.00%), the medium expected genetical gain was noticed in survival, number of branches and crown diameter whereas second to the highest value was worked out for diameter (28.57%).

Table 2

Estimates of variance components, heritabilities and genetic gains for growth characteristics in Populus deltoides

Genetic Components	Growth Character					
	Survival	Plant Height	Diameter (DBH)	No. of Branches	Crown Diameter	Volume
Genotypic :						
Coefficient of Variation	05.35	06.12	11.07	12.47	16.63	32.15
Phenotypic :						
Coefficient of Variation	10.29	13.00	22.72	27.96	45.97	47.61
Heritability : [in broad sense (%)]						
Individual Plant Basis	26.99	22.14	28.57	19.44	13.08	39.51
Clone Mean Basis	52.59	46.03	54.67	41.54	45.17	70.43
Genetic gain	00.51	00.50	01.53	1.51	24.43	12.61
Genetic gain as per cent of mean	11.10	05.00	19.49	11.12	12.31	30.28

Genotypic coefficient of variation alone is not a correct measure to know the heritable variable present and should be considered together with heritability estimates to get the best picture of the amount of genetic gain to be expected from the selection. High heritability estimate were used in finding the superior genotypes on the basis of phenotypic performance of quantitative characters (Burton and De Vane, 1953). Johnson *et al.* (1955) reported that heritabilty estimates along with expected genetic gain is more useful and realistic than the heritability alone predicting the resultant effect for selecting the best genotypes. Similar findings were reported in agreement to Johnson *et al.* (1955) by Singh (1993a) on *Bambusa pallida*, Singh and Beniwal (1993b) on *Bambusa balcooa*; Wilcox and Farmer (1967) on *P. deltoides* Lin and Zsuffa (1993) on *Salix eriocephala*; Burdon *et al* (1992) on *Pinus radiata* clones. The present result of study is also in support of referred workers.

Volume (the product of plant height and diameter - D^2h) indicated high heritability along with high genetic gain (advance). As regards the diameter which shows both heritability and genetic gain in higher direction may be attributed to the action of additive genes and non-additive genes (dominant and epistatis) as well. In contrast comparatively high heritability and low genetic gain as in case of plant height may likely be due to non-additive gene action.

Pichot and Cross (1989) while working on estimation of genetic parameters in *Populus deltoides* found that heritability estimates for diameter were higher in comparison to plant height at the age of two years. Similar results were also published on different species [*P. deltoides* - Farmer and Wilcox (1968), Randall and Cooper (1973), Nelson and Tauer (1987); *P. trichocarpa* - Rogers and Stettler (1989); *Salix eriocephala* - Lin and Zsuffa (1993); *Pinus radiata* - Burdon *et al.* (1992); *Bambusa pallida* - Singh (1993 a)]. The outcome of study in hand also exhibited the same pattern of heritability estimates.

Wilcox and Farmer (1967) observed opposite trend on *P. deltoides*. Similarly Giannini and Raddi (1992) reported higher range of heritability in plant height than diameter on clonal selection of *Cupressus sempervirens*. It may be attributed the genetic make up of plant material and selection response for the development of the clones.

Sidhu (1996) calculated the economics of plantation of different clone of Poplar. The results suggest that around 32% higher gain can be achieved than G3 as control. Puri *et al.* (2001) conducted clonal trials of Poplar in Madhya Pradesh and four clones were ear marked /ranked on the basis of field performance at the age of two years. Further analysis at the age of four years shows that same set of four clones were found out performers but internal ranking among themselves was changed. Nelson and Tauer (1987) recommended the selection of clones at the age of two years on *P. deltoides* based on plant heights and diameter. Dunlop *et al.* (1994) suggested the selection of individual on volume basis of two years growth is *P. trichocarpa*.

An average volume of three check clones namely G-3, G-48 and S7C15 (0.0572 m^3) is below the over all mean volume of the plantation. It can be concluded that selecting the top 10 per cent of clones i.e. best five clones viz. 40-N, UD 9116, 25-N, 63-N and UDH 1002 can be recommended for large scale plantations which will likely to yield 30 per cent more volume in comparison to mean value of test plantation for volume. In order to keep the balance between genetic gain and genetic base of plantation in the Poplar culture *en masse*, it is suggested that five additional promising clones based on volume analysis (38-N, UD-9020, 37-N, 34-N and G48) should be included alongwith five best clones for clonal mixtures.

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SUMMARY

Clonal performance of the 50 promising clones of *Populus deltoides*, developed within and outside the country, has been statistically analysed at one third of the commercial rotation for six growth parameters viz. survival percentage, plant height, diameter, crown diameter,

number of branches and volume. Genotypic and phenotypic coefficient of variation, broad sense heritability on individual plant basis, clone means basis and genetic gains have been worked out for all six growth parameters. Higher heritability was observed in diameter than plant height. Maximum heritability was well as genetic gain were obtained in volume. 30.28% expected genetic gain is achieved from selecting the 10% of 50 clones, i.e. 5 best clones namely 40-N, UDH-9116, 25-N, 63-N and UDH-1002.

पूर्वी उत्तर प्रदेश के पोपलर (*पोपुलस डेल्टायडिस* बार्ट्र०) का कृन्तकीय मूल्यांकन II – क्षेत्र परीक्षण से मिले आनुवांशिकीय परिमापों का अनुमान

एन०बी० सिंह, दिनेश कुमार, जी०एस० रावत, आर०के० गुप्ता, के० सिंह व एस०एस० नेगी

साराशं

देश के अन्दर तथा देश से बाहर विकसित किए गए *पोपुलस डेल्टायडिस* के 50 उत्साहप्रद कृन्तकों की क्रियाशीलता उनके छह वृद्धि परिमापों यानि अतिजीविता प्रतिशत, पौधे की ऊंचाई, व्यास, छत्र (व्यास), शाखाओं की संख्या और आयतन के लिए उसके व्यापारिक आवर्तन की तिहाई अवधि में सांख्यिकीय विश्लेषण किया गया है । सभी छहों वृद्धि परिमापों के समपित्रैक और वासप्ररूप विभिन्नता गुणांक पृथक एकल पादप और कृन्तकों का माध्य आधार पर मोटे अर्थो में पितृदायिता और आनुवांशिक लाभों को गणना द्वारा निकाला गया है । पादप ऊंचाई की अपेक्षा उसके व्यास में अधिक पितृदायिता पर्यवेक्षित हुई । अधिकतम पितृदायिता और आनुवांशिकीय लाभ भी आयतन में मिले । 30.28 प्रतिशत प्रत्याशित आनुवांशिकीय लाभ 50 कृन्तकों में से 10 प्रतिशत का अथवा 0.5 सर्वोत्तम कृन्तक नामतः 40-एन, यूडीएच 9116, 25-एन, 63-एन और युडीएच 1002 को चुल लेने पर ही मिला ।

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