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Discovery

Genetic parameters studies in *Populus deltoides* full sib F_1 progenies under field condition

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Over the years, more than 600 clones and 266 open-pollinated seed families have been introduced into India from different parts of the world. The best clones after nursery and field screening were selected for control crossing using Line × Tester design with 8 parents to develop superior hybrids. The F_1 populations of the successful crosses were raised in the nursery in uniform environment to study the extent and pattern of variation in growth and morphometric characters. In case of overall performance, G-48 X L-17/92 hybrid progeny was found outstanding for most of the growth and morphometric traits. High heritability and genetic gain were recorded for leaf area. The superior hybrids after further field evaluation and parental verification will be commercially released covering wider climatic range from tropical to temperate regions of the country.

INTRODUCTION

Increasing concerns over global climate change have led to heightened emphasis in exploiting plants as renewable source of energy. Poplar, grown as short rotation coppice, are among the most advanced biomass crops in temperate and sub tropical regions because of their potential for high yields in short cultivation cycles, ease of vegetative propagation and ability to resprout after multiple harvests. Poplars belong to the genus *Populus* and family Salicaceae; are rich in species diversity with comprises of 35 species, native to the northern hemisphere (FAO, 1979; Dickman and Stuart, 1984 and Khosla and Khurana, 1982). Six indigenous species of poplars, viz., *Populus ciliate, P. alba, P. euphratica, P. gamblii, P. jacquemontii* var. *glauca* and *P. rotundifolia* are reported in India except *P.deltoides* and *P.nigra* are exotics (Kumar and Singh, 2012). *Populus deltoides* is one of the most popular tree species in the agroforestry system of irrigated plains of Uttar Pradesh, Uttarakhand, Punjab and Haryana (Rizvi *et al.* 2008).

This genus also consuming much water with deep root system is an ideal plant for phytoremediation (Zalesny *et al.*, 2006). Poplar wood for multifarious uses particularly for plywood, pulp & paper, matchwood, packing cases and light constructional timber etc. Short rotation *Populus* plantations can accelerate the shift of wood supply from natural forests to plantations. (Rizvi *et al.*,2008). The essential purpose of tree improvement is to develop a suitable clones/variety that eventually brings about economic returns and related benefits to growers (Luna and Singh, 2009). Examples of important achievements were reported by Ragonese and Alberti (Ragonese and Alberti, 1965) from Argentina, Krstinic (Krstinic, 1979) from Yugoslavia and May (May, 1982) from Italy. However well planned genetic and breeding studies were undertaken recently and encouraging results were reported earlier (Eriksson *et al.*, 1984; Gulberg, 1988 and Zsuffa, 1988). Germplasm in the form of seed has been introduced by FRI and Dr. Y. S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh, Uttrakhand Forest Department and WIMCO Ltd (Kumar and Singh, 2012). Ever increasing demand of *Populus deltoides*, developed progenies were evaluated out best performing hybrids has been selected for further field evaluation, improvement and advance breeding programs (Mohrdiek, 1983). Keeping this in view, newly developed hybrid progenies were evaluated out of which best performing progenies has been selected for further field evaluation, improvement and advance breeding programs.

RESULTS AND DISCUSSION

In the present study hybrids (seedlings) obtained by crossing superior parents were evaluated. Analysis of variance revealed significant differences among different progenies for growth and morphometric characters, thereby indicating existence of variability amongst the different hybrids. Further, Table 2 show the overall performance of progenies derived from G-48 X L-17/92 (Plant height 316.11 cm, number of leaves 41.44 and intermodal length 4.58 cm), L-62/84 X S_7C_1 (Plant height 286.03 cm, number of leaves 41.17 and intermodal length 4.43 cm) and L-62/84 X L-17/92 (Plant height 280.00 cm, number of leaves 35.58 and intermodal length 4.01 cm) were found outstanding for most of the growth and morphometric traits which may be ascribed to genotypic superiority of the parents. However, in case of collar diameter G-48 X L-17/92 (21.22 mm) was found to be more promising than G-48 X L-124/86 (18.58 mm).

On the basis of mean values of progenies (Table 2) overall contribution of control G-48 was found to be better for most of the growth and morphometric characters. In consonance with the present study on growth and morphometric traits (Luna and Singh, 2009) on the basis of their study on *Eucalyptus* hybrids suggested that growth

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Table 1 List of clones involved in control crossing

Sr. No.	Clones	Sex	Source country/ Originally developed
1.	G-48	Female	Australia
2.	S_1	Female	India (Shyampur, Haridwar Forest Division)
3.	S_7C_8	Female	USA
4.	L-62/84	Female	India (Lalkuan Selection)
5.	S_7C_{11}	Male	USA
6.	L-124/86	Male	India (Lalkuan Selection)
7.	L-17/92	Male	India (Lalkuan Selection)
8.	S_7C_1	Male	USA

Table 2 Growth and morphometric traits in 12 progenies of *Populus deltoids*

Sr. No.	Crosses	Plant height (cm)	Collar diameter (mm)	Number of leaves/plant	Petiole length (cm)	Internodal length (cm)	Leaf area (cm^2)
1	G-48 X S_7C_{11}	210.45	14.55	41.66	6.55	3.42	109.11
2	G-48 X L-124/86	272.52	18.58	47.00	7.55	4.12	122.33
3	G-48 X L-17/92	316.11	21.22	41.44	8.41	4.58	199.80
4	G-48 X S_7C_1	265.98	17.36	48.65	8.22	4.07	128.93
5	S_1 X S_7C_{11}	266.12	17.45	50.41	9.42	4.05	119.40
6	S_1 XL-124/86	228.25	15.14	36.63	8.53	3.79	187.89
7	S_1 XL-17/92	261.21	16.97	45.55	8.42	4.11	231.50
8	S_7C_8 X S_7C_{11}	241.56	15.29	39.78	8.67	3.71	137.71
9	S_7C_8 X L-17/92	222.77	16.07	40.55	9.01	3.75	146.35
10	L-62/84 XL-124/86	217.23	13.68	29.66	7.82	4.47	176.04
11	L-62/84 XL-17/92	280.00	18.32	35.58	8.56	4.01	159.35
12	L-62/84 X S_7C_1	286.03	18.52	41.17	8.46	4.43	211.99
	Mean	255.69	16.93	41.51	8.30	4.05	160.87
	Controls						
1	G-48	224.62	15.32	33.11	7.50	4.20	195.91
2	6P	195.18	14.01	27.83	7.39	4.11	98.65
	Mean	209.90	14.67	30.47	7.45	4.16	147.28
	CD control v/s crosses	29.61	1.89	5.81	0.58	NS	NS
	CD between crosses	54.83	3.51	10.77	1.08	0.56	44.22

Table 3 Mean, range, GCV, PCV, heritability, genetic advance and genetic gain of growth and morphometric characteristics of *Populus deltoides*

Sr. No.	Characters	Mean	Range	Coefficient of variance (%)		Heritability (%)	Genetic advance (K=2.06)	Genetic gain (%)
				Genotypic	Phenotypic			
1	Plant height (cm)	255.69	210.45 – 316.11	9.59	16.88	32.31	28.74	11.24
2	Collar diameter (mm)	16.93	13.68 – 21.22	9.72	16.59	34.33	1.98	11.73
3	Number of leaves /plant	41.51	29.66 – 50.41	10.30	19.72	27.31	4.60	11.09
4	Petiole length (cm)	8.30	6.55 – 9.42	7.36	11.21	43.12	0.82	9.96
5	Internodal length (cm)	4.05	3.42 – 4.58	6.63	11.25	34.74	0.32	8.05
6	Leaf area (cm^2)	160.87	109.11 – 231.50	22.74	28.88	61.99	59.34	36.88

characters are governed by the genetic makeup of the trait and attribute significantly to the phenotypic performance at early stage giving ample opportunity for selection of the outstanding genotypes. Among all the characters (Table 3), plant height showed widest range of values (210.45-316.11 cm, mean 255.69 cm), followed by leaf area (109.11-231.50 cm^2, mean 160.87 cm^2) indicating the extent of variation existing in the plants. Phenotypic coefficient of variation (PCV) was found to be maximum for plant height (16.68%) followed by collar diameter (16.59%).

In the related *Populus* species, growth of hybrids (seedling) has been evaluated previous studies (Dhir and Mohan, 1976; Vaario *et al*.,2011 and Singh *et al*, 2013) and these are in conformity with the results obtained under present study. The characteristic studied significantly varied between the families except for leaf width and leaf area. The

significant differences were obtained for plant height, stem diameter, number of internodes and petiole length between populations of eastern cottonwood developed by crossing two sources length (Dhir and Mohan, 1976). Significant plant height and mean number of leaves were reported by Vaario *et al*. (2011) in the families of *P. tremula* obtained by controlled crossing between four male and three female trees at two different soil types. Intraspecific breeding in *Populus deltoides* was carried out by Singh *et al*. (2013) and growth traits of cottonwood hybrids at nursery stage have been studied earlier (Ozel *et al*., 2010).

Heritability and other genetic parameters signify the utility of variability in advanced breeding programmes. High genotypic coefficient of variance, heritability and genetic gain were recorded for leaf area followed by petiole length and intermodal length which revealed that traits were under strong genetic control. Higher genetic gain (36.88%) was recorded for leaf area followed by collar diameter (11.73%) suggesting that additive genetic effects are important in the determination of these characters and therefore, selection would be effective for these traits. Johnson *et al*. (1955) reported that heritability estimates along with expected gain is more useful and realistic than the heritability alone predicting the resultant effect for selecting the best genotype. The results are in accordance with findings of Kadam (2002) in full sib progenies of selected clones of *Populus deltoides*. Negligible coefficient of variance, heritability and genetic advance has been found for collar diameter and leaf area which implies that selection for these traits would be ineffective. Thus the characteristics with higher heritability and genetic gain will be exploited well for advanced breeding programs and the superior hybrids after further field evaluation for growth, biomass and physiological parameters as well as parental verification will be commercially released covering wider climatic range of the country.

MATERIALS AND METHODS

The present investigation was carried out in the Naganji nursery of the Department of Tree Improvement and Genetic Resources, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (Himachal Pradesh) is located at an elevation of 1200 m above mean sea level in the north-west of Himalaya and lies between 30°51'N latitude and 76°11'E longitude. These clones were repeatedly screened in the nursery followed by field testing. The selected superior clones were planted at many locations to test Gene × Environment interactions. On the basis of their stability performance control crossing of the selected clones (Table 1) was carried out in 2013-2015 using Line × Tester (4 × 4 factorial) with 8 parents in 2013. The seedlings were raised in the glass house and were shifted to nursery in March 2014 in Randomized Block Design. The F_1 populations of the successful crosses were grown in the nursery under uniform environment and were evaluated for growth and morphometric characters in October- December 2015.

Observations were recorded on plant height (cm), collar diameter (mm), number of leaves, internodal length (cm), petiole length (cm) and leaf area (cm^2). The statistical analysis for each parameter was carried out on mean values. Variability for growth and morphometric characters was estimated in terms of mean, range, genotypic and phenotypic coefficient of variation. Genetic parameters were also worked out with regards to estimates of heritability (broad sense), genetic advance and genetic gain as per cent of mean (Panse and Sukhatme, 1967; Burton and De Vane, 1953; Johnson *et al*., 1955 and Lush, 1940).

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