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Studies on Crossability Parameters in *Populus deltoides* Through Control Crossing

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ABSTRACT: The present investigation was carried out to gather information on crossability pattern of *Populus deltoides* and to develop suitable hybrids through controlled crossing. The per cent of successful crosses ranged between 13.35 to 66.64% and was found to be maximum in S_1 X L-17/92. Maximum germination is 93.33 % was found in G-48 X L-17/92 and in which per cent of germination ranged between 14.71 to 93.33 %. Similarly, survival per cent ranged between 5.44 to 90.44 % and was found to be maximum in G-48 X S_7C_{11}.

Key words: Controlled crossing, Successful crosses, Germination, Survival %.

INTRODUCTION

The genus *Populus* commonly known as poplar, is one of the oldest angiosperm, belongs to family Salicaceae, with total of 35 identified species (FAO, 1979; Dickman and Stuart, 1984 and Khosla and Khurana, 1982). The tree attains height between 15–50 m and trunk up to 2.5 m diameter. Its wood is in demand for pulp and paper, plywood, matchwood, packing cases and light constructional timber all over the world (Rizvi *et al.* 2008).

Populus deltoides has high vigour, 6 to 8 short rotation age, dioecious nature, natural ability for interspecific hybridization and great potential for vegetative propagation, so it is generally favored by breeders (Schreiner, 1970). It is one of the most popular tree species in the agroforestry system in irrigated plains of Western Uttar Pradesh, Uttarakhand, Punjab and Haryana (Rizvi *et al.* 2008). Hybridization between *Populus deltoides* seems to be common. In addition to the naturally occurring hybrids in various parts of the world, a considerable number of hybrids have been artificially produced by controlled mating, often rendering their identification vary at the morphological level. Natural hybridization is supported by dioecism and is affected by flowering phenology in *Populus deltoides*. The possibilities of artificial intra-specific hybridization among *Populus deltoides* are of great interest to the tree breeder as it offers high reliability of combining of the important traits and extending the range of useful progenies for selection of superior genotypes (Choudhary *et al*. 2013 and Dobhal &Thakur, 2016).

The present investigations were aimed to gather information on combining abilities to develop a suitable hybrid through controlled breeding. The objective of hybridization was to capture a sufficiently inclusive and unbiased genetic representation and to generate large hybrid families. High percentage of successful crosses, high germination percentage and survival percentage are highly desirable from any hybridization programme. Higher values of these crossability parameters suggested high range of crossability among genotypes.

MATERIAL AND METHODS

The flowering branches from females and males trees of different clones were obtained from State Forest Department, Haldwani and Shyampur, Haridwar Forest Division, Uttarakhand in month of January 2013 and February 2013, respectively (Table 1), raised in the germplasm block of Naganji nursery, Department of Tree Improvement and Genetic Resources, College of Forestry, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. These clones were repeatedly screened in the nursery followed by field testing. On the basis of their stable performance, control crossing of the selected

clones was carried out in 2013 to develop new hybrids. For experimental design, sixteen F_1 hybrids were needed for Line × Tester (4 ×4 factorial) mating design using 4 males and 4 females out of 11 male and 13 female selected initially but only twelve F_1 hybrids survived for evaluation in the nursery trial. Male catkins from selected species/clones were removed at anthesis time for collection of pollen to accomplish artificial pollination. All the female clones (Lines) were crossed with each of male clone (Testers) by hand pollination at stigma receptivity stage. Pollen was tested for in-vitro pollen viability before controlled crossing. Taken care that every controlled cross involves single pollen and no pollen mixture was attempted. After pollination the flowers were bagged and tagged. Seeds of controlled crosses were harvested when mature and sowed immediately as per international standard seed testing procedures. Further observations were recorded on following parameters.

Per cent successful crosses: Observations were recorded on per cent successful crosses as suggested by Jan and Pfeffer (1999).

Germination percentage: Germination count was made within 10 days after sowing. Per cent germination was calculated as the number of seeds that germinated out of number of seeds sown and expressed in percentage.

$$\text{Successful crosses (\%)} = \frac{\text{Successful crosses}}{\text{Total crosses}} \times 100$$

Survival per cent: Survival percentage was calculated as the number of seedlings that survived after it reached 4 leaves stage out of number of germinated seedlings and expressed in percentage.

$$\text{Germination (\%)} = \frac{\text{Germinated seeds}}{\text{Total number of seed sown}} \times 100$$

$$\text{Survival (\%)} = \frac{\text{Survived seedling}}{\text{Total number seeds germinated}} \times 100$$

RESULTS AND DISCUSSIONS

Higher percentage of successful crosses, coupled with higher germination percentage and survival rate are highly desirable for any hybridization programme. The success of controlled intra specific crosses producing viable F_1 hybrid plants and inquisition of the data appended in Table 2, indicates that high level of crossability pattern among species. The range of per cent successful crosses (Table 2) lied between 13.35 to 66.64 per cent for different crosses. Per cent successful cross was highest in S_1 X L-17/92 cross (66.64 %) followed by, S_1 X L-124/86 (41.65 %), G-48 X S_7C_1 (40%), L-62/84 X L-17/92 (33.39 %). The minimum percentage of successful cross was obtained for cross S_7C_8 X S_7C_{11} (13.35 %). Maximum germination percentage (93.33%) was recorded for crosses involving

Table 1. List of clones used in control crossing

Clones	Sex	Source country/ Originally
G-48	Female	Australia
S_1	Female	India (Shyampur, Haridwar
S_7C_8	Female	USA
L-62/84	Female	India (Lalkuan Selection)
S_7C_{11}	Male	USA
L-	Male	India (Lalkuan Selection)
L-17/92	Male	India (Lalkuan Selection)
S_7C_1	Male	USA

G-48 X L-17/92 followed by S_1 X S_7C_{11} (88.24 %) and S_1 X L-124/86 (85.99 %) was recorded and were statistically similar. Minimum (14.71%) value for germination percentage was recorded for crosses G-48 X L-124/86.

Survival percentage is one of the important factors in successful establishment of a species and is the best indicator of species with respect to adaptation and growth. The range for survival percentage was between 5.44 to 90.44 per cent among the crosses. Crosses *viz*., G-48 X S_7C_{11} recorded highest per cent survival (90.44 %) among all other crosses followed by G-48 X L-124/86 (76.67%), G-48 X S_7C_1 (60.85%) and S_1 X L-124/86 (49.17%).

Whereas, S_7C_8 X L-17/92 cross recorded minimum (5.44%) survival per cent. Verma (2012) also revealed significant differences for all the characters in *Grewia optiva*. Characters showed that mean values varied between 00.00 to 100.00 per cent for germination percentage, 00.00 to 66.66 per cent for survival percentage was recorded for intraspecific hybrids.

Likewise, Sankanur (2013) in *Terminalia chebula* revealed significant differences different parameters *viz*., per cent successful crosses lied between 0.41 to 2.14 per cent for different crosses, mean values of germination percentage lied between 47.62 to 100.00 per cent and survival percentage lied between 30 per cent to 100 per cent for different crosses.

Pichot and Teissier (1988) in clones of *Populus nigra* which produced twenty one full sib families. The present investigations are also in agreement with the findings of Bastien *et al*. (1996) and Singh (2002) in poplar. The results are in conformity with the findings of Dhiman and Gandhi (2012) whom has reported the crossability relationships among poplars.

The results of the present investigations are similar with findings of Choudhary *et al*. (2013) on hybrid performance and species crossability relationship in willows. They were also of the opinion that, higher crossability rate for intraspecific crosses as compared to inter-specific crosses.

Table 2. Mean values of different crossability parameters of various intra-specific hybrids

Crosses	Successful Crosses (%)	Germination (%)	Survival (%)
G-48 X S_7C_{11}	14.41 (22.83)	52.33 (46.33)	90.44 (71.99)
G-48 X L-124/86	22.22 (28.77)	14.71 (6.67)	76.67 (66.14)
G-48 X L-17/92	27.22 (31.62)	93.33 (75.28)	5.56 (1.43)
G-48 X S_7C_1	40.00 (39.23)	18.16 (9.78)	60.85 (51.60)
S_1 X S_7C_{11}	25.00 (27.21)	88.24 (70.31)	15.12 (6.99)
S_1 X L-124/86	41.65 (44.61)	85.99 (68.46)	49.17 (39.36)
S_1 X L-17/92	66.64 (61.62)	60.98 (52.02)	18.54 (25.39)
S_7C_8 X S_7C_{11}	13.35 (21.73)	59.56 (50.66)	18.47 (25.44)
S_7C_8 X L-17/92	16.66 (25.03)	44.67 (41.88)	5.44 (1.35)
L-62/84 X L-124/86	27.31 (31.72)	73.33 (59.61)	14.55 (21.18)
L-62/84 X L-17/92	33.39 (36.26)	65.79 (55.60)	23.49 (27.74)
L-62/84 X S_7C_1	33.00 (36.21)	80.65 (64.77)	46.42 (42.72)
CD **(0.05)**	7.87	13.44	15.67

*** Values in parenthesis are arcsine values**

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