International Journal of Forestry and Crop Improvement
Volume **8** | Issue 1 | June, 2017 | 24-29 | ■Visit us : *www.researchjournal.co.in*
e ISSN-2230-9411

RESEARCH ARTICLE

DOI: 10.15740/HAS/IJFCI/8.1/24-29

Morphological characterization and identification of *Populus deltoides* Bartr. crosses

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ABSTRACT : Leaves are of fundamental importance to plants, representing their facility to generate power and are the sensing units of plants towards the environment. In this study, an attempt was made to characterize and compare the variations of leaf, stem and petiole morphology of various *Populus deltoides* Bartr. crosses. In order to achieve these objectives, twelve crosses of *P. deltoides* Bartr. were evaluated for different parameters. On the basis of various morphological characteristics the results revealed that each cross has a distinct color pattern of leaves. Different colors observed in these crosses varied from yellow green to green. Distinct nature of the stem altitude was found. Anthocyanin distribution of leaves was also found. In this study, the morphological traits of leaves and petiole provided discriminatory grounds for separating various populations of *P. deltoides* Bartr. crosses. Character of stem studies indicates that different crosses vary considerably with regard to shape, colour and nature.

KEY WORDS : *Populus deltoides* Bartr., Leaves, Morphology, Petiole

HOW TO CITE THIS ARTICLE : Dobhal, Sneha, Thakur, Sanjeev and Kumar, Raj (2017). Morphological characterization and identification of *Populus deltoides* Bartr. crosses. *Internat. J. Forestry & Crop Improv.*, **8** (1) : 24-29, **DOI: 10.15740/HAS/IJFCI/8.1/24-29.**

ARTICLE CHRONICAL : Received : *30.01.2017;* Revised : *29.04.2017;* Accepted : *10.05.2017*

INTRODUCTION

The genus *Populus* consists of morphologically diverse species of trees which are deciduous in nature, short in rotation, and fast growing in habit (Slavov and Zhelev, 2010). The tree attains height between 15–50 m and trunks upto 2.5 m in diameter (Rizvi*et al.*, 2008). In addition, the leaves are large, deltoid (triangular), 4–10 cm long and 4–11 cm broad with a truncated (flattened) base.

The leaves are fundamental importance to plants that represents their facility to generate power and are sensing units towards the environment and ultimately provides the energy for sustaining the most terrestrial plant species on earth (Max *et al*., 2008). In this regard, the relevance of using the leaf traits as the determinants of biomass production as well as for taxonomic applications is also strongly dependent on the growth conditions of the plant species. For instance, it has been shown that increments in the leaf area and number of leaves are robust indicators of productivity under such environmental conditions, while the links between productivity and specific leaf area also vary with growth

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irradiance, temperature and the age of plants (Marron *et al*., 2003; Monclus *et al*., 2005 and Marron and Ceulemans, 2006). Hence, the findings of stable determinants still remains an open question and only a few studies have examined the relevance of leaf morphology for this purpose and more importantly rare study have been conducted for the *P. deltoides*.

It has been observed that leaf area and biomass production are closely related to each other in *P. deltoides* (Larson and Isebrands, 1972; Zavitkovski *et al*., 1974 and Isebrands and Nelson, 1982). In addition, the physiological components such as; rate of individual leaf growth, rate of leaf production and duration of growth, determine the leaf area in plant species. Hence, the detai1ed knowledge of the relationship between the components of leaf growth and tree productivity would assist efforts to increase productivity of *P. deltoides* plantations (Heilman and Stertler, 1985 and Weber *et al*., 1985).

A number of studies have demonstrated that the variation in leaf character is an adaptation that is significant for growth and survival of the plants in wide range environments (Raschke, 1960; Parkhurst and Loucks, 1972; Givnish, 1979; Hinckley *et al*., 1989 and Gurevitch, 1992). In this case, Callaham (1964) have reported the significant variation in the trees from different geographic origins due to genetic and environment effects. In addition, several studies suggest that the environment is closely correlated with and within population genetic variation in tropical tree species (Hamrick *et al*., 1979 and Hamrick and Godt, 1989). Therefore, the aim of the present investigation was to study the leaf, stem and petiole parameters, to characterize and compare the variations among the crosses of *Populus deltoides* Bartr.

EXPERIMENTAL METHODS

The studies on morphological characters were carried out at the Dr. Y.S. Parmar University of Horticulture and Forestry, Himachal Pradesh, India which is located at an elevation of 1200 m above mean sea level and lies between 30°51'N latitude and 76°11'E longitude in the North-West of Himalaya. The experimental material comprised of 12 successful crosses of *P. deltoides* Bartr. In this case, the best individuals of F_1 were selected and their progeny was cloned for observing the morphological variation among the crosses. Further, the cuttings of the selected individuals were raised in the nursery during February, 2015. In addition, the five plants were selected and from each crossed plant and 15 cuttings per replication were planted in nursery conditions. Further, the five plants in each replication were used for recording observations on morphological characters in September - October, 2015. The whole experiment was conducted in RBD design with three replication in planting material.

Observation recorded :

Different morphological features of matured, one and half-year-old leaves were studied during October to September 2015 (Fig. A). Same shape of leaf tip was studied in the following crosses *i.e.*, Narrow long acuminate 2. General shape of the leaf base: after the study of the shape of leaf tip, we concentrated on general shape of the leaf base, *i.e.*, A= Weakly cordate, B=Medium cordate and C = Strongly cordate. The leaf colour and distribution of anthocynin coloration of mid rib were determined with the help of RHS colour chart. The leaf area was measured with the help of leaf area meter.

Morphological features of the Stem :

The characteristics of stems were studied during October to September, 2015. The following characteristics of stem were studied: 1) stem colour at sun side, 2) stem nature, 3) stem shape and 4) Stem felt.

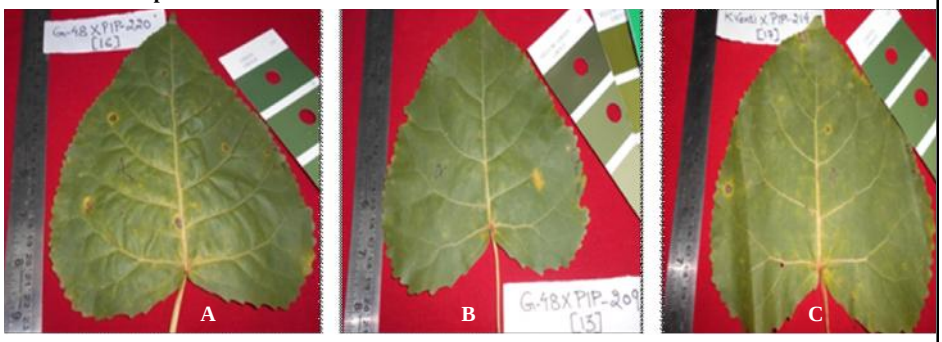
Table A : List of clones involved in development of hybrids

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

1. Shape of leaf tip

Norrow long acuminate

2. General shape of the leaf base



A=Weakly cordate, B=Medium cordate and C=Strongly cordate

3. Shape of junction with petiole

A=Steep shape, B=Shallow shape and C=Widely wedge shaped

Fig. A : Morphological features of developed leaves and petiole

Stem colour at sun side was determined with the help of RHS colour chart.

Petiole of the leaf :

The characteristics of petiole were also studied. The following characteristics of petiole were studied: 1) Colour intensity of petiole at junction, 2) Colour of petiole and 3) Shape of junction with petiole. Colour intensity of petiole at junction was determined with the help of RHS colour chart.

EXPERIMENTAL RESULTS AND ANALYSIS

The result of various morphological characteristics for the 12 crosses, have presented in Tables 1, 2 and 3. It was observed that among the various colour of stem at sun side, Yellow Green 148 (Group A) colour was observed in maximum number of hybrids the *Populus deltoides*. However, the shape of stem was recorded straight in maximum number of hybrids. In addition, the stem felt was observed to be present two hybrids (G-48 X S_7C_{11} and S_7C_8 X S_7C_{11}) only. In other case, the stem nature was recorded straight in maximum number of hybrids, while, leaf blade altitude was observed downward in all the hybrids.

The studies on leaf morphological markers showed that each cross had a distinct colour pattern of leaves in the hybrids. Among the different colours, Green 138 (Group A) colour in the leaves was observed only in S_1 X L-17/92 and S_7C_8 X L-17/92 hybrids. On the other hand, the shape of leaf tip of all the hybrids was narrow long acuminate, while leaf base was observed slightly wavy to wavy in number of hybrids. However, the general shape of most of the leaf base was weakly cordate among the hybrids. In addition, the distribution of anthocyanin coloration from base to midrib was observed in maximum

Table 1 : Cross differentiation on the basis of different morphological markers of leaves

Sr. No.	Crosses	Colour of leaf	Shape of leaf tip	Leaf base	General shape of leaf base	Distribution of anthocynin coloration of mid rib	Leaf blade altitude	Number of leaves/ plant	Leaf area (cm^2)
1.	G-48 x S_7C_{11}	Yellow-Green 147 (Group A)	Narrow long acuminate	Slightly wavy	Medium cordate	Base	Downward	41.66	109.11
2.	G-48 x L-124/86	Green- N 137 (Group A)	Narrow long acuminate	Slightly wavy	Strongly cordate	Base	Downward	47.00	122.33
3.	G-48 x L-17/92	Green 137(Group C)	Narrow long acuminate	Wavy	Weakly cordate	Base	Downward	41.44	199.80
4.	G-48 x S_7C_1	Yellow-Green 151 (Group B)	Narrow long acuminate	Slightly wavy	Strongly cordate	Base	Downward	48.65	128.93
5.	S_1 x S_7C_{11}	Green 143(Group B)	Narrow long acuminate	Slightly wavy	Weakly cordate	Base to midrib	Downward	50.41	119.40
6.	S_1 x L-124/86	Yellow-Green 146 (Group A)	Narrow long acuminate	Slightly wavy	Weakly cordate	Base to midrib	Downward	36.63	187.89
7.	S_1 x L-17/92	Green 138(Group A)	Narrow long acuminate	Wavy	Medium cordate	Base to midrib	Downward	45.55	231.50
8.	S_7C_8 x S_7C_{11}	Green 137(Group A)	Narrow long acuminate	Slightly wavy	Weakly cordate	Base to midrib	Downward	39.78	137.71
9.	S_7C_8 x L-17/92	Green 138(Group A)	Narrow long acuminate	Wavy	Weakly cordate	Base to midrib	Downward	40.55	146.35
10.	L-62/84 x L-124/86	Green 143(Group A)	Narrow long acuminate	Slightly wavy	Weakly cordate	Base to midrib	Downward	29.66	176.04
11.	L-62/84 x L-17/92	Green 143(Group C)	Narrow long acuminate	Wavy	Medium cordate	Base to midrib	Downward	35.58	159.35
12.	L-62/84 x S_7C_1	Yellow- Green 144 (Group A)	Narrow long acuminate	Slightly wavy	Weakly cordate	Base to midrib	Downward	41.17	211.99

number of hybrids except G-48 cross combinations hybrids. Moreover, among the hybrids maximum number of leaves/plant was observed in S_1 X S_7C_{11} (50.41) followed by G-48 X S_7C_1 (48.65) and G-48 X L-124/86 (47.00) whereas, the minimum average number of leaves/ plant was recorded in L-62/84 X L-124/86 (29.66). Furthermore, analysis revealed that among the hybrids, leaf area was found to be maximum in S_1 X L-17/92 (231.50 cm^2) followed by L-62/84 X S_7C_1 (211.99 cm^2) and G-48 X L-17/92 (199.80 cm^2) whereas, the minimum value was observed in G-48 X S_7C_{11} (109.11cm^2). The findings reported by Ceulemans *et al*. (1992) and Singh *et al*. (2015) observed superiority of F_1 over their parents for leaf phenology and leaf number in cross between (*Populus deltoides* x *P. trichocarpa*).

The Greyed- Red 179 (Group A) colour intensity of petiole at junction was found in maximum number of hybrids. On the other hand, only two hybrids *i.e.* G-48 X S_7C_{11} and S_7C_8 X L-17/92 showed Green 143 (Group D) colour of petiole, while rest of the hybrids showed distinctive colour. However, the widely wedge shaped was the shape of junction with petiole which was found in maximum number of hybrids, followed by steep shape, while shallow shape was found in minimum number of hybrids.

All the crosses were broadly characterized into two or three groups on the basis of morphological descriptions, *i.e.*, leaf, stem and petiole characteristics. Since different

Table 2 : Characteristics recorded on stem of *Populus deltoides* crosses

Sr. No.	Crosses	Stem colour at sun side	Stem nature	Stem shape	Stem felt
1.	G-48 x S_7C_{11}	Green N-138 (Group-B)	Slightly curved	Slightly curved	Present
2.	G-48 x L-124/86	Yellow-Green 148 (Group-B)	Straight	Slightly curved	Absent
3.	G-48 x L-17/92	Yellow-Green 148 (Group-B)	Straight	Curved	Absent
4.	G-48 x S_7C_1	Yellow-Green 148 (Group- A)	Straight	Curved	Absent
5.	S_1 x S_7C_{11}	Yellow-Green 148 (Group-A)	Straight	Straight	Absent
6.	S_1 x L-124/86	Green 138 (Group-A)	Slightly straight	Straight	Absent
7.	S_1 x L-17/92	Yellow-Green 148 (Group-A)	Straight	Straight	Absent
8.	S_7C_8 x S_7C_{11}	Yellow-Green 148 (Group-A)	Slightly straight	Straight	Present
9.	S_7C_8 x L-17/92	Yellow-Green 148 (Group-C)	Straight	Straight	Absent
10.	L-62/84 x L-124/86	Yellow-Green 146 (Group-D)	Straight	Straight	Absent
11.	L-62/84 x L-17/92	Yellow-Green 148 (Group-A)	Straight	Straight	Absent
12.	L-62/84 x S_7C_1	Yellow-Green 148 (Group-A)	Slightly Curved	Straight	Absent

Table 3 : Characteristics recorded on petiole of the leaf

Sr. No.	Crosses	Colour intensity of petiole at junction	Colour of petiole	Shape of junction with petiole
1.	G-48 x S_7C_{11}	Red 47(Group B)	Green 143 (Group D)	Steep shape
2.	G-48 x L-124/86	Greyed-Red 179 (Group A)	Yellow Green 144 (Group B)	Widely wedge shaped
3.	G-48 x L-17/92	Red 45(Group B)	Yellow 17 (Group C)	Widely wedge shaped
4.	G-48 x S_7C_1	Yellow -Green 154 (Group D)	Yellow Green 154(Group D)	Steep shape
5.	S_1 x S_7C_{11}	Greyed-Red 179(Group A)	Greyed-Yellow 160(Group A)	Widely wedge shaped
6.	S_1 x L-124/86	Red 47(Group A)	Yellow- Green 144(Group D)	Shallow shape
7.	S_1 x L-17/92	Red 45(Group A)	Yellow 11 (Group C)	Widely wedge shaped
8.	S_7C_8 x S_7C_{11}	Red 45(Group B)	Red 45 (Group C)	Shallow shape
9.	S_7C_8 x L-17/92	Green 143(Group C)	Green 143 (Group D)	Widely wedge shaped
10.	L-62/84 x L-124/86	Red 45(Group A)	Yellow-Green 145 (Group A)	Widely wedge shaped
11.	L-62/84 x L-17/92	Red 42(Group A)	Red 42 (Group A)	Steep shape
12.	L-62/84 x S_7C_1	Greyed-Red 179 (Group A)	Yellow 11 (Group –B)	Widely wedge shaped

clones of any tree species are based on a selection within the same species, it is difficult to identify different clones on visual inspection unless contrasting characteristics exit in the clones and the identity of each clonal sapling is already available, based on meticulous records.

Our findings are in conformity with the findings of Lone *et al.* (2013) reported that forty-nine exotic and indigenous clones of poplar were evaluated for eight morphological traits to identify the prominent clones of poplar. At both 2 and 3 years of age, diameter showed significant and positive phenotypic correlation only with plant height (0.5979). Similar trend was observed with other parameters such as, leaf lamina length showed significant and positive phenotypic correlation with petiole length (0.5447), total leaf length (0.8733), leaf width (0.7488), L/B ratio (0.4927) after 2 years of age. Same trend was observed with Leaf lamina length being phenotypically significant and positively correlated with petiole length (0.5447), total leaf length (0.8733), leaf width (0.7488), L/B ratio (0.4927) after 3rd year of age. Petiole length at 2 and 3 years of age was significant and positively correlated with total leaf length (0.8217) (0.8737), leaf width (0.7517 (0.5156) and L/B ratio (0.3868) (0.7317), respectively. Almost similar trend has been observed at genotypic level but with a higher degree.

Conclusion :

In this study, the morphological traits of leaves provided discriminatory grounds for separating various populations of *Populus deltoides* Bartr. crosses. The stem and other leaf parameters of developed leaves were studied which indicated that different crosses varies considerably with regard to shape of leaf tip and leaf base, color, type of leaf base and presence of anthocyanin

in leaf surface.

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