



Variation Among Poplar (*Populus Deltoides Bartr.*) Clones for Growth, Wood Traits and Tolerance to Leaf Spot Diseases

GPS DHILLON^{1*}, JAJJBIR SINGH SANDHU¹
and PARMINDER SINGH²

¹Department of Forestry & Natural Resources, Punjab Agricultural University, Ludhiana, India.

²Department of Plant Pathology, Punjab Agricultural University, Ludhiana, India.

Abstract

Poplar is economically important and fast growing tree species which is widely adopted by farmers of northwest India. The nursery study was conducted for two years to find out clonal variation for plant height, collar diameter, biomass, wood traits and incidence of leaf spot disease. Results found significant differences among the clones for all growth traits, specific gravity and fiber length. Clones L-290/84, 22-N and L-50/88 were promising for tree height and collar diameter during 1st year study. In 2nd year the tree height was highest in L-7/87 but was at par with L-34/82. L-7/87, L-247/84 and L-48/89 were promising for diameter. Clones L-48/89, L-7/87, 22-N, L-247/84, S₇C₈, and WSL-22 recorded superiority for both above ground and root biomass. The maximum fiber length was recorded in clone WSL-29 (0.936 mm) which was at par with those of WSL-22, L-17/92 and L-50/88. The wood specific gravity ranged from 0.383 to 0.498. Clone L-290/84 was at top rank but statistically par with 40-N, G-48, L-50/88 and T-90. The relative resistance for leaf spot was the higher in L-290/84, 40-N and WSL-29 in 1st year, and WSL-29, L-17/92, L-290/84, 22-N, 40-N, S₇C₈, and L-48/89 were found to be resistant during 2nd year. On the basis of all the traits clones L-48/89, 22-N, L-290/84, 40-N, and WSL-22 have shown promise and need to be tested at multiple sites before commercial cultivation.



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Introduction


Populus deltoides Bartr. Ex Marsh., commonly called eastern cottonwood or poplar, is one of the

most widely planted exotic tree species. It belongs to family Salicaceae, and is naturally distributed over the forests of Northern Hemisphere. Among

CONTACT GPS Dhillon ✉ dhilongps1@pau.edu 📍 Department of Forestry & Natural Resources, Punjab Agricultural University, Ludhiana, India.



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the native six species of this genus viz. *P. ciliata*, *P. laurifolia*, *P. gambles*, *P. euphratica*, *P. alba*, *P. jaquemontiana*, none of these is commercially important for timber production. Forest Research Institute, Dehradun introduced *Populus deltoides* in India from United Kingdom.¹ Poplar is fast growing, multipurpose tree species and can be harvested at short rotation of 7-8 years. Several promising clones [G series (Australian), SC, D and ST series (American)] were identified and planted extensively in north Indian states.^{2,3} Due to specific photoperiodic and temperature requirements, poplar has only a limited zone for plantation in India and has shown a potential for growth only in areas lying in north of 28° N latitude in states of Uttar Pradesh, Uttarakhand, Punjab, Haryana and Himachal Pradesh,⁴ but also tried in Chhattisgarh, Bihar and Maharashtra.

Poplar can contribute towards production of wood for industries and other commercial purposes, besides maintaining ecological balance in great extent. The poplar wood serve as raw material for fibre board, match sticks, plywood and packing industries, for making of pulp and paper, furniture and the artificial limbs, etc. The characters like clean bole, winter deciduous, multiple uses, soil improving properties, compatibility with agricultural crops and high economic returns make the species most ideal for agroforestry. Both block and boundary plantations of poplar have come up at large scale in north-western India.

New introductions and breeding work in India was initiated by Forest Research Institute, Dehra Dun, Uttarakhand State Forest Department, Lal Kuan, University of Horticulture and Forestry, Nauri and WIMCO seedlings Ltd. According to an estimate, 90% of the poplar plantations in India were based on the three clones. It is recommended that annual replacement of 5 to 10 % of existing clones with new superior clones to maintain the genetic diversity in fields, sustain production and reduce the outbreak of diseases and insects.⁵ Poplar plantations in a region have only small number of elite clones.^{6,7} Monoculture plantations increases the risk due to biotic stress such as leaf spots, cankers and rusts. With the change in rainfall patterns observed over north western plain zone in India, sleeper pathogens are becoming active and outbreak of foliar diseases has become more evident.^{8,9} Amongst foliar blights,

Bipolaris spp., *Myrothecium roridum*, *Alternaria alternata*, *Phoma* sp., *Curvularia* spp., *Sclerotium rolfsii*, *Rhizoctonia* sp. and *Fusarium solani* have been found associated with poplar nurseries and plantations under Punjab conditions.^{10,11,12} Emergence of new aggressive virulences in the pathogen can circumvents the resistance in the host and may lead to failure of plantations. Commercial poplar clones G-3, 3651 and 111101 suffered incremental damage in Haryana and Uttarakhand in nineties due to foliar blight caused by *Bipolaris* spp.¹³

There is a continuous need to evaluate/screen and introduce new clones and test them under different agro-climatic regions to find promising ones for diversification and sustainable wood production. This study was planned to evaluate poplar clones under the nursery conditions for growth, wood traits and tolerance to diseases.

Materials and Methods

Study Site

The study was carried out at research farm of Department of Forestry and Natural Resources, at main campus of Punjab Agricultural University, Ludhiana. The site is located at latitude of 30°56' N, longitude 75°52' E and at 247 m above mean sea height. The climate of this region is sub-tropical with hot and dry summers and very cold winters. The mean annual rainfall is 732 mm and almost 80 per cent of which occurs during *monsoon* season (July to September). The topography is plain with well drained, deep soils (inceptisols soils, USDA classification). The texture of soils is sandy loam having with lower humus content with soil pH of 8.0. The farm has good irrigation facility, mainly by tube well with occasional irrigations from canal water.

Experimental details and observations: The nursery trial was conducted for two years. During 1st year, 12 poplar clones (WSL-29, L-17/92, WSL-22, T-90, G-48, Ranikhet, S₇C₂₀, L-290/84, 22-N, 40-N, S₇C₈ and L-50/88) and 16 clones (added five new clones G-3, L-48/89, L-7/87, L-247/84 and L-34/82 and removed one poorly performing clone (T-90) were tried in 2nd year. Uniform cuttings (20 cm length and 3 cm diameter) were planted following randomized block design with five replications and plot size of 16 cuttings. The field was kept moist with light irrigations till the sprouting of the cuttings and all

the recommended practices of weeding, irrigation, fertilizer application, etc were applied uniformly to all the plots throughout the year. The plant height was recorded from the ground level to the tip with a long measuring scale and collar diameter was measured by vernier caliper at 5 cm above the ground level. Two randomly selected plants were digged from the soil. The shoot and root biomass was weighed after putting the samples into oven (70°C) for more than 48 hrs. The specific gravity was calculated by following Maximum-moisture method¹⁴. The wood

samples were macerated in a solution of 10 % chronic acid and 10% nitric acid for 24 hours and washed thoroughly with distilled water. The washed pulp was stained with saffranin (1 % alcohol) and fiber length and fiber width was measured under the compound microscope. Randomly selected plants were observed for diseases (*Pseudo cercospora* spp., *Alternaria* spp. and *Drechslera* spp) using 0 to 5 scale on the basis of per cent incidence as given below.

Disease Score	Per cent Incidence
0	No disease
1	up to 10 %
2	10 % to <20 %
3	>20 % to 40 %
4	>40 to 60 %
5	>60 %

The data on growth, wood traits and disease score were subjected to statistical analysis using CPCS statistical software, developed by Punjab Agricultural University, Ludhiana under Completely Randomized Block Design (CRBD). The means were compared with LSD ($p=0.05$).

Results & Discussion

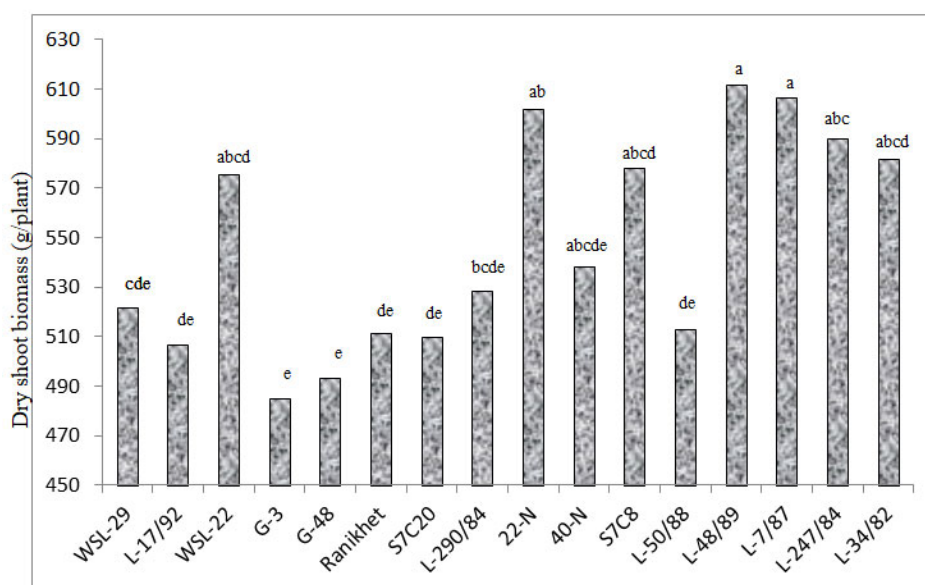
The data on plant height and collar diameter for both the years are given in Table-1. Both the growth parameters i.e. height and collar diameter witnessed significant differences among the clones for both the years. During the 1st year, clone 22-N registered the highest value (4.79 m) and was significantly superior to all clones except L-290/84 and L-50/88. The maximum value (3.68 cm) for collar diameter was recorded by clone L-290/84 which was however at par with five other clones i.e. L-50/88, 22-N, WSL-22, Ranikhet and S₇C₈. The bottom rank for height and collar diameter was in case of L-17/92 with respective values of 3.83 m and 2.60 cm. The plant height varied from 4.31 to 5.38 m during 2nd year. Clone L-7/87 recorded the top rank for height with value of 5.38 m and was superior to all clones except L-34/82. Clone L-34/82 was however at par with seven other clones i.e. 22-N, L-48/89, S7C8, WSL-22, L-247/84, L-50/88 and Ranikhet. The collar diameter varied from 2.69 to 3.22 cm. Clone L-7/87

again registered the highest value (3.22 cm) and was at par with two clones L-48/89 (3.09 cm) and L-247/84 (3.05 cm). The lowest value for height was recorded by L-17/92 (4.31 m), whereas clone 40-N registered the bottom rank for collar diameter with value of 2.80 cm.

The present study showed that ample variation existed among the clones for height and diameter. Such a significant variation may be due to their distinct genetic constitution. Earlier studies conducted in this region and elsewhere also support the findings. Significant difference among the *P. deltoides* clones for tree height was reported.¹⁵ The significant genetic variation for height and collar diameter among sixteen clones of *P. deltoides* in nursery were also found in a study conducted at Ludhiana for three consecutive years.¹⁶ Similarly the variation among poplar clones was also reported from many other regions of India and abroad.^{17,18,19}

Table 1: Mean values of growth traits of poplar clones planted under nursery conditions for two years

Clone	1 st Year		2 nd Year	
	Height (m)	Collar Diameter (cm)	Height (m)	Collar Diameter (cm)
WSL-29	4.26	3.07	4.76	2.91
L-17/92	3.83	2.60	4.31	2.82
WSL-22	4.28	3.45	5.07	2.97
T-90	4.12	3.16	-	-
G-3	-	-	4.42	2.80
G-48	4.18	3.00	4.75	2.83
Ranikhet	4.19	3.42	4.98	2.99
S7C20	3.97	3.00	4.57	2.77
L-290/84	4.48	3.68	4.93	2.90
22-N	4.79	3.54	5.13	2.94
40-N	3.84	3.10	4.95	2.69
S7C8	4.31	3.40	5.09	2.89
L-50/88	4.48	3.64	5.01	2.98
L-48/89	-	-	5.10	3.09
L-7/87	-	-	5.38	3.22
L-247/84	-	-	5.02	3.05
L-34/82	-	-	5.18	2.90
CD (p=0.05)	0.38	0.39	0.22	0.20

**Fig. 1: Variation among poplar clones for dry shoot biomass under nursery conditions**

The dry shoot biomass given in Fig 1 showed the significant differences among the poplar clones. L-48/89 registered the top rank with the value of 611.7 g/plant. It was superior to others except seven clones i.e. L-7/87, 22-N, L-247/84, L-34/82, S₇C₈, 40-N and WSL-22. The lowest value was recorded in the clone G-3 (485.0 g/plant). Values for dry root biomass varied from 171.2.0 gm to 238.8 gm (Fig 2). The maximum dry root biomass was noticed in clone L-7/87 (238.8 gm) which was at par with L-247/84, S₇C₈, L-48/89, WSL-22, 22-N and L-34/82. Again, the lowest value (183.0 g/plant) was recorded by clone G-3. The perusal of results indicated that significant variation existed among the clones for shoot and root biomass (Fig 1, Fig 2). Such variation may be due to

their genetics and may be exploited for identification of high yielding clones. Clones like L-7/87, S₇C₈, L-247/84 and L-48/89 recorded relatively higher biomass values. The findings of study²⁰ conducted on *P. deltoides* and *P. deltoides* X *P. nigra* was also in conformity with the findings of the present study. Significant variation for dry shoot weight, and dry root weight among fifteen clones of *P. deltoides* under nursery conditions while conducting a study at Hisar.²¹ Similarly, another study²² examined twelve poplar genotypes and found that above ground biomass production varied significantly among genotypes. The differences among the clones may be due to their varying genotypes, as uniform cultural conditions were applied to the plants.

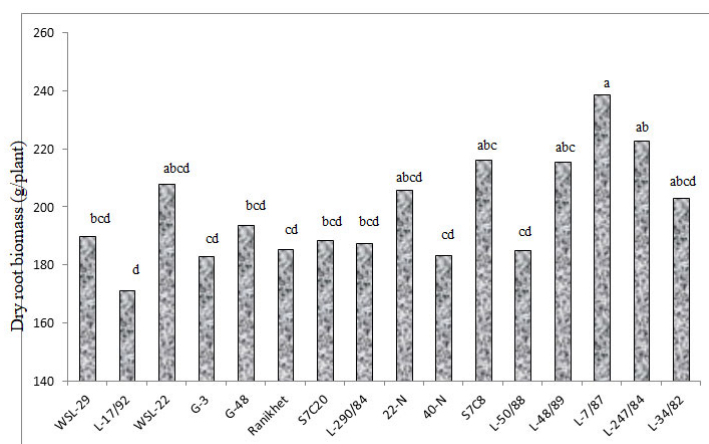


Fig. 2: Variation among poplar clones for dry root biomass under nursery conditions

Table 2: Variation in wood traits among poplar clones

Clones	Fibre length(mm)	Specific gravity
WSL-29	0.936	0.383
L-17/92	0.910	0.368
WSL-22	0.933	0.408
T-90	0.835	0.424
G-48	0.866	0.438
Ranikhet	0.874	0.404
S7C20	0.839	0.351
L-290/84	0.849	0.448
22-N	0.830	0.393
40-N	0.865	0.446
S7C8	0.798	0.394
L-50/88	0.891	0.431
CD (p=0.05)	0.54	0.37

The data presented in Table 2 showed the significant difference among the clones for fibre length and specific gravity. It was observed that clone WSL-29 recorded the maximum value (0.936 mm) for fibre length which was statistically higher than other clones except clone WSL-22 (0.933 mm), L-17/92 and L-50/88. Minimum value was noticed in clone S₇C₈ (0.798 mm) and at par with four other clones. The differences among clones for fibre width were not significant. Clone L-290/84 recorded the top rank for specific gravity with value of 0.448 and was at par with four clones i.e. 40-N, G-48, L-50/88 and T-90. The lowest value was attained by clone S₇C₂₀

which was at par with clones WSL-22 and L-47/92. The results are in conformity with the earlier studies from this region.^{23,24} The significant interclonal variations in anatomical parameters and specific gravity of 18 clones of *P. deltoides* were found.²⁵ Significant variation among the twenty clones of *P. deltoides* for wood characteristics was found.²⁶ Another study²⁷ also reported the significant variation among clones of *P. deltoides* for specific gravity and fibre dimensions. The significant genetic variation for fiber length and wood density was also noticed in *P. deltoides*,²⁸ *P. tomentosa*,^{29,30} *Populus x euramericana*³¹ and among hybrid poplar clones.³²

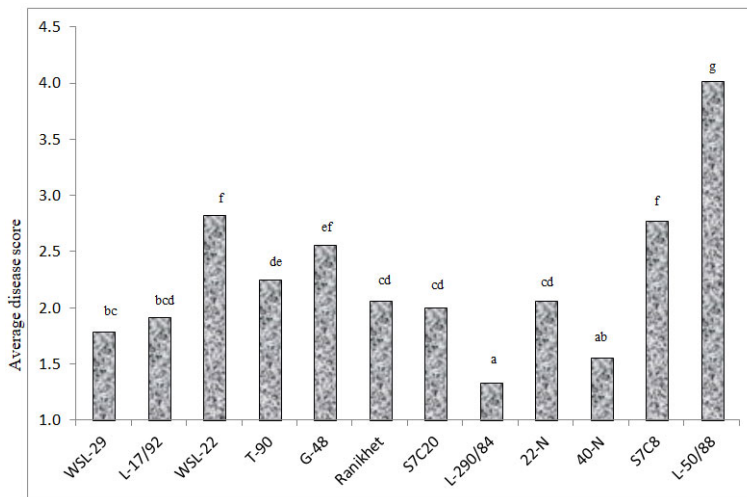


Fig. 3: Variation in leaf spot incidence on 12 poplar clones on basis of scale (1-5) (1st year)

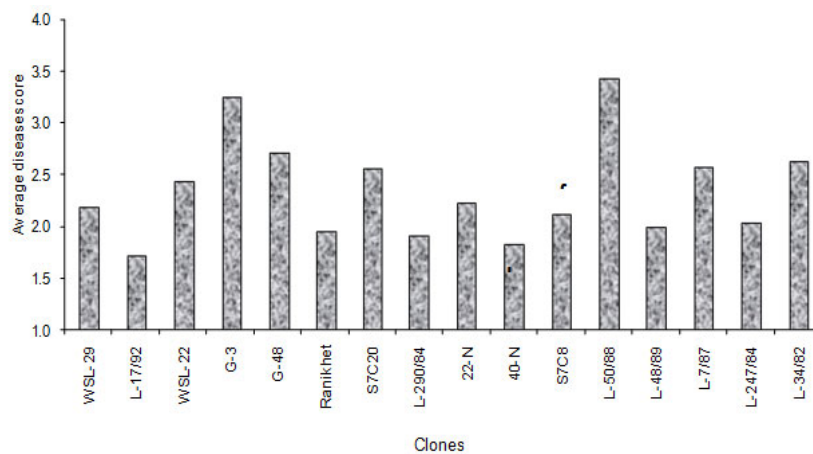


Fig. 4: Variation in leaf spots incidence on 16 poplar clones on basis of scale (1-5) (2nd year)

The plants were evaluated using 0 to 5 scale on the basis of visual observations for incidence of leaf spot disease during the months of July to October for two years. Leaf spot included different species of *Pseudocercospora*, *Alternaria* and *Drechslera*. Amongst 12 clones evaluated during first year, clone L-290/84 showed significantly ($p < 0.05$) highest resistance to foliar leaf spots with disease score of 1.3, closely followed by clone 40-N with score of 1.55 (Fig 3). During, the second year clone L-17/92 exhibited maximum resistance to leaf spot with average disease score of 1.7 and it was statistically placed together with WSL-29, Ranikhet, L-290/84, 22-N, 40-N, S₇C₈, L-247/84 and L-48/89 clones (Fig 4). Clone L-50/88 proved most susceptible in both years with the average disease score of 4.0 and 3.4, respectively (Fig 4). The perusal of results show that significant variation among clones for leaf spot incidence during both the years. Disease performance of some clones *viz.* L-290/84, L-17/92 and 40-N was not consistent in the years of evaluation. It may be attributed to variable response of the genotypes with ageing or influence of different climatic conditions prevalent in these years. Based on the response of clones L-290/84, 40-N, WSL-29, Ranikhet, L-290/84, 22-N, 40-N, S₇C₈, L-247/84 and L-48/89 to leaf spots, these can be further used in breeding programmes.

Foliar diseases of poplar can be controlled in nurseries with fungicides but it is difficult in plantations due to delay in early detection and inappropriate coverage of foliage with spray mixture. Therefore, incorporation of stable resistance against foliar blights and cankers and extensive screening is necessary for identifying and growing health clones and enhancing their field durability.^{33,34} Significant variation among clones of *P. deltoides*, *P. robusta*, *P. yunnanensis*, *P. trichocarpa*, and *P. eugenei* has been reported for leaf spot incidence.³⁵ Similarly, different disease reaction has been reported in commercial clones of *P. deltoides*, where WSL-39

came out to be resistant to foliar pathogens.^{36 37} classified poplar clones W39, W108, W22, Udai, W109, FRIAM 70 and WSL 22 as resistant to foliar diseases. Long term economic benefits can be gained only if clones with desirable characteristics are taken to field. The present study has revealed significant variation for all the growth traits and reaction to disease incidence. The clones which looked promising were L-48/89, 22-N, 40-N, L-290/84, and WSL-22. Clone L-50/88 had fast growth rate but was relatively susceptible to disease. The shortlisted clones need to be tested at multiple sites.

Conclusion

The present study has revealed significant variation for all the growth traits and reaction to disease incidence. Poplar clones L-290/84, 40-N, WSL-29, Ranikhet, L-290/84, 22-N, 40-N, S₇C₈, L-247/84 and L-48/89 were found promising as resistant stocks against leaf spots. Overall, the clones which looked promising based on growth, wood traits and resistance to leaf spot disease were L-48/89, 22-N, 40-N, L-290/84, and WSL-22. Clone L-50/88 had fast growth rate but was relatively susceptible to disease. The shortlisted clones need to be tested at multiple sites and these can be further used in tree breeding programmes.

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Conflict of Interest

The authors do not have any conflict of interest.

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