Print : ISSN 0970-7662

Journal of Tree Sciences

online available at www.ists.in

Volume 34

No.2

December, 2015

Development and Release of Clones: A Case Study of Screening 1999 Poplar Breeding Population at Wimco Seedlings

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ABSTRACT

Paper presents a protocol followed in developing two Populus deltoides Bartr. clones from the seed collected from crosses made among selected parents and from open pollinated trees of seven clones. The protocol includes intensive screening of seedling population for three years at nursery stage, seven years at two local level field trials and for varying period in four multiple field trials. Out of a base population of 2059 individual seedlings produced from full-sib and 19511 individuals from half-sib populations, 33 individuals from full-sib and 108 from half-sib populations were selected during the nursery screening phase. These 141 individuals plus G48 as control were planted at two sites, out of which 16 individuals- 2 from full-sib and 14 from half-sib were selected at the age of 7 years based on growth index (height and DBH) and quality index (stem straightness, clear stem and crown size). These 16 individuals were then clubbed with clones selected from other year poplar breeding populations and were planted at four sites. Out of these 16 clones of 1999 breeding population, two clones have been found outstanding from multiple field trials and are now being mass multiplied for supply to growers of the Tarai Region of Uttar Pradesh and Uttarakhand where these trials were conducted.

Key words:

Populus deltoides, clone, breeding population, selection index.

INTRODUCTION

Poplar (*Populus deltoides* Bartr.) is one of the domesticated trees grown on farm land in parts of Indogangetic plains of Northwestern India. The wide spread presence of poplars on the farmlands in the states of Punjab, Haryana, Western Uttar Pradesh and Tarai Region of Uttarakhand is enough testimony to the wide acceptance of the tree by the farmers. Its culture has now attain synergy with agriculture crop production (Dhiman 2012) where it is grown as cash crop and harvested at a very young age varying from around 4 years to 8 years rotation. Poplar now find uses for around three dozen products and huge economical activities based on its culture and usage is taking place throughout its region of intensive culture and elsewhere. One common feature of green revolution in agriculture sector has been constant development and release of new crop varieties from time to time to replace those which were less productive and susceptible to diseases and insect pests. Development and release of clones for long duration plantation species like poplars is more important for sustaining their culture (Virat 1982,



Chandra and Joshi 1994). Development of new clones in long duration tree crops requires a lot of patience, time and efforts to select outstanding ones in term of productivity, adaptability and resistance to insect pests and diseases. Poplar attains reproductive age in around 6-7 years under field conditions and produces abundant seed each year in the region of its intensive culture in India (Dhiman 2014). Poplar is largely a unisexual tree and its male and female trees are separate. Each plant produced from seed is therefore different from others and this creates a lot of variation in the newly produced seedling population. Breeding in poplar is also relatively easy, some Populus species had normal self hybridization in nature (Dhiman et al 2014). Seedling population thus has a lot of variation but only the useful one is carried forward in the selection process for making productive plantations with high degree of resistance to insect pests and diseases.

In India, poplar breeding and improvement work is carried out by a number of government and private sector institutes of which Wimco Seedlings (now unit of ITC-PSPD but earlier as a separate company); Uttarakhand Forest Department (earlier part of Uttar Pradesh Forest Department); University of Horticulture and Forestry, Solan; Forest Research Institute Dehradun, (Uttarakhand); G B Pant University of Agriculture and Technology, Pantnagar; and Punjab Agriculture University, Ludhiana have reported development of poplar clones (Dhiman 2014). Wimco Seedlings has been at the centre stage of poplar research and development for the last around four decades and the major poplar planted in India originates from the clones those have been developed, released and introduced by the company (Dhiman and Gandhi 2012). This paper presents the release of two clones by screening poplar breeding population produced during the year 1999 at Wimco Seedlings. It involved a complete protocol of hybridization through manipulated crosses (full-sib), collection of seed of selected female parents (half-sib) from open pollination, germination of seed, raising of plants in nursery beds, their handling till planted in nursery beds, screening for four years in

nurseries, local level and multiple trials and final selection of two outstanding individuals for their introduction in nursery production system and supply to the farming community.

MATERIAL AND METHODS

The process of hybridization for making crosses among selected parents for the year 1999 was started in July 1998 when plantlets of evergreen clone 65/27 developed in root trainers from mini cuttings were planted in nursery beds so that they attained a size of pencil thickness by January 1999 for making grafting of shoots having reproductive buds of selected female parents. Twelve female parents viz., 3324, A49, G48, Kranti, S7C8, S7C13, St72, St121, St171, WSL27, WS32 & WSL39 were selected, their shoots bearing reproductive buds were collected from the crown of mature trees and grafted on the stool beds of evergreen clone. Eighteen male clones selected for making crosses during the year were 72/58, 3167, 112910, 113324, 82-92-5, A26, G3, L34/82, S4C2, S4C21, S7C3, S7C4, S7C15, S7C20, St63, St 70, WSL22 and L154/84. The shoots bearing reproductive buds of these male clones were collected during the last week of Feb., 1999 when their buds started swelling. These shoots were kept in sugar solution in water (2.5%) in flask fully covered with muslin cloths to avoid contamination of pollen from other sources. Pollen from these shoots was collected in separate petri dishes, used for pollination for three successive days on each fresh opened female flowers, and stored in fridge for maintaining its viability. The brushing of pollen on each flower was done during the morning and evening hours for three successive days.

Control pollination between selected parents (clones) was done during March-April 1999 at R&D Centre, Bagwala. There were attempts to make 90 crosses between 12 female and 18 male clones of *P. deltoides* during 1999, out of which 32 combinations of crosses involving 9 female clones viz., G48, Kranti, S7C8, S7C13, St121, St72, St171, WSL32 & WS39, and 10 male clones viz., G3, St63, S7C3, S7C4, S7C20, 113324, 3167, 72/58, S4C21 and St70 were successful during the year. Crosses of G48 were made with G3, St63, St63,

S7C3, S7C4, S7C20 & 113324; Kranti with G3 & S7C3; S7C8 with G3, S7C3, S7C4, S7C20, St63, St70, 72/58, 3167 & 113324; S7C13 with G3, S7C3, St63 & St70; St121 with S7C3, S7C4, S7C20, S4C21 & St70; St171 with S7C3; WSL39 with S7C3; WSL32 with 113324; St72 with S7C3, S7C4 & St70. In case of male clones, crosses of G3 were made with G48, Kranti, S7C8 & S7C13; St63 with G48. S7C8 & S7C13: S7C3 with G48. Kranti. S7C8, S7C13, St121, St72, St171 & WSL39; S7C4 with G48, S7C8, St121 & St72; S7C20 with G48, S7C8 & St121; 113324 with G48, S7C8 & WSL32; 3167 with S7C8; 72/58 with S7C8; S4C21 with S7C8; and St70 with S7C8, S7C13, St121 & St72. Breeding orchard was frequently irrigated, kept weed free and adequate measures were taken to avoid insect infestation and premature fall of capsules/catkins which has been a common feature in poplar breeding orchards at Wimco Seedlings, Bagwala, Rudrapur.

Capsules started maturing in April-May, were collected during 4th week of April to 1st week of May 1999 when they started cracking and changing to brown colour. Catkins/capsules were also collected from mature trees of seven female clones (half-sib) G48, S7C8, S7C13, Wimco01, Wimco62, UN61 and Kranti those received pollen from unknown sources. Seed was manually separated by rubbing the cotton on the wire mesh and was sown immediately after collection. It was placed in small furrow marks in lines made with a stick on a light media filled in germination trays and kept inside mist chambers. Seed started germination in 2-3 days of period. Seedlings at two to four leaf stage were shifted in root trainers filled with a soil mix of soil: sand: decomposed FYM in equal ratio (1:1:1). The seedlings were maintained and grown with normal cultural operations including regular irrigation in root trainers. Seedlings were sprayed with water extracts of leaf blight (Bipolaris maydis) and rust infested leaves (Melampsoras pp) and also kept in beds having seedlings of susceptible clones so that susceptible seedlings are marked and culled at this stage itself. These seedlings were planted in nursery beds at normal spacing of 50X30 cm during July 1999

itself. Saplings during this year were subjected to rigorous screening for, growth form and disease & insect pest resistance during Nov.-Dec. 1999. Selected seedlings after culling out those not having good form and resistance to insect pests and diseases were further multiplied and again planted in nursery beds at normal spacing of 70X60 cm spacing during Feb., 2000, and Feb., 2001 for normal growth and another process for screening for the above parameters. Selected seedlings were also planted in alternate rows of susceptible clones to disease and pests during 2001.

Two randomized and replicated field trials were established using finally selected saplings during Feb., 2002, one each in Rampur District of Uttar Pradesh and another at Kichha Tehsil of Udham Singh Nagar District of Uttarakhand, both sites being in the Tarai Region near the Himalayan foothills. There were thus 142 treatments of clones (including G48 as control) with three replications and three trees in each replication planted at 5X4 m spacing. The fields having these trials had sugarcane as intercrop during the first two years and thereafter wheat during winters till the trees were harvested at 7 years age. The data for tree height, diameter at Breast height (DBH) and survival were recorded at 84 months of age. An index of height (m)*DBH(cm) and another composite quality index having a range from 1-10 for straightness of stem (1 for straightness and 10 for serpentine growth), and clear bole (1 for half the tree height without stem branches and 10 for branches towards the base of the trees) and crown size (1 for narrow and 10 for wide crown width) was also developed. Data for height and DBH were subjected to statistical analysis for comparison of average mean values of tested clones with control clone at 95% level of significance to draw inferences. Clones which had growth index over 30 and quality index below 2 were selected. The data in the results is presented only for the selected 16 individuals from both the local level field trials and is compared with the average of all the tried clones in the trials and also with that of control for drawing inferences on the performance of the

clones. The survival of the tested clones varied from 75% to 100% and there were non-significant differences in the mean values for this trait among clones. The data of survival and its interpretation is therefore not included in the paper.

RESULTS AND DISCUSSION

Out of a total of 90 crosses made, only 32 crosses could produce seed and seedlings. There were 2059 seedlings obtained from the crosses involving 9 female and 10 male clones. The details of seedlings/saplings at different stages on nursery screening are given in Table-1. Out of a total of 2059 seedlings produced, 1745 (84.75%), 1431(69.50%), 74(3.59%) and 33(1.60%) seedlings/saplings were retained after 1st, 2nd, 3rd and 4th s respectively during three years of nursery screening phase. A maximum number of

14 individuals were finally selected from female clone S7C8, followed by 7 from G48, 4 from S7C13, 4 from St121, 2 from St72, 1 from WSL 32, 1 from Kranti as female parents. In respect of male parents in manipulated crosses, 3 individuals were selected from G3, 3 from St63, 7 from S7C3, 3 from S7C4. 2 from S7C20. 7 from St70. 3 from 113324, 2 from 3167, 1 from 72/58 and 1 from S4C21. There were 17 cases where male clones could not produce viable seedlings and 14 cases where female parents could not produce viable seed. Out of 32 crosses, nursery screening for three years lead to selection of 33 individuals belonging to 18 crosses whereas, saplings of other 14 crosses were screened out and culled out at the nursery stage itself. Maximums election of three individuals were made from three crosses viz., one each from G48XS7C4, S7C8XG3and St121XSt72,

S. No.	Female	Male	No. prod	After 1st	After 2nd	After 3rd	After 4th
1	G48	G3	21	17	16	0	0
2	G48	St63	157	139	113	4	2
3	G48	S7C3	100	82	20	2	1
4	G48	S7C4	119	95	93	9	3
5	G48	S7C20	10	9	9	0	0
6	G48	113324	54	42	40	4	1
7	Kranti	G3	16	11	10	0	0
8	Kranti	S7C3	16	14	14	1	1
9	S7C8	G3	256	246	245	6	3
10	S7C8	S7C3	190	96	75	3	2
11	S7C8	S7C4	15	14	11	1	1
12	S7C8	S7C20	146	134	126	5	2
13	S7C8	St63	45	42	40	0	0
14	S7C8	St70	365	355	321	8	2
15	S7C8	72/58	80	70	20	2	1
16	S7C8	3167	23	21	20	4	2
17	S7C8	113324	42	23	20	4	1

Table- 1. Screening of seedlings/saplings grown from crosses made between different parents.

S. No.	Female	Male	No. prod	After 1st	After 2nd	After 3rd	After 4th		
18	S7C13	G3	5	5	5	0	0		
19	S7C13	S7C3	60	42	41	1	1		
20	S7C13	St63	9	8	8	1	1		
21	S7C13	St	30	29	29	3	2		
22	St121	S7C3	16	12	10	1	0		
23	St121	S7C4	16	15	15	1	0		
24	St121	S7C20	10	9	7	0	0		
25	St121	S4C21	7	4	4	1	1		
26	St121	St	63	55	44	7	3		
27	St72	S7C3	64	54	49	5	2		
28	St72	S7C4	10	9	8	0	0		
29	St72	St	16	15	0	0	0		
30	St171	S7C3	73	60	0	0	0		
31	WSL 39	S7C3	9	4	4	0	0		
32	WSL 32	113324	16	14	14	1	1		
Total 2059			2059	1745	143	74	33		
Per	cent Sele	ected		84.75	69.50	3.59	1.60		
Per cent	Per cent Rejected 15.25 30.50 96.41 98.40								

Table 2 Multistage screening of 1999 half-sib population in the nursery.

Sr. No.	Parent		Seedlings (No.)					
		produced	After 1 st	After 2 nd	After 3 rd	After 4 th		
			screening	screening	screening	screening		
1	G48	1559	1356	0	0	0		
2	S7C8	4489	3903	3209	126	35		
3	S7C13	9326	8858	7499	174	61		
4	Wimco01	276	240	0	0	0		
5	Wimco62	121	100	0	0	0		
6	UN61	3716	3018	2752	54	11		
7	Kranti	24	17	4	1	1		
	Total	19511	17492	4	1	1		
Per cent selection			89.65	69.01	1.82	0.55		
Per cent rejection			10.35	30.99	98.18	99.45		

In case of open pollinated population, 19511 number of seedlings were raised from seed collected from trees of seven clones viz., G48 (1559), S7C8 (4489), S7C13 (9326), Wimco01 (276), Wimco 62 (121), UN61 (3716) and Kranti (24). There were four screenings of these seedlings in three years during the nursery production phase. Out of a total of 19511 seedlings produced, 17492 (89.65%), 13464 (69.01%), 355 (1.82%), and 108 (0.55%) seedlings were retained after 1st, 2nd, 3rd and 4th screening respectively. After third screening, individuals were multiplied in adequate numbers for field trials with only those clones which were passed through 4th screening. The screening process was same as was followed for full-sib population given above.

There was a long list of 142 clones (including G48 as control) in both these trials and the data given in Table-3 and Table-4 is for only 15 and 13 clones (plus G48 as control) of 1999 breeding population in local level field trial I and II respectively. The data for height, DBH and index was not presented for the remaining 126 and 129 clones of trial 1 and trial 2 respectively to save space in this manuscript

and also to simplify the presentation and understanding of the good performing clones. Clone No. 53 (Code 53/9.99) and 299 (code 299/6.99) in field trial 1 and clone 7 (code 73/7.99) in trial 2 did not have similar good performance in both the local level field trials and hence they represent good performance only in one trial. In both these trials, there were significant differences in height and DBH growth at the end of 7 years growth among different clones. Most of these clones produced significantly higher mean values for height and DBH when compared with mean values of 142 clones and also in most cases when compared with that of G48 clone (control). Despite a few individuals showing mean values for height and DBH near the control and mean values, they had better quality index than the remaining ones and therefore they were selected for further trial. There was not much variation regarding standard error (SE) and Covariance (COV) within 9 ramets (from three replications) for each clone and each trial and therefore their interpretation and discussion is ignored.

Table 3. Growth data of individuals selected from local level field screening of 1999 full-& half-sibpopulation at Chandain Farm, Bilaspur, Rampur.

S1. No.	o. Individual Individual Par		Parents	Final size (mean		
	Number	Code		Height (m)	DBH(cm)	
1	13	13/2.99	S7C13	22.0(1.22)05	20.2(3.21)16	
2	53	53/9.99	S7C13	24.4(0.24)01	23.0(0.31)01	
3	92	92/3.99	S7C13	24.1(0.87)03	24.6(1.39)06	
4	106	106/10.99	S7C13	21.7(1.98)09	20.0(2.15)11	
5	110	106/10.99	S7C13	23.7(1.42)06	21.8(2.46)11	
6	174	174/11.99	UN 61	23.4(1.50)06	21.5(1.71)05	
7	186	186/16.99	S7C8	24.7(0.82)03	24.2(1.00)04	
8	219	219/17.99	S7C13	24.2(0.24)01	24.4(0.79)03	
9	229	229/1.99	S7C13	24.7(1.31)05	23.3(0.69)03	
10	299	299/6.99	G-48 X St -63	24.0(1.41)06	21.8(2.39)11	
11	309	309/12.99	S7C8	22.7(0.72)03	21.1(0.44)02	
12	324	324/14.99	S7C8 X 113324	25.2(0.51)02	24.6(0.57)02	

S1. No.	Individual	Individual	Parents	Final size (mean(SE)Cov)		
	Number	Code		Height (m)	DBH(cm)	
13	368	368/13.99	S7C8	22.7(0.16)01	20.8(1.24)06	
14	412	412/5.99	S7C8	23.3(1.64)07	22.5(1.05)05	
15	K/S	KS/15.99	Kranti	23.8(0.86)04	24.9(0.95)04	
16	G-48 (Contro	ol)	23.3(0.43)02	20.0(0.8)04		
Mean(SD)CV				22.9(1.04)04	20.9(1.53)07	
SE diff				0.84	1.11	
CD 0.05				1.65	2.18	

Table 4. Growth data of individuals selected from local level field screening of 1999 full- & half-sibpopulation at Rajpura Block, Kichha, Uttarakhand.

S1.	Individual	Individual	Parents	Final size(mean(SE)Cov)			
No.	Number	Code		Height (m)	DBH(cm)		
1	13	13/2.99	S7C13	22.7(1.59)07	20.4(1.44)07		
2	53	53/9.99	S7C13	23.2(1.36)06	21.2(2.73)13		
3	73	73/7.99	S7C13	24.5(1.06)04	22.7(1.38)06		
4	92	92/3.99	S7C13	26.6(0.63)02	28.7(1.65)06		
5	106	106/10.99	S7C13	25.5(0.65)02	25.8(1.03)04		
6	174	174/11.99	UN - 61	25.7(0.57)02	26.5(0.46)02		
7	186	186/16.99	S7C8	25.4(0.75)03	24.0(0.96)04		
8	219	219/17.99	S7C13	24.4(1.12)05	23.5(2.23)09		
9	309	309/12.99	S7C8	24.7(0.16)01	26.0(2.27)09		
10	324	324/14.99	S7C8 X 113324	24.2(0.24)01	21.7(0.39)02		
11	368	368/13.99	S7C8	25.9(0.82)03	25.3(1.18)05		
12	412	412/5.99	S7C8	24.5(0.57)02	24.8(2.02)08		
13	K/S	KS/15.99	Kranti	24.9(0.19)01	25.3(1.75)07		
14	G 48 (Contr	ol)		22.7(0.52)02	19.9(0.89)04		
Mean(SD)CV			23.6(1.07)04	21.5(2.05)09		
SE diff				0.72	1.21		
CD 0.05				1.41	2.37		

From these two local level field trials, 2 clones from manipulated crosses viz., one each from G48X St63 and S7C8X 113324; and 14 clones from open pollination of 4 parents viz, 8 from S7C13, 4 from S7C8, 1 from Kranti, and 1 from UN61 were selected based on growth index and quality index for their further field trials. Out of these 16 clones, only 8 clones have expressed their sex (5 as male and 3 as female) during the trial period. 5 of 8 clones having male sex at this stage may still not be conclusive proof of the formers having better growth and productivity when compared with that with the female ones. Dhiman and Gandhi (2012) have already indicated that expression of male sex in poplar trees is earlier in than in female clones. Presently, Wimco Seedlings grow planting stock of around 18 clones out of which the leading one viz., Wimco 110, WSL 32, WSL 39 and G48 have more than 50% of the total planting stock produced are from these four female clones. There is another version of poplar culture related to male clones in India. For example, a male clone G3 was once the most dominant clone having over 90% of total poplar planted during 1990's before it became highly susceptible to *Bipolaris* leaf blight and now its share is less than 1% and that too in only dry locations where infestation of leaf blight is not noticed.

Since there was some variation among ramets of same ortets, may be due to local micro level site factors, the data of the height, and DBH of the best growing ramets in each clone was recorded and their growth and quality index was developed (Table-5). Multiple parameters are used for selection of individuals in such trials (Pryor and Willing 1965, Mohn and Randall 1971, Stanaton et al. 2014). We followed the approach as mentioned above since most of the poplar grown in India is on farm fields and therefore the parameters followed here are based on tree growth and architect. The best performing individual ramets out of these local level trials were thus selected based on growth index and quality index (Table-5) and were carried forward for multiple field trials in the Tarai Region.

Table 5. The individuals selected out of the above two local level trials based on a composite index of growth and straightness

Sr. No.	Ind. No.	Ind. Code	Pare	ent	Growth months	at 84 age	Index		Sex
			Female	Male	Height (M)	DBH (cm)	Growth (H*D)	Quality	
1	13	13/2.99	S7C13		24.6	25.6	6.2976	1	
2	53	53/9.99	S7C13		26.6	23.8	6.3308	2	
3	73	73/7.99	S7C13		24.6	25.2	6.1992	2	
4	92	92/3.99	S7C13		25.6	26.3	6.7328	2	
5	106	106/10.99	S7C13		26.6	31.4	8.3524	2	F
6	110	110/4.99	S7C13		25.6	25.7	6.5792	2	
7	174	174/11.99	UN 61		25.6	28.3	7.2448	2	Μ
8	186	186/16.99	S7C8		26	24.7	6.422	2	М

Sr. No.	Ind. No.	Ind. Code	Parent		Growth at 84 months age		Index		Sex
			Female	Male	Height (M)	DBH (cm)	Growth (H*D)	Quali ty	
9	219	219/17.99	S7C13		26	27.3	7.098	2	F
10	229	229 / 1.99	S7C13		23.4	24.5	5.733	2	
11	299	299/6.99	G48	St63	26	25.6	6.656	1	
12	309	309/12.99	S7C8		27.6	31.1	8.5836	2	М
13	324	324/14.99	S7C8	113324	27.6	31	8.556	2	М
14	368	368/13.99	S7C8		24.6	24.7	6.0762	2	F
15	412	412/5.99	S7C8		25	23.1	5.775	1	
16	K/S	KS/15.99	Kranti		26.6	28.7	7.6342	2	М

Table 6. Performance of selected clones of 1999 breeding population clubbed with those of other years at multiple trials in the Tarai Region.

Location	Trial established in Feb ., during	Data recorded after (months)	No. Of clones in the trial	Leading clone of 1999 population	Height (m)	DBH (cm)
Chandain Farm,	2012	36	280	7.99	14.1	13.1
Uttar Pradesh				14.99	17.1	15.6
			Average of clones	280	12.7	11.6
Chandain Farm,	2010	60	85	7.99	15.7	16.7
Bilaspur, Rampur, Uttar Pradesh			Average of	85 clones	14.8	16.1
PPL, Kichh a,	2011	48	12	14.99	18.8	18.1
U.K.			Average of 12 clones		15.7	14.8
PPL, Kichha, Rudrapur, U.S.N	2011	48	283	7.99	20.5	21.2
Uttarakhand			Average of clones	283	19.1	18.4

The results of these four trials clearly confirm better performance of two clones viz., 73/7.99 and 324/14.99 in term of their selection index. One of them is from half-sib (73/7.99) and another one from full-sib cross (324/14.99). The earlier nursery screening for three years and field testing for 7 years at two locations having randomized and replicated trials also confirmed their good performance for recorded qualitative and quantitative parameters. Dhiman and Gandhi (2006) while reviewing poplar clonal testing over 150 acre Chandain Farm for over two decades have confirmed that repeated testing of poplar clones is necessary for their adoption in any locality as they are grown on farm land with agricultural crops and each field receives variable cultural and management inputs each season, year and over the tree growth period as many agricultural crops are grown with these trees.

Poplar improvement carried out at Wimco Seedlings could enable sustenance of poplar culture in the country. Clone G3 one of the leading clones throughout the RIPC during 1980s suddenly developed very high susceptibility to leaf blight (Bipolaris maydis) causing repeated defoliation and drying of trees and nursery saplings. Indigenously developed Udai clone (Wimco's clone) occupied the space vacated by G3, though G48 which was at $2^{nd}-3^{rd}$ place earlier started commanding first position thereafter. Newly developed two clones from the present study now have proved their good performance at local level trials in Tarai Region. Their descriptors are now being documented as per ITC guidelines and would be sent for registration in the IPC register. They are also now multiplied in adequate number for supply to the growers in Tarai Region and also for under taking multi-location trials in the entire poplar growing region of Uttar Pradesh, Uttarakhand, Punjab and Haryana before being supplied to the growers of those states.

Development of new clones is necessary to maintain poplar culture by replacing those old aging ones on becoming susceptible to diseases and pests with that of fast growing ones yielding higher wood and value to the growers and also to match them to site specific niches. Wimco's poplar programme integrates well with the practical application in poplar culture since its newly developed clones are always tested on farm fields where different agricultural crops grown with trees. Such clones are therefore better accepted by the farming community and hence this programme is helping a great deal in maintaining and sustaining its culture. The bulk of intensive poplar culture in India is grown at low latitudes where non of poplar species have ever existed in the past and is largely dependent on a limited germ plasm of low latitude populations of P. deltoides (Virat 1982, Land and Singh 1998). New inter-species crosses with *P. ciliata* and *P. deltoides* have also been developed (unpublished) which are under field testing stage. This will further help in broadening the genetic base of poplar culture and its sustenance in India.

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