ESTABLISHMENT OF BREEDING ORCHARD OF *POPULUS DELTOIDES* BARTR.

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Introduction

The forecast about demand and supply of wood for 2000 A.D. for India shows a very wide gap and the demand far exceeds the supply (Chaturvedi, 1982). Average production of wood in India is 0.7 m^3 per hectare per year, whereas intensively managed Poplar plantations with superior clones yield 29.3 m^3/ha at the age of 5-7 years (Verma, 1993). The estimated annual demand for fuelwood is 234 million m^3 against production of 40 million m^3, and the annual demand for industrial wood in India is 27.5 million m^3 against production of 12 million m^3 (Tewari, 1993). At the same time the growth of population and industry is increasing the pressure on the country's resources, subverting all the balances. Therefore, it is very essential to grow as much as possible in the shortest period of time.

Industrial plantations with the fast-growing species are most important potential source to fill this gap. High priority has, therefore, been given to cultivation of Poplar and development of site-specific clones (Land and Singh, 1998).

Poplar is among the fast-growing industrial tree species which can be grown both in pure stands as well as in association with agriculture crops (agroforestry systems). Its wood is light and homogeneous, and does not have any taste and flavour. The wood is in demand for plywood, match splints, pulp, medium density fibre board, packing cases for fruit and industrial goods, sports goods, furniture etc.

Realising the importance of poplars, France created its National Poplar Commission in 1942. In 1947, the International Poplar Commission was set up under the aegis of the Food and Agriculture Organisation (FAO). India became a member of the International Poplar Commission in 1965. The Forest Research Institute (FRI) Dehra Dun started introduction programme of poplars as early as in 1950 with a view to select suitable species and clones of *Populus*. In 1958, FRI, Dehra Dun initiated a systematic programme of introduction and research on Poplar when 24 clones of various hybrids were obtained from Forestry Commission in England. Since then several species, clones and cultivars of exotic poplars have been introduced, multiplied and tested by FRI, Dehra Dun, State Forest Department, Haldwani (Uttaranchal), Dr. Y.S. Parmar

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Among the successful exotic poplars introduced in India, the most widely planted species is *P. deltoides*. It is grown on a large scale in the Tarai region of Uttar Pradesh and the plains of Punjab, Haryana, Himachal Pradesh, Uttar Pradesh and Arunachal Pradesh. A large number of exotic clones of these species are grown in field plantations, e.g., Australian selections viz. G3 and G48 of *P. deltoides*, American selections viz. D66, D121, D75 and D81 of *P. deltoides*, Italian selections viz. Lux 69/55 of *P. deltoides* and 72/58 of *P.* x *euramericana*, etc. Some of the new clones, introduced recently, which have shown promise in agroforestry systems, are S7C4, S7C8, S7C15, S7C20, etc. Clones of 'L' series developed by State Forest Department at Haldwani Research Centre (Uttaranchal) from open-pollinated seeds of G48 and D121 mother plants have shown encouraging results and they are soon expected to become more popular among the farmers than the existing clones under cultivation (G3, G48). WIMCO Seedlings Ltd., Rudrapur (Uttaranchal) has also come out with some clones namely Udai, Kranti and Bahar which are also being planted by the farmers. However, the clones developed by Uttaranchal Forest Department and WIMCO Seedlings Ltd. have very narrow genetic base and, as a result, none of the L-series clones could perform better than G48 in clonal field trial in Punjab (Sidhu, 1996). In order to explore the possibility of augmenting the genetic base of new clones, Kumar *et al.* (1999) and Singh *et al.* (1999) suggested breeding among 40 best clones which were classified into four populations on the basis of geographic origin and field performance. Assembling the best clones would enable to increase the probability of finding more heterotic hybrids by creating greater genetic variability through the fixing of gene complexes for recurrent selection.

Breeding orchard of *P. deltoides* has so far not been raised in India. A plantation of mature trees in reproductive phase is required in order to undertake a continuous, long-term genetic improvement programme of this species at FRI, Dehra Dun. In view of this, the authors have recently established a breeding orchard at FRI, Dehra Dun. Individuals rationally selected from different geographic origins have been included in the orchard for seed production for the subsequent screening and release of new clones possessing characteristics such as higher productivity, disease resistance, pest resistance, etc.

In view of the above scenario, the aims of Poplar breeding are as follows :

1. To create wide spectrum of Poplar clones which are adapted to the site conditions of India.
2. To improve the quality of stem form and timber.
3. To improve the growth rate (fast growth, high yield).
4. To develop greater tolerance to biotic and abiotic stresses.
5. To produce timber suitable for diversified utilisation.
6. To increase the chance for intra-population and inter-population mating, which will yield a range of new genetic variability for recurrent selection and testing.
7. To increase the frequency of extreme genotypes.

Material and Methods

For the establishment of a breeding orchard of Poplar (*P. deltoides*), geographical origins of the clones were determined. These clones were ranked as per their field performance in the plantations raised by Uttaranchal Forest Department, Haldwani. The available clones were classified into four populations.

Sex identification of Poplar clones was carried out in the experimental plantations raised by Uttaranchal Forest Department at Gangapur Patia, Phoolbagh and Tanda. Branch cuttings from the leading shoots of selected clones were brought to FRI, Dehra Dun in January, 1997 and ETPs were raised in the nursery.

The breeding orchard was established at FRI, Dehra Dun in February 1998 with the planting of 40 clones of *P. deltoides* (Table 1) in pits of size 60 x 60 x 90 cm^3. Each female clone was represented by two ramets and each male clone by one ramet. Planting was done in alternate rows of male and female clones. Planting was done at the spacing of 7m x 7m. Ten clones, namely, L-200/84, L-34/82, Udai, # 36, UD-88, PD-1, 100-7, 103, UD-55 and 98 (Table 2) developed by State Forest Department, Haldwani WIMCO Ltd. and Dr. Y.S. Parmar University of Horticulture and Forestry, were further added to the orchard in 1999.

Discussion

Valuable individual genotypes of tree species in general, and poplars in particular, have originated by random mating in nature. The need for establishment of white Poplar seed orchard was first emphasised by Bartha (1996) in Hungary. Breeding orchard of *P. deltoides* had not so far been established anywhere in India, although germplasm banks or clonal banks have been developed by different organisations in the country. The present breeding orchard of FRI, Dehra Dun has been established on the basis of systematic survey, collection and evaluation of desirable geographical races. The main objective of establishment of breeding orchard will be production of progeny with different combinations of parents, and selection of desirable genotypes will be done from progeny trials.

The following principles constituted the basis of developing the breeding orchard :

- To maximise pollination among clones of the four different populations and achieving greater seed set, alternate rows of male and female clones were planted.
- Two ramets of each female clone and one ramet of each male clone were planted at sufficiently wide spacing to allow crown development and reproductive growth.
- In order to avoid pollen contamination, an isolation strip of at least 600 m is necessary around the seed orchards. Extraneous trees of *Populus deltoides* do not exist up to a much greater distance than this limit from the newly-established breeding orchard.
- The seeds from the clonal seed orchard of *P. deltoides* will serve as a perennial source of new genotypes for recurrent selection in Poplar improvement.
- In view of dioecious nature of the species the clonal seed orchard is

Table 1

Populus deltoides clones ranked based on stem volume performance and identification of sex

Clone	Rank	Origin			Source country of clone	Sex
		Latitude	Longitude	Place (County, State)*		
1	2	3	4	5	6	7
S7C8	1	31°00' N	96°30' W	Brazos Texas	USA	F
82-35-4	2	31°00' N	96°30' W	Brazos Texas	USA	F
113324	3	30°37' N	91°00' W	E.Baton Rouge, Louisiana	USA	M
G48	4	31°00' N	96°30' W	Brazos Texas	Australia	F
3167	5	30°55' N	91°40' W	Robertson Texas	USA	M
3324	6	30°37' N	91°00' W	W. Baton Rouge Louisiana	USA	F
A-13	9	31°14' N	87°55' W	Clarke Alabama	Germany	M
D74	10	33°00' N	91°00' W	Issaquena Mississippi	USA	M
D75	11	33°00' N	91°00' W	Issaquena Mississippi	USA	M
S4C21	12	30°30' N	94°30' W	Liberty Texas	USA	M
82-33-3	13	31° N	98° W	Llano Texas	USA	F
ST-72	14	33°00' N	91°00' W	Issaquena Mississippi	USA	F
D121	22	33°00' N	91°00' W	Washington Mississippi	USA	F
2502	31	33°30' N	91°00' W	Washington Mississippi	Netherlands	M
421-2	46	30°32' N	91°48' W	St. Landry Louisiana	USA	M
111828	7	32°07' N	91°00' W	Claiborne Mississippi	USA	M

Contd...

1	2	3	4	5	6	7
113520	-	31°00' N	91°00' W	Issaquena Mississippi	USA	M
A-194	57	31°14' N	87°55' W	Clarke Alabama	Germany	M
D171	23	34°10' N	91°00' W	Coahoma Mississippi	USA	F
82-42-5	19	approx. 30° N	approx 97°W	Victoria Texas	USA	M
D82	25	33°00' N	91°00' W	Issaquena Mississippi	USA	M
S7C2	30	31°00' N	96°30' W	Brazos Texas	USA	M
3567	35	30°08' N	85°05' W	Liberty Florida	USA	F
82-40-2	39	31°00' N	96° 30' W	Brazos Texas	USA	F
113413	36	30°00' N	86°00' W	Liberty Florida	USA	F
G3	54	31°00' N	96°30' W	Brazos Texas	Australia	M
S13C11	56	33°00' N	93°50' W	Bowie Texas	USA	M
S7C7	27	31°00' N	96°30' W	Brazos Texas	USA	M
ST-124	24	33°00' N	91°00' W	Issaquena Mississippi	USA	F
S7C4	20	31°00' N	96°30' W	Brazos Texas	USA	M
S4C2	-	31°00' N	96°30' W	Brazos Texas	USA	M
S7C15	16	31°00' N	96°30' W	Brazos Texas	USA	M
S7C20	17	31°00' N	96°30' W	Brazos Texas	USA	M
S13C14	51	33°00' N	93°50' W	Bowie Texas	USA	M
D67	28	33°00' N	91°00' W	Issaquena Mississippi	USA	M
S7C1	29	31°00' N	96°30' W	Brazos Texas	USA	M

Contd...

1	2	3	4	5	6	7
404-3	-	33°00' N	91°00' W	Issaquena Mississippi	USA	M
82-36-1	33	30°30' N	94° 30' W	Liberty Texas	USA	M
82-26-5	43	32°30' N	96°50' N	Dallas Texas	USA	F
110702	15	33°46' N	91°00' W	Bolivar Mississippi	USA	F

Table 2

Clones of Populus developed in India which have been planted in the breeding orchard

Clone	Source	Parentage	Sex
L-200/84	State Forest Department, Haldwani	G48 x G3	Female
L-34/82	State Forest Department, Haldwani	G48 x G3	Female
Udai	WIMCO Seedlings Ltd., Rudrapur	G48 x G3	?
# 36	Univ. of Horti. & Forestry, Solan	Open-pollinated selection U.S.A.	?
U.D.-88	Univ. of Horti. & Forestry, Solan	Open-pollinated selection U.S.A.	?
P.D.-1	Univ. of Horti. & Forestry, Solan	Open-pollinated selection U.S.A.	?
100-7	Univ. of Horti. & Forestry, Solan	Open-pollinated selection U.S.A.	?
103	Univ. of Horti. & Forestry, Solan	Open-pollinated selection U.S.A.	?
U.D.-55	Univ. of Horti. & Forestry, Solan	Open-pollinated selection U.S.A.	?
98	Univ. of Horti. & Forestry, Solan	Open-pollinated selection U.S.A.	?

Note : '?' indicates that sex is not known at this stage. These clones are included on the basis of outstanding performance in the field.

Table 3

Breeding population candidates in breeding orchards

Population # 1		Population # 2		Population # 3		Population # 4	
Clone	Sex	Clone	Sex	Clone	Sex	Clone	Sex
S7C8	F	S4C21	M	D74	M	113324	M
82-35-4	F	82-33-3	F	D75	M	3324	F
G48	F	82-42-5	M	ST-72	F	111828	M
3167	M	82-36-1	M	D121	F	A-13	M
S7C15	M	82-26-5	F	D171	F	3567	F
S7C20	M	421-2	M	ST-124	F	A-14	M
S7C4	M	S13C14	M	D82	M	404-3	M
S7C7	F	S13C11	M	D67	M	113413	F
S7C1	M	82-40-2	F	2502	M	113520	M
S7C2	M	S4C2	M			110702	F
G3	M						

Population # 1 - Brazos County, Texas, USA
Population # 2 - South and Eastern Texas, USA
Population # 3 - West Mississippi
Population # 4 - South Mississippi, South Louisiana, South Alabama and West Florida

suitable for obtaining the seed to assess the genetic components of half-sib progenies of female clones.

- Reproductive buds will become available for control-pollination to produce full-sib families.

Such a breeding orchard of mature trees of *P. deltoides* will help in undertaking continuous, long-term breeding work of this species. Outstanding clones that may develop from the germplasm of the USA origin, which has recently been introduced in FRI, Dehra Dun, will also be accommodated as to further broaden the genetic base in due course of time.

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SUMMARY

In order to maximise the chances of inter-population and intra-population open-pollination in *Populus deltoides*, a breeding orchard has been established at Forest Research Institute, Dehra Dun. The orchard will also provide reproductive buds for undertaking control-pollination among promising clones of this species. Seventeen female clones and 25 male clones have been planted in the orchard. Eight outstanding clones, which are yet to manifest their sex, have also been included in the orchard.

पोपुलस डेल्टायडिस का प्रजनन उद्यान स्थापित करना

एन०बी० सिंह, दिनेश कुमार, जी०एस० रावत व आर०के० गुप्त

सारांश

पोपुलस डेल्टायडिस में अन्तर्सस्य और अन्तर-सस्य खुला परागण होने के अवसर अधिकतम बनाने के लिए वन अनुसन्धान संस्थान देहरादून में एक प्रजनन उद्यान स्थापित किया गया है । इस उद्यान से इस वृक्षजाति के उत्साहप्रद कृन्तकों में नियन्त्रित परागण कराने के लिए पुनरूत्पादी कलिकांए भी उपलब्ध कराई जा सकेंगी । उद्यान में सत्रह मादा (स्त्रीलिंग) और पच्चीस नर (पुर्लिंग) कृन्तक उगाए गए हैं । इनके अलावा आठ अन्य अत्युत्तम कृन्तक, जिनका लिंग भेद अभी प्रकट नहीं हो पाया है, भी इस उद्यान में लगाए हुए हैं ।

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