Indian Forester, **139** (12) : 1079-1083, 2013
http://www.indianforester.co.in

ISSN No. 0019-4816 (Print)
ISSN No. 2321-094X (Online)

GROWTH BEHAVIOUR OF POPLAR (*POPULUS DELTOIDES*) CLONES UNDER FARM FORESTRY

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ABSTRACT

The study was conducted to explore the growth performance of different clones of *Populus deltoides* under farm forestry. The experiment was established during February, 2006 with six poplar clones under two environments i.e. pure poplar plantation and agroforestry plantation (poplar with wheat and mung) and laid out in Split Plot Design with three replications. Results of the studies revealed that all growth parameters of poplar clones i.e. DBH, height and crown spread exhibited better performance under agroforestry plantation. Overall, clone SWL 22 showed best performance under both the environments.

Key words: Growth behaviour, Poplar, Clones, Farm forestry.

Introduction

In the developing countries like India, traditionally, trees occupy a place of paramount importance in meeting the basic needs of timber, fodder and energy. But, unabated deforestation brought about by increasing population over the years has swelled up the demand for wood and wood products coupled with the problems of soil erosion, floods, land slides, silting of reservoirs, drought, air, water and noise pollution, etc. The supply of wood from forest reserves has gradually declined over the years, which have resulted into the widening of gap between demand and supply of forest produce. To minimize the gap, an insight into the aforesaid situation clearly revealed that there is an urgent need to evolve some strategies, which should focus on sustainable development of all land use systems.

Punjab is the richest state in the country in term of per capita income and has earned the name as food bowl of the country. Achieving high productivity without caring for natural resources has resulted in a considerable loss in the inherent production potential and deterioration of soil health. Stating the scenario of forestry in Punjab, figures are really discouraging. The recorded forest area of Punjab is 3,084 km^2, which constitutes only 6.12 per cent of the total geographical area of the state against the 33 per cent target of National Forest Policy of 1988 (FSI, 2005). The only option, which finds some rays of hope is farm forestry, which is a dynamic, ecologically based, natural resource management system that through the integration of trees on agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels, seems to hold promising potential.

Poplar (*Populus deltoides*), being among the fastest growing exotics with short rotation is most suitable farm forestry tree on the agricultural landscape. Though, the *P. deltoides is* widely planted in Punjab, yet only few genetically improved clones have been identified and given to the farmers so far. For the last two decades farmers have planted mostly two clones i.e. G-48 and G-3 on large scale and 90 per cent of all clones planted have begun to exhibit signs of susceptibility to a variety of pathogens (Chandra, 2001). Therefore, introduction and evaluation of different poplar clones is a continuous process, which has assumed a great significance in plantation forestry. Keeping in view the utility of poplars in farm forestry this study was undertaken to evaluate and analyze the growth performance of different poplar clones.

Material and Methods

The present investigation was carried out at the experimental area of the Department of Forestry and Natural Resources, College of Agriculture, Punjab Agricultural University, Ludhiana during the year 2007-2008. Clones were planted on 17th, Feb., 2006. The experimental area is situated at 247 m amsl and lies between 30^{0}54' latitude and 75^{0}40' longitude, which represents the central agroclimatic zone of the Punjab. In general, the climate is subtropical to tropical with a long dry season from late September to early June and wet season from July to early September. The site receives an

Growth parameters of poplar clones based on DBH, height and crown spread exhibited better performance under agroforestry plantation.

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average annual rainfall of 568 mm, which is not evenly distributed and most of it (75 to 80%) is received during the rainy season i.e. July to September. During this period, temperature fluctuates around 29.9 °C. The lowest mean monthly temperature of 10.7 °C is attained in January and highest of 32.3 °C in June.

The experiment was laid out in split plot design with six clones (PL 1, PL 2, PL 3, PL 4, PL 5 and SWL 22) of poplar were planted as pure plantation as well as farm forestry plantation in three replications, spaced 4×4 m between plants. The main plots were allotted to environments and sub plots were allotted to clones and there were five plants per plot and total number of trees was 180. Agroforestry plantations, wheat (variety-PBW-343) was grown in the rabi season and mung (variety-SML-668) was grown in kharif season as intercrops. Various meteorological parameters viz. air temperature; soil temperature (0-15 cm) and relative humidity were recorded for agroforestry and farm forestry plantations with the help of portable weather monitoring system. Data on survival percent and various growth parameters of poplar viz. diameter at breast height (DBH), plant height and crown spread recorded monthly from April, 2007 to April, 2008. Growth measurements were made using digital caliper, tape, graduated bamboo pole, height measuring multimeter and scale.

Results and Discussion

Tree growth is an irreversible increase in size and shape of the tree. It is influenced by genetic constitution of tree species as well as environmental factors viz. rainfall, temperature, relative humidity, soil nutrients and moisture, etc. The growth of poplar depends upon various factors such as genetic constitution of clones, quality of planting stock, spacing of trees, intercrops, site quality, climate and management practices (Tewari, 1995).

Meteorological parameters: Maximum and minimum air temperature in poplar plantation without crops (E_1) ranged from 14.5 to 40.0°C and 2.8 to 28°C, respectively and is presented in Table 1. The corresponding figures in agroforestry plantation (E_2) were 12.5 to 38.4°C and 6.7 to 29.3°C, respectively. Maximum soil temperature varied from 9.7 to 47.0°C in pure plantation (E_1) and 11.3 to 36.1°C in agroforestry plantation (E_2), whereas minimum temperature varied from 4.5 to 31°C in pure plantation (E_1) and 8.4 to 29.8°C in agroforestry plantation (E_2). In general, air and soil temperatures showed that maximum temperature was higher in case of poplar grown individually, whereas, minimum temperature was higher when poplar was grown with agricultural crops. Thus showing microclimatic effect of poplar on associated agricultural crops. The maximum relative humidity in pure plantation (E_1) ranged from 49

Table 1 : Meteorological data for various parameters under farm forestry

Months	Environment	Parameters					
		Air temperature (°C)		Soil temperature (°C)		Relative humidity (%)	
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
July, 2007	E_1	35.3	28.0	44.5	31.0	94.0	62.0
	E_2	35.7	29.3	34.6	29.8	83.5	52.5
August, 2007	E_1	35.2	25.0	44.0	27.0	85.0	62.0
	E_2	34.1	26.2	31.4	27.5	76.5	57.0
September,2007	E_1	31.0	22.2	37.5	23.4	95.0	72.0
	E_2	27.4	24.2	27.4	25.8	83.0	67.5
October, 2007	E_1	32.8	13.8	37.0	19.5	92.0	26.0
	E_2	29.8	20.8	29.8	20.8	72.0	19.5
November, 2007	E_1	27.8	11.2	28.8	13.5	94.0	35.0
	E_2	22.3	7.6	22.1	13.9	83.0	29.5
December, 2007	E_1	19.4	3.0	21.6	5.0	97.0	54.0
	E_2	12.5	10.7	12.5	10.7	63.5	26.5
January, 2008	E_1	16.0	3.4	9.7	4.5	97.0	44.0
	E_2	16.4	8.2	11.8	9.5	74.0	37.0
February, 2008	E_1	14.5	2.8	20.8	5.0	100	58.0
	E_2	14.6	6.7	11.3	8.4	84.5	50.0
March, 2008	E_1	28.8	15.4	36.4	17.5	81.0	39.0
	E_2	28.0	17.8	22.9	17.4	68.5	36.5
April, 2008	E_1	40.0	20.0	47.0	26.0	49.0	16.0
	E_2	38.4	24.5	36.1	25.3	38.4	24.5

Note: * Data was recorded in last week of each month
E_1 represents pure poplar plantation
E_2 represents agroforestry plantation

Table 2 : Survival and growth performance of *Populus deltoides* Marsh. clones under farm forestry

Clones		Parameters/Environment							
		Survival (%)		Diameter at breast height (cm)		Plant height (m)		Crown spread (m)	
		E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2
	PL 1	100	100	7.39	8.69	7.6	8.5	3.5	3.5
	PL 2	100	100	6.99	8.26	7.2	8.3	3.0	3.0
	PL 3	100	100	7.21	8.62	7.2	8.4	3.3	3.4
	PL 4	100	100	6.86	8.21	7.1	8.2	2.4	2.5
	PL 5	100	100	7.04	8.20	7.1	7.8	3.0	3.0
	SWL 22	100	100	7.50	9.12	7.7	8.5	3.9	3.9
CD at 5%	Clone :	NS		NS		NS		NS	
	Environment :	NS		0.15		0.012		0.09	
	Clone×Environment :	NS		0.38		0.031		NS	

Note: E_1 represents pure poplar plantation
E_2 represents agroforestry plantation

to 100 per cent, while in agroforestry plantation (E_2) it varied from 38.4 to 84.5 per cent indicating lower relative humidity in agroforestry plantation (E_2). The values ranged from 16 to 72 per cent for minimum relative humidity in pure plantation (E_1) and 19.5 to 67.5 per cent in agroforestry plantation (E_2) showing less humidity under agroforestry plantation. Microclimatic variation has a major impact on crop performance as extremes affect growth, development and yield in a wide range of species. Air temperature is important as excessively hot conditions during critical developmental stages may greatly reduce yield; thus, temperatures exceeding 30°C may induce pollen sterility and reduce seed or fruit yield (Porter and Semenov, 2005). Shade from overstorey trees may ameliorate microclimatic conditions for understorey crops, increasing growth and productivity. Agroforestry may provide a financially viable way of protecting crops in areas where microclimatic factors regularly exceed the optimal range (Lin, 2007). Agroforestry systems can modify the micro-climates and may help in maintaining the productivity of agriculture crops by lowering the understorey air temperatures (Sehgal *et al.*, 2008). Trees induce microclimatic changes by reducing soil and air temperatures. These modifications directly influence the productivity of intercrops (Chauhan and Dhiman 2007). These results are in conformity with the findings of Dhillon *et al.* (2008). They studied micro-climate of the understorey crops measured in terms of photosynthetic active radiation (PAR), air temperature and relative humidity (RH) and reported that all these factors jointly affected the eco-physiology of the understorey grown crops and thus their performance depending upon their adjustments to these conditions varied significantly than the open condition. At the same time boundary plantation of poplar had favourable effect on the micro-climate which improved the status of soil moisture between 6-9 m distance and increased the water use efficiency (Sharma *et al.*, 2001).

Survival per cent : Hundred per cent survival recorded in all clones in both the environments (Table 2). The differences between clones as well as clone × environment interaction were non-significant. The reason for very high survival percentage may be attributed to buffering capacity of poplar plantation governed mainly by genetic constitution of clones. Similarly, Chandra and Joshi (1994) have reported more than 85 per cent of survival for poplar clones.

Diameter at breast height (DBH): All clones varied significantly for their performance in environments, whereas, no significant differences were observed between the clones (Table 2). Diameter in pure plantation (E_1) ranged between 6.86 cm to 7.50 cm. The maximum diameter in pure plantation (E_1) was recorded in SWL 22 (7.50 cm). In agroforestry plantation (E_2) values for DBH ranged between 8.20 to 9.12 cm. Highest value was recorded in SWL 22 (9.12 cm). The per cent increase for DBH in agroforestry plantation (E_2) was 21.5 over pure plantation (E_1), which can be correlated with findings of Singh and Sharma (2007). They recorded 15.60 per cent higher GBH in one year old poplar intercropped with fodder wheat rotation. Mishra *et al.* (2006) also reported 3.92 to 41 per cent increase in DBH when poplar was intercropped with soybean.

Plant height: Data on plant height of different clones is presented in Table 2 and it can be observed from the table that the height between clones did not differ significantly. Whereas, clones showed significant differences between environments. Height of various clones ranged between 7.1m (PL4 and PL5) to 7.7 m (SWL 22) in pure plantation (E_1) and 7.8 m (PL 5) to 8.5 m (SWL 22) in agroforestry plantation (E_2). The interaction between clones and environments was found significant.

All the clones showed at par performance in individual environments, however, increase in agroforestry plantation (E_2) over pure plantation (E_1) was 10.38 per cent. Increase in height of poplar in agroforestry system was also reported by Mishra *et al.* (2006). They observed 3.3 to 6.2 per cent increase in poplar height intercropped with soyabean. Rivest *et al.* (2005) also reported increase in height of poplar intercropped with agricultural crops. Significantly, higher (17.2 %) height in one year old poplar intercropped with fodder wheat rotation was noticed by Singh and Sharma (2007).

Crown spread: The data pertaining to crown spread of different clones is given in Table 2. It is apparent from the data that crown spread varied from 2.4 m to 3.9 m in pure plantation (E_1) and 2.5 m to 3.9 m in agroforestry plantation (E_2). The clone x environment interaction effect for crown spread was found to be statistically non-significant. Whereas, the clones were significantly different in their performance in the different environments. Clones PL 3 and PL 4 in agroforestry plantation i.e. E_2 had more crown spread than pure plantation i.e. E_1 while rest of clones were having same performance in both environments. Maximum crown spread in pure plantation (E_1) was recorded for SWL 22 (3.9 m) and minimum crown spread was recorded for PL 4 (2.4 m). In agroforestry plantation (E_2) SWL 22 (3.9 m) showed maximum crown spread and minimum was recorded in PL 4 (2.5 m). Earlier, Sharma and Singh (1992) observed crown width of 4.08 m under agroforestry practices. The clone × environment interaction for crown spread was found significant. Similarly, Chauhan *et al.* (2007) reported that in agrisilvicultural system crown spread in poplar was 7.45 m^2 in one year old plantation.

Conclusion

The above study indicates that the poplar shows very good performance when grown with intercrops. All clones of poplar evaluated showed good performance under agroforestry plantation as compared to pure plantation of poplar clones. All parameters recorded showed higher values when poplar was grown with intercrops and this can be attributed to management operations like irrigation, weeding, fertilization etc applied to associated agricultural crops. Also meteorological data indicated that microclimate of associated agricultural crops i.e. wheat and mung was modified by the poplar plantation. It is suggested that farmers should evaluate clone SWL 22 in their fields which showed best performance in both pure as well as agroforestry plantation.

कृषि वानिकी के तहत पाप्लर (*पॉपुलस डेल्टोईड्स*) का वृद्धि व्यवहार

अर्चना वर्मा, एच.एस. सरोल्च, संजीव चौहान, सरेस एन.वी., एम संकनुर तथा वरूण श्रीवास्तव

सारांश

यह अध्ययन, फार्म वानिकी के अन्तर्गत *पॉपुलस डेल्टोईड्स* के विभिन्न कृन्तकों की वृद्धि निष्पादकता का पता लगाने के लिए की गई। फरव 2006 के दौरान दो वातावरणों अर्थात् शुद्ध पाप्लार रोपणों और कृषि वानिकी रोपणों (गेहूं और मूंग के साथ पॉप्लर) में छः पॉप्लर कृन्तकों को विखंडि भूखंडों में स्थापित किया गया। अभिकल्प को तीन बार दोहराया गया। अध्ययन के परिणामों से पता चला कि पाप्लार कृन्तकों के वृद्धि प्राचलों अर्थ डी बी एच, ऊँचाई, छत्र विस्तार आदि ने कृषि वानिकी रोपणियों में उत्तम निष्पादकता का प्रदर्शन किया। कुल मिलाकर कृन्तक एस डब्ल्यू एल-22 दोनों वातावरणों में सर्वोत्तम निष्पादकता प्रदर्शित की।

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