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EFFECT OF ARABLE CROPS ON THE GROWTH OF POPLAR (*POPULUS DELTOIDES*) TREE IN AGROFORESTRY SYSTEM

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Poplar AY-48 was planted at the density of 1075 trees per hectare and at the spacing of 1.52 x 6.10m and 3.05 x 3.05m under intercropped and pure stand agroforestry systems. Intercropped agroforestry system gave higher diameter (dbh), dbh increment, crown width and wood volume (m^3/ha) compared to pure tree stand agroforestry system after 8 years of planting. Intercropping agroforestry system was more economical at the rotation of 4 & 6 years compared to pure poplar stand. The rotation age of 8 years was found to be uneconomical under both the agroforesty systems.
Key words: Arable crops, agroforestry system, poplar, intercropping

INTRODUCTION

Poplar (*Populus deltoides*) is a deciduous and fast growing tree with straight clean bole. It remains leafless during winter months and combines very well with most of the winter season agricultural crops (Jain et al., 1999). Owing to the higher market price that poplar wood fetches (about three/four times that of eucalyptus wood) and certain other factors, the farmers cultivate poplar within agricultural fields with arable crops like wheat, sugarcane, turmeric, potatoes, tomatoes, vegetables, berseem, maize fodder, etc. It gives good returns in short rotation of 6-8 year (Sharma, 1996). Its fast rate of growth, ease of establishment, easy marketing, no fruiting and multifarious uses make poplar the most popular tree species for agroforestry systems. The spacing for poplar plantations is generally kept 5 x 4m or 5 x 5m, which allows tractor ploughing, and other cultivation operations without difficulty.

Pakistan has a long tradition of agroforestry. Farmers and landowners in different parts of the country integrate a variety of woody perennials in their crop and livestock production fields depending upon the agroclimatic conditions and local needs. According to Hussain et al. (1999) almost all agroforestry systems are being practiced in the province of Punjab, but the most common system being practiced was 'Agrisilviculture'. Various efforts have recently been made at government level to boost up the wood production and presently farm forestry is, therefore, being emphasized as pragmatic alternative. For this purpose the indigenous slow growing species are being replaced by some fast growing exotic species. Poplar is one of the most popular amongst the species introduced recently.

There are reports that poplar tree grows better under agroforestry conditions (Singh et al., 1988; Chaturvedi, 1992). There are also reports that poplar tree growth is effected by arable crop intercropping (Burgess et al., 1997). However, information on the growth performance of poplar in pure form and under agroforestry systems as well as economic viability is still very limited. The purpose of this study was to evaluate the growth of poplar under agroforestry systems with the intercropping of wheat-fodder maize. Hence an attempt has been made to determine the effect of intercropping on the growth of poplar trees.

MATERIALS AND METHODS

This study was conducted at the research garden, Punjab Forestry Research Institutes, Faisalabad. The site is well-drained, alluvial and fine loamy soil. It is located in aridic moisture regime with 300mm precipitation having Longitude 73.11 °E, Latitude 31.28 °N and elevation 183m from sea level.

Poplar (*Populus deltoids* clone AY-48) was planted at a density of 1075 trees/ha, at the spacing of 1.52 x 6.10m and 3. 05 x 3.05m, by digging 75cm deep and 30cm wide pits during first week of February, 1991. The soil was prepared by using mechanical means before planting of poplar. It was ploughed 4-5 times with tractor mounted cultivator, followed by planking and leveling. Planting was done by using one year old, bare rooted entire nursery plants of uniform size. Good compaction and ramming of the plants was done after planting. First irrigation with canal water was given immediately after planting. After 24 hours of irrigation the leaning and wind fallen plants were straightened by adding and compacting more soil. Average height and diameter of plants was 4.5m and 5cm respectively at the time of planting. There were four rows of poplar under each treatment. The orientation of rows was south-east to north-west. The study was replicated three times. The poplar plots with the spacing of 1.52 x 6.10m were intercropped with wheat-fodder maize, while the plots having 3.05 x 3.05m spacing were kept

as pure poplar stand. Poplar tree data on the growth parameter of diameter at breast height (cm), plant height (m), clean bole (m) and crown width (m) were recorded each year upto rotation age of 8 years.

Agricultural crops namely, wheat (*Triticum aestivum*) variety Inqalab-91and fodder maize *(Zea mays)* variety Neelum were sown alternately during 'Rabi' and 'Kharif' seasons each year throughout the entire study period in poplar plots with 1.52 x 6.10m spacing. Wheat was sown during third week of November through broad cast method using 125kg seed per hectare each year. Fertilizers (Urea, Di-ammonium phosphate (DAP) and Sulphate of potash (SOP)) were applied at the rate of 125kg/ha. DAP and SOP was applied at the time of sowing while urea was applied at the time of first and third irrigation in equal doses. Similarly fodder maize was sown during third week of July through broad cast method using 100kg seed per hectare. Fertilizer (Urea) was applied at the rate of 125kg/ha at the time of first and fourth irrigation. Yield data of both the crops were recorded for economic analysis. The experimental data was put in economic analysis using the methodology described in CIMMYT (1988). The net present value (NPV) and benefit cost ratio (BCR) was calculated using 14% discount rate.

RESULTS AND DISCUSSION

To evaluate the effects of intercropping on the growth of the trees, the growth data of intercropped stand was compared with the pure stand cultivated under similar conditions. The intercropped stand had the highest diameter at breast height (dbh) increment and the dbh growth peak appeared in 3rd year of planting, while the highest value for the pure stand was also in the same year (Table 1). DBH increment of the intercropped stand was 13.4% higher than that of the pure stand.

Height gain was similar under both the systems. However, clean bole formation was highest in pure stand compared to intercropped stand (Table 2). There was 5.4% less clean bole formation in intercropped stand than that of pure stand. On the other hand crown development in intercropped stand was greater (11%) than that of pure stand (Table 2).

Wood production from intercropped stand was higher than that of the pure stand (Table 3). Wood yield was 29.4% higher in intercropped stand compared to that of pure stand. The comparison of wood yields between both the stand revealed that at the same tree density the variation in wood volume production was merely due to intercropping of wheat-fodder maize. Similarly per tree contribution in wood volume was 27.3% more in trees intercropped with wheat-fodder maize than monoculture of poplar trees.

The results of present study are in line with the observations of Singh et al. (1988) who observed more growth in poplar trees under agroforestry conditions than that of forest conditions in their study. Chaturvedi (1992) reported that poplars grow better with agricultural crops than pure stands and agriculture should continue till rotation of harvest of poplars. These findings are also in consonance with the results of Mohsin et al. (1996) who reported that *Populus deltoides* attained better height and dbh than their pure stands at their early (2&3years) and advanced (6&7 years) ages when intercropped with mint and *Cymbopogon spp.* Biomass production was also highest in intercropped trees as compared to sole stand at all ages.

The results of present study showed a positive effect of intercropping wheat-fodder maize crops on poplar tree growth. Rapid growth of the trees under intercropped agroforestry system is suggestive of the fact that trees in this system have better-utilized water, fertilizers and nutrients beyond the reach of arable crops with additional benefits of cultural operations for arable crops.

Table 1. Growth pattern of *P. deltoides* under agroforestry system

Agroforestry system	Spacing	No. of trees/ha	Year wise Diameter (cm) increment								Total increment
			1	2	3	4	5	6	7	8	
Intercropped	1.52x6.10m	1075	0.00	3.26	5.42	1.91	1.81	1.05	1.00	0.68	15.13
Pure	3.05x3.05m	1075	0.00	3.40	5.30	1.88	1.38	0.45	0.46	0.47	13.34

Table 2. Mean growth of *P. deltoides* (diameter, height, clean bole and crown width) under agroforestry system at the age of 8 years

Agroforestry system	Spacing	No. of trees/ha	DBH* (cm)	Height (m)	Clean bole (m)	Crown width (m)
Intercropped	1.52x6.10m	1075	20.13	13.37	6.15	4.10
Pure	3.05x3.05m	1075	18.36	13.36	6.50	3.70

*Diameter at breast height

Table 3. Populus deltoides wood production under agroforestry system

Agroforestry system	Spacing	No. of trees/ha	DBH (cm)	Basal area (m^2/ha)	Wood volume (m^3/ha)	Wood vol. Contribution/tree (m^3)
Intercropped	1.52x6.10m	1075	20.13	34.20	149.1	0.14
Pure	3.05x3.05m	1075	18.36	28.45	115.2	0.11

Economic analysis of both the agroforestry systems showed that these were economical at the age of 4 years. But intercropped system was highly economical at this age. At the age of 6 years intercropped system was still economical but poplar monocropping system became uneconomical. However, at the age of 8 years both the systems were not economically viable (Fig. 1 & 2). In the present study net present value (NPV) and benefit cost ratio (BCR) analyses have shown that intercropping of wheat-fodder maize with poplar trees was more profitable than pure poplar plantation. Singh et al. (1988), Khan and Betters (1990), Siddiqui (1991), Hafeez and Hafeezullah (1993), Neupane and Thapa (2001), Ramirez et al. (2001) and Rodrigo et al. (2001) reported that agroforestry with poplar was economically viable.

CONCLUSIONS

Growth and yield of poplar trees under intercropping agroforestry system is superior as compared to monoculture of trees. Intercropping of poplar in wheat-fodder maize agroforestry system at a tree density of 1075 tree/ha is economically viable option at short rotation of 4-6 years compared to pure tree stand and rotation age of 8 years.

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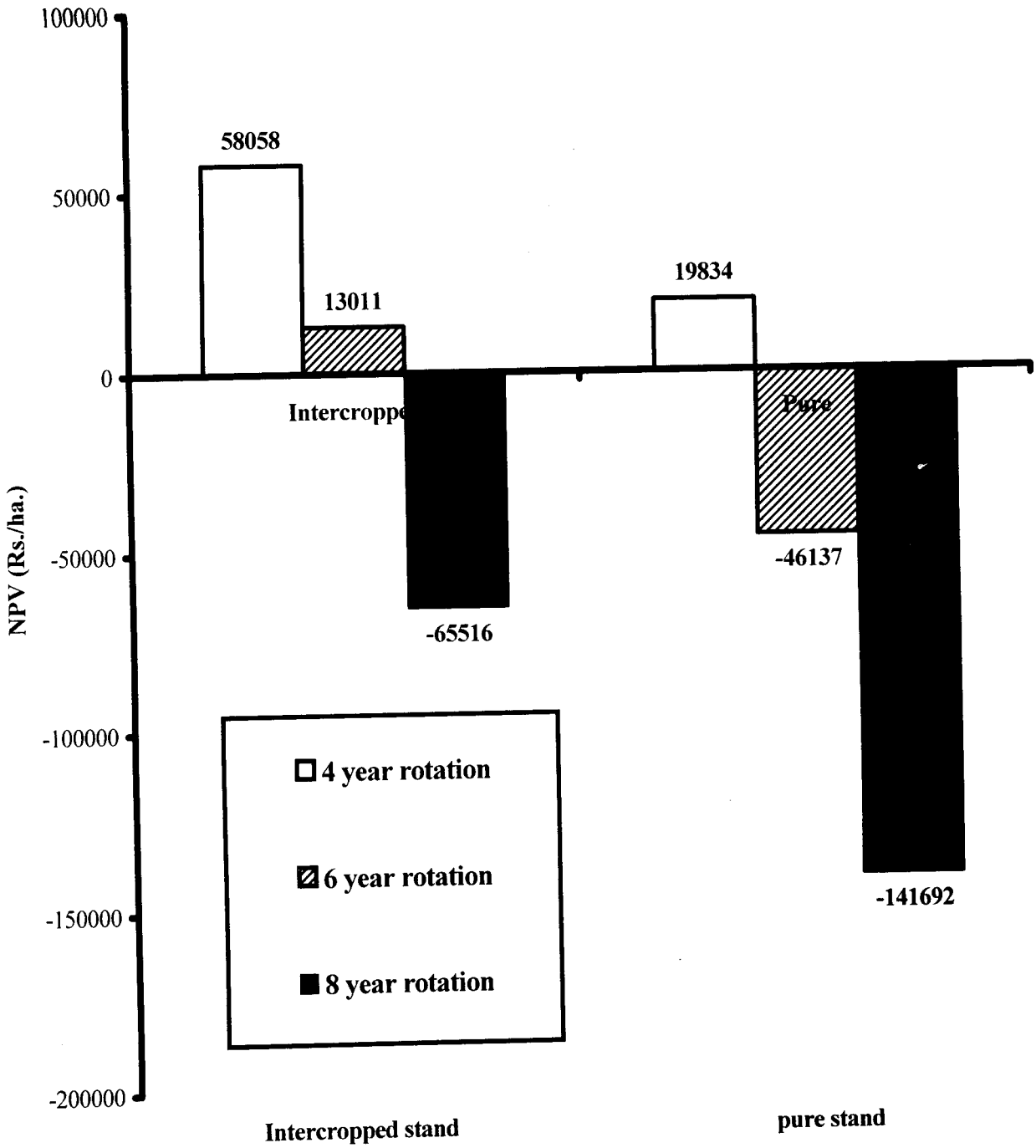

Figure 1: Net present value (NPV) of intercropping of wheat-fodder maize under P.deltoides at different ages