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VARIATIONS IN ROOT BIOMASS AND EXTENT OF EXPANSION IN *EUCALYPTUS CAMALDULENSIS*, *BOMBAX CEIBA* AND *POPULUS DELTOIDES* ON PLANTING ALONG NORTH-SOUTH DIRECTION

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The variation in root biomass and extent of expansion in *Eucalyptus camaldulensis*, *Bombax ceiba* and *Populus deltoides* on planting along north-south direction were studied at Punjab Forestry Research Institute, Faisalabad, Pakistan. The Trees were growing in lines adjacent to agricultural field along north-south direction with trenches along eastern and western direction. Each type of tree was replicated thrice and they were eight year old. Soil samples were collected up to a depth of 50 cm along northern and southern aspect at 1, 2, 3 and 4 metres. Roots were separated from the soil and weighed to measure biomass. *P. deltoides* had higher root biomass than *E. camaldulensis* and *B. ceiba*. Root biomass was high on the northern aspect of *E. camaldulensis* and *B. ceiba* as compared to southern aspect and it decreased with increase in distance from the base of the tree. There was no difference in root biomass of *P. deltoides* between northern and southern aspects.
Key words: Root biomass, toot expansion

INTRODUCTION

Planting fast growing tree species along with agricultural crops has remained a common practice among farmers (Byerlee and Tariq 1992). Trees compete with the adjoining agricultural crop for sunlight and nutrients (Hunter 2003). It has been reported that planting trees in rows along north-south direction has minimum effect on the yield of adjoining agricultural crops due to the geographical location of the region (Tewari *et al* 2002). Furthermore, farmers are encouraged to dig trenches parallel to these rows along eastern and western aspects to reduce root competition between trees and the agricultural crop (Hafeez and Akhtar 1998). The affect on roots of trees planted along north-south direction, with trenches along eastern and western direction, has to be studied to understand the root competition between trees. The present study was conducted to measure the lateral expansion in root system, along north-south direction, of three fast growing tree species; *Eucalyptus camaldulensis*, *Bombax ceiba* and *Populus deltoides*.

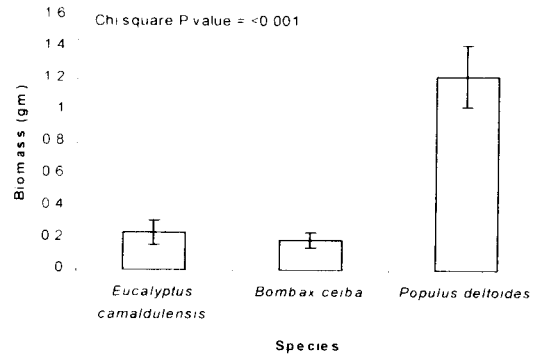
MATERIALS AND METHODS

Selection of the three types of trees for the study was made from ongoing agroforestry experiments at the Punjab Forestry Research Institute, Faisalabad. The Trees were growing in lines adjacent to agricultural field along north-south direction with trenches along eastern and western direction. Each type of the tree was replicated thrice and all trees were of the same age (eight years). The spacing between trees was twelve metres. Soil samples were collected up to a depth of 50 cm along northern and southern aspect at 1, 2, 3 and 4 metres. Roots were separated from the soil and weighed to measure biomass. In few of the replications there were missing values of biomass on the two aspects since the root system of these replications did not extend up to a distance of four metres from the base of the tree. Therefore, due to the unequal sample size, differences between the root biomass of the three tree species and also each individual species was statistically analysed by Residual Maximum Likelihood method (REML) through the use of Genstat version 4.2 (Lawes Agricultural Trust 2000). Difference between individual mean values were tested through Least Significant Difference (LSD) method by using standard error of difference (SED) (LSD = 2 x SED).

RESULTS AND DISCUSSIONS

There was a significant difference in root biomass of the three tree species (Figure 1). The higher biomass of *Populus deltoides* was probably due to its high water requirement as compared to *Eucalyptus camaldulensis* and *Bombax ceiba*. Brandis (1921) and Chandrasekharaiah and Prabhakar (1988) also reported that the water requirement of *P. deltoides* was high. Leles *et al* (1998) concluded that the roots of *E. camaldulensis* have the capability of expanding horizontally as well as vertically in the soil depending upon the availability of water and nutrients hence the

Figure 1. Mean (±SE) root biomass of three tree species planted adjacent to agriculture crop along north-south direction.



overall root biomass on each axis was low. Although *B. ceiba* also has high water requirement but its taproot is more developed than the lateral roots (Parker 1924) and that might be the reason for its low root biomass.

Besides overall differences in root biomass of the three tree species there were significant differences within each tree species along the two aspects (Table 1). The higher biomass on the northern aspect of *E. camaldulensis* and *B. ceiba* (Table 1a,b) was probably due to the reason that the soil on the northern aspect of tree retains higher moisture than the southern aspect since the roots along northern aspect provide a natural barrier against the flow of moisture. Since the roots close to the base of the tree provide the highest barrier hence growth in root biomass was highest up to a distance of one meter. Furthermore the geographical

Table 1. REML adjusted mean root biomass of a) Eucalyptus camaldulensis; b) Bombax ceiba; and c) Populus deltoides planted adjacent to agricultural crop along north-south direction. Values with similar superscripts are not significantly different at P = 0.05.

a) Eucalyptus camaldulensis

Distance (D) (m) Aspect (A)	1	2	3	4	Aspect Mean
North	0.81^{b}	0.54^{ab}	0.06^{a}	0.15^{a}	0.39^{b}
South	0.09^{a}	0.14^{a}	0.02^{a}	0.04^{a}	0.07^{a}
Chi square P-value for A					0.017

Differences between individual mean values were tested through LSD (see methods).
Standard error of difference for aspect means = 0.13
Standard error of difference within aspect means = 0.26

b) *Bombax ceiba*

Distance (D) (m) Aspect (A)	1	2	3	4	Aspect Mean
North	0.26^{ab}	0.57^{b}	0.33^{ab}	0.07^{a}	0.31^{b}
South	0.19^{a}	0.08^{a}	0.08^{a}	0.11^{a}	0.11^{a}
Chi square P-value for A					0.034

Difference between individual mean values were tested through LSD (see methods)
Standard error of differences for aspect means = 0.09
Standard error of difference within aspect means = 0.18

c) *Populus deltoides*

Distance (D) (m) Aspect (A)	1	2	3	4	Aspect Mean
North	1.15^{a}	1.85^{a}	1.40^{a}	0.51^{a}	1.23^{a}
South	0.97^{a}	1.58^{a}	1.40^{a}	0.93^{a}	1.22^{a}
Chi square P-value for A					0.990

Difference between individual mean values were tested through LSD (see methods)
Standard error of differences for aspect means = 0.41
Standard error of differences within aspect means = 0.82

location of the study area is such that the southern aspect is more exposed to sun as compared to the northern aspect (Brazel and Marcus 1991) hence the evapo-transpiration rate is high on the southern as compared to the northern aspect resulting in better root growth on the northern aspect. The natural blockage of moisture on the northern aspect of the tree decreases as the distance from the tree increases.

Hafeez and Akhtar (1998) has mentioned that in *P. deltoides* more than 75% of total root biomass was located in 75cm soil depth within 100cm radial distance from the base of the tree. Since the measurement of root biomass in the present study started at one meter from the base of the tree hence less variation was expected in root biomass of *P. deltoides* along the two aspects (Table 1c).

CONCLUSIONS

Among the three tree species the root system of *P. deltoides* is most suited for planting with agricultural crops since it expands extensively to a limited distance hence competition with the adjoining agricultural crop is minimum. The high water requirement of *P. deltoides* has to be taken into consideration before recommending it for planting on farmlands. If water is a limiting factor then *E. camaldulensis* is most suited for planting since its roots can adapt to both horizontal and vertical expansion for attaining water and nutrients. Since the root biomass of *E. camaldulensis* and *B. ceiba* decreases as the distance from the base of the tree increases, particularly on the northern aspect, hence their root systems will have minimum competition if planted at appropriate spacing. The planting space of four meters will be sufficient for better growth of the three tree species.

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