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Response of Paddy Planted under *Butea monosperma* Trees in Chhattisgarh

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ABSTRACT

Butea monosperma (Lamk.) Taub, locally known as *palash* is a multipurpose tree species. It yields fibre, dye and fuel wood for local consumption. Studies conducted in Bilaspur district to explore tree- crop interaction under traditionally natural agroforestry system cleared that the crop parameters of paddy declined towards the bole of the tree. With increasing distance from tree bole these parameters increased. Among crop parameters studied shoot number was maximum towards the open area (305.6 ± 9.8 m^{-2}) for D_5 and D_1 had minimum towards the tree base (205.0 ± 5.2 m^{-2}). Maximum (12.6 ± 0.40 Mg ha^{-1}) shoot biomass was observed for D_5 (open area), followed by D_4, D_3, D_2 and D_1. Grain yield also increased with increasing distance of crop from the tree base and was highest for D_5 (5.2 ± 0.20 Mg ha^{-1}). As the component plant species in agroforestry system depend on the same reserve of growth resources such as light, water and nutrients and hence there will be influence of one component of a system on the performance of the other components as well as system as a whole. It can be speculated that along with competition, this decrease may be due to the decreased availability of light.

Key Words: Crown Cover, Basal cover, Density, Biomass reduction, Grain Yield.

INTRODUCTION

Prosperity generated by the green revolution in irrigated areas made the general scarcity of fuel wood, and farmers therefore, took the progressive step of planting fast growing trees around their homesteads, along field boundaries, irrigation channels and also within fields. *Palash* (*Butea monosperma* (Lamk.) Taub) is found growing wildly in Chhattisgarh. It is an important multipurpose tree to farmers. *Palash* is widely used by tribals and local people as fuel wood and its green leaves are used for making plates or *dona* and serve as a good host for lac cultivation (yield ~ 40 kg lac per tree) thereby, helps in increasing the economy of poor farmers. In the cropping system paddy is grown in >80 % of the agricultural land in the rainy season and this state is also known as 'Rice bowl' of the country and rice based food habit predominates in this region. In this state naturally occurring traditional agroforestry system (tree component) is one of the most widely practiced land use system and farmers realize the importance of trees in the combined production system but only few studies (mainly associated with *Acacia nilotica* based agroforestry system) were done (Pandey et al. 1999, Bargali et al. 2004), whereas studies on *B. monosperma* based traditional agroforestry system is untouched in this area. The naturally growing important trees in agricultural fields (generally in bunds and boundaries) are dominated by *Acacia nilotica*, *Ternimalia tomentosa*, *Butea monosperma*, *Albizia procera* and *Tectona grandis*.

Light intensity, soil moisture and soil nutrients are probably major factors determining the functioning of agroforestry system. Generally tree and herb layer (crop) in an agroforestry system develop competitive interaction (Anderson and Sinclair 1993). Trees modify resource availability to understory vegetation (Vetaas 1992), produce either detrimental or beneficial effects on crop production. Under some circumstances crop productivity is lower under tree canopies (Puri et al. 1992) whereas in other circumstances crop productivity is higher (Tiedemann and Klemmedson 1977).

So, the matter is of immense importance when paddy is raised in association with palash. Hence, the present investigation was carried out to study the effect of, *B. monosperma* on associated paddy crop (Swarna variety).

STUDY AREA

The study area was located in Bilaspur district 21^{0}37' N latitude and 81^{0}12'–83^{0}79' E longitude in Chhattisgarh state. The altitude was 292 m above mean sea level. Soils in the sites were vertisol, brown to black in colour, clay to clay loam in texture, and montmorillonitic in nature. Soil swells up upon wetting and shrinks when dry causing deep wide cracks. The climate is monsoonal sub-humid tropical and is characterized by seasonality. The year can be divided into three seasons, rainy (mid June to September), winter (November to February) and summer months (February to mid June). October is the transition month between rainy and winter season. Mean monthly maximum temperature varied from 25.4^{0}C in January to 40.5^{0}C in May and mean monthly minimum from 11.2^{0}C in January to 27.1^{0}C in June. Mean annual rainfall is 1255 mm of which 88% occurs during rainy season (south-west monsoon).

MATERIALS AND METHODS

Paddy fields along with *B. monosperma* trees on field bunds, were selected in village Beerkona in Bilaspur district. Phytosociological parameters such as density, basal area and canopy cover of trees were measured. The effect of *palash* trees on paddy was estimated by studying crop parameters like shoot number m^{-2}, shoot biomass Mg ha^{-1} and grain yield Mg ha^{-1}. For the measurements of paddy crop, sample plots of 0.25 m^2 were laid in a line running perpendicular to the tree line and replicated three times, the lines were D1 (1.0-4.0 m), D2 (5.0- 8.0 m), D3 (9.0- 12.0 m), D4 (13.0-16.0 m) and d5 (17.0- 20.0 m; considered as an open area). In each sampling plot, numbers of hills were counted for the number of tillers. The mean tiller value was multiplied with number of hills to find out the total number of tillers in the sample plots. From each sample plot 5 tillers were removed and kept in labeled polyethylene bags and brought to the laboratory to quantify biomass. Tiller density and shoot biomass were measured when crop was at its peak growth. Sample for grain yield was taken when crop was mature for harvesting. The correlation coefficient test and regression techniques were used to develop relationship between crop parameters and tree line distance from the crop.

RESULTS AND DISCUSSION

In the study area, *B. monosperma* trees had a density of 136.0 ± 2.55 stems ha^{-1}, basal cover of 8.2± 0.63 m^2 ha^{-1} and a canopy cover of 20.80 ± 3.18 m^2 tree^{-1}.

Studies on the crop showed that the shoot number increased with increasing distance from the trees. Shoot number ranged from 205.0 ± 5.2 m^{-2} to 305.6 ± 9.8 m^{-2}, and the highest shoot number was obtained for D_5 (Table 1). The reduction (%) in shoot number increased with decreasing distance (Figure 1). Reduction was lowest (3.1 %) for D_4, and highest (32.9 %) for D_1.

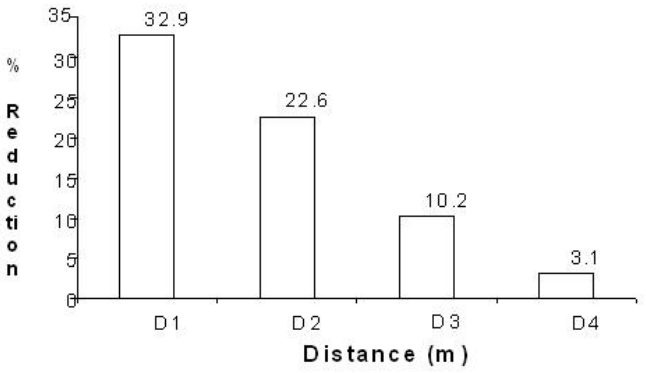

Figure 1. Reduction (%) in shoot number with distance. For D1 to D5 see text.

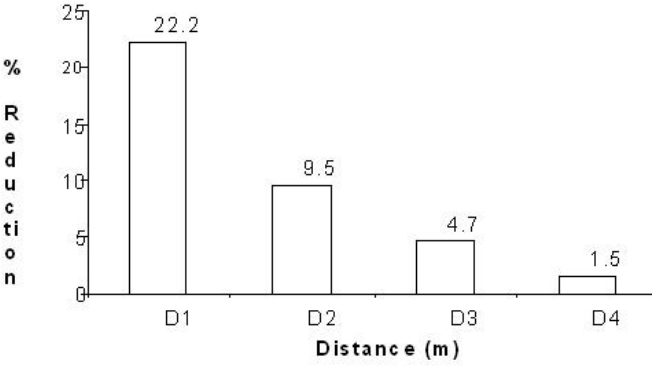

Figure 2. Reduction (%) in shoot biomass with distance. For D1 to D5 see text.

Table 1: Various crop growth parameters of paddy under *Butea monosperma* trees

	D1 (1.0- 4.0 m)	D2 (5.0- 8.0 m)	D3 (9.0- 12.0 m)	D4 (13.0- 16.0 m)	D5 (17.0- 20.0 m)
Shoot number m^{-2}	205.0 ± 5.2	236.4 ± 5.2	274.4 ± 12.45	295.9 ± 10.9	305.6 ± 9.8
Shoot biomass, Mg ha^{-1}	9.8 ± 0.25	11.4 ± 0.31	12.0 ± 0.44	12.4 ± 0.37	12.6 ± 0.40
Grain yield Mg ha^{-1}	3.3 ± 0.07	4.2 ± 0.11	4.9 ± 0.18	5.1 ± 0.24	5.2 ± 0.20

Shoot biomass varied between 9.8 ± 0.25 Mg ha^{-1} to 12.6 ± 0.40 Mg ha^{-1}. It increased with increasing distance from tree base (Figure 2). The reduction in shoot biomass was minimum (22.2 %) for D_4 and maximum (1.5 %) for D_1.

Paddy grain yield varied from 3.3 ± 0.07 to 5.2 ± 0.20 Mg ha^{-1}. It increased with increasing distance from tree base and was lowest for D_1 and highest for D_5 (Figure 3). Regression equations for different characters given in Table 2 show that the shoot number, shoot biomass and grain yield are positively and significantly ($p<0.05$) correlated with the distance from tree trunk.

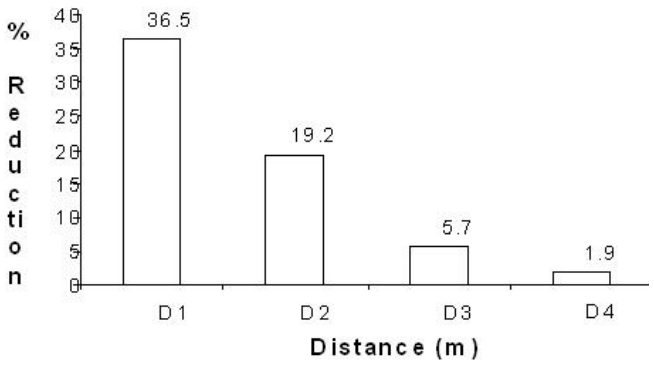

Figure 3. Reduction (%) in grain yield with distance. For D1 to D5 see text

Table 4. Regression between distance (X) and shoot number, shoot biomass and grain yield of paddy

Parameters	Regression equations	R^2
Shoot number	$Y= -4.268X^2 + 51.67X + 155.37$	0.9937
Shoot biomass	$Y= -0.214X^2 + 1.946X + 8.16$	0.9856
Grain yield	$Y= -0.15X^2 + 1.37X + 2.08$	0.9968

The climate of study area was sub-humid and hence, soil water is not limiting to plant growth and productivity. Light becomes a limiting factor under tree canopy and growth of crop depressed under tree crown due to competition for light (Ferrell 1992, Kessler 1992; Pandey et al. 1999, Bargali et al. 2004). Contrary to these observations, growth and productivity of crops are reported to increase under tree canopy in the arid environment (Puri et al. 1994).

The reduction in yield under the influence of tree had been reported by several workers (Sharma et al. 1996, Hocking et al. 1997). Puri et al. 1994 reported that *Acacia nilotica* (L.) tree reduced crop yield under its canopy, and this reduction varies with distance from tree trunk. The reduction in yield under the trees may be caused by the shade and hence, lower photosynthetic rates (Bremner 1972). However, the yield reduction of any component in an agroforestry system is not only due to shading effects but also the sharing of important resources such as available moisture and nutrients (Buck 1986; Jackson 1986). Intensive cropping decreases humus content gradually and causes rapid deterioration of soil physical properties (Lal 1989), which result in decrease in crop yield. Kessler (1992) and Pandey et al. (1999) also reported that the density and grain yield of different crops were directly related to distance from tree. The intensity of light generally increases with increasing distance from the tree trunk (Pandey et al. 1999). Decrease in crop parameters showed that paddy responded to the light intensity.

CONCLUSION

Though *B. monosperma* tree reduced the grain yield with the increasing distance from tree trunk (base) in this region, the farmers allow it to grow in their agricultural fields as they consider it as important constituent of land use system as a source of fuel wood lac rearing,

making of traditional plates (dona) and other economic benefits. This study indicates that the potential of traditional agroforestry system needs to be developed to solve the land management (including tree management) problems of Chhattisgarh plains.

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