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Influence of canopy pruning on tree growth and grain yield of intercrops in white siris (*Albizia procera*)-based agrisilviculture system

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ABSTRACT

A field experiment was conducted during 2005–07 at Jhansi to elucidate the influence of shoot pruning on growth of [*Albizia procera* (Roxb.) Benth] and grain yield of intercrop. The experiment was conducted in split plot design with 2 crop sequences, namely blackgram (*Vigna mungo* (L.) Hepper) – mustard (*Brassica juncia* L. Czern. & Coss.) and greengram (*Vigna radiata* Roxb.) – wheat (*Triticum aestivum* L. emend. Friori & Paol.) with 3 pruning regimes (70% canopy pruning, 50% canopy pruning and control unpruned). The results reveal that the growth of *A. procera* (dbh, height and canopy diameter) was significantly ($P \leq 0.05$) higher in control (unpruned trees) compared with the 50% canopy pruning and 70% canopy pruning. Grain yield of greengram–wheat crop sequence was 41.21 and 83.45% higher than the blackgram–mustard crop sequence. Among the pruning regimes, 70% canopy pruning gave 129.94% higher grain yield than the control (unpruned trees).

Key words: Agrisilviculture, Canopy pruning, Intercrops, Unpruned tree

In agrisilviculture system, trees and crops compete inevitably for light, nutrients and other resources that affect the growth performance of the crop. Pruning of tree component is a powerful approach to regulate this competition (Frank and Eduardo 2003). However, as the functional balance of the tree is altered through pruning, it reacts both morphologically and physiologically in response to the change consequently, the growth and development of shoots and foliage may be altered. If sufficient recovery time is provided after pruning, such as reduction in growth gradually decreases and pruned trees resume their normal growth status. In agrisilviculture systems, presence of a well developed tree canopy and resultant shade make light an important factor in determining the potential of understorey crops (Osman *et al.*1998). Shoot pruning alleviates shading of crops and appeared as an effective means of increasing the light permeability and grain yield of intercrops (Ram Newaj *et al.* 2007).

Pruning also reduces the competitive ability of trees, which allow the crop to take advantage of the higher nutrient availability under tree cropping system. Biomass yields and productivity of crops have also been reported higher under pruned trees (Droppelmann and Berliner 2003, Dar and Ram Newaj 2008). Keeping these points in view the present study was undertaken to find out the effect of different pruning regimes on tree growth and grain yield of intercrops.

MATERIALS AND METHODS

A field experiment was conducted during 2005–07 at National Research Centre for Agroforestry, Jhansi, Uttar Pradesh. The soil was intermixed black and red soil group of Bundelkhand regions, Uttar Pradesh covered under the order of Alfisol. The soil depth varied from 0.5 m to 0.6 m with several rocky patches. Its *p*H, EC (ds/m), organic carbon (%), available N, P and K were 6.57, 0.07, 0.54, 181.09, 17.40 and 139.99 kg/ha, respectively within the 0–15 cm soil horizon and 6.57, 0.06, 0.46, 166.91, 14.25 and 128.54 kg/ha, respectively within the 15–30 cm soil horizon. The experiment was conducted in a well established 5-year old white siris [*Albizia procera* (Roxb.) Benth.] trees planted with tree spacing of 8 m × 4 m. The experiment consisted of 2 crop sequences, blackgram (*Vigna mungo* (L.) Hepper) – mustard (*Brassica juncia* L. Czern. & Coss.) and greengram (*Vigna radiata* Roxb.) – wheat (*Triticum aestivum* L. emend. Friori & Paol.) with 3 pruning regimes, viz 70% canopy pruning, 50% canopy pruning and control (unpruned tree). The experiment was conducted in split-plot design with 3 replications. Levels of canopy pruning were based on a percentage of green crown length. Pruning was done once in

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every year at least 15 days before sowing of intercrops during *rabi* season. Growth parameters of *A. procera,* diameter at breast height (dbh), height and canopy diameter were measured in February during both the years.

'T 9' blackgram was sown on 21 and 17 July in 2005 and 2006, respectively and 20: 40 kg N and P/ha was applied as basal dose. 'Varuna' Indian mustard was sown on 18 and 23 November in 2005 and 2006, respectively and N, P and K were applied @ 60:40:40 kg/ha, respectively. The full doses of phosphorus and potassium and half dose of N were applied as basal, whereas half of the nitrogen was applied at the time of first irrigation. 'PDM 54' greengram was sown on 20 and 17 July in 2005 and 2006, respectively and 20:40 kg nitrogen and phosphorus/ha was applied as basal dose. 'HD 2189' wheat was sown on 14 and 16 November in 2005 and 2006, respectively and N P and K were applied @ 80:40:40 kg/ha. The full dose of phosphorus and potassium and half dose of N were applied as basal, whereas half N was applied in 2 splits, viz crown root initiation and late tillering stage. Other cultural practices were applied as per recommendation of the crop. The net plot size of 484 m^2 was harvested to determine the intercrop yield. Grain yield of intercrops was converted to equivalent of wheat for statistical analysis. To determine treatment and interaction effects, the variables were tested by using General Linear Model (GLM) of SYSTAT (SYSTAT 11).

RESULTS AND DISCUSSION

Pruning and tree growth

The growth of *A. procera* has been given in Table 1 which clearly indicates that tree growth (DBH, height and canopy diameter) was higher in blackgram–mustard compared with the greengram–wheat crop sequence. The DBH and canopy diameter did not exhibit significant variation due to crop sequence, whereas tree height was significantly ($P \leq 0.05$) affected by the crop sequence. Higher tree growth in blackgram–mustard crop sequence may be probably due to the fact that same plot was utilized for soybean–wheat crop sequence up to 4 years before this study. Trees with this sequence benefited from higher dose of fertilizer, irrigation and other cultural practices which resulted in higher tree growth (Ram Newaj *et al.* 2005).

The canopy pruning significantly influenced the tree growth. Among the pruning regimes, the trees in control (unpruned tree) had significantly ($P \leq 0.05$) higher DBH, height and canopy diameter than 50 and 70% canopy pruning. It has generally been found that the impact of pruning on tree growth increases with the amount of the pruning (Pinkard *et al.* 2004, Chandrashekhara 2007). Because heavy pruning leads to a greater removal of leaf area than light pruning, and more strongly reduces the overall carbohydrate production of a tree. In pruning not only the productive leaves are removed, but also some unproductive wood. This implies that pruning reduces both the production and the consumption of the carbohydrates, which affect the tree growth. In a similar study, Ram Newaj *et al.* (2007) reported that in *A. procera*- based agrisilviculture system, unpruned trees attained maximum height, dbh and crown diameter than tree pruned up to 70% plant height.

Grain yield of intercrops

The grain yield of intercrops was considerably higher in greengram–wheat as compared to blackgram–mustard crop sequence (Table 2). After converting grain yield of

Table 1 Growth of *Albizia procera* under different pruning regimes

Pruning regime	Crop sequence					
	Blackgram–mustard			Greengram–wheat		
	DBH (cm)	Height (m)	Canopy dia (m)	DBH (cm)	Height (m)	Canopy dia (m)
70% canopy pruning	15.75	8.55	3.64	15.43	8.14	3.57
50% canopy pruning	15.99	8.92	4.71	15.72	8.61	4.63
Control (unpruned)	16.50	9.43	5.97	16.52	9.02	5.88
Mean	16.08	8.97	4.77	15.89	8.59	4.69
LSD (*P*=0.05)						
Crop sequence	NS	0.11	NS			
Pruning	0.47	0.18	0.25			
Pruning × crop sequence	NS	NS	NS			
70% canopy pruning	17.88	10.09	3.84	17.74	9.92	3.73
50% canopy pruning	18.75	10.84	4.98	18.36	10.68	4.92
Control (unpruned)	19.19	11.02	6.30	18.95	10.77	6.22
Mean	18.61	10.65	5.04	18.35	10.46	4.96
LSD (*P*=0.05)						
Crop sequence	NS	0.06	NS			
Pruning	0.38	0.21	0.24			
Pruning × crop sequence	NS	NS	NS			

Table 2 Grain yield of crops under different pruning regimes of *A. procera*

Pruning regime	Yield (kg/ha)						
	Blackgram–mustard		Yield equivalent to wheat	Greengram –wheat		Yield* equivalent to wheat	Mean (yield equivalent)
			2005–06				
70% canopy pruning	92.63	325.74	888.55	79.33	1163.96	13.22.63	1105.59
50% canopy pruning	85.54	315.10	852.29	74.77	1113.35	1262.88	1057.59
Control (unpruned)	40.45	183.40	479.47	29.84	490.10	549.78	514.63
Mean			740.10			1045.10	
LSD (P=0.05) for crop sequence 12.78; pruning 27.74 and pruning × crop sequence 39.23							
			2006–07				
70% canopy pruning	45.67	271.27	617.26	52.53	1021.20	1116.72	866.99
50% canopy pruning	40.40	230.87	527.84	43.80	911.40	991.04	759.44
Control (unpruned)	20.20	109.53	252.12	21.15	417.00	455.45	353.79
Mean			465.74			854.40	

LSD (P=0.05) for Crop sequence =39.73; Pruning = 88.76 and pruning × crop sequence = 125.52

LSD only compares the value of grain yield equivalent to wheat

* Total value of yield equivalent to wheat for both the crops

Market price of blackgram, greengram, mustard and wheat was Rs 16, 18, 20 and 9/kg in 2005–06 and 18, 20, 22 and 11/kg in 2006–07 respectively.

intercrops equivalent to wheat, grain yield exhibits significant ($P \leq 0.05$) variation due to crop sequence. Grain production of greengram–wheat crop sequence was 41.21 and 83.45% higher than the blackgram–mustard in 2005–06 and 2006–07, respectively. The difference in grain yield of intercrops was mainly due to the fact that inclusion of wheat in the crop sequence comparatively gave higher grain yield than other crop sequence. After converting the grain yield of blackgram and mustard to wheat equivalent, the blackgram–mustard crop sequence could not touch yield level of greengram–wheat crop sequence. It indicated that greengram–wheat crop sequence is more compatible with *A. procera* than blackgram–mustard crop sequence.

Pruning significantly influenced the grain production of intercrops. Grain yield was significantly ($P \leq 0.05$) higher in 70% canopy pruning than 50% canopy pruning and control. Grain production in 70% canopy pruning was 4.53 and 114.83% higher than 50% canopy pruning and control, respectively in 2005–06, whereas in 2006–07 grain yield was 14.16 and 145.06% higher than 50% canopy pruning and control, respectively. In agrisilviculture system, canopy pruning of trees facilitates penetration of light and alleviates shading of understorey crop. Ram Newaj *et al.* (2007) also reported 43.18 and 26.13% higher grain yield of blackgram and mustard, respectively with pruned trees than unpruned trees. In another study, Upadhyaya and Nema (2003) reported optimum yield of wheat under 40% canopy pruning.

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