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

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ABSTRACT

A field experiment was conducted during 2006–08 at Jhansi to elucidate the influence of canopy pruning in white siris [*Albizia procera* (Roxb.) Benth.] on light interception and grain yield of intercrop. The experiment was conducted in randomized block design with three replications. Blackgram (*Vigna mungo* (L.) Hepper) - mustard (*Brassica juncia* L. Czern. and Coss.) crop sequence was taken as intercrop. The pruning of tree canopy was done with 3 pruning regimes namely 70% canopy pruning, 50% canopy pruning and control (unpruned tree). The results reveal that the growth of *A. procera* (dbh, height and canopy diameter) was significantly (P= 0.05) higher in control (unpruned trees) compared with 50% canopy pruning and 70% canopy pruning. Grain yield of blackgram was two times higher in 70% canopy pruning than the yield obtained with unpruned trees. Similarly the yield of mustard was three times higher in 70% canopy pruning than unpruned trees during both the years. The grain yield of intercrop under 50% canopy pruning was also significantly higher than unpruned trees. Light interception by intercrops was higher under 70% canopy pruning and lower with unpruned trees. The light interception increased with increasing distances from tree base. The grain yield of intercrops was linearly correlated with light interception.

Key words: Agrisilviculture, Canopy pruning, Intercrops, Light interception

According to the potential of agroforestry there are many different systems of agroforestry. In general there are four or five basic sets of components namely tree, crop, grasses, livestock which are managed by growers in all agroforestry systems. Agrisilviculture define as intercropping arrangement of annual food crops and woody perennials in a land use system that tries to enhance productivity and ensure sustainability. The system has high potential to protect and stabilizing the ecosystem, producing a high level of output of economic goods, viz. fuel, fodder, small timber, organic fertilizer etc. and providing stable employment, improved income and basic materials to rural populations. In agrisilviculture system, trees compete with crops for light, nutrients and other resources that affect the growth performance of the intercrops. But at same time integration of trees with crops in agroforestry system may result in more efficient use of solar radiation, moisture and plant nutrients which is not generally possible in mono-cropping of either agriculture or forestry crops. There may be competition between trees and crops for these resources but net effect is positive, if such systems are designed and managed scientifically. Pruning of tree component is a powerful approach to regulate this competition (Frank and Eduardo 2003). 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).

Albizia procera is a moderately fast growing and nitrogen fixing tree which provides protein rich fodder, small timber, pulp, firewood and enriches soil by fixing atmospheric nitrogen and through addition of leaf litter. Thus, it is increasingly being used for afforestation in agroforestry programmes in different parts of India**.** Therefore, the present study was planned to evaluate the impact of different pruning regimes on light interception and their influence on grain yield of intercrops.

MATERIALS AND METHODS

A field experiment was conducted during 2006–08 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

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of Alfisol. The soil depth varied from 0.5 m to 0.6 m with several rocky patches. Its pH, EC (dS/m), organic carbon (%), available N, P and K were 6.49 , 0.073, 0.62, 193.93, 18.28 and 177.20 kg/ha, respectively within the 0-15 cm soil depth and 6.54, 0.064, 0.46, 178.60, 14.77 and 154.74 kg/ha, respectively within the 15-30 cm soil depth. The experiment was conducted in a well established 6-years-old white siris [*Albizia procera* (Roxb.) Benth.] planted at 8 m × 4 m spacing. Blackgram [*Vigna mungo* (L.) Hepper] - mustard (*Brassica juncea* L. Czern. & Coss.) crop sequence was taken as intercrop. Trees were pruned with three pruning regimes, viz 70% canopy pruning, 50% canopy pruning and control (unpruned tree). The experiment was conducted in Randomized Block Design (RBD) with three replications. Levels of canopy pruning were based on a percentage of green crown length. Pruning was done once in every year at least 15 days before sowing of intercrops during *rabi* season. Growth parameters of *Albizia procera,* diameter at breast height (dbh), height and canopy diameter were measured in February during both the years.

Blackgram PU 39 was sown on 10 and 11 July 2006 and 2007, respectively and 20: 40 kg N and P/ha was applied as basal dose. Mustard Varuna was sown on 18 and 23 November in 2007 and 2008, 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. Other cultural practices were applied as per recommendation for the crop. For determining the grain yield of intercrops, the crop was harvested on quadrate basis at different distances from tree base at both the side of tree line keeping the tree in the centre in all the replications. The mean values of yield at each distance were used to interpret the results. Light interception was measured with Steady State Porometer. The intensity of light was measured at different distances from tree base (0.5, 1.0, 2.0, 3.0 and 4.0 m) just above the canopy of crop at 10 am, 12 noon, 2 pm and 3 pm. The mean values of data recorded at different periods were used for light interception. The light interception was recorded at different growth stages (at 30, 60 days after sowing and at harvest) for *kharif* crops and for *rabi* crops, it was recorded at 30, 60, 90 days after sowing and at harvest in all pruning regimes (70% canopy pruning, 50% canopy pruning and control). The light interception by the understorey crop was expressed in $\mu mol/m^2s^1$. To determine treatment effects, the variables were tested by using General Linear Model (GLM) of SYSTAT (SYSTAT 11).

RESULTS AND DISCUSSION

Effect of pruning on tree growth

Tree pruning influenced the tree growth significantly over unpruned trees (Table 1). Tree growth interms of height, dbh and crown diameter was lowest (10.05 - 11.84 m, 17.34-19.0 cm and 6.21-6.72 m, during 2006–07 - 2007–08, respectively) in 70% canopy pruning as compared to unpruned trees. It has been reported that the impact of pruning on tree growth increases with the intensity of pruning (Chandrashekhar 2007). The reason may be explained that heavy pruning leads to greater removal of leaf area than light pruning and more strongly reduces the overall carbohydrate production of a tree. In pruning, not only the leaves are removed, but also some unproductive wood is also removed. This implies that pruning reduces both the production and the consumption of the carbohydrates, which affect the tree growth adversely. Similar results have been observed by Dar and Ram Newaj (2007) with *Albizia procera* grown with field crops in agrisilviculture system. The tree growth was better under agrisilviculture system as compared to that of pure tree. It might be due to fact that in agrisilviculture, trees were benefited from fertilizers, irrigation and other cultural practices applied to the intercrops which resulted in higher tree growth. Similar results were also obtained by Swamy *et al.* (2008) with *Gmelina arborea* and Ram Newaj *et al*. (2010) with *Albizia procera* grown with field crops.

Influence of canopy pruning on grain yield of intercrops

The grain yield of blackgram (236.84 and 201.09 kg/ha during 2006 and 2007, respectively) and mustard (367.50 and 349.78 kg/ha during 2006–07 and 2007–08, respectively) was significantly (P=0.05) higher in 70% pruning and lower in unpruned tree (Tables 2, 3) during both the years. Higher grain yield of blackgram and mustard was due to higher amount of tree pruning, which facilitate the more light availability to intercrop. The similar results have also been reported by Ram Newaj *et al.* (2003) and Dar and Ram

Table 1 Effect of pruning regimes on tree growth

Pruning regime	Tree height (m)		DBH (cm)		Crown diameter (m)	
	2006–07	2007–08	2006–07	2007–08	2006–07	2007–08
70% canopy pruning	10.05	11.84	17.34	19.00	6.21	6.72
50% canopy pruning	10.78	12.48	18.80	20.31	6.69	7.20
Control (unpruned)	11.48	12.88	19.24	21.05	6.78	7.17
LSD (P=0.05)	0.22	0.25	0.43	0.36	0.29	0.34
Pure tree	10.56	12.75	16.87	18.12	6.57	7.10

Table 2 Grain yield of blackgram under different pruning regimes and distances from tree base

Distance from tree base (m)	Pruning regime							
	2006				2007			
	70%	50%	Control	Mean	70%	50%	Control	Mean
	Grain yield (kg/ha)							
0.5	56.93	53.13	49.19	53.08	47.37	46.89	39.71	44.66
1.0	109.54	92.73	77.92	93.40	92.04	82.28	62.89	79.07
2.0	289.22	177.54	107.40	191.39	245.57	156.69	86.25	162.84
3.0	352.75	230.34	142.40	241.83	300.48	202.56	114.95	206.00
4.0	375.75	271.10	173.44	273.43	320.00	239.25	140.44	233.23
Mean	236.84	164.97	110.07	170.63	201.09	145.53	88.85	145.16
LSD (*P*=0.05)	Pruning = 28.53; Distance=21.74				Pruning = 25.97; Distance=20.24			
Pure crop				435.56				380.63

Table 3 Grain yield of mustard under different pruning regimes and distances from tree base

Distance from tree base (m)	Pruning regime							
	2006–07				2007–08			
	70%	50%	Control	Mean	70%	50%	Control	Mean
	Grain yield (kg/ha)							
0.5	35.65	26.83	10.93	24.47	30.48	15.84	5.45	17.26
1.0	107.39	79.46	30.22	72.36	84.10	67.74	23.96	58.60
2.0	270.92	190.65	80.93	180.83	245.74	181.28	59.75	162.26
3.0	581.38	453.37	198.05	410.93	556.89	414.76	168.30	379.98
4.0	842.15	599.14	275.20	572.16	831.70	600.33	279.31	570.45
Mean	367.50	269.89	119.07	252.15	349.78	255.99	107.35	237.71
LSD (*P*=0.05)	Pruning = 32.51; Distance = 45.70				Pruning = 29.17; Distance= 41.33			
Pure crop				925.23				897.66

Newaj (2007) in agrisilviculture. Grain yields of intercrops increased with increasing distances from tree base and it was maximum at 4 m distance during both years. It might be again the effect of more light availability (Fig 1) and lesser competition for growth resources at distances away from tree base as compared to nearby tree base (0.5 m). These results are in conformity with the results obtained by Kumar and Ram (2009) and Ram Newaj *et al.* (2003). The grain yield of pure crop was higher to that of intercrop grown with tree. It was due to the fact that there was no light break in

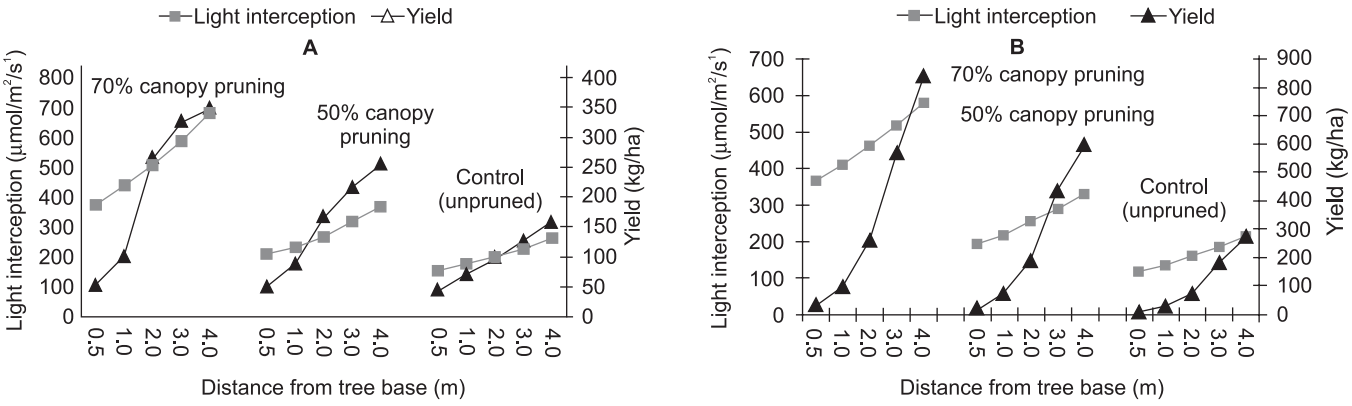

Fig 1 Light interception by blackgram during 2006–07 (A) and by mustard during 2006–07 and 2007–08 (B) and their relation with grain yield at different distances from tree base. The values of light interception and grain yield are the mean values of growth stages of crop and different years

Table 4 Relationship between light interception and grain yield of intercrops

Intercrop	Canopy pruning	Regression equation (Y = a + bx)	Multiple (R^2)
		2006–07	
Blackgram	70%	Y= - 521.379 + 1.303X	90.4
	50%	Y= - 246.221 + 1.222 X	96.3
	Control	Y = - 143.378 + 1.064 X	99.3
Mustard	70%	Y= - 1333.980 + 3.541 X	96.6
	50%	Y= - 769.734 + 4.352 X	96.6
	Control	Y= - 285.673 + 2.895 X	96.3
		2007–08	
Blackgram	70%	Y= - 186.167 + 0.854 X	87.1
	50%	Y=- 168.114 + 1.431 X	94.8
	Control	Y = - 80.754 + 1.081 X	99.7
Mustard	70%	Y= - 1595.539 + 4.313 X	95.8
	50%	Y= - 974.171 + 4.513 X	97.2
	Control	Y= 8.169 + 0.421 X	98.8

pure crops. It has already been proved by many researchers that the light interception in agrisilviculture system is less than in open field (Pandey *et al.* 2011).

Effect of light interception on grain yield of intercrops

The light availability to blackgram and mustard was significantly (*P*=0.05) influenced by pruning regimes and plant distances from tree base. Maximum light interception was recorded in 70% canopy pruning and minimum with unpruned trees in both the crops during both the years. Light interception increased with increasing distances from tree base and similar pattern was also observed in grain yield of blackgram and mustard. Similar findings were also reported by Droppelmann and Berliner (2003). The relationship between yield and light interception under different pruning regimes at different distances from tree base is presented in Fig 1. The recorded relationship can be described mathematically for light interception under different pruning regimes with grain yield of blackgram and mustard during 2006–07 and 2007–08 (Table 4).

Where Y is yield of blackgram and mustard in kg/ha, a is constant, b is regression coefficient of X and X is light interception (μmol/m^2s^1). The relationship suggests the importance of light interception for attaining higher grain yield. For example, when light interception is 374.61 μmol/m^2s^1 at 0.5 m away from tree base the grain yield of blackgram is 52.15 kg/ha in 70% canopy pruning. Further, increase in light interception 439.02 at 1.0 m away from tree base gave about 1.9 times higher yield than yield achieved at 0.5 m away from tree base. It indicates that increased the availability of light to intercrop helps in increasing grain yield of blackgram and mustard.

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