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Original Research Article

Effect of Different Punning Regime on Crop Root Length Density under Blackgram-Mustard Crop Sequence in *Albizia procera* Based Agro Forestry System

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Keywords

Canopy pruning, root study, crop sequence and tree *Albizia procera*

A B S T R A C T

A field experiment was conducted during 2006-2008 at Jhansi to elucidate the effect of different pruning regime on root length density under blackgram-mustard crop sequence in *Albizia procera* based Agroforestry system. The experiment was conducted in randomized block design with three replications. Blackgram (*Vigna mungo* (L) Hepper) and mustard (*Brassica juncia* (L) Czem. and Coss.) crop sequences was taken as intercrop. Thepruning 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 ofroot length density of tree *Albizia procera* upto 30 cm soil depth were significantly maximum under unpruned tree and minimum in 70% canopy pruned tree in both crop sequences during both the years. With regards to distance from tree base, significantly maximum root length density was found at 0.5 m distance which reduced with each increase in distance from tree base. In case of intercrops, root length density increased with pruning intensity and increased with increasing distance from tree base.

Introduction

In agroforestry system, management of tree component through proper pruning has become an essential practice for reducing both above and belowground competition with associated crops (Fownes and Anderson, 1991; Sinclair *et al.,* 1998). The knowledge of tree-crop root behavior is essential to design and management agroforestry system. Huxley (1983) and Maydell (1987) advocated the need of gaining knowledge of root distribution of trees for optimizing the productivity of trees and crops in various agroforestry systems.

Once competition between tree and crop is observed, it can be minimized by limiting the components by some management practices like tree pruning and interculture operations.

The Competition for both the above- and below-ground resources may arise between trees and crops growing in the same space and soil mass, especially when the trees have more competitive advantage than the crops (Schroth, 1999). The rooting pattern of Dalbergia sisso under agrisilvicultural

system was examined by Ram Newaj *et al.*, (2001).

The highest root length density was measured in the top soil, regardless of season or cropping system (tree or crop alone or intercropped). The highest root length density was found when the pruned trees were intercropped with sorghum. If the trees were not pruned, combining trees and crop did not increase root length density. Intercropping resulted in a spatial separation of the root system of trees and crops between the hedgerows; sorghum is having more roots in the top soil and the trees having more roots in the subsoil under alley cropping than in monoculture, Lehmann *et al.*, (1998).

Root length density was higher at 0.5 m away from tree base and it decreased with subsequent increase in distances from tree base. The root length density and specific root length were less in pruning of trees upto 70 per cent tree height as compared to tree allowed to grown normally. However, specific root length was less at 0.5 m away from tree base and it increased with increasing distances from tree base as observed by Bhargava (2003).

Farish (1991) and Joslin and Handerson (1987) observed seasonal variation in root biomass of tree species. They reported an annual peak in fine root biomass of trees during spring or early summer season than in rest part of the year.

The evaluated the effect of intercrop sequences on tree growth of *Albizia procera* at NRCFA Jhansi. He observed that diameter at breast height (dbh) and plant height of *A. procera* increased due to intercropping sequences of black gram-mustard and green gram-wheat as compared to pure tree stand. Dar (2007) reported that root biomass in *Albizia procera* was higher during *kharif* cropping than *rabi* cropping.

Kanopka *et al.*, (2006) reported increase in root biomass of *Cryptomeria japonica* until like summer (August) and then declined. Jones *et al.*, (1998) also reported that root length density reduced in pruned plots of *Prosopis juliflora* in a semi-arid region of north-east Nigeria.

The success of the simultaneous intercropping of trees with crops in agroforestry system is dependent on the temporal and spatial complementarily of resource capture by trees and crops (Akinnifesi *et al.*, 2004).

Scratch their roots growing in the deeper soil layers. It has beensuggested that competition between the trees and cropsfor belowground resources could be minimized by (1) deep ploughing so that the tree roots growing in the topsoil layer are sloughed off (Kowar and Radder, 1994), 1995, 1999), and low when the trees have few rootsgrowing in the rooting horizon of the crops and more of However, as the functional balance of the tree is altered by pruning, it reacts both morphologically and physiologically in response to the changes and consequently, the growth and development of shoots and foliage may be altered (Singh and Thompson, 1995).

Although agroforestry practice in India is very old and traditional. There are number of basic issues which have to be understood before it is possible to improve the systems. These include interaction between the trees and crops or grasses for shade, rooting pattern, competition for plant nutrients and moisture, soil fertility and compatibility between various trees and crop or grass species. The agroforestry research requires a long term commitment in research resources

and it is not easy to separate the complex interacting factors involved in the system (Anderson and Sinclair, 1993). The advantages of agroforestry cannot be qualified simply in terms of productivity alone; because some of the benefits are due to environmental improvements which cannot be measured are only a few seasons.

Materials and Methods

The present investigation entitled "Effect of different pruning regime on root length density under blackgram-mustard crop sequencein *Albizia procera* based Agroforestry system" was undertaken at Research Farm of National Research Centre for agroforestry, Jhansi (U.P.) during two consecutive year's viz. 2006-2007 and 2007-2008.

Blackgram variety PU-39 was used in the experiment. It was developed at Pantnagar University and recommended for summer season and also in late *kharif* season. It's duration is 70-75 days with average yield potential of 10-12 q/ha. Sowing was done using seed drill at 30 cm apart by using 15 kg seed/ha. The blackgram was sown on 10th and 17th July during 2006 and 2007, respectively. The fertilizers were applied @ 16 kg N + 40 kg P_2O_5/ha through DAP, whole fertilizer was applied as basal dose at sowing time in deep furrows.

One hand weeding was done after 15 to 20 days after sowing. The crop was not given any irrigation. At poding stage, one dusting of 25 kg/ha Methyl parathion 2 per cent dust and one spray of 1.5 l/ha endosulphon 25 EC at 15 days interval was done for insect control. Crop was harvested on 30th September during 2006 and 3rd October during 2007. Mustard variety Varuna was sown in the experiment. It is a popular variety in whole Uttar Pradesh. Duration is 125-130 days with 20-25 q/ha seed yield. Plants are tall with profuse branching.

Mustard was sown on 16th November during 2006 and 26th October during 2007 using 5 kg seed/ha. Sowing was done by tractor driven seed drill at 30 cm apart Plant distance was maintained 10 cm by thinning of extra plants after 20 days of sowing. The fertilizers were applied @ 40 kg N + 40 kg P_2O_5/ha at sowing while extra 40 kg N/ha was top dressed in standing crop at first irrigation applied after 25-30 days of sowing.

Second irrigation was applied at pod formation stage. Crop was harvested on 20th march 2007 and 18th march 2008. Spraying of phosphamidan (dimecron) 85 per cent S.L. @ 250 ml/ha was done twice, at flower initiation and pod formation stages to control aphid. One hand weeding during each year was also done after 20 days of sowing at the time of thinning to keep the crop free from weeds. In root studies, root length density (cm root length/cm^3 soil volume) of tree and crop plants were measured under each treatment plot. Roots were measured at different distances from tree base (0.5, 1, 2, 3 and 4 m) on both sides in two soil depths of 0-15 cm and 15-30 cm. Root measurement was done before maturity of crops by coring technique.

A core sampler 0.5 cm diameter and 15 cm length was used for coring. For storing core sample, labeled plastic bucket was used in which cored soil sample was soaked overnight. After soaking, the soil was removed carefully from core and washed with clean water. At complete washing, muddy water was filtered through 0.87 mm sieve and sorted out the whole root from water and kept in Petri dish to wash again with distilled water. Live and dead roots were separated on the basis of colour and

tensile strength. The live roots were placed on soaking paper for few minutes to minimize the water content and the total root length was measured by the root image analysis system.

After measuring the root length, sample was kept for drying in oven at 70°C temperature up to one hour. At drying, weight of sample was taken by electronic balance. Then root length density and specific root length were calculated using the following formula:

Root length density = cm root length ÷ cm^3 soil volume

Results and Discussion

Root length density

The roots of *Albizia procera* were measured once in a year after harvest of *kharif* crop in the sequence. The data were recorded from two soil depth of 0-15 cm and 15-30 cm in both year observations. In each case, root length densitywas recorded.

The data presented in Table 1.1 revealed that root length density in 0-15 cm soil depth was significantly influenced by pruning treatments and distance in both crop sequences.

Among pruning treatments, unpruned tree produced significantly maximum root length density while minimum was recorded in 70% pruning. Distance from tree base at 0.5 m showed significantly maximum root density which reduced with increase in distance significantly upto 4 m distance in blackgram-mustard sequence during each year. The pruning of 50 and 70% canopy reduced root density compared to unpruned tree by 16.6 and 29.1 per cent in first year and 12.3 and 26.5 per cent in second year, respectively in blackgram-mustard sequence. Similarly, increase in distance from 0.5 m to 1, 2, 3 and 4 meters reduced root density by 15.6, 29.4, 42.2 and 57.8 per cent in first year and 16.2, 30.5, 40.6 and 54.8 per cent in second year, respectively under blackgram-mustard sequence. These results show that pattern of root length density under different treatments was similar under blackgram-mustard crop sequences. The interaction effect between pruning and distances was not found significant on root density in any case of observation.

The data for 15-30 cm soil depth are furnished in Table 1.1 which indicate that pattern of root length density under different treatments was similar to that of 0-15 cm soil depth. Unpruned trees recorded significantly maximum root length density which reduced in 50% and 70% pruning by 14.7 and 25.0 per cent in first year and 14.6 and 24.9 per cent in second year, respectively under blackgram-mustard sequence.

Increasing distances from 0.5 m to 1, 2, 3 and 4 m reduced root density by 14.2, 27.5, 38.3 and 51.2 per cent in first year and 11.2, 24.4, 35.1 and 47.5 per cent in second year, respectively under blackgram-mustard sequence. The interaction effect of pruning regimes x distances was not found significant in any case on this character. However, root length density on an average was recorded 13.0 per cent higher under blackgram-mustard sequence during first and second year, respectively. One thing is also clear from these results that root length density was higher in 15-30 cm soil depth than 0-15 cm depth in all cases. On an average, root length density in 15-30 cm soil depth was 38.3 and 23.2 per cent higher in first year and 31.2 and 29.8 per cent higher in second year, respectively under blackgram-mustard sequence.

Table.1 Root length density (cm root length/cm^3 soil volume) of tree *Albizia procera* under pruning regimes and distance from tree base (0-15 cm)

Distances from tree base (m)	Pruning regimes							
	2006-07				2007-08			
	70%	50%	Control	Mean	70%	50%	Control	Mean
	Blackgram-mustard(0-15 cm)							
0.5	0.207	0.233	0.279	0.240	0.214	0.239	0.273	0.242
1.0	0.175	0.202	0.241	0.206	0.183	0.211	0.250	0.215
2.0	0.153	0.170	0.198	0.174	0.162	0.175	0.211	0.183
3.0	0.126	0.148	0.171	0.148	0.130	0.152	0.190	0.157
4.0	0.102	0.118	0.130	0.117	0.109	0.131	0.142	0.127
Mean	0.153	0.174	0.204	0.177	0.160	0.182	0.213	0.185
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.007	0.010	NS	NS	0.015	0.021	NS	NS
	Blackgram-mustard (15-30 cm)							
0.5	0.207	0.233	0.279	0.240	0.214	0.239	0.273	0.242
1.0	0.175	0.202	0.241	0.206	0.183	0.211	0.250	0.215
2.0	0.153	0.170	0.198	0.174	0.162	0.175	0.211	0.183
3.0	0.126	0.148	0.171	0.148	0.130	0.152	0.190	0.157
4.0	0.102	0.118	0.130	0.117	0.109	0.131	0.142	0.127
Mean	0.153	0.174	0.204	0.177	0.160	0.182	0.213	0.185
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.007	0.010	NS	NS	0.015	0.021	NS	NS

Table.2 Root length density (cm root length/cm^3 soil volume) of blackgram under pruning regimes and distance from tree base

Distances from tree base(m)	Pruning regimes							
	2006-07				2007-08			
	70%	50%	Control	Mean	70%	50%	Control	Mean
	30 DAS							
0.5	0.069	0.065	0.055	0.063	0.065	0.063	0.055	0.061
1.0	0.074	0.069	0.059	0.067	0.068	0.065	0.058	0.064
2.0	0.081	0.074	0.062	0.072	0.078	0.074	0.070	0.074
3.0	0.088	0.080	0.065	0.078	0.086	0.082	0.075	0.081
4.0	0.101	0.088	0.070	0.086	0.098	0.091	0.083	0.091
Mean	0.083	0.075	0.062	0.073	0.079	0.075	0.068	0.074
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.002	0.004	NS	NS	0.005	0.007	NS	NS
Pure crop	-	-	-	0.125	-	-	-	0.119
	60 DAS							
0.5	0.079	0.071	0.068	0.073	0.075	0.069	0.067	0.070
1.0	0.085	0.081	0.078	0.081	0.090	0.080	0.076	0.082
2.0	0.089	0.085	0.081	0.085	0.091	0.084	0.080	0.085
3.0	0.099	0.090	0.086	0.092	0.097	0.089	0.085	0.090
4.0	0.114	0.106	0.093	0.104	0.112	0.104	0.092	0.103
Mean	0.093	0.087	0.081	0.087	0.093	0.085	0.080	0.086
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.003	0.005	NS	NS	0.006	0.009	NS	NS
Pure crop	-	-	-	0.141	-	-	-	0.136
	90 DAS							
0.5	0.094	0.085	0.080	0.086	0.090	0.083	0.080	0.084
1.0	0.101	0.096	0.091	0.096	0.102	0.095	0.089	0.095
2.0	0.107	0.102	0.097	0.102	0.106	0.100	0.095	0.100
3.0	0.117	0.108	0.101	0.109	0.115	0.106	0.100	0.107
4.0	0.135	0.126	0.111	0.124	0.131	0.123	0.108	0.121
Mean	0.111	0.103	0.096	0.103	0.109	0.101	0.094	0.101
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.008	0.009	NS	NS	0.007	0.008	NS	NS
Pure crop	-	-	-	0.152	-	-	-	0.144

Table.3 Root length density (cm root length/cm^3 soil volume) of mustard under pruning regimes and distance from tree base

Distances from tree base (m)	Pruning regimes							
	2006-07				2007-08			
	70%	50%	Control	Mean	70%	50%	Control	Mean
	30 DAS							
0.5	0.039	0.029	0.021	0.030	0.032	0.028	0.018	0.026
1.0	0.043	0.036	0.030	0.036	0.036	0.033	0.027	0.032
2.0	0.049	0.043	0.040	0.044	0.045	0.040	0.036	0.040
3.0	0.056	0.050	0.045	0.050	0.052	0.048	0.044	0.048
4.0	0.059	0.056	0.055	0.057	0.055	0.052	0.050	0.052
Mean	0.049	0.043	0.038	0.043	0.044	0.040	0.035	0.040
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.003	0.004	0.007	0.008	0.004	0.006	0.010	0.010
Pure crop	-	-	-	0.072	-	-	-	0.068
	60 DAS							
0.5	0.074	0.071	0.067	0.071	0.068	0.065	0.059	0.064
1.0	0.080	0.078	0.072	0.077	0.077	0.072	0.067	0.072
2.0	0.088	0.085	0.080	0.084	0.085	0.079	0.073	0.079
3.0	0.099	0.095	0.089	0.094	0.094	0.085	0.080	0.086
4.0	0.114	0.108	0.100	0.107	0.106	0.099	0.096	0.100
Mean	0.091	0.087	0.082	0.087	0.086	0.080	0.075	0.080
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.005	0.008	NS	NS	0.003	0.005	NS	NS
Pure crop	-	-	-	0.128	-	-	-	0.122
	90 DAS							
0.5	0.105	0.088	0.078	0.090	0.092	0.078	0.070	0.080
1.0	0.123	0.101	0.092	0.105	0.101	0.092	0.082	0.092
2.0	0.138	0.123	0.105	0.122	0.110	0.099	0.091	0.100
3.0	0.149	0.137	0.114	0.133	0.128	0.109	0.101	0.113
4.0	0.175	0.152	0.128	0.152	0.141	0.120	0.111	0.127
Mean	0.138	0.120	0.103	0.120	0.114	0.100	0.091	0.102
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.006	0.009	0.015	0.015	0.008	0.012	0.020	0.021
Pure crop	-	-	-	0.197	-	-	-	0.162

Root length density of *kharif* crops

The data recorded at different stages of crop are arranged in Table 1.2 which indicated that effect of pruning and distance from tree base was significant in blackgram crops. Root density increased with pruning intensity and 70% pruning significantly had maximum root density in almost all cases while minimum was recorded in unpruned treatment. In blackgram, at the harvest stage (90 DAS) 50 and 70% pruning had higher root density over control (unpruned) by 7.3 and 15.6 per cent in first year and 7.4 and 16.0 per cent in second year respectively. Increasing distance from tree base also

increased root density which significantly maximum under 4 m distance in all cases. At harvest stage (90 DAS) increasing plant distance from 0.5 to 1, 2, 3 and 4m increased root density by 11.6, 18.6, 26.7 and 44.2 % in first year and 13.1, 19.0, 27.4 and 44.0% in second year, respectively. Root density increased with age of crop up to 90 days after sowing. Interaction effect between pruning and distance was not found significant on root density of blackgram in any case of observation. Interaction affect was found significant at 60 DAS but it could not alter the pattern of results at different levels. It is also clear from the data of blackgram crops that pure crop maintained higher root density than tree-crop system.

Root length density of rabi crops

The related data for mustard crops are presented in Table 1.3 respectively. The pattern of root density under different treatments was similar to kharif crops. Pruning intensity showed significant increase upto 70% canopy pruning while plant increased root density upto widest of 4 m from tree in all cases of observation. Root length density was recorded remarkably higher in 4 m mustard. At final stage of 90 DAS, in mustard crop, 50 and 70% pruning increased root density over control by 16.5 and 34.0% in first year and 9.9 and 25.3% in second year, respectively. Similarly increase in plant distance from 0.5 to 1, 2, 3 and 4 m improved root density by 16.7, 35.6, 47.8 and 68.9% in first year and 15.0, 25.0, 41.2 and 58.7% in second year, respectively. In case of mustard, the interaction was significant at 30 DAS and 90 DAS stages. Results at 30 DAS indicated that effect of distance was more pronounced in control and 50% pruning than 70% pruning while at 90 DAS, the effect of plant distance was more pronounced under 70% pruning than under 50% pruning and control treatment.

Root length density of tree *Albizia procera* upto 30 cm soil depth were significantly maximum under unpruned tree and minimum in 70% canopy pruned tree in both crop sequences during both the years. With regards to distance from tree base, significantly high root length density was found at 0.5 m distance which reduced with each increase in distance from tree base. In case of intercrops, root length density. Root length density of intercrops was increased with pruning intensity and increasing distance from tree base.

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