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Original Research Article

A Study on Different Pruning Regime of Crop Root Length Density under Greengram-Wheat crop Sequence and *Albizia procera* based Agroforestry System

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Keywords

Albizia procera, crop, pruning regime, agroforestry system

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 greengram-wheat crop sequence in *Albizia procera ((Roxb.)Benth)* based Agroforestry system. The experiment was conducted in randomized block design with three replications. Green gram (*Vigna radiata,* (L) *Wilczek:* and wheat (*Triticum aestivum* (L) crop sequences 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 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 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

Management of tree component in agroforestry systems at suitable age intervals is of vital importance. Out of different tree management practices, pruning is most common and also utmost importance. In pruning, the removal of some parts of tree obviously reduces the competition ability of tree because of better light penetration to understory crop. Demand of moisture and nutrients of pruned trees also declined which reduces the tree competitive with intercrops. Besides, pruned biomass is applied into the soil which acts as mulch and also provide nutrients to the soil, thus intercrops are benefited by both ways. In absence of pruning, the growth of understory vegetation decreased due to poor light penetration with the increased canopy of trees (Acciaresi *et al.,* 1994).

Pruning of trees also helps to maintain the quality and quantity as well of tree products like timber, fruit etc. Pruning of the tree component is a powerful approach to regulate the tree-crop competition for light, nutrients and other resources (Frank and

Eduarbo, 2003). Impact of pruning on tree growth and yield of intercrops depends mainly on severity and time of pruning. Many research workers have tried different extent and stages of pruning to examine their effects on tree growth and performance of arable intercrops grown in agroforestry system. Pinkered *et al.*, (2004) observed that removal of crown length between 30 and 50% was appropriate for *Eucalyptus globulus* plantation verging on canopy closure. The significant reduction in tree height associated with removal of 50 or 70 % of crown length suggested that pruning should remain below 50% of crown length, if reduced stem growth of pruned trees is to be avoided. Stem volume was only significantly reduced over the period of experiment by 70 per cent pruning, but it was estimated that standing volume following removal of 50% of crown length be reduced by 82 m^3/ha over a 20- years rotation.

Bhargava (2003) tested the effect of pruning in *Albizia procera* on intercrops at Jhansi and observed that germination, plant height, yield attributes and yield of intercrops blackgram and mustard were higher with 70 % pruning than lower pruning intensity.

Dadhwal *et al.,* (1986) studied the effect on distribution of eight years old *Eucalyptus* hybrid trees standing on field boundary and their impact on rainfed maize and wheat crops. The tree root competition in the surface one meter depth (per unit volume of trench) consisted upto 47 roots more than 10 cm per diameter, 49 of 2.5 cm per diameter and numerous roots of less than 2 cm per diameter. These roots would have entered the crops field in 12.5 m long segment, had these been no trench to eliminate them.

The rooting pattern of *Dalbergia sisso* under agrisilvicultural system was examined by Ram Newaj *et al.,* (2001). In general, the specific root length was lower in 15 cm top soil layer nearly the tree base and it increased sharply with increase of distances from tree base. The upper 30 cm soil layer contained maximum roots (76-84 %), 30-45 cm soil layer (8.75-13.12 per cent), 45-60 cm soil layer (5.25-9.48 %), 60-75 cm soil layer (1.0 %) and in 75-105 cm soil layer, the roots were negligible.

The concept of competition or complementarity between tree and crop roots for below ground resources have been a major debate in simultaneous systems. 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).

Materials and Methods

The present investigation entitled "A study on different pruning regime of crop root length density under greengram-wheat crop sequence and *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.

Crop greengram

Variety PDM-54 developed at IIPR, Kanpur was used in the study. It is dull green seeded variety of 65-70 day with 8-10 q/ha average yield under normal condition. It was also sown by seed drill at 30 cm apart using 15 kg seed/ha on 11th July 2006 and 13th July 2007. Fertilizers were applied at the time of sowing. No irrigation was done while plant protection and weeding operations through pre-emergence herbicide (Pendimethalin).

Harvesting was done on 24th September during 2006 and 28th September during 2007.

Crop wheat

Wheat variety 'HD-2285' was selected for study. It is a well-established variety for normal as well as late sowings under irrigated condition. Its duration is 120-125 days with 45-50 q/ha average yield potential. The sowing of wheat was done by seed drill at 25 cm apart by using 100 kg seed/ha on 23rd and 17th November during 2006 and 2007 respectively. The fertilizers were applied @ 60 kg N + 60 kg P_2O_5 + 40 kg K_2O/ha at sowing time in deep furrows. Besides, 60 kg N/ha was top dressed in standing crop after first irrigation. In all, four irrigation were applied to the crop on crown root initiation (21days after sowing), tillering, dough and milking stage. No plant protection was needed in wheat crop during any of the experimental year. The crop was harvested by manual labour on 11th and 7th April during 2006 and 2007, respectively. To keep the wheat crop free from weeds, one hand weeding was done during each year of study after 20 to 25 days of sowing.

Measurement methods of Root length density

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 dia 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. 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 70^0C 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 formulae:

Root length density = cm root length $\div$ cm^3 soil volume

Results and Discussion

Root length density

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 both sequence during each year. Bhargava (2003) In case of greengram-wheat sequence, 50 and 70% pruning reduced root density by 12.4 and 24.3 % in first year and 13.0 and 23.9% in second year, respectively than unpruned trees. In greengram-wheat

sequence, the respective reductions from 0.5 m were found 13.7, 30.2, 38.7 and 50.9% in first year and 12.4, 28.0, 39.4 and 50.9% in second year in root length density. These results show that pattern of root length density under different treatments was similar under both crop sequences. However, root density on an average was 21.1 and 14.2% higher under greengram-wheat sequence in first and second year, respectively. 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 15.0 and 25.0% in first year and 13.7 and 24.6% in second year under greengram-wheat sequence were found 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%in first year and 11.2, 24.4, 35.1 and 47.5% in second year, respectively under greengram-wheat sequence during both years. 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 7.9 and 13.0% higher under greengram-wheat sequence compared 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% higher in first year and 31.2 and 29.8% higher in second year, respectively under sequence greengram-wheat sequence as compared to 0-15 cm soil depth.

The data regarding this character are presented in Table 1.1 for 0-15 cm and 15-30 cm soil depth.

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 both 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.

Newaj *et al.*, (2001). In greengram, at harvest stage (90 DAS) 50 and 70% pruning had higher root density as compared to control (unpruned) by 11.4 and 21.4% in first year and by 8.6 and 18.6% in second year, respectively. Similarly, increasing distance from tree base 0.5 m to 1, 2, 3 and 4 m increased the root density by 13.3, 30.0, 43.3 and 61.7% in first year and 19.6, 39.3, 51.8 and 69.6% in second year, respectively. Root density of greengram increased remarkably up to 60 DAS while difference between 60 and 90 days stages was only marginal. 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 crops that pure crop maintained higher root density than tree-crop system.

Root length density of Rabi crop

The related data for mustard and wheat crops are presented in Table 1.3 respectively. The pattern of root density under different treatments was similar to kharif crops.

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 and 15-30 cm)

Distances from tree base (m)	Pruning regimes							
	2006-07				2007-08			
	70%	50%	Control	Mean	70%	50%	Control	Mean
	Greengram-Wheat (0-15 cm depth)							
0.5	0.190	0.215	0.231	0.212	0.195	0.218	0.241	0.218
1.0	0.161	0.180	0.207	0.183	0.169	0.190	0.215	0.191
2.0	0.128	0.145	0.172	0.148	0.137	0.153	0.180	0.157
3.0	0.106	0.130	0.153	0.130	0.109	0.131	0.157	0.132
4.0	0.087	0.103	0.122	0.104	0.090	0.107	0.125	0.107
Mean	0.134	0.155	0.177	0.155	0.140	0.160	0.184	0.161
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.007	0.011	NS	NS	0.007	0.010	NS	NS
Pure crop	-	-	-	0.082	-	-	-	-
	Greengram-Wheat (15-30 cm depth)							
0.5	0.219	0.246	0.279	0.248	0.226	0.270	0.302	0.266
1.0	0.186	0.217	0.256	0.220	0.206	0.228	0.269	0.234
2.0	0.170	0.185	0.220	0.192	0.183	0.205	0.236	0.208
3.0	0.134	0.149	0.192	0.158	0.158	0.172	0.209	0.180
4.0	0.118	0.136	0.155	0.136	0.132	0.157	0.182	0.157
Mean	0.165	0.187	0.220	0.191	0.181	0.207	0.240	0.209
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.012	0.015	NS	NS	0.009	0.011	NS	NS
Pure crop	-	-	-	0.121	-	-	-	0.128

Table.2 Root length density (cm root length/cm^3 soil volume) of greengram under different 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	0.056	0.054	0.049	0.053	0.054	0.052	0.048	0.051
1.0	0.065	0.061	0.055	0.060	0.063	0.060	0.052	0.058
2.0	0.077	0.069	0.064	0.070	0.072	0.068	0.063	0.068
3.0	0.080	0.073	0.069	0.074	0.076	0.072	0.068	0.072
4.0	0.090	0.083	0.078	0.084	0.084	0.081	0.077	0.081
Mean	0.074	0.068	0.063	0.068	0.070	0.067	0.062	0.066
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.002	0.003	NS	NS	0.003	0.004	NS	NS
Pure crop	-	-	-	0.115	-	-	-	0.112
	60 DAS							
0.5	0.063	0.057	0.051	0.057	0.055	0.053	0.050	0.053
1.0	0.071	0.065	0.056	0.064	0.068	0.063	0.055	0.062
2.0	0.078	0.073	0.065	0.072	0.075	0.069	0.064	0.069
3.0	0.083	0.077	0.071	0.076	0.082	0.075	0.070	0.076
4.0	0.094	0.086	0.080	0.087	0.093	0.085	0.079	0.086
Mean	0.078	0.072	0.065	0.072	0.075	0.069	0.064	0.069
Factors	Pruning	Dist.	P (D)	D (P)	Pruning	Dist.	P (D)	D (P)
LSD (5%)	0.003	0.004	0.007	0.007	0.004	0.007	0.011	0.011
Pure crop	-	-	-	0.121	-	-	-	0.117
	90 DAS							
0.5	0.067	0.060	0.053	0.060	0.059	0.056	0.052	0.056
1.0	0.076	0.069	0.059	0.068	0.075	0.068	0.059	0.067
2.0	0.085	0.078	0.070	0.078	0.085	0.077	0.071	0.078
3.0	0.093	0.085	0.079	0.086	0.092	0.084	0.078	0.085
4.0	0.106	0.096	0.088	0.097	0.105	0.093	0.088	0.095
Mean	0.085	0.078	0.070	0.078	0.083	0.076	0.070	0.076
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.008	0.011	NS	NS	0.008	0.012	NS	NS
Pure crop	-	-	-	0.126	-	-	-	0.119

Table.3 Root length density (cm root length/cm^3 soil volume) of wheat under different 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	0.071	0.059	0.042	0.057	0.071	0.058	0.040	0.056
1.0	0.073	0.065	0.048	0.062	0.072	0.065	0.047	0.061
2.0	0.078	0.071	0.057	0.069	0.077	0.069	0.055	0.067
3.0	0.085	0.079	0.063	0.076	0.085	0.079	0.062	0.075
4.0	0.091	0.084	0.071	0.082	0.092	0.083	0.070	0.082
Mean	0.080	0.072	0.056	0.069	0.079	0.071	0.055	0.068
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.009	0.013	NS	NS	0.008	0.013	NS	NS
Pure crop	-	-	-	0.108	-	-	-	0.107
	60 DAS							
0.5	0.103	0.081	0.071	0.085	0.098	0.087	0.069	0.085
1.0	0.113	0.100	0.085	0.099	0.105	0.096	0.078	0.093
2.0	0.131	0.112	0.099	0.114	0.124	0.103	0.091	0.106
3.0	0.144	0.128	0.114	0.129	0.132	0.124	0.107	0.121
4.0	0.158	0.141	0.127	0.142	0.141	0.135	0.121	0.132
Mean	0.130	0.112	0.099	0.114	0.120	0.109	0.093	0.107
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.015	0.018	NS	NS	0.020	0.026	NS	NS
Pure crop	-	-	-	0.178	-	-	-	0.171
	90 DAS							
0.5	0.135	0.109	0.098	0.114	0.121	0.103	0.088	0.104
1.0	0.149	0.140	0.118	0.136	0.134	0.123	0.104	0.120
2.0	0.182	0.160	0.137	0.160	0.165	0.136	0.122	0.141
3.0	0.203	0.178	0.162	0.181	0.178	0.172	0.145	0.165
4.0	0.214	0.195	0.181	0.197	0.196	0.184	0.167	0.182
Mean	0.177	0.156	0.139	0.157	0.159	0.144	0.125	0.143
Factors	Pruning	Dist.	P (D)	D (P)	Pruning.	Dist.	P (D)	D (P)
LSD (5%)	0.009	0.013	NS	NS	0.009	0.012	NS	NS
Pure crop	-	-	-	0.192	-	-	-	0.181

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 wheat crop and 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.

Root density of wheat also behaved in a similar manner to mustard but some wider differences between treatments. The pruning

of 50 and 70% canopy increased root density of wheat over control at final stage of 90 DAS by 12.2 and 27.3% in first year and by 15.2 and 27.2% in second year, respectively.

The increasing distance from 0.5 m to 1, 2, 3 and 4 m increased root density by 19.3, 40.4, 58.8 and 72.8% in first year and 15.4, 35.6, 58.7 and 75.0% during second year, respectively at same stage of 90 DAS. Pattern was also similar at earlier stages of 30 and 60 DAS during both years. The interaction effect could not affect the root density of wheat at any stage of observation. On an average root density was found more in wheat crop. In all cases, pure crop recorded much more root density than in tree-crop system in case of wheat crops.

The experiment comprised of crop sequences (greengram-wheat) assigned to main plots and three pruning resumes (70% canopy pruning, 50% canopy pruning and unpruned control) kept in sub-plots of a split plot design replicated thrice.

One extra treatment of pure crop and another one of pure tree were also maintained to compare with agroforestry system. 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 crop sequences during both the years. As regards 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 while reverse in case of root length density. In case of intercrops, root length density increased with pruning intensity and increased with increasing distance from tree base.

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