EFFECT OF *DALBERGIA SISSOO* TREE ROWS ON THE GROWTH AND YIELD OF COTTON CROP

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Abstract

Data were collected from five different sites to evaluate the impact of *Dalbergia sissoo* linear planting on the growth and yield of cotton crop. The crop density was significantly affected on northern, eastern and western aspect upto 3.0 m from the base of tree rows. There was non-significant affected of tree rows on southern aspect. Crop height was also significantly affected upto 3.0m distance from the base of trees on northern and western aspects while it was non-significant on eastern and southern aspects. Boll formation and cotton yield were significantly affected on northern, eastern and western aspects. However on southern aspect, tree row did not produce any significant effect on cotton crop. More reduction in yield was observed near the base of trees and yield improved progressively with the increase in distance from tree rows. Significant reduction in yield was observed upto 11.0m on northern aspect; upto 3.0 and 7.0m on eastern aspect and upto 7.0m distance from tree rows on western aspect.

Maximum percent reduction in yield (per acre) was observed on northern aspect (10.18%) followed by eastern (10.11%), western (9.12%) and minimum on southern aspect (4.97%). Adverse effect on yield was noticed upto 1.63 times the average height of the tree row on northern aspect; 0.67 times on southern aspect; 1.12 to 1.63 times on eastern aspect and 1.47 times on western aspect respectively.

Tree rows with close spacing produced more adverse effect than those planted at wider spacing. Adverse effect of shade caused by the tree rows can be minimized with proper spacing and pruning of trees. Yield losses can also be compensated from the sale of marketable trees.

Introduction

Dalbergia sissoo Roxb. Is an important tree species having great value for its excellent quality of timber and high quality fuelwood. It is also a multipurpose tree used in agroforestry system to protect soil and crops when planted as shelterbelts and windbreaks. The tree has the ability to improve soil and crop production due to fixation of nitrogen. The species can also provide long term financial security to the growers because of its high demand. These characteristics make *D. sissoo* an ideal species for planting on farmlands. Raising *D. sissoo* along field boundaries is a common practice in the irrigated plains of Punjab owing to sustainable financial returns. The specific objective

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of this study was to evaluate the effect of *D. sissoo* tree rows on the growth and yield of cotton crop – an important cash crop of Pakistan.

Material and Methods

The study was conducted in Multan and Bahawalpur districts of the Punjab (Pakistan) during 1998 and 1999 under Rapid Rural Appraisal technique. A 2m x 2m sample plot was used to collect cotton data. Samples were taken at 1, 5, 9, 14 and 19 meters upto a distance equal to double the height of tree row. The control sample was taken beyond the double height of tree row assuming no adverse effect of tree row on cotton crop. Transects were replicated three times. For each sample plot, the cotton crop data showing number of plants, bolls, crop height and weight in gram (gm) were recorded in addition to row orientation, tree age, spacing, height, diameter at breast height and crown width.

Data collected were analysed using one-way ANOVA followed by Duncan's new multiple range tests (Steel and Torrie, 1960). The percent decrease or increase in cotton yield at various distances from tree row over control was calculated by using the formula:

$$\text{Percent decrease or increase} = \frac{T_c - T_i}{T_c} \times 100$$

Where,

T_c = Average control yield (gm/4m^2)

T_i = Average yield at various distances from tree row (gm/4m^2)

Results

Results of data collected from five different sites are described as under:

Site I

The growth and yield data of cotton crop collected from the eastern aspect of north-south oriented, 10 years old, tree row is given in table-1. Trees were spaced 0.92m apart. The average height and average diameter at breast height of trees were 9.80m and 13.57cm respectively with average crown width of 4.12m.

The statistical analysis of data revealed the significant effect of tree row on boll formation and crop yield. However, plant density and crop height were not significantly different. The significant effect on crop yield was found upto 7.0m distance from the base of tree row and non-significant effect continued upto 16m. Beyond this, no adverse effect was observed. The yield was low near the base of tree row and it increased consistently with the increase in distance from tree row. When compared with the average height of

the tree row, the adverse effect was observed upto 1.63 times the height of trees. The net loss in yield was 88.0 Kg per acre. The percent reduction in yield per acre was 10.11%.

Table 1. Effect of 10 years old Shisham tree row on the growth and yield of cotton crop on eastern aspect

Distance from tree row	Crop parameters			
(m)	Plant Density (per $4m^2$)	Crop Height (cm)	No. of Bolls	Yield ($gm/4m^2$)
1	7a	101a	43d	152c (-82.32)
5	7a	110a	101c	370b (-56.98)
9	8a	104a	189b	757a (-11.98)
14	10a	116a	223ab	850a (-1.16)
19	10a	122a	255a	867a (+0.81)
Control	10a	128a	248a	860a

* Means having similar letters are not significant at 0.05 P

** Figures in brackets indicate percent decrease (–) or increase (+) over control

Site II

The growth and yield data of cotton crop collected from the eastern aspect of north-south oriented, 10 years old, tree row is given in table-2. Trees were spaced 2.44m apart. The average height and average diameter at breast height of trees were 9.80m and 20.80cm respectively with average crown width of 6.25m.

Table 2. Effect of 10 years old Shisham tree row on the growth and yield of cotton crop on eastern aspect

Distance from tree row	Crop parameters			
(m)	Plant Density (per $4m^2$)	Crop Height (cm)	No. of Bolls	Yield ($gm/4m^2$)
1	6c	137ab	62b	207b (-77.00)
5	11ab	146ab	191a	720a (-20.00)
9	9b	146ab	228a	857a (-4.78)
14	10ab	158a	231a	908a (+0.89)
19	11a	162a	220a	890a (-1.11)
Control	11a	162a	233a	900a

* Means having similar letters are not significant at 0.05 P

** Figures in brackets indicate percent decrease (–) or increase (+) over control

The statistical analysis of data revealed the significant effect of tree row on plant density, boll formation and crop yield. However, non-significant effect was observed on

crop height. Plant density, boll formation and crop yield were significantly affected upto 3.0m distance from the base of tree row. Non-significant effect on yield continued upto 11.0m from the tree row. Beyond this, no adverse effect was observed. More losses were observed near the tree row and yield increased progressively with the increase in distance from tree row. When compared with the average height of tree row, adverse effect was observed upto 1.12 times the height of trees. The total loss in yield was 62.0Kg per acre. The percent reduction in yield per acre was 6.80%.

Site III

The growth and yield data of cotton crop collected from the western aspect of north-south oriented, 12 years old tree row is presented in table-3. Trees were spaced 3.05m apart. The average height and average diameter at breast height of trees were 10.87m and 28.30cm respectively with average crown width of 2.44m.

The statistical analysis of data (table-3) showed significant effect of tree row on plant density, crop height, boll formation and crop yield. Plant density and crop height were significantly affected upto 3.0m while boll formation and crop yield were significantly affected upto 7.0m distance from the base of tree row, Non-significant effect on yield continued upto 16.0m. Beyond this, no adverse effect was observed. The yield was low near the base of tree row and it increased consistently with the increase in distance from tree row. When compared with the average height of tree row, adverse effect was observed upto 1.47 times the height of trees. The net loss in yield was 76.0Kg per acre. The percent reduction in yield per acre was 9.12%.

Table 3. Effect of 10 years old Shisham tree row on the growth and yield of cotton crop on eastern aspect

Distance from tree row	Crop parameters			
(m)	Plant Density (per $4m^2$)	Crop Height (cm)	No. of Bolls	Yield ($gm/4m^2$)
1	6d	88c	48c	178c (-77.03)
5	12bc	122b	119b	470b (-42.89)
9	14abc	137ab	180a	710a (-13.73)
14	12bc	149a	180	807a (-1.94)
19	17a	140a	194a	823a (0.00)
Control	16ab	149a	187a	823a

* Means having similar letters are not significant at 0.05 P

** Figures in brackets indicate percent decrease (–) or increase (+) over control

Site III

The growth and yield data of cotton crop collected from the northern aspect of east-west oriented, 10 years old tree row are given in table-4. Trees were spaced 2.13m apart. The average height and average diameter at breast height of trees were 9.8m and 18.80cm respectively with average crown width of 5.18m.

The statistical analysis of data (table-4) showed significant effect of tree row on plant density, crop height, boll formation and crop yield. Plant density and crop height were significantly affected upto 7.0m while boll formation and crop yield were significantly affected upto 11.0m distance from the base of tree row, Non-significant effect on yield continued upto 16.0m beyond this, no adverse effect was observed. The yield was low near the base of tree row and it increased consistently with the increase in distance from tree row. When compared with the average height of tree row, adverse effect was observed upto 1.63 times the height of trees. The net loss in yield was 102Kg per acre. The percent reduction in yield per acre was 10.18%.

Table 4. Effect of 10 years old Shisham tree row on the growth and yield of cotton crop on northern aspect

Distance from tree row	Crop parameters			
(m)	Plant Density (per $4m^2$)	Crop Height (cm)	No. of Bolls	Yield ($gm/4m^2$)
1	6c	101c	46d	147d (-85.15)
5	7bc	131d	121c	447c (-54.85)
9	11a	140c	253a	860b (-13.13)
14	9ab	143bc	196b	880a (-1.01)
19	10ab	146ab	285a	1005a (+1.51)
Control	10ab	149a	271a	990a

* Means having similar letters are not significant at 0.05 P

** Figures in brackets indicate percent decrease (–) or increase (+) over control

Site IV

The growth and yield data of cotton crop collected from the southern aspect of north-south oriented, 11 years old tree row are given in table-5. Trees were spaced 3.96m apart. The average height and average diameter at breast height of trees were 10.36m and 25.95cm respectively with average crown width of 6.71m.

The statistical analysis of data (table-5) revealed that crop density, height, boll formation and crop yield were significantly effected. Non-significant effect on crop yield was observed upto 7.0m distance from the base of tree row. Beyond this, no adverse effect was observed. The yield was low near the base of tree row and it increased consistently with the increase in distance from tree row. When compared with the average height of tree row, adverse effect was observed upto 0.67 times the height of trees. The net loss in yield over control was 31Kg per acre. The percent reduction in yield per acre was 4.97%.

Table 5. Effect of 11 years old Shisham tree row on the growth and yield of cotton crop on southern aspect

Distance from tree row	Crop parameters			
(m)	Plant Density (per $4m^2$)	Crop Height (cm)	No. of Bolls	Yield ($gm/4m^2$)
1	10c	125c	91b	310b (-49.76)
5	14bc	137bc	136ab	467ab (-24.31)
9	19ab	149ab	181a	623a (+0.97)
14	16abc	158ab	180a	617a (0.00)
19	16abc	158ab	184a	600a (-2.75)
Control	20a	149a	178a	617a

* Means having similar letters are not significant at 0.05 P

** Figures in brackets indicate percent decrease (–) or increase (+) over control

Discussion

Orientation of tree rows produced adverse effect on cotton yield. East-west oriented tree rows produced more reduction on northern aspect as compared to southern aspect. On both aspects, yield was low near the trees and it improved considerably as the distance from tree row increased. More reduction on northern aspect is mainly due to shade of trees, which did not allow sunlight to reach the ground. Boll formation was less and ripening of bolls delayed due to continuous shade on northern aspect. The results indicating more reduction on northern aspect were in conformity with those reported earlier (Sheikh and Haq, 1986; Sing et al., 1999). On the southern aspect reduction in yield was observed under the tree canopy only. Beyond the tree canopy, no adverse effect was observed. Southern aspect did not show any significant effect on plant density, crop height, boll formation and yield. However on northern aspect all the parameters were significantly affected.

In case of north-south oriented tree rows, reduction in yield was slightly less on western aspect as compared to eastern aspect. This was due to fact that both the aspects are almost equally benefited from sunlight. These tree rows produced significant effect on plant density and crop height upto 3.0m distance from tree rows.

Effect on crop due to distance from tree row

The unit increase in distance from the tree row had significant effect on the growth and yield of cotton crop. Effect of increase in distance on plant density and crop height was significant only under the tree canopy upto 3.0m. Severe yield losses were observed near the base of tree rows and yield increased consistently with the increase in distance from tree row. Several researchers have reported similar results on agricultural crops other than cotton Malik and Sharma (1990); Jafri et al. (1991); Khan and Ehrenreich (1994) and Sharma et al. (1996).

Khan and Khan (1988) reported adverse effect of *D. sissoo* on cotton yield upto 8.5m to the north and 3.5m to the south. Sunil et al. (1995) reported negative effect of 18 years old windbreak of *Dalbergia sissoo* on cotton yield upto 2H (36m), where H is tree height.

Effect of Tree Spacing on Crop Yield

Closely spaced tree rows produced more reduction in yield as compared to widely spaced tree rows. From the eastern aspect of north-south oriented 10 years old tree row planted at a spacing of 0.91m, the reduction in yield was 10.11%. On the contrary, in the eastern aspect of north-south oriented 10 years old tree row planted at a spacing of 2.44m, the reduction in yield was only 6.80%. From the above observations it can be concluded that close spacing and large crowns, less sunlight was available for photosynthesis, which ultimately affected boll formation and yield.

Conclusions

- Crop density is significantly affected on northern, eastern and western aspects only under the tree canopy upto 3.0m while the affect is not significant on the southern aspect.

- Crop height affect is significant under the tree canopy upto 3.0m distance from the base of trees on northern and western aspects.

- Boll formation and cotton yield are affected on northern, eastern and western aspects.

- More reduction in yield is observed near the base of trees and yield improved progressively with the increase in distance from tree rows. Significant reduction in yield is observed upto 11.0m on northern aspect; upto 7.0m on eastern aspect and upto 7.0m distance from tree row on western aspect.

- Maximum percent reduction in yield (per acre) is observed on northern aspect (10.18%) followed by eastern (10.11%), western (9.12%) and minimum on southern aspect (4.97%). Generally, the reduction in yield of cotton crop grown along the east-west oriented tree rows is relatively less than when grown along the north-south oriented tree rows.

- Adverse effect on yield is noticed upto 1.63 times the average height of tree row on northern aspect; 0.67 times the average height of tree row on southern aspect; 1.63 times the average height of tree rows on eastern aspect and 1.47 times the average height of tree row on western aspect respectively.

- Tree rows with close spacing produced more adverse effect than those planted at wider spacing. Adverse effect of shade caused by tree rows can be minimized with proper spacing and proper pruning of trees. Yield losses can also be compensated from the sale of trees.

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