IMPACT OF *EUCALYPTUS CAMALDULENSIS* FIELD BOUNDARY PLANTATIONS ON THE PERFORMANCE OF COTTON CROP

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ABSTRACT

This study was conducted on six different farmlands of Southern Punjab (Pakistan) with the objective to evaluate the effect of *Eucalyptus camaldulensis* boundary plantations on the growth and yield of cotton crop. With north-south oriented tree rows, more reduction in yield (per acre) was observed on eastern aspect (20.0 %) as compared to western aspect (19.40 %). With east-west oriented tree rows, more reduction in yield was observed on northern aspect (16.90 %) as compared to southern aspect (15.80 %) respectively. The reduction in yield of cotton crop grown along the east-west oriented tree a row was relatively less than when grown along the north-south oriented tree rows. Minimum percent reduction in cotton yield (7.47%) on western aspect was observed where Eucalyptus was planted on main water channel and excessive amount of irrigation water was always available to the trees to meet their most of moisture and nutrient requirement. Plant density was significantly affected on northern, eastern and western aspects up to 7 m distance from the base of tree rows while it was non-significantly affected on southern aspect. Crop height was significantly affected up to 7.0 m distance from the base of trees on northern and southern aspects while significant effect on eastern and western aspects was observed up to 11m distance. Boll formation and cotton yield were significantly affected on eastern, western, northern and southern aspects. Cotton yield was deleteriously affected near the base of tree rows and it improved progressively with the increase in distance from tree rows. Significant reduction in yield was observed up to 11 m on northern aspect; up to 7.0 m on southern aspect and up to 16.0 m distance from tree row on eastern and western aspects respectively. Adverse effect on yield was noticed up to 1.64 times the average height of tree row on northern aspect; 1.51 times the average height of tree row on southern aspect; 1.58 times the average height of tree rows on eastern aspect and 1.51 times the average height of tree row on western aspect, respectively. Severe adverse effect of Eucalyptus on cotton crop can be attributed to the fact that the nutrient and water consumption of Eucalyptus is very high resulting in depletion of moisture and nutrients for cotton crop with low water requirement. Additional quantity of water and fertilizers should be provided up to 11.0 m distance from tree row to minimize the root competition.

INTRODUCTION

Eucalyptus camaldulensis, a fast growing exotic tree species, can be grown on a variety of soils including saline, sodic and waterlogged wastelands. During the last two decades, it has been extensively planted on private farmlands of Punjab in compact as well as linear plantations along field boundary in farm forestry projects. However, it is considered as one of the most controversial tree species in agroforestry system because of its depletion of water and nutrients from the soil. The matter is of immense concern when field crops of low water requirement are grown in association with Eucalyptus (Nadagouda *et al*., 1997).

Cotton is an important cash crop of Pakistan. The water requirement of cotton is low and that of Eucalyptus is very high. With this background, the present study was

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carried out to see the extent of adverse effect of Eucalyptus field boundary plantations on the growth and yield of cotton crop.

MATERIAL AND METHODS

The study was conducted in Multan and Bahawalpur districts of Punjab province, 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, 19 and 24 m etc. up to 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. Following observations were recorded for each tree row: orientation, age, average spacing, average height; average diameter at breast height and average crown width.

Data collected were analyzed using analysis of variance technique followed by Duncan's new multiple range tests (Steel & Torrie, 1960).

RESULTS

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

EFFECT OF EAST-WEST ORIENTED TREE ROWS

Site I

The growth and yield data of cotton crop collected from the northern and southern aspects of east-west oriented 4 years old tree row is presented in Table 1. Trees were spaced 1.83 m apart. The average height and average diameter at breast height of trees were 10.61 m and 14.20 cm respectively with average crown width of 3.20 m.

Northern Aspect

The statistical analysis of data (Table 1) showed non-significant effect of tree row on plant density. However, adverse effect on plant density was observed up to 3.0 m. Crop height, boll formation and yield were significantly affected. Crop height was significantly affected up to 7.0 m distance while boll formation and cotton yield were significantly affected up to 11.0 m distance from the base of tree row. Non-significant effect on crop yield continued up to 16.0 m. Beyond this, no adverse effect was observed. The yield was deleteriously affected 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 up to 1.51 times the height of trees. The net loss in yield was 133 Kg per acre. The percent reduction in yield per acre was 14.06 %.

Southern Aspect

The statistical analysis of data (Table 1) showed non-significant effect of tree row on plant density. Non-significant effect on plant density was observed up to 3.0 m. However, crop height, boll formation and yield were significantly affected. All these parameters were significantly affected up to 7.0 m distance from the base of tree row. Non-significant effect on crop yield continued up to 16.0 m. When compared with the average height of tree row, adverse effect was observed up to 1.51 times the height of trees. The net loss in yield was 103 Kg per acre. The percent reduction in yield per acre was 11.0 %.

Site II

The growth and yield data of cotton crop collected from the northern and southern aspects of east-west oriented 6 years old tree row is presented in Table 1. Trees were spaced 1.52 m apart. The average height and average diameter at breast height of trees were 12.80 m and 19.29 cm respectively with average crown width of 3.75 m.

Northern Aspect

The statistical analysis of data (Table 1) showed significant effect of tree row on plant density, crop height, boll formation and crop yield. Plant density and crop height were significantly affected up to 7.0 m while boll formation and crop yield were significantly affected up to 11.0 m distance from the base of tree row. Non-significant effect on crop yield continued up to 21.0 m. 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 up to 1.64 times the height of trees. The net loss in yield was 121 Kg per acre. The percent reduction in yield per acre was 16.90 %.

Southern Aspect

The statistical analysis of data (Table 1) showed significant effect of tree row on plant density, crop height, boll formation and crop yield. Plant density and crop height were significantly affected up to 7.0 m while boll formation and crop yield were significantly affected up to 11.0 m distance from the base of tree row. Non-significant effect on crop yield continued up to 21.0 m. 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 up to 1.64 times the height of trees. The net loss in yield was 98 Kg per acre. The percent reduction in yield per acre was 15.80 %.

Table 1. Effect of east-west oriented tree rows on cotton crop parameters

Farm No.	Cotton Side	Crop Parameters	Distance from tree row (m) 1	5	9	14	19	24	Control
I	North	*Plant density (No.)	6	10	11	14	13	-	13
		***Crop Height (cm)	55	67	94	110	119	-	119
		***Boll Formation (No.)	23	94	153	245	256	-	259
		***Cotton Yield (gm)	55 (-94.12)	270 (-71.12)	605 (-35.29)	870 (-6.42)	940 (+0.53)	-	935
I	South	*Plant density (No.)	4	12	13	14	12	-	12
		***Crop Height (cm)	64	85	107	116	128	-	128
		***Boll Formation (No.)	21	129	194	226	225	-	221
		***Cotton Yield (gm)	65 (-92.97)	495 (-46.49)	755 (-18.38)	875 (-5.41)	927 (+0.22)	-	925
II	North	***Plant density (No.)	7	8	9	11	10	12	12
		***Crop Height (cm)	55	79	85	116	122	128	125
		***Boll Formation (No.)	24	59	108	186	236	227	224
		***Cotton Yield (gm)	62 (-91.23)	167 (-76.38)	330 (-53.32)	563 (-20.37)	700 (-0.99)	710 (+0.42)	707
II	South	**Plant density (No.)	7	9	12	12	12	13	12
		***Crop Height (cm)	49	76	113	122	110	125	125
		***Boll Formation (No.)	29	69	95	192	197	182	200
		***Cotton Yield (gm)	67 (-89.07)	140 (-77.16)	303 (-50.57)	547 (-10.77)	590 (-3.75)	615 (+0.33)	613

* Stands for means non-significant
** Stands for means significant at 5% level
*** Stands for means significant at 1% level
() Figures indicate percent decrease (-) or increase (+) in yield over control

EFFECT OF NORTH-SOUTH ORIENTED TREE ROWS

Site III

The growth and yield data of cotton crop collected from the eastern aspect and western aspects of north-south oriented 7 years old tree row is given in Table 2. Trees were spaced 1.52 m apart. The average height and average diameter at breast height of trees were15.20 m and 21.75 cm respectively with average crown width of 3.80 m.

Eastern Aspect

The statistical analysis of data (Table 2) showed the significant effect of tree row on crop height, boll formation and crop yield. However, plant density was non-significantly affected. Crop height, boll formation and crop yield were significantly affected up to 11.0 m distance from the base of tree row and non-significant effect on crop yield continued up to 21.0 m distance from tree row. 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, the adverse effect was observed up to 1.38 times the height of trees. The net loss in yield over control was 124 Kg per acre. The percent reduction in yield per acre was 18.76 %.

Western Aspect

The statistical analysis of data (Table 2) showed the significant effect of tree row on plant density, crop height, boll formation and crop yield. Plant density was significantly

Table 2. Effect of north-south oriented tree rows on cotton crop parameters

Farm No.	Cotton side	Crop parameters	Distance from tree rows (m) 1	5	9	14	19	24	29	34	Control
III	East	*Plant density (No.)	11	11	12	11	13	14	13	-	14
		***Crop Height (cm)	34	67	98	113	131	137	140	-	143
		***Boll Formation (No.)	37	41	67	104	162	168	159	-	148
		***Cotton Yield (gm)	87 (-86.68)	110 (-83.15)	210 (-67.84)	483 (-26.03)	620 (-5.05)	660 (+1.07)	653 (0.00)	-	653
III	West	***Plant density (No.)	5	8	9	10	11	11	11	-	11
		***Crop Height (cm)	46	61	101	122	140	131	137	-	140
		***Boll Formation (No.)	28	43	56	129	151	156	158	-	150
		***Cotton Yield (gm)	77 (-88.89)	150 (-78.35)	217 (-68.69)	477 (-31.17)	637 (-8.08)	695 (+0.29)	695 (+0.29)	-	693
IV	East	***Plant density (No.)	5	4	5	10	9	10	9	11	11
		***Crop Height (cm)	76	76	85	101	119	122	116	125	113
		***Boll Formation (No.)	26	33	46	61	125	120	139	147	136
		***Cotton Yield (gm)	40 (-89.47)	60 (-84.21)	133 (-65.00)	244 (-35.79)	352 (-7.37)	373 (-1.84)	387 (+1.84)	382 (+0.53)	380
IV	West	***Plant density (No.)	4	7	11	9	11	12	13	11	12
		***Crop Height (cm)	79	94	88	128	131	149	143	143	149
		***Boll Formation (No.)	22	27	49	84	99	110	101	109	110
		***Cotton Yield (gm)	55 (-84.72)	70 (-80.56)	135 (-62.50)	275 (-23.61)	330 (-8.33)	365 (+1.39)	360 (0.00)	375 (+4.17)	360
V	West	***Plant density (No.)	0	3	7	10	9	-	-	-	10
		***Crop Height (cm)	0	67	98	110	116	-	-	-	110
		***Boll Formation (No.)	0	49	220	282	297	-	-	-	286
		***Cotton Yield (gm)	0 (-100.0)	127 (-86.59)	586 (-38.12)	863 (-8.87)	947 (0.00)	-	-	-	947
VI	West	*Plant density (No.)	9	9	8	10	10	-	-	-	11
		***Crop Height (cm)	98	116	134	137	158	-	-	-	152
		**Boll Formation (No.)	49	73	87	83	91	-	-	-	110
		***Cotton Yield (gm)	197 (-51.95)	265 (-35.37	330 (-19.51)	390 (-4.88)	417 (+1.71)	-	-	-	410

* Stands for means non-significant
** Stands for means significant at 5% level
*** Stands for means significant at 1% level
() Figures indicate percent decrease (-) or increase (+) in yield over control

affected up to 3.0 m; crop height and boll formation up to 11.0 m and crop yield was significantly affected up to 16.0 m distance from the base of tree row. Non-significant effect on crop yield continued up to 21.0 m distance from tree row. 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, the adverse effect was observed up to 1.38 times the height of trees. The net loss in yield over control was 136 Kg per acre. The percent reduction in yield per acre was 19.40%.

Site IV

The growth and yield data of cotton crop collected from the eastern aspect and western aspects of north-south oriented 8 years old tree row is given in Table 2. Trees were spaced 1.83 m apart. The average height and average diameter at breast height of trees were 15.20 m and 27.5 cm respectively with average crown width of 3.2 m.

Eastern Aspect

The statistical analysis of data (Table 2) showed the significant effect of tree row on plant density, crop height, boll formation and crop yield. Plant density and crop height were significantly affected up to 11.0 m and boll formation and crop yield were significantly affected up to 16.0 m distance from the base of tree row and non-significant effect on crop yield continued up to 26.0 m distance from tree row. 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, the adverse effect was observed up to 1.58 times the height of trees. The net loss in yield over control was 77 Kg per acre. The percent reduction in yield per acre was 20.0%.

Western Aspect

The statistical analysis of data (Table 2) showed the significant effect of tree row on plant density, crop height, boll formation and crop yield. Plant density was significantly affected up to 7.0 m; crop height, boll formation and crop yield were significantly affected up to 11.0 m distance from the base of tree row. Non-significant effect on crop yield continued up to 21.0 m distance from tree row. 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, the adverse effect was observed up to 1.28 times the height of trees. The net loss in yield over control was 64 Kg per acre. The percent reduction in yield per acre was 17.58 %.

SITE-V

The growth and yield data of cotton crop collected from the western aspect of north-south oriented 5 years old tree row is given in Table 2. Trees were spaced 1.52 m apart. The average height and average diameter at breast height of trees were10.60 m and 16.29 cm respectively with average crown width of 3.60 m.

The statistical analysis of data showed significant effect of tree row on plant density, crop height, boll formation and crop yield. Plant density was significantly affected up to 7.0 m; crop height up to 3.0 m and boll formation and crop yield were significantly affected up to 11.0 m distance from the base of tree row. Non-significant effect on crop yield continued up to 16.0 m. Beyond this, no adverse effect was observed. The yield was deleteriously affected near the base of tree row and it increased progressively with the increase in distance from tree row. When compared with the average height of tree row, adverse effect was observed up to 1.51 times the height of trees. The net loss in yield was 152 Kg per acre. The percent reduction in yield per acre was 15.87%.

SITE-VI

The growth and yield data of cotton crop collected from the western aspect of north-south oriented 5 years old tree row is given in Table 2. Trees were planted on a main water channel spaced 1.52 m apart. The average height and average diameter at breast height of trees were10.60 m and 18.25 cm respectively with average crown width of 3.01 m.

The statistical analysis of data showed significant effect of tree row on crop height, boll formation and crop yield. Plant density was non-significantly affected. Crop

height and boll formation were significantly affected up to 7.0 m distance. Crop yield was significantly affected up to 3.0 m distance from the base of tree row and non-significant effect on crop yield was observed up to 16.0 m. Beyond this, no adverse effect was observed. The yield was low near the base of tree row and it increased progressively with the increase in distance from tree row.

When compared with the average height of tree row, adverse effect was observed up to 1.51 times the height of trees. The net loss in yield was 31 Kg per acre. The percent reduction in yield per acre was 7.47 %.

DISCUSSION

Effect of orientation of tree row

Orientation of tree rows whether east-west or north-south significantly produced adverse effect on the growth and yield of cotton crop. East-west oriented tree rows produced comparatively more reduction on northern aspect (14.06 and 16.90 %) as compared to southern aspect (11.0 and 15.80%). On both aspects, crop height, boll formation and yield were significantly low near the base of trees and all the parameters improved considerably as the distance from tree row increased. On northern aspect plant density was significantly affected and non-significant effect was observed on southern aspect. More reduction on northern aspect is mainly due to shade of trees, which did not allow sunlight to reach the ground. Similar results indicating more reduction on northern aspect were reported by other researchers (Sheikh and Haq, 1986; Singh et.al.1999).

In case of north-south oriented tree rows, more percent reduction in yield was observed on eastern aspect (18.76 and 20.0 %) as compared to western aspect (7.47, 15.87, 17.58 and 19.40 %). On both aspects all the parameters of cotton crop were significantly affected.

In general, north-south oriented tree rows produced more percent decrease in yield as compared to east-west oriented tree rows.

Effect of increase in distance from tree row

The unit increase in distance from the tree row had significant effect on the growth and yield of cotton crop. Plant density was significantly affected up to 3-7 m; crop height up to 7-11m; boll formation up to 7-16 m and significant effect on yield was observed up to 3-16 m distance respectively from the base of tree rows. 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).

Age of the tree row, spacing between trees and height of tree row had adverse effect on cotton crop parameters. Closely spaced tree rows do affect the growth and yield of cotton crop due to shade and root competition. Shade is not the major cause of deleterious effect on account of light crown of Eucalyptus casting less shade. Severe adverse effect of Eucalyptus on cotton crop can be attributed to the fact that the nutrient and water consumption of Eucalyptus is very high (Malik and Sharma, 1990) resulting in

depletion of moisture and nutrients for crop with low water requirement. Severe losses were observed on those sites where there was shortage of irrigation water. It is important to mention that minimum percent reduction in cotton yield (7.47%) was observed on site VI where Eucalyptus was planted on main water channel and excessive amount of irrigation water was always available to the trees to meet their most of moisture and nutrient requirement.

In tropical Africa, Onyewotu *et al.* (1994) reported competitive adverse effect of *Eucalyptus camaldulensis* on an adjacent millet (*Pennisetum typhoides*) crop up to a distance of 1.5 H (where H is tree height). Basu *et al*. (1987) also reported the poor growth and yield of agri. crops in its vicinity due to release of photo toxins in the soil.

CONCLUSION

From analysis of data, following conclusions can be drawn:

- 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.

- Cotton yield is deleteriously affected near the base of tree rows and it improved progressively with the increase in distance from tree rows. Significant reduction in yield is observed up to 11 m on northern aspect; up to 7.0 m on southern aspect and up to 16.0 m distance from tree row on eastern and western aspects respectively.

- Shade is not the major cause of deleterious effect on account of light crown of Eucalyptus casting less shade. Severe adverse effect of Eucalyptus on cotton crop can be attributed to the fact that the nutrient and water consumption of Eucalyptus is very high resulting in depletion of moisture and nutrients for crop with low water requirement.

- Minimum percent reduction in cotton yield (7.47%) is observed on site VI where Eucalyptus was planted on main water channel and excessive amount of irrigation water was always available to the trees to meet their most of moisture and nutrient requirement.

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