GROWTH AND YIELD OF COTTON CROP AS AFFECTED BY *BOMBAX CEIBA* (SIMAL) FIELD BOUNDARY PLANTATIONS

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ABSTRACT

Survey of farmlands was conducted to assess the impact of *Bombax ceiba* boundary plantations on the growth and yield of cotton crop. Data were collected from seven different farmlands. Analysis of data revealed non-significant effect of tree rows on plant density in all the farms. Crop height was significantly affected up to 3.0 m distance from the base of tree rows on eastern and western aspects with north-south orientation while it was non-significantly affected on northern and southern aspects of East-west oriented tree rows. Crop yield was significantly affected up to 11.0 and 7.0 m distance on northern and southern aspects of east-west oriented tree rows. Significant effect on cotton yield on eastern and western aspects of north-south oriented tree rows was observed up to 7.0 m distance. More losses were observed near the base of trees and yield improved considerably with the increase in distance from tree rows.

Maximum percent reduction in yield (per acre) was observed on northern aspect (11.29%) followed by eastern (8.43%), western (8.22%) and minimum on southern aspect (3.40%) respectively. The reduction in yield of cotton crop grown along the east-west oriented tree rows was slightly less than when grown along the north-south oriented tree rows. Adverse effect on yield was noticed up to 1.38 times the average height of tree row on northern aspect; 0.72 times the average height of tree rows on southern aspect; 1.28 times the average height of tree row on eastern aspect and 1.22 times the average height of tree row on western aspect, respectively. Tree rows with close spacing and large crowns produced more adverse effect. Adverse effect of shade caused by tree rows can be minimized with proper spacing and proper pruning of trees. Yield losses would be compensated from the sale of trees.

INTRODUCTION

Pakistan has meager forest resources. The existing forests are insufficient to meet the ever-increasing demand for fuel wood and timber. As the area and resources are limited in the country, the only option to increase tree cover is by growing trees on farmlands. Agro forestry is an effective system of land and water resource utilization for sustained production that can provide economic and social security in the event of crop failure in drought and famine. Mostly farmers hesitate to plant trees on their fertile agricultural lands because they are concerned about a decline in the yield of agricultural crops due to competition for light, moisture and nutrients etc. However, farmers desire to grow fast growing trees to meet their domestic wood requirements and for extra income.

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Bombax ceiba (Simal) is one of the most popular fast growing tree species among farmers that is extensively planted in the irrigated plains (cotton grown areas) of Punjab province. This study was undertaken under Rapid Rural Appraisal Survey of farmlands to determine the impact of linear tree rows of Simal on the performance of cotton crop.

MATERIAL AND METHODS

Survey of farmlands was conducted in Multan and Bahawalpur districts of Punjab province, Pakistan during 1998 and 1999 under Rapid Rural Appraisal to assess the effect of *Bombax ceiba* tree rows on cotton crop. Farms selected for data collection had uniform tree rows i.e. single species, even-aged and almost uniform spacing etc. with same variety and uniform cotton crop on either side or single side of the tree row. Consent of the farmers was obtained prior to data collection.

A 2m x 2m sample plot was used to collect cotton data. Sample plots were laid out in lines running perpendicular to tree rows at 1, 5, 9, 14, 19, and 24 m etc. distance from the base of tree row. This procedure was continued up to a distance equal to double the height of tree row. Beyond this, it was assumed that there is no adverse effect of tree row on cotton crop. Control sample plots were also taken away from and out of the influence of tree rows for comparison. Transects were replicated three times. For each sample plot, the cotton crop data regarding number of plants, bolls, crop height and cotton weight in gram (gm) were recorded. Following observations were recorded for each tree row:

The orientation of the tree row, age, average spacing of trees, average height of trees; average diameter at breast height and average crown width.

The data collected on cotton crop parameters was statistically analyzed using analysis of variance technique. Treatment means were compared by using Duncan's new multiple range test (Steel and Torrie, 1960).

RESULTS

Results of data collected from seven different farmlands are presented in Table 1 and are described as under:

Farm I

The growth and yield data of cotton crop were collected from the **northern aspect** of east-west oriented 10 years old tree row spaced 1.83 m apart. The average height and average diameter at breast height of trees were 11.58 m and 23.9 cm respectively with average crown width of 6.86 m.

Table 1. Effect of Simal tree rows on cotton crop parameters

Farm No.	Cotton side	Crop parameters	Distance from tree rows (m)						
			1	5	9	14	19	24	Control
1	North	*Plant density	19	13	13	15	17	-	16
		*Crop Height	104	110	110	110	131	-	125
		**Boll Formation	45	54	94	137	159	-	160
		**Cotton Yield	130 (-77.16)	205 (-64.04)	460 (-19.30)	563 (-1.23)	572 (+0.35)	-	570
2	North	*Plant density	14	13	16	15	17	12	16
		***Crop Height	113	146	171	171	168	174	174
		***Boll Formation	26	47	63	121	127	123	124
		***Cotton Yield	96 (-80.41)	195 (-60.20)	387 (-21.02)	460 (-6.12)	510 (+4.08)	480 (-2.04)	490
3	North	*Plant density	11	11	12	11	13	-	14
		*Crop Height	125	126	125	137	125	-	131
		**Boll Formation	89	106	137	160	182	-	170
		**Cotton Yield	276 (-58.18)	424 (-35.76)	560 (-15.15)	668 (+1.21)	659 (-0.15)	-	660
3	South	*Plant density	14	11	10	10	12	-	11
		*Crop Height	110	104	107	116	119	-	122
		*Boll Formation	105	110	137	149	158	-	153
		*Cotton Yield	390 (-39.06)	530 (-17.19)	654 (+2.19)	640 (0.00)	660 (+3.13)	-	640
4	North	*Plant density	13	12	10	9	13	16	15
		*Crop Height	119	128	122	125	134	131	122
		***Boll Formation	66	135	166	186	198	198	196
		***Cotton Yield	153 (-80.88)	329 (-58.88)	680 (-15.00)	793 (-0.88)	806 (+0.75)	815 (+1.88)	800
4	South	*Plant density	11	15	12	10	10	13	11
		*Crop Height	116	125	122	140	134	137	137
		***Boll Formation	68	133	192	207	215	213	209
		***Cotton Yield	216 (-73.88)	713 (-13.78)	841 (+1.69)	827 (0.00)	825 (-0.24)	839 (+1.45)	827
5	East	*Plant density	6	25	13	13	12	14	14
		**Crop Height	122	134	143	155	155	155	152
		**Boll Formation	110	180	217	240	255	265	255
		***Cotton Yield	273 (-64.08)	446 (-41.32)	654 (-13.95)	720 (-5.26)	775 (+1.97)	760 (0.00)	760
5	West	*Plant density	12	14	15	16	16	13	16
		*Crop Height	125	134	149	152	161	158	155
		***Boll Formation	53	169	227	234	258	261	258
		***Cotton Yield	240 (-68.30)	478 (-36.86)	665 (-12.15)	720 (-4.89)	765 (+1.06)	758 (+0.13)	757
		*Plant density	9	6	12	11	10	12	11

Farm No.	Cotton side	Crop parameters	Distance from tree rows (m)						
			1	5	9	14	19	24	Control
6	East	**Crop Height	82	91	113	122	131	119	113
		***Boll Formation	41	119	131	187	205	216	209
		***Cotton Yield	190 (-68.85)	350 (-42.62)	540 (-11.48)	580 (-4.92)	622 (+1.97)	605 (-0.82)	610
7	West	*Plant density	11	9	9	10	11	-	14
		**Crop Height	101	110	125	128	125	-	128
		**Boll Formation	110	128	180	200	198	-	205
		**Cotton Yield	207 (-59.41)	283 (-44.51)	460 (-9.80)	526 (+3.14)	503 (-1.37)	-	510

* 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 (+) over control

The statistical analysis of data showed the significant effect of tree row on boll formation and crop yield. However, plant density and crop height were non-significantly affected. Crop yield was significantly affected up to 7.0 m distance from the base of tree row and non-significant effect continued 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 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 63.0 Kg per acre. The percent reduction in yield per acre was 10.92 %.

Farm II:

The growth and yield data of cotton crop were collected from the **northern aspect** of east-west oriented 13 years old tree row. Trees were spaced 2.44 m apart. The average height and average diameter at breast height of trees were 13.71 m and 28.0 cm respectively with average crown width of 4.42 m.

The statistical analysis of data revealed the significant effect of tree row on crop height, boll formation and crop yield. However, non-significant effect was observed on plant density. Crop height was affected up to 7.0 m distance from tree row. Boll formation and crop yield were significantly affected up to 11.0 m distance from the base of tree row and non-significant effect continued up to 16.0 m from the tree row. 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 up to 1.17 times the height of trees. The total loss in yield was 56 Kg per acre. The percent reduction in yield per acre was 11.29 %.

Farm III:

The growth and yield data of cotton crop were collected from the northern and southern aspects of east-west oriented 8 years old tree row. Trees were spaced 2.44 m apart. The average height and average diameter at breast height of trees were 9.76 m and 23.7 cm respectively with average crown width of 3.20 m.

Northern Aspect

The statistical analysis of data showed non-significant effect of tree row on plant density, crop height and boll formation. However, significant effect of tree row was observed on crop yield. Crop yield was significantly affected up to 7.0 m distance from the base of tree row and non- significant effect continued up to 11.0 m. 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 1.13 times the height of trees. The net loss in yield was 49 Kg per acre. The percent reduction in yield per acre was 7.33%.

Southern Aspect

The statistical analysis of data showed non-significant effect of tree row on all parameters of cotton crop. Reduction in yield was observed up to 7.0 m distance from the base of tree row.

Beyond this, no adverse effect was observed. The yield was affected near the base of tree row. When compared with the average height of tree row, adverse effect was observed up to 0.72 times the height of trees. The total loss in yield was 22.0 Kg per acre. The percent reduction in yield per acre over control was 3.4%.

Farm IV

The growth and yield data of cotton crop were collected from the northern and southern aspects of east-west oriented 12 years old tree row. Trees were spaced 3.05 m apart. The average height and average diameter at breast height of trees were13.10 m and 28.0 cm respectively with average crown width of 6.10 m.

Northern Aspect

The statistical analysis of data showed non-significant effect of tree row on plant density and crop height. However, significant effect of tree row was observed on boll formation and crop yield. Crop yield was significantly affected up to 11.0 m distance from the base of tree row and non-significant effect continued up to 16.0 m distance from 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 up to 1.22 times the height of trees. The net loss in yield was 83 Kg per acre. The percent reduction in yield per acre was 10.25 %.

Southern Aspect

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

The significant effect on yield was observed up to 7.0 m 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, the adverse effect was observed up to 0.53 times the height of trees. The total loss in yield was 47 Kg per acre. The percent reduction in yield per acre was 5.61 %.

Farm V

The growth and yield data of cotton crop were collected from the eastern and western aspects of north-south oriented 14 years old tree row. Trees were spaced 2.44 m apart. The average height and average diameter at breast height of trees were 13.10 m and 29.6 cm respectively with average crown width of 5.18 m.

Eastern Aspect

The statistical analysis of data revealed that crop height, boll formation and crop yield were significantly affected and non-significant effect was observed on plant density. Crop yield was significantly affected up to 7.0 m distance from the base of tree row and non-significant effect continued up to 16.0 m distance from 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, the adverse effect was observed up to 1.22 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 8.32 %.

Western Aspect

The statistical analysis of data showed non-significant effect of tree row on plant density and crop height and significant effect on boll formation and crop yield. The significant effect on yield was observed up to 7.0 m distance from the base of tree row and non-significant effect continued up to 16.0 m distance from 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, the adverse effect was observed up to 1.22 times the height of trees. The total loss in yield was 63 Kg per acre. The percent reduction in yield per acre was 8.22 %.

Farm VI

The growth and yield data of cotton crop were collected from the **eastern aspect** of north-south oriented 13 years old tree row. Trees were spaced 2.44 m apart. The average height and average diameter at breast height of trees were12.5 m and 29.6 cm respectively with average crown width of 6.20 m.

The statistical analysis of data showed the significant effect of tree row on crop height, boll formation and crop yield. However, plant density was non-significantly affected. Crop yield was significantly affected up to 7.0 m distance from the base of tree row and this reduction in yield continued up to 16.0 m. 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 1.28 times the height of trees. The net loss in yield was 52.0 Kg per acre. The percent reduction in yield per acre was 8.43%.

Farm VII

The growth and yield data of cotton crop were collected from the **western aspect** of north-south oriented 11 years old tree row. Trees were spaced 3.05 m apart. The average height and average diameter at breast height of trees were 12.80 m and 26.3 cm respectively with average crown width of 6.10 m.

The statistical analysis of data showed the significant effect of tree row on crop height, boll formation and crop yield. However, plant density was

non-significantly affected. Crop yield was significantly affected up to 7.0 m distance from the base of tree row and this reduction in yield continued up to 11.0 m. 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 0.86 times the height of trees. The net loss in yield was 38.0 Kg per acre. The percent reduction in yield per acre was 7.36 %.

DISCUSSION

Effect of orientation of tree row

An abstract of results is presented in Fig.1. Orientation of tree rows adversely affected 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 boils delayed due to continuous shade on northern aspect. Similar results indicating more reduction on northern aspect were reported by other researchers (Sheikh and Haq, 1986; Singh *et al*., 1999). On the contrary, southern aspect received full sunlight through out the day. Reduction in yield was observed under the tree canopy only. Beyond the tree canopy, no adverse effect was observed.

However, plant density and crop height were not affected significantly on northern as well as southern aspect. 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 with sunlight. Tree rows produced no adverse effect on plant density. However, crop height was significantly affected up to 3.0 m distance from tree rows. Boll formation and crop yield were significantly effected on the either side of the tree rows.

In general, plant density was not affected whether the orientation was east-west or north-south.

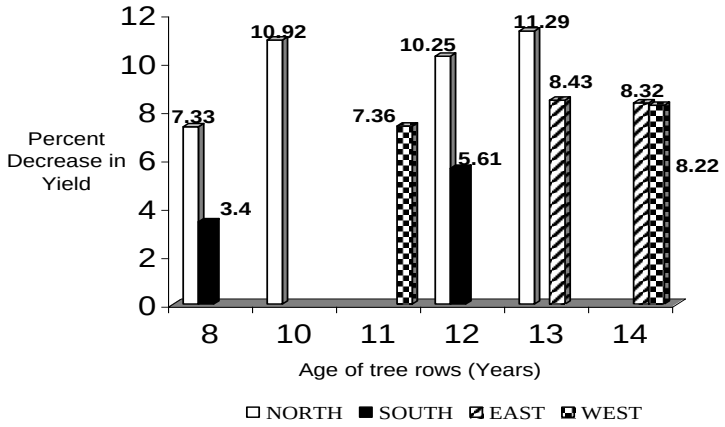

Fig.1. Showing percent decrease in yield with different ages of tree rows along the four aspects

Effect of increase in distance from tree row

The unit increase in distance from the tree rows had significant effect on the performance of cotton crop. Effect of increase in distance on plant density was non-significant. Crop height was affected significantly only under the tree canopy up to 3.0 m distance from the tree row. Boll formation and cotton yield were significantly affected up to 7.0 and 11.0 m distance from tree row. 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, height of tree row and crown formation also had adverse effect on cotton crop parameters. With increase in age, trees become larger and their crowns spread. Trees with large crowns produced more reduction in the yield near the tree row as compared to trees with small crown formation. Closely spaced tree rows produced more reduction in yield as compared to widely spaced tree rows. Due to close spacing and large crowns less sunlight was available for photosynthesis, which ultimately affected boll formation and yield.

CONCLUSION

From analysis of data, following conclusions arrived at:

- Simal tree rows have no effect on plant density.

- Crop height is affected under the tree canopy only up to 3.0 m distance from the base of trees.
- Boll formation and cotton yield are adversely affected whether orientation is east-west or north-south.

- More yield losses are observed near the base of trees and yield increased progressively with the increase in distance from tree rows.

- Maximum reduction in yield (per acre) was observed on northern aspect followed by eastern, western and minimum on southern aspect. The reduction in yield of cotton crop grown along the east-west oriented tree rows was slightly less than when grown along the north-south oriented tree rows.

- Adverse effect on yield is observed up to 1.13-1.38 times the average heights (9.76-11.58m) of tree rows on northern aspect; 0.54 & 0.72 times the average heights (13.10 & 9.76 m) of tree rows on southern aspect; 1.22 & 1.28 times the average heights (13.10& 12.5 m) of tree rows on eastern aspect and 0.86 & 1.22 times the average heights (12.80 &13. 10) of tree rows on western aspect respectively.

- Close spacing between trees and large crown formation also have adverse effect on cotton crop due to shade. Adverse effect of shade can be minimized with proper spacing and proper pruning of trees.

- Cotton yield losses would be compensated from the wood value of trees.

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