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Studies on the Effect of Plant Spacing on the Yield of Recently Approved Varieties of Cotton

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Abstract
In field experiment at Sahiwal, Pakistan conducted during winter 2006, the effect of plant spacing 15cm, 22.5cm and 30cm on the yield of three recently approved varieties of cotton CIM-496, CIM-534 and MNH-786 was investigated. Effect of cultivars and different plant spacing was significant in yield and yield components except in quality parameters like Ginning out turn. Statistically same seed cotton yield was produced by CIM-496 (2488 kg ha^{-1}) and MNH-786 (2400 kg ha^{-1}) while minimum yield was produced by CIM-534 (2109 kg ha^{-1}). Plant height, number of sympodial branches per plant, monopodial branches per plant, number of bolls per plant and average boll weight was significantly higher in CIM-496. Significantly maximum seed cotton yield was obtained when crop was sown at 22.5 cm plant spacing.

Key words: *Gossipium hirsutum* L., plant spacing, varieties, yield.

Introduction

Cotton, the king of fiber crops is the most important commercial crop which plays a key role in the economy of Pakistan. It is the most important textile fiber crop and second most important oilseed crop in world. It is the cash crop Pakistan and earns a good fortune to the country in the form of foreign exchange. In 2005-06 cotton was grown on an area of 3096 thousand hectares with a production of 12.417 million bales with average production of 682 kg ha^{-1}. It accounts for 8.6 % of the value added in agriculture and about 1.9% to GDP. (Govt. of Pakistan, 2006). Seed cotton yield per unit area is still for below than many other cotton growing countries in the world. Among the various factors responsible for low yield of cotton crop in the country, low plant population and use of low potential varieties are of primary importance. Plant population is very crucial for attaining optimum crop growth and yield under irrigated conditions. In cotton plant spacing has effects on the growth and yield characteristics of the plant. One of the options for maximizing yield per unit area is optimum plant population per unit land area and it varies from variety to variety. Every variety has its own plant to plant distance requirements. Some plants are erect type and require less space, i.e more density to give potential yield while other being bushy growth habits require more space and results in low plant density to give potential yield. Maximum yield can be obtained by maintaining optimum plant population according to plant morphological characteristics. Hussain *et al.,* (2000) reported that 30 cm spacing between plants increased plant height, number of bolls per plant and average boll weight as compared to 10 cm and 20 cm, however seed cotton yield was greater in 10 cm. Muhammad *et al.,* (2002) concluded that the boll weight decreases by increasing plant population. Considerable work on comparisons of varieties of cotton crop is available world over. Guo *et al.,* (1994) reported that cotton variety Zhongmianeuo-21 in regional cotton variety tests yielded (944.3 kg ha^{-1}) an increase of 6% over control variety Zhongmianeuo-12. Keeping this in view, the present study was therefore designed to determine the effect of plant spacing on the yield of recently approved varieties of cotton.

Materials and Methods

A field experiment to evaluate the effect of plant spacing on the yield of recently approved varieties of cotton was conducted at Cotton Research Station Sahiwal, Pakistan, during kharif, 2006. The Experiment was laid out in a randomized complete block design with split plot arrangement having three replications and a net plot size of 4.57 m x 3.0 m. The varieties were kept in main plot and plant spacing in sub-plots. Three varieties CIM-496, CIM-534 and MNH-786 were sown at three different plant spacing 15cm, 22.5cm and 30cm. Cotton crop was sown at 75 cm spaced rows manually with single row hand drill. Whole of the phosphorous at the rate of 75 kg ha^{-1} was applied at the time of sowing in the form of SSP while the nitrogen at the rate of 115 kg ha^{-1} was applied in the form of Urea in three splits 1/3 at the time of sowing and remaining 1/3 nitrogen with first irrigation

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and 1/3 with second irrigation. Thinning was done at four leaf stage to maintain a plant to plant distance as per treatment. All other agronomic practices were kept normal and uniform for all the treatments. Yield contributing parameters were recorded and the data collected was analysed statistically by using Fisher's analysis of variance techniques and differences among treatment means were compared using least significant difference test at 5% probability level (Steel *et al*., 1997).

Results and Discussion

Plant population is a yield contributing parameter and has direct effect on the yield of cotton crop. It is evident from the data that there were significant differences among plant populations at different plant densities. In case of 15 cm plant spacing there were 118.2 plants per plot and at 22.5 cm there were 78.22 plants per plot and at 30 cm number of plants were recorded as 58.44. So the number of plants per plot decreased significantly with increase in plant spacing and highest numbers of plants were recorded in case of 15 cm plant spacing. The difference among varieties for plant population and interaction between plant spacing and varieties were found to be non significant. Increase in plant population with decrease in plant spacing has also been reported by Brar *et al.,* (2002).

Greater number of monopodial branches per plant is an indication of its potential for higher production of cotton. Data regarding number of monopodial branches per plant as affected by plant spacing showed significant differences. Significantly minimum number of monopodial branches per plant (0.58) was recorded with 15 cm plant spacing against the maximum (1.92) with 30 cm plant spacing. It means that the numbers of monopodial branches per plant were increased significantly by increasing plant spacing. Alfaqeih (2002) also reported that the number of monopodial branches per plant increased by increasing plant spacing. Decrease in number of monopodial branches per plant may be due to more competition between the plants due to less space for light and nutrients. Varieties show non significant results. The non significant results among genotypes had also been reported by Brar *et al.,* (2002). The interaction between the varieties and plant spacing was also found to be non significant.

Greater number of sympodial branches per plant is an indication of good yield. Data regarding number of sympodial branches per plant as affected by plant spacing and varieties showed significant results. Significantly maximum number of sympodial branches per plant (26.61) was found when crop was sown with 30 cm plant spacing. However significantly minimum number of sympodial branches per plant (21.86) was recorded in case of 15 cm plant spacing. By increasing plant spacing the number of sympodial branches per plant also increased linearly. The increase in number of sympodial branches per plant might be due to more availability of space and less competition among crop plants. These results are in line with those of Alfaqeih (2002). Data regarding varieties also showed that CIM-496 had significantly more number of sympodial branches per plant (25.78). However significantly minimum number of sympodial branches per plant (23.27) was recorded in variety CIM-534. The difference among varieties might be due to different growth habits and genetic make up. These results are in accordance with those of Brar *et al.,* (2002). The interaction between the varieties and plant spacing was found to be non significant.

Number of bolls per plant is an important yield contributing parameter. Data from the table shows that by increasing plant spacing there was significant increase in number of bolls per plant. Maximum number of bolls per plant (28.67) was recorded in case of 30 cm plant spacing against the minimum (21.89) in 15 cm plant spacing. Increase in number of bolls per plant with increasing plant spacing can be attributed to more availability of space, less competition and more number of sympodial branches per plant. These results are in line with those of Siddiqui (2007) who stated that increase in density decreases number of bolls per plant. Varieties also showed the significant results in case of number of bolls per plant. Statistically same number of bolls per plant was recorded in variety CIM-496 and MNH-786 against the minimum number of bolls per plant (23.89) in case of variety CIM-534. These results are in accordance with those of Hussain *et al.,* (2000) who reported significant increase in number of bolls per plant using different varieties. Such increase in number of bolls per plant was direct consequence of more number of monopodial and sympodial branches per plant. However the interaction between the varieties and plant spacing was found to be non significant.

Boll weight is an important yield contributing parameter. It is evident from the data that average boll weight affected significantly by plant spacing. Statistically same average boll weight (3.78 gm) was obtained in 30 cm plant spacing and 22.50 cm plant spacing (3.77 gm) against the minimum value of (3.60 gm) in case of 15 cm plant spacing. So the greater average boll weight at higher plant spacing might be due to less competition and availability of resources. These results are in line with those of Hussain *et* *al.,* (2000) and Boquet (2005) who reported that by increasing plant density average boll weight decreases. Different varieties also varied significantly for their average boll weight. The maximum average boll weight (3.89 gm) was produced by CIM-496 against the minimum average boll weight (3.57 gm) in case of CIM-534. The significant differences among the varieties for average boll weight had also been reported by Hussain *et al.,* (2000). The interaction between the varieties and plant spacing was found to be non significant.

The effect of plant spacing was found to be significant on the plant height of cotton crop. Significantly maximum plant height (129.88 cm) was observed in 15 cm plant spacing while minimum plant height (121.0 cm) was recorded in 30 cm plant spacing. Iqbal (2007) also reported that plant height was significantly affected by different plant spacing. From the present study it was also observed that varieties also showed significant results regarding plant height. Significantly maximum plant height (129.99 cm) was recorded in CIM-496 and minimum plant height (121.55 cm) was observed in CIM-534.The difference in plant height among varieties might be due to difference in genetic make up of varieties. The interaction between the varieties and plant spacing was found to be non significant.

Seed cotton yield is the combined effect of various yield components under particular environmental conditions. It is evident from the data that varying plant spacing had significant effect on seed cotton yield. Significantly maximum seed cotton yield (2512 kg ha^{-1}) was recorded when crop was sown at 22.5 cm plant to plant spacing. However minimum yield (2201 kg ha^{-1}) was obtained in case of 15 cm plant spacing. This decrease in yield may be due to over population and more competition between the plants for light and nutrients. Boquet (2005) also stated such type of results that by increasing plant density boll weight and number of bolls per plant decreases which ultimately decreases the final yield. Varieties also showed significant results regarding seed cotton yield. Statistically similar seed cotton yield was recorded in CIM-496 and variety MNH-786 while the minimum yield was obtained in case of CIM-534. These results are in line with those of Iqbal (2007). The interaction between the varieties and plant spacing was found to be non significant.

Fiber length is very important character regarding the fiber quality and is very useful for textile industry. Plant spacing showed non significant results on fiber quality. Hussain *et al.,* (2000) also concluded the similar results. It is evident from the data that varieties showed significant results regarding fiber length. Significantly maximum fiber length (30.69 mm) was recorded in CIM-534 followed by MNH-786 and CIM-496. Donald (2005) also reported the same results. This difference in fiber length may be due to different genetic make up of varieties. The interaction between the varieties and plant spacing was found to be non significant.

Ginning out turn is very important character and it determines the %age of lint in seed cotton and especially important for the textile industry. Data showed non significant results in G.O.T. to different plant spacing. So there was no effect of plant spacing on G.O.T. These results are in accordance with those of Hussain *et al.,* (2000). Varieties also showed non significant results. Therefore it is concluded that G.O.T. is genetically controlled. Donald (2005) also concluded the same results. However the interaction between the varieties and plant spacing was also found to be non significant.

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Table 1Studies on the Effect of Plant Spacing on the Growth Indices of Recently Approved Varieties of Cotton.

	Plant population (m^{-2})	No. of monopodial branches per plant	No. of sympodial branches per plant	Plant height (cm)
Varieties (V)				
V_1 = CIM-496	84.66	1.47	25.78 a	129.99 a
V_2 = CIM-534	85.10	1.17	23.27 c	121.55 c
V_3 = MNH-786	85.0	1.31	23.83 b	124.66 b
LSD	NS	NS	0.53	0.50
Plant spacing (S)				
S_1 = 15.0 cm	118.2 a	0.58 c	21.86 c	129.88 a
S_2 = 22.5 cm	78.22 b	1.45 b	24.42 b	125.33 b
S_3 = 30.0 cm	58.44 c	1.92 a	26.61 a	121.0 c
LSD	1.22	0.22	0.61	1.27
Interaction (V x S)				
V_1S_1	118.0	0.66	23.36	135.66
V_1S_2	78.0	1.53	26.10	129.33
V_1S_3	58.0	2.24	27.90	125.0
V_2S_1	118.66	0.34	20.46	125.0
V_2S_2	77.66	1.48	23.43	121.66
V_2S_3	59.0	1.69	25.93	118.0
V_3S_1	118.0	0.74	21.76	129.0
V_3S_2	79.0	1.34	23.73	125.0
V_3S_3	58.0	1.85	26.0	120.0
LSD	NS	NS	NS	NS

Table 2 Studies on the Effect of Plant Spacing on the Yield indices of Recently Approved Varieties of Cotton.

	No. of bolls plant^{-1}	Av. Boll wt. (gm)	Seed cotton yield (kg ha^{-1})	Fiber length (mm)	G.O.T. (%)
Varieties (V)					
V_1 = CIM-496	26.22 a	3.89 a	2488 a	28.98 b	35.29
V_2 = CIM-534	23.89 b	3.57 b	2109 b	30.69 a	35.17
V_3 = MNH-786	25.78 a	3.65 c	2400 a	29.69 b	34.96
LSD	1.0	0.10	144.3	0.87	NS
Plant spacing (S)					
S_1 = 15.0 cm	21.89 c	3.60 b	2201 c	29.64	35.19
S_2 = 22.5 cm	25.33 b	3.77 a	2512 a	30.01	35.22
S_3 = 30.0 cm	28.67 a	3.78 a	2284 b	29.70	35.02
LSD	1.49	0.06	77.37	NS	NS
Interaction (V x S)					
V_1S_1	22.66	3.79	2367.98	28.63	35.30
V_1S_2	25.67	3.95	2726.79	29.50	35.46
V_1S_3	30.33	3.93	2368.0	28.80	35.13
V_2S_1	20.33	3.50	1985.29	30.66	35.23
V_2S_2	24.67	3.55	2224.47	30.66	35.30
V_2S_3	26.67	3.66	2216.85	30.73	35.0
V_3S_1	22.67	3.52	2248.40	29.63	35.06
V_3S_2	25.67	3.67	2583.28	29.86	34.90
V_3S_3	29.0	3.77	2367.98	29.56	34.93
LSD	NS	NS	NS	NS	NS