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Plant Spacing Effects on Growth, Yield and Lint of Cotton

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Abstract: The field experiment was conducted to assess the performance of cotton varieties (CRIS-9, Karishma and Niab-78) under different plant spacing (15, 25 and 35 cm) at Student's Farm, Sindh Agriculture University, Tandojam. It was noted that plant height, branches, open bolls plant^{-1}, un-open bolls plant^{-} ,^{1}lint and seed cotton yield were significantly affected by plant spacing and varieties, while their interactions were non significant for all the crop parameters. Cotton with 35 or 25 cm plant spacing recorded satisfactory lint weight and seed cotton yield, this increment in yield was associated with the increase in all growth and yield attributes. It was concluded that among the tested varieties, Niab-78 displayed maximum seed cotton yield (1700 kg ha^{-1}) with 35 cm plant spacing.

Key words: Cotton, spacing, plant height, seed, yield, lint, bolls, branched, growth

INTRODUCTION

Pakistan is the ancient home of cotton cultivation and is the 4th largest exporter of raw cotton in the world. Seed cotton yield per hectare in country is quite low as compared to other cotton growing countries of the world. One of the most conspicuous reasons of this low production is un-awareness of various agronomic practices of which the proper space between plants is considered to be the most important practice for improving cotton yield. Kumar (1989) reported that cotton planted in optimum plant spacing (30 cm) displayed more seed cotton yield over closer and wider plant spacing, although closer plant spacing produced taller plants, while yield parameters were superior under wider plant spacing. Mukharjee (1999) observed that seed cotton yield was maximum (1650 kg ha^{-1}) under wider plant spacing (30 cm) in all three varieties due to the improvement in all yield components. Yadav (1997) reported that combination of 75×30 cm row and plant spacing displayed more seed cotton yield i.e., 1800 kg ha^{-1} and all the fiber quality traits were also superior under some row and plant spacing. Boquet and Coco (1996) suggested that little yield difference should be expected between 30 and 40 inches row spacing and that closer row spacing required higher rates for maximum yield. Singh and Singh (1998) found that yield increased as inter and intra row spacing enhanced up to 2×60 cm, this increment in yield was associated due to increase in all yield components. Sharma (1994) reported that wider space between rows and within plants resulted in improved vegetative growth and yield components, while total seed cotton yield was obtained maximum under 30×75 cm row and plant spacing combinations. Shrivastava (1993) reported that cotton planted at 25×75 cm inter and intra row spacing gave more seed cotton yield, when compared with 15×45, 20×60 and 30×90 cm in all varieties, while, closer space between and within plant resulted in more height. Sharma (2004) reported that the plant spacing of 60×15 cm recorded the highest seed cotton yield (954 kg ha^{-1}) compared with 60×30 and 60×60 cm spacing (826 and 764 kg ha^{-1}, respectively), further, the cultivar BH-79-5-3 recorded the highest yield (1072 kg ha^{-1}), followed by Vikram which recorded 974 kg ha^{-1}. Sarkar and Malik (2004) reported that intermediate plant-to-plant spacing of 45 cm improved the growth and yield attributes of cotton and resulted higher seed-cotton yield of 5.6 and 18.9% over the narrower and wider spacing of 30 and 60 cm, respectively. Buttar *et al.* (2005) reported that the higher seed cotton yield was recorded in April sown crop compared with March and May sown crop. Higher seed cotton yield was also recorded when alternate irrigation with canal and tube well water was adopted. Soomro *et al.* (2005) reported that the effects of spacing (60×22.5, 60×30, 75×22.5 and 75×30 cm, row-to-row and plant-to-plant spacing) on the seed cotton yield cv. Shahbaz-95 were studied in Tandojam, Pakistan. The spacing of 75×30 cm resulted in the highest yield in 1997 (2975 kg ha^{-1}) and 1998 (3246 kg ha^{-1}) and in the highest yield (2985 kg ha^{-1}). Keeping the above facts in the view the present study was carried out to determine the influence of plant spacing on the growth and yield of cotton varieties.

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MATERIALS AND METHODS

Field experiment was carried on to study the performance of cotton varieties under different plant spacing at Student's Experimental Farm, Sindh Agriculture University Tandojam, Pakistan. The treatments were: three varieties viz., CRIS-9, Karishma and Niab-78 and three plant spacing viz., 15, 25 and 35 cm. The cotton varieties were raised and different plant spacing were kept under four replications in a randomized complete block design having a net plot area of 5×3 m. The crop was given 6-7 irrigations where as phosphorous and nitrogenous fertilizer was applied at recommended dose of 112-56 kg ha^{-1}. Phosphorus was applied in the form of DAP at the time of sowing and nitrogen in the form of urea was incorporated in three splits i.e., during 2nd, 3rd and 4th irrigations. All the required cultural operations were adopted throughout the growing period uniformly in all the treatments. For recording agronomic observations 5 plants were selected randomly from each treatment for recording, plant height, branches $plant^{-1}$, open bolls $plant^{-1}$, un-open bolls $plant^{-1}$, total bolls $plant^{-1}$, lint weight $plant^{-1}$, seed weight $plant^{-1}$ and seed cotton yield kg ha^{-1}. All the collected data were subjected to analysis of variance following the procedures of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The data on growth and yield performance of cotton varieties as affected by plant spacing revealed highly significant ($p<0.01$) differences for all the growth and yield components.

Plant height: Cotton plant at a plant spacing of 15 cm recorded taller plants (140.16 cm), followed by 25 cm (139.79 cm), while wider plant spacing of 35 cm displayed dwarf plants (134.41 cm) (Table 1). These results are in agreement with the results reported by Kumar (1989) and Sharma (1998) they reported that closer plant spacing increased the height of the plants. It was further observed that variety CRIS-9 produced taller plants (151.88 cm) followed by Karishma (137.15 cm), while Niab-78 produced lowest plant height (127.34 cm). This may attributed to the genetical make-up of the material. The interaction between 10cm plant spacing and variety CRIS-9 recorded maximum plant height (154.43 cm), followed by 20 cm x CRIS-9 and 15 cm x Karishma giving 152.12 and 140.12 cm plant height, respectively. While the interaction of 35 cm plant spacing x variety Niab-78 produced lowest plant height (125.95 cm).

Branches $plant^{-1}$: It was observed that branches $plant^{-1}$ in cotton planted at wider intra row spacing (35 cm) gave more branches (13.85 and 12.30 $plant^{-1}$), followed by optimum plant spacing (25 cm) displayed 12.30 $plant^{-1}$ (Table 1). However, closer plant spacing (15 cm recorded lowest number of branches (10.08 $plant^{-1}$). These results are in agreement with the results reported by Sharma (1994), Singh and Singh (1998), Sharma (1998) and Mukharjee (1999) all were in the view that wider plant spacing enables plant to attain maximum branches due to efficiency in the rate of photosynthesis. It was noted that variety Niab-78 produced greater number of branches (15.67 $plant^{-1}$), followed by CRIS-9 (11.20 $plant^{-1}$), while variety Karishma recorded lower number of branches (9.36 $plant^{-1}$). These differences may be attributed to the genetical makeup of the material and efficiency of the variety to adopt the climatic conditions. The interaction between 35 cm plant spacing and variety Niab-78 recorded maximum number of branches (18.10 $plant^{-1}$), followed by 20 cm plant spacing variety Niab-78 and 10 cm plant spacing and variety-78 giving 15.47 and 13.45 number of branches $plant^{-1}$, respectively. However, the interaction between 15 cm plant spacing and variety Karishma exhibited lowest number of branches (7.45 $plant^{-1}$).

Number of open bolls $plant^{-1}$: Cotton sown in plant spacing of 35 or 25 cm correspondingly increased in the number of open bolls (30.55 and 27.07 $plant^{-1}$), while closer plant spacing (15 cm) did lowest number of open bolls (22.15 $plant^{-1}$). The data further showed that variety Niab-78 displayed greater open bolls (33.91 $plant^{-1}$), followed by CRIS-91 (25.39 $plant^{-1}$), however, variety Karishma produced lowest number of open bolls (20.48 $plant^{-1}$) (Table 1). The interactions between 30 cm plant spacing and variety Niab-78 produced more number of open bolls (38.15 $plant^{-1}$), followed by 20 cm x variety Niab-78 and 30 cm x variety CRIS-9 recording 35.12 and 29.72 number of open bolls $plant^{-1}$, respectively. However, the interactions of 10 cm plant spacing x variety Karishma showed lowest number of open bolls (17.50 $plant^{-1}$). These results are in accordance with the results reported by Yadav (1997), Singh and Singh (1998) and Sharma (1998) all concluded that plant spacing and varietal performance significantly showed different results for open bolls.

Un-open bolls $plant^{-1}$: It was noted from the results that cotton sown in plant spacing of 35 or 25 cm produced higher number of un-open bolls (6.48 and 5.67 $plant^{-1}$), whereas closer plant spacing displayed lower number of un-opened bolls (4.34 $plant^{-1}$). It was further found that

Table 1: Characters of different cotton varieties under varying plant spacing

Plant height (cm)

Varieties	Plant spacing 15 cm	25 cm	35 cm	Mean of varieties
CRIS-9	154.43	152.12	149.10	151.88a
Karishma	140.12	137.13	134.20	137.15b
Niab-78	125.95	130.12	125.95	127.34c
Mean for plant spacing	140.16a	139.79ab	136.41b	-

	Plant spacing (S)	Varieties (V)	Interactions (S x V)
SE	1.121	1.121	1.942
CDI	2.916	2.916	-
CDII	3.140	3.140	-

Branches plant^{-1}

Varieties	Plant spacing 15 cm	25 cm	35 cm	Mean of varieties
CRIS-9	9.35	11.80	12.45	11.20b
Karishma	7.45	9.63	11.00	9.36c
Niab-78	13.45	15.47	18.10	15.67a
Mean for plant spacing	10.08c	12.30b	13.85a	-

	Plant spacing (S)	Varieties (V)	Interactions (S x V)
SE	0.357	0.357	0.618
CDI	0.929	0.929	-
CDII	1.000	1.000	-

Open bolls plant^{-1}

Varieties	Plant spacing 15 cm	25 cm	35 cm	Mean of varieties
CRIS-9	20.50	25.95	20.72	25.39b
Karishma	17.50	20.15	23.78	20.48c
Niab-78	28.45	35.12	38.15	33.91a
Mean for plant spacing	22.15b	27.07a	30.35a	-

	Plant spacing (S)	Varieties (V)	Interactions (S x V)
SE	1.243	1.243	2.153
CDI	3.231	3.231	-
CDII	3.480	3.480	-

Un-opened bolls plant^{-1}

Varieties	Plant spacing 15 cm	25 cm	35 cm	Mean of varieties
CRIS-9	4.13	5.10	6.00	5.08b
Karishma	3.75	4.12	4.50	4.14c
Niab-78	5.15	7.78	8.95	7.29a
Mean for plant spacing	4.34b	5.67a	6.48a	-

	Plant spacing (S)	Varieties (V)	Interactions (S x V)
SE	0.286	0.286	0.495
CDI	0.743	0.743	-
CDII	0.800	0.800	-

Lint weight (g plant^{-1})

Varieties	Plant spacing 15 cm	25 cm	35 cm	Mean of varieties
CRIS-9	19.63	23.46	24.16	22.42b
Karishma	12.07	15.71	17.15	14.98c
Niab-78	22.65	23.83	25.32	23.93a
Mean for plant spacing	18.12b	21.00a	22.21b	-

	Plant spacing (S)	Varieties (V)	Interactions (S x V)
SE	0.189	0.189	0.327
CDI	0.492	0.492	-
CDII	0.530	0.530	-

Table 1: Continued

Cotton seed yield (kg ha^{-1})

Varieties	Plant spacing 15 cm	25 cm	35 cm	Mean of varieties
CRIS-9	1230	1450	1500	1293b
Karishma	975	1085	1190	1083c
Niab-78	1350	1697	1700	1585a
Mean for plant spacing	1185b	1411a	1463a	-

	Plant spacing (S)	Varieties (V)	Interactions (S x V)
SE	18.690	12.690	32.372
CDI	43.595	48.595	-
CDII	52.333	52.335	-

cotton variety Niab-78 recorded greater number of un-opened bolls (7.29 plant^{-1}), followed by CRIS-9 (5.08 plant^{-1}), while variety Karishma produced lowest number of bolls (4.12 plant^{-1}). The interactions of 35 cm plant spacing x Niab-78 recorded lower number of un-opened bolls (8.95 plant^{-1}), followed by 20 cm x Niab-78 and 30 cm plant spacing x CRIS-9 recording 7.78 and 6.00 number of un-opened bolls plant-1, respectively (Table 1). These results are in agreement with the findings of Singh and Singh (1998) that un-open bolls are noted in the plots where plant to plant space become closer.

Lint weight (g plant^{-1}): The cotton lint yield was found satisfactory (22.21 g plant^{-1}) in the plots where plants were sown at plant spacing of 35 or 25 cm apart, while plant spaced at 15 cm exhibited lower lint weight (18.12 g plant^{-1}). Among three cotton varieties, Niab-78 produced maximum lint weight (23.93 g plant^{-1}), followed by CRIS-9 (22.42 g plant^{-1}), while variety Karishma produced lowest lint weight (14.98 g plant^{-1}). These differences may be attributed to the genetical makeup of the material (Table 1). The interaction between 30 cm plant spacing x Niab-78 recorded higher lint weight (25.32 g plant^{-1}), followed by 25 cm x CRIS-9 and 25 cm x Niab-78 by recording 24.16 and 23.83 g plant^{-1}, respectively. However, the interaction between 15 cm plant spacing x variety Karishma recorded lowest lint weight (12.07 g plant^{-1}). These results are supported with the findings of Yadav (1997) that lint weight in cotton increases due to increase in the plant spacing and wider spacing significantly increases the lint weight.

Seed cotton yield (kg ha^{-1}): The seed cotton yield was observed superior under plant spacing of 35 or 25 cm. These plant spacing equally recorded maximum seed cotton yield (1163 and 1411 kg ha^{-1}, respectively), while closer plant spacing (15 cm) exhibited lowest seed cotton yield (1185 kg ha^{-1}). Further it was observed that variety Niab-78 was efficient in recording better seed cotton yield (1582 kg ha^{-1}), while variety Karishma produced lowest seed cotton yield (1083 kg ha^{-1}) (Table 1). This may be

due to change in parental material. The interaction between 30 cm plant spacing x Niab-78 showed maximum seed cotton yield (1700 kg ha^{-1}), followed by 25 cm x Niab-78 and 25 cm x CRIS-9 by recording 1697 and 1450 kg ha^{-1}, respectively. However, the interaction between 15 cm plant spacing x Karishma produced lower seed cotton yield (975 kg ha^{-1}). Similar results have been reported by Shrivastava (1993), Shastri and Singh (1994), Yadav (1997) Singh and Singh (1998) and Mukharjee (1999), Soomro *et al.* (2005), Sharma (2004), Sarkar and Malik (2004) all were in the view that wider and optimum plant spacing enables plant to capture solar radiation which in turn increase the photosynthesis of the plants and ultimately seed cotton yield.

CONCLUSIONS

The experimental results for varietal performance under varying plant spacing concludes that cotton variety Niab-78 sown at wider plant spacing of 35 cm significantly enhanced all the growth and yield parameters.

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