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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet

Asian Network for Scientific Information

308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 3 (9): 1367-1369, 2000

Effect of Geometric Arrangement on Agronomic Traits and Fibre Quality of Hirsutum Cotton

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Abstract: Investigation into the effect of different geometric arrangements on morpho-qualitative traits of a cotton cultivar NIAB-86 were carried out at the University of Agriculture, Faisalabad. The geometric arrangement comprised 60, 70, and 80 cm spaced single row and 90, 105 and 120 cm double-row strip plantation. Plant population of about five plants m^{-2} arranged in the pattern of 90 cm spaced double-row strips with 30 cm space between the rows of strip (30/90 cm) appeared to be optimum for getting good yield of seed cotton. The maximum seed cotton yield of 1693 kg ha^{-1} was obtained from the crop planted in 90 cm spaced double-row strips against the minimum of 1431 (kg ha^{-1}) in case of 60 cm spaced single-row plantation. However, both fibre length and fibre strength were not affected significantly by the different geometric arrangements.

Key words: Geometric arrangement, agronomic traits, hirsutum cotton, fibre quality

Introduction

Cotton (*Gossypium hirsutum* L.) is a crop of high economic value in Pakistan. It earns about 50% of the foreign exchange earning for the country. Moreover, cotton seed, the major source of vegetable oil and cotton-seed cake, is a valuable animal feed. According to an estimate about 50% of vegetable oil requirements of Pakistan are met by cotton seed. At present cotton is grown on an area of about 3.00 million hectares with a total annual production of 8.00 million bales with average yield 581 kg ha^{-1} which is much lower than many other cotton growing countries like Australia (1500 kg ha^{-1}), Turkey (1178 kg ha^{-1}), China (983 kg ha^{-1}), Egypt (851 kg ha^{-1}), Uzbekistan (769 kg ha^{-1}) and U.S.A (682 kg ha^{-1}) that are getting about one and half times higher yield than Pakistan (Anonymous, 2000). Low cotton yield is mainly attributed to poor agro-management practices and inadequate plant protection measures. Among the agronomic constraints of low cotton productivity at farmer's fields, low plant population and conventional method of plantation are considered to be the major ones and need special attention of the research workers. Recently a new method of planting cotton in 90 cm spaced 2-row strips with 30 cm space between the rows of a strip (30/90 cm) has been designed which not only ensures optimum plant population but also facilitates intertillage with bullock/tractor drawn implements besides improving plant growth and seed cotton yield. However this new method of plantation is yet to be compared with conventional ones in all respects before recommending it to the farmers. Consequently the present study was planned to determine the feasibility and production efficiency of the newly designed geometry of planting against the traditional ones under the agro-ecological conditions of Faisalabad in irrigated environments.

Materials and Methods

The study reported herein was conducted at the University of Agriculture, Faisalabad on a cotton cultivar NIAB-86 during the year 1990-91 on a sandy-clay loam soil. The experiment was laid out in a randomized complete block design with four replications. The net plot size measured 7.20 × 8.75 m for 60 cm apart single row and 90 cm apart double-row strip plantation while 9.60 × 8.75 m for 80 cm and 120 cm apart single row and double-row strip plantation. The experimental treatments comprised 60, 70 and 80 cm spaced single row and 90, 105 and 120 cm spaced double-row strip plantation. The crop was sown on the 12th of June, 1990 on a well prepared seed bed using normal seed rate. The cotton seed was soaked in water for about four hours before sowing and rubbed with cow dung to separate the individual seeds for facilitating drill sowing. The crop was thinned to maintain desired intra-row/plant spacing when plants attained the height of 30 cm. First irrigation was given 30 days after planting, while the subsequent irrigations were applied as and when needed. In all six irrigations were given to mature the crop in addition to 81.7 mm rainfall received during the entire growing period. Fertilizer at 75 kg N and 50 kg P_2O_5 ha^{-1} in the form of urea and nitrophos, respectively was applied. The whole of phosphorus along with half of nitrogen was applied at sowing while the remaining half of nitrogen was top dressed at pre-flowering stage. The crop was kept free of weeds by giving two hoeings. All other agronomic operations including plant protection measures were kept normal and uniform for all the treatments. Observations on desired parameters were recorded using standard procedures. Fibre length was measured by Tuft method while the strength was determined by Presaley's fibre strength tester (2953). The data collected were statistically analysed using Fisher's analysis of variance technique and the treatment means were compared using LSD test at 0.05 P (Steel and Torrie, 1984).

Results and Discussion

Plant population (m^{-2}) at harvest: The plant population varied significantly under the different geometric arrangements (Table 1). Significantly more population density m^{-2} was recorded in case of 60 cm and 90 cm spacing patterns than that recorded at 75 and 105 cm or at 80 and 120 spacing patterns which were also different from each other. These differences were attributed to variable spacing pattern in each case.

Plant height at harvest: The various spatial arrangements had significant effect on plant height. Plants grown in 120 cm spaced double-row strips attained significantly more height than that grown in the pattern of either 60 and 70 cm spaced single rows or 90 cm spaced double-row strips but was at par with that grown either in the pattern of 80 cm spaced single rows or 105 cm spaced double-row strips.

Table 1: Agronomic traits, fibre length and strength of cotton as affected by different spatial arrangements

Spatial arrangement	1	2	3	4	5	6	7	8	9	10	11
60 cm spaced single rows	5.09a	103.5b	1.30NS	18.28cd	22.03c	2.15b	48.25b	33.40c	1413d	28.4^{NS}	86.2^{NS}
2. 90 cm spaced double-row strips	5.07a	98.8c	1.95	18.95bc	26.25ab	2.29a	60.33a	34.47a	1693a	28.8	88.3
70 cm spaced single rows	4.24b	96.3c	1.80	16.90d	26.10ab	2.24ab	58.70a	33.84bc	1663ab	29.5	87.5
105 cm spaced double row strips	4.10 b	112.6 a	1.83	18.20 cd	24.20 dc	2.28 a	58.25 a	34.21ab	1545c	28.2	88.1
5. 80 cm spaced single rows	3.90 c	121.3 ab	1.65	20.28 ab	26.48 ab	2.22 ab	59.00 a	33.91ab	1573bc	28.9	89.1
6. 120 cm spaced double-row strips	3.93 c	120.7 a	1.78	21.70 a	27.75 a	2.25 ab	59.48 a	33.74 bc	1526 c	28.2	88.8

1 = Plant density m^{-2}, 2 = Plant height at harvest (cm), 3 = Monopodial braches $plant^{-1}$, 4 = Sympodial branches $plant^{-1}$, 5 = No. Of bolls $plant^{-1}$, 6 = Weight $boll^{-1}$, (g) 7 Wt. Of seed cotton $plant^{-1}$, 8 = G.O.T (%), 9 = Seed cotton yield (kg h^{-1}), 10 = Fibre length (mm), 11 = Fibre strength (1000 lbs/sq. inch). Values in a column not sharing a letter differ significantly at 0.05 P. LSD. NS = Non-significant

More plant height at wider spacing patterns was ascribed to comparatively more nutritional area per plant and better circulation of light and air which favoured plant growth. Increase in cotton plant height under the influence of wider spatial arrangements has also been reported by Nikolov (1988).

Number of monopodial branches per plant: Number of monopodial branches is more or less a genetically controlled phenomenon. The different spatial arrangements had no significant effect on the number of monopodial branches per plant which on the average varied from 1.30 to 1.95. Uniform growth pattern of plants under the influence of various spacing patterns was probably due to strong inheritance of the cultivar used in this experiment, for this trait.

Number of sympodial branches $plant^{-1}$: The planting geometry exhibited significant influence on the number of sympodial branches $plant^{-1}$. Cotton plants grown in the pattern of either 80 cm spaced single rows or 120 cm spaced double-row strips produced significantly more number of sympodial branches $plant^{-1}$ than all other planting arrangements. However, differences among 60 and 70 cm single row spacings and that of 105 cm spaced double-row strips were non-significant. These findings are in line with those of Thiagarajan and Ramaswamy (1984) and Hau and Goebel (1987) who reported that number of fruiting branches were affected significantly by the various inter-row spacings.

Number of bolls $plant^{-1}$: There were significant differences among the various spatial arrangements with regard to bolls $plant^{-1}$. Although 120 spaced double-row strip plantation produced significantly greater number of bolls $plant^{-1}$ than that of 60 cm spaced single rows and 105 cm spaced double-row strip plantation yet it was at par with rest of patterns of plantation. Higher fruiting at wider spacing was attributed to better circulation of light and air and more nutritional area per plant which enhanced fruiting because of increased NAR of the plant. These results are supported by the findings of Thiagarajan and Ramaswamy (1984) who observed that number of sympodial branches and bolls per plant were significantly higher with wider than with narrow spacing.

Weight $boll^{-1}$: The weight of an individual boll has a great bearing on the final yield of cotton. The different geometric arrangements affected the boll weight significantly. Though the crop sown in the pattern of 90 cm spaced double-row strips produced significantly heavier boll (2.29 g) than that planted in 60 cm spaced single rows (2.15 g) yet it is at par with all other treatments. Higher boll weight at wider spacing arrangements has also been reported by Hau and Goebel (1987).

Weight of seed cotton $plant^{-1}$: The final yield of seed cotton ha^{-1} is ultimately a function of seed cotton weight $plant^{-1}$. The maximum weight of seed cotton $plant^{-1}$ (80.33 g) was obtained from the crop planted in 90 cm spaced paired rows which was significantly higher than that planted in 60 cm apart single rows (48.25 g) but was statistically equal to all rest of the treatments producing from 58.70 to 59.48 grams of seed cotton $plant^{-1}$. Low seed cotton weight per plant at 60 cm spaced row planting was probably ascribed to less nutritional area per plant and poor penetration of light and air due to closer spacing. These results are in line with those of Abd-El-Gawad *et al.* (1986) and Kerby *et al.* (1990).

Seed cotton yield ha^{-1}: The yield of seed cotton ha^{-1} varied significantly under different geometrical arrangements. Crop planted in 90 cm spaced double-row strips produced significantly higher seed cotton yield ha^{-1} (1693 kg) than all other treatments with the exception of 70 cm spaced row planting which produced 1693 kg ha^{-1} of seed cotton and was at par with it. Significantly the minimum seed cotton yield of 1493 kg ha^{-1} was obtained from the crop planted in 60 cm spaced single rows. However, the differences among 105 and 120 cm spaced double-row planting patterns and that planted at 80 cm spaced single rows were non-significant and produced seed cotton yield ranging between 1526 and 1573 kg ha^{-1}. Higher seed cotton yield in case of 90 cm spaced double-row strip plantation was attributed to relatively more plants m^{-2}, greater number of bolls per plant and higher weight of seed cotton per boll probably because of better adjustment of plants over the field which ultimately resulted in better reproductive development of the plants. These findings are corroborated with those of Brar and Singh (1978), Arshad *et al.* (1986), Virk *et al.* (1985), Thiagarajan and Ramaswamy (1984), Kerby *et al.* (1990) and Tupper *et al.* (1995) but are contrary to those of Birajdar *et al.* (1987) who reported that cotton hybrid-4 planted at different spacings in uniform or paired rows gave similar yields.

Ginning out turn (G.O.T.): The various geometric arrangements had significant effect on G.O.T. Plantation in 90 cm spaced double-row strips though gave significantly higher G.O.T. (34.47%) than that planted either in 60 and 70 cm spaced single rows or 120 cm spaced paired rows yet was at par with rest of the treatments. The minimum G.O.T (33.42%) was recorded in case of 60 cm spaced single-row plantation. These results are not in consonance with those of Singh and Warsi (1985) who reported that ginning percentage was higher in cotton sown in 60 spaced rows than that sown in 30 or 45 cm apart rows. Similarly Sappenfield (1987) narrated that cotton sown in 75 cm apart rows gave 20% greater lint yield than 90 cm apart rows while Makram *et al.* (1982) reported that row spacings had little effect on lint percentage.

Fibre length and strength: Both the length and strength of the fibre was not influenced significantly by the different geometric arrangements. However, on the average fibre length varied from 28.2 to 29.5 mm while fibre strength ranged between 86.2 to 89 (1000 lb./sq. inch). These results support the concept that both the fibre length and strength of a variety are mainly controlled by its genetic make-up rather than different agronomic practices. These results are in accordance with those of Hutchinson *et al.* (1985) who reported that different spatial arrangements did not affect earliness, fibre length or strength and all the test cultivars responded similarly.

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