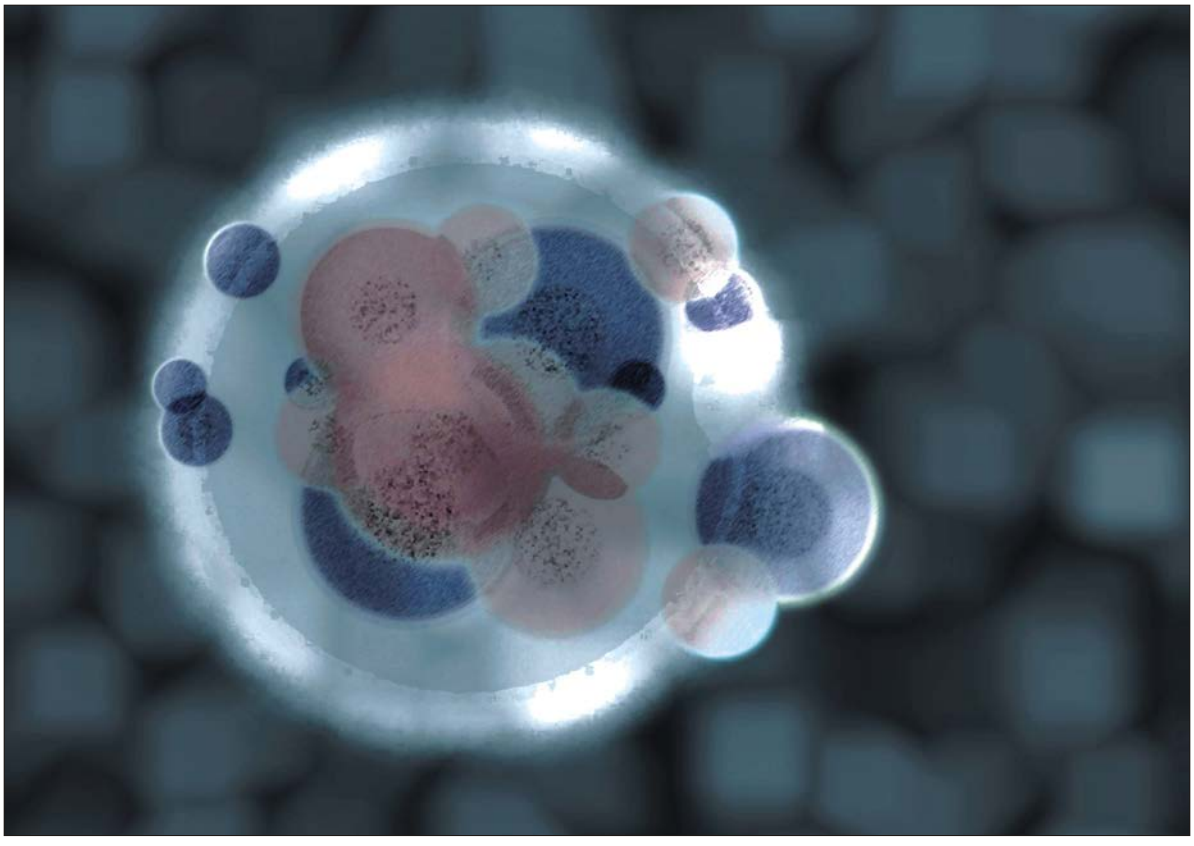

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Effect of Bunch and Flat Plantation in Different Spatial Arrangements on the Yield and Staple Length of Upland Cotton (*Gossypium hirsutum* L.)

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Abstract: The effect of bunch and flat plantation on the yield and fibre quality of a hirsutum cotton genotype NIAB-26 was determined. The treatments comprised 100 cm apart 100 × 100 cm pit plantation with a bunch of 5, 7 and 9 plants per pit, 60 × 60 cm hills with two plants per hill, 90 cm spaced double-row strips (30/90 cm) and 60 cm spaced single rows. The results revealed that although bunch plantation in 100 cm apart 10 × 100 cm pits improved the fruiting potential and boll size to a significant extent but did not compensate the yield loss due to lower plant population per unit area compared to flat plantation with a normal plant population The highest seed cotton yield of 3637 kg ha^{-1} was obtained from flat plantation in 90 cm spaced double-row strips (30/90 cm) against the lowest of 1675 kg ha^{-1} from pit plantation with a bunch of 5 plants per pit.

Key words: Bunch and flat plantations, spatial arrangement, hirsutum cotton genotype, staple length

Introduction

In Pakistan, cotton is grown on an area about 3.00 million hectares with a total annual production of 8.00 million bales giving an average yield of 581 kg ha^{-1} (Anonymous, 2000). About 60% of the foreign exchange is earned by exporting cotton and its products. It also supplies raw material to various agro-based industries and provides employment to the millions of people. Although Pakistan ranks fifth in acreage and sixth in cotton production but its average yield ha^{-1} is still 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 USA (682 kg ha^{-1}) that are getting about one and half times higher yield than Pakistan (Anonymous, 2000). This situation is really a challenge to the agricultural experts because the present production is not sufficient to meet the expanding demands of the local textile industries, export targets etc.

Low yield of seed cotton in Pakistan is mainly attributed to poor yield potential of the existing cotton cultivars, improper agro-management practices and inadequate plant protection measures. Among the agro-management practices, geometry of planting and sub-optimal plant population per unit area are considered to be of prime importance. Recently bunch plantation technology in pits and double-row strip plantation on flat has been developed which have shown lot of agro-advantages besides giving higher yield ha^{-1} than the conventional method of plantation in 60 cm spaced single rows. However, this technology of plantation is still to be compared with the conventional ones to establish its superiority. The project was, therefore, conducted to determine the effect of bunch and flat plantation in different spatial arrangements on the yield and staple length of upland cotton under the agro-ecological conditions of Faisalabad in irrigated environment.

Materials and Methods

The effect of flat and bunch plantation in pits was studied on the growth and seed cotton yield of upland cotton under different spatial arrangements giving rise to variable plant density per unit area on the sandy-clay loan soil at the Agronomic Research Area, University of Agriculture, Faisalabad during the year 1991-92. The experiment was laid out in a randomized complete block design with a net plot size of 2.40 × 8.00 m^2. The planting geometry comprised 100 cm apart 100 × 100 cm pits with a bunch of 5, 7 and 9 plants per pit, 60 × 60 cm hills with two plants/hill, 60 cm apart single rows and 90 cm apart double-row strips (30/90 cm) on flat. A promising cotton genotype NIAB-26 was used as a medium of the trial. Before sowing, the cotton seed was soaked in water for about 5 h and then rubbed with cow dung in order to separate seeds for facilitating uniform distribution through the seeding drill.

Pits were dug at zero tillage to a depth of 45 cm and then refilled with the same soil to the depth of 35 cm maintaining normal compunction. Sowing was done with the help of a single row hand drill in case of flat planting while in hills and pits sowing was done with the help of a properly designed dibbler. Thinning was done when the cotton plants attained a height of 30 cm maintaining a plant to plant distance of 30 cm in case of flat planting while in bunch treatments plant density was maintained as per treatments. Pits were irrigated by basin method while flood irrigation was done to flat planting treatments. First irrigation was given 30 days after planting. In all six irrigations each of 7.5 cm were given to mature the crop. A fertilizer dose of 100 kg n ha^{-1} in the form of urea was applied in two equal splits each at sowing and pre-flowering stage in addition to 50 kg P_2O_5 ha^{-1} in the form of SSP given at sowing. Cotton planted in bunches was given fertilizers only in pits. The crop was sprayed four times to check the insect pests. Crop was harvested in three pickings manually. Observations on desired parameters were recorded by using standard procedures. Data collected were subjected to Fisher's analysis of variance technique and LSD test at 0.05 P was used for the statistical comparison of treatment means (Steel and Torrie, 1984).

Results and Discussion

Plant population density m^{-2} at harvest: The bunch plantation treatments differed significantly from one another with regards to population density m^{-2} which increased linearly with an increase in bunch size (Table 1). However, differences among the flat plantation treatments were non significant and the plant population density on the average varied from 5.23 to 5.43 m^{-2}. This was ascribed to similar land area per plant in all the three flat treatments. By contrast, the differences among the bunch plantation treatments were attributed to variable land area per plant maintained as per treatment.

Plant height at harvest: Flat plantation produced significantly higher plants than bunch plantation probably because of more plant density m^{-2} which favoured vertical growth and vice versa was true in case of bunch plantation where reduced

Table 1: Agronomic traits and fibre length of American cotton as affected by bunch and flat plantation under different spatial arrangement

Planting patterns	plant density m^{-2}	plant heigh at maturity (cm)	No. of monopodial branches $plant^{-1}$	No. of sympodial branches $plant^{-1}$	No. of bolls $plant^{-1}$	Wt. of seed cotton $boll^{-1}$ (g)	Yield of seed cotton (kg ha^{-1})	G.O.T. (%)	Staple length (mm)
A bunch of 5 plant per pit of 100 × 100 cm.	1.41d	79.35d	2.08a	12.25ab	49.00a	3.59ab	1675e	36.00NS	29.25NS
A bunch of 7 plants per pit of 100 × 100 cm.	1.75c	82.38cd	1.88ab	11.88abc	43.25b	3.54ab	2073d	36.63	28.50
A bunch of 9 plants per pit of 100 × 100 cm.	2.25b	88.75bc	1.88ab	10.25c	28.75c	3.75a	2002d	36.50	29.75
60 x 60 cm hills with 2 plants per hill	5.23a	92.50b	1.65abc	10.20c	29.77c	3.38bc	2796c	35.75	30.00
90 cm spaced double row strip	5.43a	104.00a	1.33bc	12.65a	28.75c	3.19c	3637a	36.13	28.75
60cm spaced single rows	5.32a	101.69a	1.58bc	10.55bc	26.35c	3.50b	3242b	36.00	28.75

Means within a column not sharing a letter differ significantly at 0.05 P, NS = Nonsignificant

plant density m^{-2} encouraged horizontal growth of plants due to wider space (Table 1). The minimum plant height of 79.35 cm was recorded in pits with a bunch of 5 plants which was at par with a bunch of 7 plants. On the contrary, the maximum plant height of 104 cm was observed in case of 90 cm spaced double-row strips which was statistically equal to that recorded in 60 cm spaced single row plantation (101.69 cm). These results are in line with those of Makram *et al.* (1982) but are contrary to the finding of Nikolov (1985b) who reported increase in plant height with a decrease in density from 180000 to 30000 plants ha^{-1} .

Number of monopodial branches $plant^{-1}$: The different planting patterns had significant effect on number of monopodial branches per plant recording significantly the minimum (1.33) in 90 cm spaced double-row strip plantation against the maximum of 2.08 in pits with a bunch of 5 plants which was at par with 7 and 9 plants bunch treatments including hill plantation producing on the average 1.65 to 1.88 monopods per plant. Tyaminov (1983) and Nikolov (1985b) found same findings.

Number of sympodial branches $plant^{-1}$: The effect of planting geometry on number of sympodial branch plant-1 was significant. Plants grown in the pattern of 90 cm spaced double-row strips produced statistically the same number of sympodial branches $plant^{-1}$ (12.65) as recorded in case of planting in pits with a bunch of 5 and 7 plants with an average of 12.25 and 11.88 $plant^{-1}$ respectively. The minimum sympodial branches $plant^{-1}$ (10.20) was recorded in 60 × 60 cm hill with two plants per hill which was at par with plantation in pits with a bunch of 7 and 9 plants per pit and 60 cm spaced single rows producing on the average 11.88, 10.25 and 10.55 sympodial branches $plant^{-1}$, respectively. Almost similar results were reported by El-Akkad *et al*. (1980), Thiagarajan and Ramaswamy (1984) and Nikolov (1985a).

Number of bolls $plant^{-1}$: The number of bolls $plant^{-1}$ has a direct bearing on the final yield of seed cotton ha^{-1}. The data on bolls $plant^{-1}$ (Table 1) revealed significant differences between the patterns of plantation. Plant grown in pits with a bunch of 5 plants produced significantly the highest number (49 bolls $plant^{-1}$) followed by linear decrease in that planted in pits with a bunch of 7 and 9 plants. However, differences among rest of the treatments including 9 plants bunch plantation were nonsignificant. The differences among the various planting patterns were ascribed to variable plant population density and space adjustment of plants. These results are in consonance with those of Brar and Singh (1978), Makram *et al*. (1982), Meire *et al*. (1983) and Nikolov (1985a, b).

Weight of seed cotton $boll^{-1}$: Different methods of plantation had significant effect on weight $boll^{-1}$. Although plantation in pits of 100 × 100 cm with bunch of 9 plants produced significantly heavier bolls than flat plantation either in 60 cm spaced single rows or 90 cm spaced paired rows or in 60 × 60 cm hills with 2 plants $hill^{-1}$ but was at par with pit plantation with a bunch of 5 or 7 plants per pit. By contrast, difference between paired row and hill plantation was nonsignificant producing 3.38 and 3.19 grams $boll^{-1}$, respectively with the maximum of 3.75 g in case of pit plantation with a bunch of 9 plants per pit. These results are supported by findings of Makram *et al*. (1982) who reported that boll weigh was not affected significantly by different planting patterns.

Yield of seed cotton ha^{-1}: Seed cotton yield ha^{-1} was significantly affected both by pit and flat plantations under different spatial arrangements. Crop planted in 90 cm spaced double-row strips gave significantly higher yield of seed cotton (3637 kg ha^{-1}) than all rest of the planting methods with the minimum of 1675 kg ha^{-1} in case of pit plantation with a bunch of 5 plants/pit. However, the seed cotton yields obtained from pit plantation with a bunch of 7 and 9 plants per pit were statistically similar and amounted to 2027 and 2002 kg ha^{-1}, respectively. Higher seed cotton yield ha^{-1} in 90 cm spaced paired row plantation was ascribed to more number of plants per unit area and relatively higher number of sympodial branches $plant^{-1}$. Cotton planted in the pattern of 90 cm spaced double-row strips besides producing significantly higher yield of seed cotton ha^{-1} exhibited many other agro-advantages like easily mechanical hoeing, spraying of insecticides and better circulation of light and air which ultimately help improving the photosynthetic potential of the plants. These results are in line with those of Ewida *et al.* (1981), Bavale (1982), Jain and Katti (1983), Thiagarajan and Ramaswamy (1984), Virk *et al.* (1985), Tupper *et al.* (1995), Abd-EL-Gawad *et al.* (1986) and Nazir *et al.* (2000) who reported lot of variation in seed cotton yield ha^{-1} as a result of different spatial arrangements and population density per unit area under different agro-edaphic climatic conditions.

Ginning out turn (G.O.T.): Both the bunch and flat plantation in different spatial arrangements had no significant effect on

G.O.T. which on the average varied from 35.75 to 36.63%. Similar results were reported by El-Shaer *et al.* (1977), Bilbro (1981) and Nazir *et al.* (2000). By contrast Curley *et al*. (1982) and Singh and Warsi (1985) observed that ginning out turn (G.O.T.) was lower at narrow row spacing.

Staple length: The various planting patterns under pit and flat arrangements did not affect significantly the staple length which on the average ranged between 28.50 to 3.00 mm. These results are corroborated with those of Nagwekar and Kairon (1978) and Bilbro (1981) but are contradictory to those of Fowler and Ray (1977) who reported that increased stand density increased fibre length.

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