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Effect of Planting Patterns and Different Intercropping Systems on the Productivity of Cotton (*Gossypium hirsutum L.*) Under Irrigated Conditions of Faisalabad

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ABSTRACT

Yield and yield components of cotton grown in two patterns and as sole and in different intercropping systems was studied. Cotton was planted in two patterns viz., 80-cm spaced single rows and 120-cm spaced double row strips of cotton (40/120 cm). Intercropping systems were cotton alone, cotton+mungbean, cotton+mashbean, cotton+sesame, cotton+ricebean, cotton+maize, cotton+sorghum, cotton+cowpeas and cotton+soybean. Planting patterns had non-significant effect on seed cotton yield. Intercropping systems significantly affected seed cotton yield. Seed cotton produced by cotton alone was at par with that from cotton+mashbean and cotton+cowpeas. However, in all the other intercropping systems under study, cotton production was significantly decreased as compared to cotton alone.

Key Words: Cotton; Planting patterns; Intercropping systems; Seed cotton yield

INTRODUCTION

Cotton is the most important cash crop of Pakistan. It accounts for about 58.70% of the total export earnings (Anonymous, 1998). However, Pakistan is still deficient in edible oil, wheat grain and pulses. In 1996-97, 1.2 million tonnes of edible oil worth Rs. 33 billion, 4.1 million tonnes of wheat worth Rs. 30 billion and 0.262 million tonnes pulses worth Rs. 3.0 billion were imported (Anonymous, 1997). Shortage of fodder is another problem especially with small farmers (Abdullah & Chaudhary, 1996). Such situation demands a simultaneous increase in the productivity of cotton, edible oilseeds, wheat grain, pulses and fodders to fulfil the increasing diversified needs of the ever growing population.

For this purpose, cotton-based intercropping seems to be a promising strategy. Though intercrops reduced seed cotton yield of the associated cotton by 8-31% yet total crop productivity and net return per unit area were higher in intercropping than sole cropping (Mohammed *et al.,* 1994). Different cotton-based intercropping systems have been reported to increase farm income by 30-40% (Saeed *et al.,* 1999). But magnitude of such agro-economic advantages depends upon the type of intercrop (Rao, 1991). Conventional method of planting cotton in closely spaced single rows does not permit convenient intercropping in it. Recently, a new pattern of cotton plantation in widely spaced multi-row strips has been developed which not only gives seed cotton yields comparable with that of the conventional single-row plantation (Deshpande *et al.,* 1989) but also facilitates intercropping. The present study was conducted to find out a suitable planting pattern of cotton facilitating intercropping without affecting the productivity of cotton at large and assessing the feasibility of different cotton-based intercropping systems

MATERIALS AND METHODS

The study was conducted at Agronomic Research Area, University of Agriculture, Faisalabad. The experiment was laid out in randomized complete block design with split arrangement and four replications. Planting patterns were randomized in main plots and intercrops in subplots. Plot size was 4.8mx7m. Cotton cultivar NIAB 78 was sown in 80-cm spaced single rows and 120-cm spaced 2-row strips with the help of a single row cotton drill on May 27 and 29 during *kharif* 1996 and 1997, respectively. Mungbean (*Vigna radiata L.*), mashbean (*Vigna mungo L.*), soybean (*Glycine max L.*), sesame (*Sesamum indicum L.*), maize (*Zea mays L.*), Sorghum (*Sorghum vulgare L.*), cowpeas (*Vigna unguiculata*) and ricebean (*Vigna umbellata*) were intercropped in space between the cotton rows/strips next day after sowing of cotton. Mungbean, mashbean, sesame and soybean were harvested at their physiological maturity. Ricebean, maize, sorghum and cowpeas were harvested at flowering as green fodder. Observations on growth, yield and quality parameters of cotton were recorded by following standard procedures. Ginning out turn (GOT) was determined using the relationship: GOT= (weight of lint/ weight of seed cotton) x 100. Fibre length was measured by tuft method (Brown, 1975).

The data collected were subjected to analysis of variance (ANOVA) technique and LSD using MSTATC computer package.

RESULTS AND DISCUSSION

Plant density (m^{-2}). Data showed statistically similar number of cotton plants m^{-2} in all intercropping systems under both the planting patterns (Table I). This was primarily due to the fact that cotton plant population in rows

Table I. Impact of different planting patterns and intercropping systems on growth, seed cotton yield and fibre quality of cotton

Treatment	Plants m^{-2}	Plant height (cm)	M. Branches $plant^{-1}$	S. Branches $plant^{-1}$	Bolls $plant^{-1}$	Boll weight (g)	Seed Cotton yield (kg ha^{-1})	G.O.T. (%)	Seed oil yield (kg ha^{-1})	Staple length (mm)
Planting patterns (P)								37.0^{NS}	220^{NS}	26.1^{NS}
P_1 (80-cm spaced single rows)	4.11^{NS}	122^{NS}	1.97^{NS}	10.2^{A}	18.8^{NS}	2.73^{NS}	1917^{NS}	36.9	223	26.12
P_2 (120-cm spaced 2-row strips)	4.15	119	2.01	9.9	18.6	2.77	1942			
Intercropping systems (S)								37.1^{NS}	262a	26.2
S_1 (Cotton alone)	4.20^{NS}	133a	2.10ab	10.8bc	21.5a	2.77bc	2269a	36.9	238b	26.19
S_2 (Cotton + mungbean)	4.19	130ab	1.95bc	10.9abc	18.7d	2.86a	2050b	36.9	251ab	26.06
S_3 (Cotton + mashbean)	4.17	129abc	2.03abc	11.4a	21.7a	2.65c	2176a	36.8	86.8e	25.62
S_4 (Cotton + sesame)	4.13	89.3f	1.73d	4.1e	7.6e	2.59cd	749d	36.8	225b	26.18
S_5 (Cotton + ricebean)	3.93	124cd	2.15a	10.2	19.1cd	2.85a	1944bc	37.0	229b	26.16
S_6 (Cotton + maize)	4.11	119de	1.86cd	10.4cd	19.9bc	2.73bc	1990b	36.8	216b	26.14
S_7 (Cotton + sorghum)	4.14	114e	1.98bc	10.7bcd	19.8bc	2.62c	1925bc	37.1	236b	26.13
S_8 (Cotton + cowpeas)	4.12	124cd	2.08ab	11.2ab	20.0bc	2.81ab	2094ab	37.0	250ab	26.32
S_9 (Cotton + soybean)	4.16	127bc	2.05ab	10.6bcd	20.1b	2.86a	2168a	**	NS	NS
P x S	NS	*	NS	**	NS	NS	NS			

NS= Non-significant; Means bearing different letters in a column differ significantly at 0.05 probability levels; S= Sympodial branches; M= Monopodial branches; $^{a}P_1$= 80-cm spaced single rows of cotton; P_2 = 12-cm spaced 2-row strips of cotton; C = Cotton; I = Intercrop

was maintained by thinning in all the treatments during both the years. Secondly, planting geometry was altered in such a way that number of rows of cotton plants was same in both the planting patterns. Interactive effect was also found to be non-significant. De *et al.* (1978) reported intercropping experiments in which the plant population of base crop was kept constant while the planting geometry was altered. Willey (1979) and Deshpande *et al.* (1989) also reported similar effect of different planting patterns and intercropping systems on crop stand.

Plant height (cm). Cotton plant height was statistically similar in both the planting patterns (Table I). Intercropping systems had highly significant effect on cotton plant height. Maximum and statistically similar plant heights were recorded where cotton was grown alone (133 cm) or where mungbean (130 cm) and mashbean (129 cm) were intercropped. All other intercrops reduced cotton plant height to variable extent. The smallest plants (89.3 cm) were harvested from plots where sesame was intercropped in cotton. Combinations of various planting patterns (P) and intercropping systems (S) had a highly significant effect on cotton plant height at harvest. The maximum plant height was attributed to penetration of light and circulation of air into the plants and comparatively more nutritional area available to sole crop. Mungbean and mashbean intercropped in cotton did not influence the cotton plant height primarily due to their short stature and nitrogen fixation character. Drastic reduction of cotton plants in cotton+sesame intercropping system was due to fast growth of sesame at earlier growth stage, which suppressed the growth of companion cotton crop. Sorghum intercropped in cotton also severely competed with it and reduced its height to a greater extent. This may be due to the exhaustive nature of sorghum. The competitive effect of sorghum on the companion crops in different intercropping systems has also been reported by Beltrao *et al.* (1986)

Plant canopy (m^3). Planting cotton in 120-cm spaced double row strips reduced plant canopy significantly as compared with that planted in 80-cm spaced single rows (Table I). Maximum plant canopy size (0.57 m^3) was achieved when cotton was grown alone. Different intercropping systems reduced canopy size of cotton plant to variable extent. Intercropping sesame in cotton at either planting pattern produced plants with minimum canopy size of 0.19 to 0.22 m^3. The reduction in cotton canopy size was in the order of sole cotton > cotton+mungbean > cotton+mashbean > cotton+soybean > cotton+ricebean > cotton+maize > cotton+sorghum > cotton+sesame. The interactive effect of planting patterns and intercropping systems was highly significant. The reduction of canopy size in this order can be related to the competitive effect of these crops on cotton.

Monopodial branches $plant^{-1}$. Planting patterns had non-significant effect on monopodial branches in cotton (Table I). All intercropping systems except cotton+sesame and cotton+maize produced similar number of monopodial branches as those recorded for cotton grown as sole crop. Interactive effect was non-significant. Sesame intercropping suppressed the number of monopodial branches to the maximum extent. This was ascribed to the more competitive and exhaustive behavior of sesame, which suppressed the growth of companion crop to a large extent.

Sympodial branches $plant^{-1}$. More sympodial branches (10.2) were recorded for cotton grown in 80-cm spaced single rows as compared with 9.90 produced where cotton was grown in 120-cm apart double row strips (Table I). More branches in 80-cm spaced single rows of cotton were attributed to more intra-row spacing compared with cotton planted in 120-cm spaced, paired row strips facilitating more growth of the cotton plants. However, Saeed *et al.* (1999) reported contradictory results to these findings. All intercropping systems except cotton+mungbean, cotton+mashbean and cotton+cowpeas reduced fruit bearing branches; these three being statistically at par in this respect with cotton grown alone.

Bolls plant^{-1}. All intercropping systems except cotton+mashbean produced statistically less number of bolls plant^{-1} as compared with those produced by cotton grown alone (Table I). Minimum bolls plant^{-1} (7.60) were produced in cotton+sesame intercropping system. Interactive effects of patterns x intercropping systems were non-significant in this regard. Malik *et al.* (1991) also reported reduction in number of bolls in different intercropping systems. This was ascribed to an intensive competition between the component crops in different intercropping systems for the factors such as water, nitrogen, light etc. required for boll setting.

Boll weight (g). Planting patterns (P) did not influence boll weight of cotton (Table I). Intercropping mungbean, soybean, ricebean and cowpeas produced maximum of 2.86, 2.86, 2.85 and 2.8 g boll weight, respectively; but statistically at par with each other. Similarly, cotton+mashbean, cotton+sesame, cotton+sesame, cotto+maize and cotton+sorghum did not affect boll weight statistically with each other but differed significantly with that from rest of the intercropping systems (S). Interactive effect of P x S for boll weight was highly significant. Reduction in boll weight was attributed to more bolls plant^{-1} crop. Higher boll weight was recorded in those intercropping systems where number of bolls plant^{-1} was lesser. Similarly, reduction in boll weight has also been reported by Goma and Radwan (1991), and Goma (1991).

Seed cotton yield (kg ha^{-1}). Planting patterns did not affect seed cotton yield (Table I). Rao and Sadaphal (1993) and Prasad *et al.* (1993) also reported that seed cotton yield was not affected by planting patterns. However, Saeed *et al.* (1999) and Asim (1998) reported that paired row strips of cotton gave higher seed cotton yield as compared with single row planting pattern.

Seed cotton yield differed significantly in various intercropping systems. However, intercropping systems of cotton+mashbean, cotton+soybean and cotton+cowpeas gave statistically similar seed cotton yields of 2176, 2168, 2094 kg ha^{-1}, respectively. The yield in aforementioned systems was at par with that obtained from cotton grown alone (2269 kg ha^{-1}). Similar effect of mashbean (Rao, 1991) and soybean (Hosny *et al.,* 1994) intercropping was reported previously. Cotton+mungbean, cotton+maize, cotton+ricebean and cotton+sorghum produced statistically similar seed cotton with each other but significant reduction occured as compared to cotton+mashbean and cotton+soybean. Cotton+sesame produced the lowest seed cotton yield (749 kg ha^{-1}). All other intercropping systems viz. Cotton+mungbean, cotton+ricebean, cotton+maize, cotton+sorghum and cotton+cowpeas resulted in 9.65, 14.3, 12.3 15.2 and 7.71% reduction in seed cotton yield as compared with sole cotton. Mohammad *et al.* (1991) also reported reduction in seed cotton yield in different intercropping systems as compared to sole cotton plots. Contrary to this, Kairon and Singh (1972) found that seed cotton yield was increased when it was intercropped with mungbean. The reduction in seed cotton was attributed to significant reduction in plant growth, fruit bearing branches, number of boll plant^{-1} and also boll weight. Cotton+sesame intercropping system resulted in maximum reduction (67.5%) in seed cotton yield which was ascribed to much shading effect of sesame on associated cotton due to its fast growth at earlier stage resulting in tall plants and possibly due to inter-specific competitive effect of sesame on cotton. Similarly, Gardner and Craker (1981) reported decreased light interception and total dry weight in beans intercropped with maize. Chandravanshi (1975) reported negative effects of sorghum on the yield of the associated crop.

Ginning out turn (GOT%). Neither planting patterns (P) nor intercropping systems (S) affected G.O.T (Table I). Saeed *et al.* (1999) also reported non-significant effect of planting patterns and intercropping systems on ginning out turn of cotton.

Seed oil yield (kg ha^{-1}). Planting pattern did not influence seed oil yield significantly. This might be due to the reason that oil content is controlled genetically. Seed oil yield varied to a significant level in different intercropping systems. Sole cotton produced maximum quantity of oil as compared to that grown as intercrop. However, it was at par with oil yield of cotton in cotton+mashbean and cotton+soybean system. Cotton grown as cotton+mungbean, cotton+ricebean, cotton+maize, cotton+sorghum and cotton+cowpeas systems produced statistically similar seed oil. Seed oil was drastically reduced (66.92%) in cotton+sesame system. This severe reduction was due to its far low seed cotton yield (67%) as compared to cotton alone. Cotton seed oil yield in cotton+sesame was 66.9, 63.5, 65.4, 61.5 62.1, 59.8, 63.2 and 65.3% lower as compared with cotton alone, cotton+mungbean, cotton+mashbean, cotton+ricebean, cotton+maize, cotton+sorghum, cotton+cowpeas and cotton+soybean, respectively. Variation in seed oil yield in different intercropping systems was not attributed to seed oil content percentage as none of the systems have significant impact on this characteristic. Differences in seed oil yield were ascribed to variation in seed cotton yield in these systems.

Staple length (mm). Staple length was not affected by any of the intercropping systems in this study. Effect of planting patterns on this characteristic was also non-significant. Similar results were reported by Beltrao *et al.* (1986) and Gardezi (1993).

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