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Agro-Economic Assessment of Different Cotton-Based Inter/Relay Cropping Systems in Two Geometrical Patterns

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ABSTRACT

The study was designed to evaluate the feasibility and agro-economic aspects of different cotton-based inter/relay cropping systems in two patterns of cotton (*Gossypium hirsutum* L.) plantation. For this purpose a field experiment was conducted at the University of Agriculture, Faisalabad. The planting patterns were 60-cm spaced single rows and 90-cm spaced double-row strips (30/90 cm) while intercropping systems included cotton alone, cotton + sesamum, cotton + mungbean, cotton + mashbean, cotton + mothbean and cotton + cowpea while wheat and lentil were relayed in standing cotton (after the harvest of intercrops) in November. Seed cotton yield was significantly greater in cotton grown in 90-cm spaced double-row strips than that in 60-cm spaced single rows. All intercrops caused almost equal decrease (20–27%) in seed cotton yield compared to cotton alone. Maximum net income of Rs. 48052 ha^{-1} was obtained from cotton + mashbean /lentil inter-relay cropping system followed by cotton + mungbean /lentil (Rs. 47415 ha^{-1}) and cotton + mungbean/wheat (Rs. 46732 ha^{-1}) against Rs. 32348, 32883 and 20552 for cotton/wheat, cotton/ lentil and cotton-fallow, respectively.

Key Words: Cotton-based inter/relay cropping; Geometrical patterns of cotton; Agro-economic assessment

INTRODUCTION

Inter/relay cropping is an effective production system for increasing the income and production per unit area/time from both the irrigated and rainfed agriculture. The intercropping can help the small growers to meet their diversified domestic needs from a limited land area. Cotton (*Gossypium hirsutum* L.) accounts for about 60.3% of the total export earnings and over 61.4% of the domestic oil production (Anonymous, 1998). Its average yield is 528 kg ha^{-1} (Anonymuos, 1999) which is much lower than the biological potential of the existing domestic cultivars of cotton, as a result of which farmer's income ha^{-1} is substantially lowered. This necessitates developing an inter/relay cropping technology for increasing the income ha^{-1} without doing much damage to the base crop.

Raising of cotton in widely spaced rows or strips along with suitable inter/relay crops may be followed to get additional income and yield advantage over its monocropping (Chowdhry & Singh, 1982; Rao, 1991). Under agro-climatic conditions of Pakistan, this technology needs to be evaluated with respect to feasibility and agronomic aspects for which the present study was planned.

MATERIALS AND METHODS

A field experiment was conducted at the University of Agriculture, Faisalabad during the year 1993–94. The experiment was laid out in the randomized complete block design with split plot arrangement and three replicates. The planting patterns were randomized in main plots and inter/relay crops in subplots. Plot size measured 2.4 m x 12 m. Cotton was raised at 60-cm spaced single rows and 90-cm spaced double-row strips (30/90 cm). The intercropping systems comprised cotton alone, cotton + sesamum, cotton + mashbean, cotton + mungbean, cotton + mothbean, cotton + cowpea.

Cotton cultivar NIAB-86 was sown with a single row hand drill on June 6,1993. In both the planting patterns within row plant to plant distance of 30 cm was maintained through thinning at a plant height of 15 cm. Sesamum (*Sesamum indicum* L.), mashbean (*Vigna mungo* L.), mungbean (*Vigna radiata* L.), mothbean (*Phaseolus econitifolius*) and cowpea (*Vigna unguiculata* L.) were intercropped in space between the cotton rows/strips on June 6,1993. Intercrops were harvsted at their physiological maturity except mothbean and cowpea which were harvested at flowering as green fodder. After harvesting intercrops, wheat (*Triticum aestivum* L.) and lentil (*Lens esculanta* Medic) were relayed in standing cotton on November 15, 1993. Before sowing, wheat and lentil seed was soaked in water for 12 and 6 hours, respectively. All other agronomic practices were kept normal and uniform for all the experimental treatments. Observations on relevant parameters of all the component crops were recorded by following standard procedures (Shahid, 1995).

Ginning out turn (GOT) in cotton was determined using the relationship: GOT = (Weight of lint/weight of seed cotton) x 100.

The data collected were analyzed following Fisher's analysis of variance technique and treatment differences were compared for significance by applying LSD test at 0.05 P (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

The data pertaining to different agro-qualitative traits of cotton are given in Table I. Since treatment combinations did not differ significantly, only the main effects are discussed.

Plant density m^{-2}. Both the patterns of cotton plantation (PP) and intercropping systems (IS) differed non-significantly in plant density. Deshpande *et al.* (1989) reported non-significant effect of intercropping legumes in relation to PP of hybrid cotton on plants m^{-2} at harvest.

Plant height. The height of cotton plants at harvest was not influenced significantly by both PP and IS. Eweida *et al.* (1981) reported non-significant effect of PP and intercropping on plant height of cotton.

Monopodial branches plant^{-1}. Number of monopodial branches plant^{-1} is partially genetically controlled character of cotton. Both IS and PP did not significantly affect monopodial branches plant^{-1}, the grand mean of which was 1.93.

Sympodial branches plant^{-1}. Number of sympodial branches plant^{-1} was not affected significantly by different PP and IS. However, the grand mean of sympodial branches plant^{-1} was 11.97. Similar number of sympodial branches plant^{-1} was probably due to uniform plant population of cotton which resulted in similar competition with intercrops.

Bolls plant^{-1}. Number of bolls plant^{-1} has a direct bearing on the seed cotton yield ha^{-1}. The PP did not significantly affect bolls plant^{-1} which varied from 33.6 to 34.2. On the contrary, different IS caused significant reduction in bolls plant^{-1} compared with sole cropping of cotton. Cowpea as an intercrop caused maximum reduction (24.9%) in bolls plant^{-1} but was statistically on a par with other three intercrops, *viz.* mothbean, mungbean and mashbean. By contrast, sesamum caused the minimum reduction (19.74%) in bolls plant^{-1} of the associated cotton. These results suggest an intense competition between the component crops in different intercropping systems for the factors such as water, nitrogen, light etc. required for boll setting.

Weight of seed cotton boll^{-1}. Neither the PP nor the IS had significant effect on weight of seed cotton boll^{-1} However, grand mean seed cotton weight boll^{-1} was 3.52 g.

Yield of seed cotton ha^{-1}. Crop grown in 90-cm spaced double-row strips produced significantly higher seed cotton yield ha^{-1} (1057 kg) than that planted in 60-cm spaced single rows (913 kg ha^{-1}). Higher seed cotton yield obtained in 90-cm spaced double-row strips could be due to the fact that double-row strip plantation produced relatively greater number of bolls plant^{-1} than that planted in 60-cm spaced single rows. Paired-row planting has been reported to be efficient in using soil resources like nutrients, moisture etc. through better root development and more solar radiation interception (Abdel-malik *et al.*, 1991; Koraddi *et al.*, 1991).

Table I. Agronomic traits and fibre quality of cotton as affected by different intercropping systems and patterns of cotton plantation

Treatment	Plant density (m^{-2})	Plant height (cm)	Monopodial branches (plant^{-1})	Sympodial branches plant^{-1}	Bolls plant^{-1}	Seed cotton weight boll^{-1} (g)	Seed cotton yield (kg ha^{-1})	GOT (%)	Staple length (mm)
A. Patterns of cotton plantation. (PP)									
P_1 60-cm spaced single rows	5.42 NS	123 NS	1.95 NS	12.0 NS	33.6 NS	3.52 NS	913.46 b	35.7 NS	29.2 NS
P_2 90-cm spaced double-row	5.43	124	1.92	12.0	34.2	3.53	1057.31 a	36.0	29.4
B.Intercropping systems. (IS)									
I_0 Cotton alone	5.45 NS	127 NS	1.80 NS	12.3 NS	40.9 a	3.56 NS	1236 a	35.8 NS	29.8 NS
I_1 Cotton + Sesamum	5.43	123	1.92	11.9	33.9 b	3.56	957 b	35.9	28.0
I_2 Cotton + Mashbean	5.42	123	1.85	11.6	31.2 bc	3.47	915 b	36.0	29.8
I_3 Cotton + Mungbean	5.40	123	2.02	12.3	30.9 c	3.54	987 b	36.0	28.8
I_4 Cotton + Mothbean	5.40	122	1.94	12.1	31.0 c	3.52	901 b	35.9	29.3
I_5 Cotton + Cowpea	5.42	124	2.09	11.7	30.7 c	3.51	916 b	35.5	29.8
C. PP x IS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Values in a column and within each group of treatments not sharing a letter differ significantly at LSD (0.05)
NS = Non-significant

Table II. Yield and net income of different cotton-based inter/relay cropping systems

Inter/relay cropping system	Seed cotton yield (kg ha^{-1})	Intercrops yield (kg ha^{-1})	Relay crops yield (kg ha^{-1})	Expenditure (Rs. ha^{-1})			Net income (Rs.ha^{-1})
				Cotton	Intercrop	Relay crop	
Cotton alone	1236	-	-	10338	-		20552
Cotton/wheat	1236	-	3187	10338	-	7336	32348
Cotton /lentil	1236	-	586	10338	-	2329	32883
Cotton + sesamum /wheat	957	703*	3414	10338	1127	7336	43183
Cotton + sesamum /lentil	957	703*	636	10338	1127	2329	43606
Cotton + Mashbean /wheat	915	741*	3247	10338	1081	7336	42127
Cotton + Mashbean /lentil	915	741*	816	10338	1081	2329	48052
Cotton + Mungbean /wheat	987	827*	3350	10338	993	7336	46732
Cotton + Mungbean /lentil	987	827*	629	10338	993	2329	47415
Cotton + Mothbean /wheat	901	13363**	3350	10338	763	7336	32939
Cotton + Mothbean /lentil	901	13363**	629	10337	763	2329	32839
Cotton + Cowpea /wheat	916	14332**	3475	10338	925	7336	31950
Cotton + Cowpea /lentil	916	14332**	723	10338	925	2329	35982

Market rates (Rs kg^{-1})

Seed Cotton = 25, Wheat = 06, Sesamum = 25, Lentil = 25, Mashbean = 25, Mothbean = 0.60, Mungbean = 25, Cowpea = 0.60

* Seed yield, **..Green fodder yield

All the intercrops reduced seed cotton yield significantly compared with sole planting of cotton and reduction amounted to 20.17 to 27.11%. At the cost of this reduction in seed cotton yield, additional yield of 703, 741 and 827 kg seed ha^{-1} of sesamum, mashbean and mungbean, respectively and 13363, 14332 kg green fodder ha^{-1}of mothbean and cowpea were obtained which not only compensated the losses in seed cotton yield but also gave additional economic return. Reduction in yield of cotton by different associated cultures has been reportd by Jain *et al.* (1982), Koraddi *et al.* (1990) and Kalonda (1993).

Ginning out turn (GOT). Both the PP and IS did not significantly affect the GOT. However, grand mean GOT was 35.83%. Beltrao *et al.* (1986) reported non-significant effect of PP on GOT of cotton.

Staple length. Different PP and IS had no significant effect on staple length. However, the grand mean of staple length was 29.27 mm. These results concur with findings of Gardezi (1993) who reported that staple length was not affected significantly by agronomic practices.

Seed or green fodder yield of various intercrops. Intercrops such as mothbean and cowpea produced 13.3 and 14.3 t ha^{-1} of green fodder, respectively while sesamum, mashbean and mungbean produced seed yield of 703, 741 and 828 kg ha^{-1} (Table II). The produce of intercrops compensated much more than the losses in seed cotton yield due to intercropping. Koraddi *et al.* (1990) obtained an additional yield from cowpea intercropped in cotton which gave substantial amount of additional economic return over sole cropping of cotton.

Net income from different cotton based inter/relay cropping systems. Both the feasibility and profitability of an inter/relay cropping system is reflected by its net economic return. Data on comparative economic analysis of various inter/relay cropping systems (Table II) revealed that relay crops of wheat and lentil in cotton gave seed yield of 3187 and 586 kg ha^{-1}, respectively which resulted in 57 and 60% higher net income than cotton-fallow cropping system.

Cotton + mashbean/wheat, cotton + sesamum/wheat and cotton + mungbean/wheat inter/relay cropping systems resulted in 30, 33 and 44%, respectively higher net income than cotton-wheat relay cropping with benefit–cost ratio of 3.25, 3.30 and 3.50. Similarly cotton + sesamum/lentil, cotton + mungbean/lentil and cotton + mashbean/lentil inter/relay cropping systems increased net income by 33, 44 and 46%, respectively over cotton-lentil relay cropping with BCR of 4.16, 4.47 and 4.50. Cotton alone had BCR of 2.99 against 2.82 and 3.60 in cotton/wheat and cotton/lentil relay cropping systems, respectively. On the contrary, cotton + mothbean/wheat, cotton + mothbean/lentil,. cotton + cowpea/wheat, and cotton + cowpea/lentil inter/relay cropping systems gave net income ha^{-1} almost equal to cotton/wheat and cotton/lentil relay cropping systems. Greater net return from various cotton-based inter/relay cropping systems has also been reported by Padhi *et al.* (1993).

CONCLUSION

Cotton should be planted in 90-cm spaced double-row strips for convenient inter/relay cropping. Cotton + mashbean/lentil proved to be the most profitable inter/relay cropping system followed by

cotton + mungbean /lentil and cotton + mungbean/wheat, respectively.

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