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PRODUCTION OF SOYBEAN (*Glycine max* L.) AS COTTON BASED INTERCROP

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Abstract: Cotton-based intercrop of soybean was grown for two years i.e. 1996-97 and 1997-98 at the Agronomic Research Area, University of Agriculture, Faisalabad. Cotton cultivar NIAB-78 was planted in 80-cm apart single rows and 120-cm spaced double row strips with the help of a single row hand drill. Experiment was laid out in a randomized complete block design with split arrangements in four replications. Planting patterns were kept in main plots and intercropping systems in sub-plots. Intercrop was sown in the space between 80-cm apart single rows as well as 120-cm spaced double row strips. Growing of cotton in 120-cm spaced double row strips proved superior to 80-cm spaced single rows. Intercropping resulted in significant reduction of seed cotton, however, inter crop of soybean not only covered this loss but also increased over all productivity. Long term residual effects of different intercropping systems on the productivity of the following crops, residual soil fertility, and resource base degradation need to be monitored to plan strategies leading to sustainable agricultural productivity.

Key words: Cotton, intercropping system, legume, planting pattern, soybean.

INTRODUCTION

Pakistan is an agricultural country but still deficient in edible oil. Cotton has main share in domestic edible oil production (57.43 %) [Govt. of Pakistan, 2003a]. However, there is big gap in demand and domestic production of this important food item. Consequently Pakistan is investing a huge amount of foreign exchange on its import to meet the needs.

In 2001-02, 1.2 million tons of edible oil worth US $ 55 million [Govt. of Pakistan, 2003b] was imported. Such situation demands a simultaneous increase in the productivity of cotton and other oilseed crops.

Soybean was introduced as a new oil seed crop. In Punjab its growing season overlaps with cotton and we could not allocate area for this crop on the cost of cotton. In the present situation of small landholdings and overlapping of growing seasons, intercropping can help in increasing crop productivity particularly at small farms of Pakistan. However, conventional planting geometry of cotton does not permit convenient intercropping. There is dire need to search a new pattern of cotton plantation in widely spaced multi-row strips that can give seed cotton yields compatible with that of the conventional plantation and also facilitates intercropping. Some work has been done on these lines. However, details of different aspects of intercropping in cotton at various patterns of cotton plantation need to be explored. This study was designed in order to develop new patterns for cotton sowing to make the cotton-based intercropping system more feasible, productive and economical.

MATERIALS AND METHODS

The experiments were conducted at Agronomic Research Area, University of Agriculture, Faisalabad (Pakistan) during 1996-97 and 1997-98. Experimental site consists of very deep, well drained medium textured soil, developed in mixed calcareous and medium textured alluvium.

Cotton was sown in two different planting patterns i.e., 0.80-m spaced single rows and 1.20-m spaced 2-row strips (0.40/1.20 m). Soybean (*Glycine max* (L.) Merr.) cv. NARC 1, an important leguminous oil seed crop was sown in the above mentioned two planting patterns. Cropping systems studied were cotton alone (S_1) and cotton+soybean (S_2). Experiment was laid out in randomized complete block design (R.C.B.D.) with split arrangement and four replications. Patterns were randomized in main plots and intercrops in subplots. Plot size was 4.8 m x 7.0 m. All the cultural practices were kept uniform during both of the years under study. The intercrop was also sown as a sole crop for determining the merits and demerits of intercropping as compared to sole crop.

At physiological maturity, number of plants m^{-2} , plant height, branches $plant^{-1}$, pods $plant^{-1}$, grains pod^{-1}, 1000-seed weight (g), grain yield (kg ha^{-1}) and biological yield (kg ha^{-1}) were recorded according to standard procedure. Harvest index (HI) was calculated by the following formula.

$$\text{H. I.} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

RESULTS AND DISCUSSION

The highest, significant plant density was recorded in the sole crop. However, the planting density of soybean was statistically at par in both the planting patterns (Table 1).

Table 1: Performance of soybean intercropped in cotton planted in different planting patterns (Two years average data).

Parameter	P_1	P_2	P_3	Sx
Plant density (m^{-2})	13.5 b	14.7 b	20.1 a	0.34
Plant height (cm)	81.6 NS	83.9	83.8	2.06
Branches $plant^{-1}$	19.8 b	20.0 b	26.6 a	0.44
Pods $plant^{-1}$	29.7 b	32.0 ab	37.6 a	0.92
Seeds $plant^{-1}$	44.8 b	47.8 b	58.3 a	2.09
1000-seed weight (g)	85.2 NS	84.8	83.6	2.08
Seed yield (kg ha^{-1})	395 c	470 b	802 a	13.9
Biological yield (kg ha^{1})	1283 c	1544 b	2573 a	41.3
Harvest index (%)	30.8 NS	30.4	31.2	1.01

P_1 = 0.80-m spaced single rows of cotton, P_2 = 1.20-m spaced double rows strips of cotton,
P_3 = sole crop, Figures followed by different letters are significant at 0.05 probability levels using LSD.

Reduction in plant population of intercropped soybean in different planting patterns of cotton as compared with sole soybean was attributed to less area in case of intercrop as compared with sole soybean. This resulted in less germination count m^{-2} (data not shown) in intercropped soybean which obviously resulted in a smaller plant population density m^{-2} in intercropped soybean at harvest. Ahmad [1997] also reported reduction in plant population of intercrops in associated cultures. Years had a non-significant effect on plant population of soybean. However, population count was less than recommended even in sole soybean crop due to its poor germination.

Plant height was not affected significantly due to any of the planting techniques under study. On an average plant height ranged from 0.816 to 0.839 m. However, these findings are contrary to those reported by Shahid and Saeed [1997] who concluded that plant height of lentil in wheat-lentil association was decreased due to inter-specific competition (Table 1).

Statistically significant difference in the number of branches plant^{-1} was recorded in different planting techniques. Sole crop produced the highest number of branches plant^{-1} compared to other two planting techniques, which were in turn at par with each other. Lesser branches in intercropped soybean were attributed to competition between the intercrops for various resources like nutrients, water, light as compared with the sole crop, that resulted in a depressed growth of the intercropped soybean [Roquib *et al*.1973]. A similar number of branches plant^{-1} was recorded for soybean grown during both years under study.

The lowest significant number of pods were recorded when the crop was sown in 0.8-m spaced single rows of cotton as compared to sole planting (Table 1). However, differences in pod number due to planting geometry of cotton were not significant. The sole crop of soybean produced the highest number of pods plant^{-1} and statistically at par with those of double row strips [Aslam *et al*. 1993 and Saxena 1972].

Decrease in pods plant^{-1} in intercropping might be due to competition for light nutrients, and moisture, which reduced the growth of component crops. This competition was less in 1.20-m apart paired rows facilitating more light penetration as compared with 0.8-m apart single rows of cotton. Reduction in size of yield components of mung bean in associated cultures of cotton has been reported by Rao [1982] and Tsay [1985]. Interactive effects of years x planting patterns were non-significant.

The highest, significant number of seeds plant^{-1} were recorded in the sole crop compared to double row strips and single rows of cotton. These findings are similar to those reported by Shanthaverabhaderaiah and Path [1986]. However, aforementioned two treatments were at par with each other in this regard. Reduction in number of seeds plant^{-1} in intercropped soybean was attributed primarily to a fewer number of pods plant^{-1} (Table 1) as compared with sole soybean, which resulted in variation in seeds plant^{-1}. Secondly, variable seeds plant^{-1} in the soybean might be due to intercrop competition for added and natural resources. Ali (1990) also reported reduction in various yield components of associated crops in different intercropping systems due to intercrop and inter-specific competitive effects.

Soybean planted as a sole crop or intercropped in cotton grown at both planting patterns gave similar 1000-seed weights. In intercrop shading may have contributed to keep the 1000-seed weight at par with sole crop [Aal 1991]. On an average, 1000-seed weight ranged between 83.6-85.2 g, statistically similar 1000-seed weights were recorded for soybean during both the years under study (Table 1).

The highest, significant seed yield of soybean (802 kg ha^{-1}) was recorded in the sole crop. Soybean intercropped in the 1.20-m double row strips in turn produced a significantly greater seed yield (470 kg ha^{-1}) than that intercropped at 0.80-m spaced single rows (395 kg ha^{-1}). Yield reduction in the intercropped soybean was attributed primarily to a fewer number of plants m^{-2}, a fewer branches $plant^{-1}$ and seeds per plant as compared with the sole crop of soybean [Satao *et al*.1996].

Suppressive effects of intercropping on different yield components of soybean grown in association with cotton might be due to variable inter-specific competition for different growth factors [Allen and Obura 1983, and Bohool *et al*. 1992]. This competition was less severe in case of soybean intercropped in 120-cm spaced double row strips of cotton as compared with its intercropping in 0.80-m apart single rows of cotton. The former planting pattern facilitated more light penetration. Gode *et al*. [1992] reported a yield reduction of 35-7% in cotton+ soybean system as compared with sole soybean yield (1.66 t ha^{-1}).

Soybean grown as a sole crop gave a significantly higher biological yield (2573 kg ha^{-1}) than the biological yield realized from soybean inter-cropped in cotton grown at both planting patterns in this study [Gomaa and Radwan 1991]. However, biological yield for 0.80-m spaced single rows was reduced significantly (1283 kg ha^{-1}) than that from 1.20-m spaced double row strips (1544 kg ha^{-1}). Reduction in biological yield of intercropped soybean was ascribed to intercrop competition for different growth factors which reduced various growth and yield parameters as compared with the sole soybean [El-Edward *et al*. 1985]. Higher total bio-mass in double row strips may be due to higher plant density, taller plants and greater seed yield. Gomaa [1991] and Mansur *et al*. [1993] reported reduction in growth and yield of soybean in cotton + soybean association.

A non-significant effect of planting techniques of soybean on harvest index was recorded. This was ascribed to proportionately more seed yield and less biological yield (Table 1) of soybean in sole crop of soybean that might be attributed to competition between the component crops for moisture, nutrients and light which caused significant reduction in seed yield of soybean. Reduction in harvest indices to a variable extent due to intercropping had been reported by Raghuwanshi *et al*. [1994] and Mandal *et al*. [1990].

CONCLUSION

Growing of cotton in 1.20-m spaced double row strips proved superior to 0.80-m spaced single rows. Soybean intercropped in the 1.20-m double row strips produced a significantly greater seed yield than that intercropped at 0.80-m spaced single rows.

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