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Studies on Sugarcane-Sunflower Intercropping System at Different Geometrical Patterns and NPK Levels During Autumn Planting

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Abstract: Studies on the feasibility of intercropping sunflower (SF) in sugarcane (SC) under different geometrical patterns and fertilizer doses were conducted. Experiment comprised of three fertilizer levels viz., 140:100:100, 160:120:150 and 180:140:200 and seven geometrical pattern viz., sole sugarcane (SC), one row of sugarcane + one row of sunflower (SC 1 row + SF 1 row), SC 2-row strip + SF 1 row, SC 2-row strip + SF 2-rows, SC 3-row strip + SF 2-rows, SC 3-row strip + SF 3-rows, and sole SF. The main effect for fertilizer doses were statistically significant for all the parameters examined. The best performance for all the parameters was shown by the fertilizer application at the rate of 180:140:200 (NPK kg ha^{-1}). The planting geometries differed significantly in affecting the yield parameters of the component crops. The planting geometry of 1SC+1SF gave the second highest net return of Rs.51307 after the sole crop of sugarcane in 1995 and the highest net return of Rs.51084 in 1996 followed by sole crop of sugarcane with net return of Rs.50296. This geometry produced the highest net return and caused the highest reduction in weed biomass thus it helped in avoiding weed control through chemicals, which bring about environmental pollution and hence it is recommended in autumn planted sugarcane for higher income.

Key words: Geometrical patterns, Intercropping, sugarcane, sunflower, fertilizer

Introduction

Sugarcane (*Saccharum officinarum* L.) is an important cash crop of Pakistan. In N.W.F.P., the farmers plant sugarcane on a vast acreage due to a well established sugar industry and the lucrative income generated by gur making. Although, it is a cash crop, but the yield and net returns obtained per unit area are well below the yields and net returns produced in other countries around the world. In Dera Ismail Khan sugarcane average yields in 1992-93 were 35 tons ha^{-1} but yields as high as 51 tons per hectares have been achieved at Charsada districts of NWFP (Agricultural Statistics of NWFP, 1993-94, depicting a scope of vertical increase in yield.

Autumn planting has been proved to be more productive than spring planting but due to its long duration, it is still not well introduced into the farmers community of the area. To overcome the above cited deficiency, intercroping of some suitable crop with sugarcane can be practiced.

There is a great shortage of edible oils in Pakistan and the imports of edible oils during 1999-2000 amounts to Rs. 21.4 billion (Anonymous, 2000).

Intercropping is an approach of getting additional farm income. It helps in several ways to improve yield and net income compared to sole crop from the same unit of land. Misra *et al.* (1989) reported that intercropping reduced smut disease of sugarcane by interrupting the smut spores. Intercropping spices with sugarcane reduced the attack of pyrallid attack on sugarcane (Varun *et al.*, 1990). Jayabal *et al.* (1990) produced superior quality cane juice by intercropping with soybean. Rehman *et al.* (1989) reported the highest economic benefit from intercropping sugarcane with potato from mulching and lowest from pure cane. Pirngadi *et al.* (1987) found that legumes intercropped in sugarcane gave lower total yields equivalent to sugarcane as sole crop.

To reduce the oil import bill and to increase net returns per unit area the intercropping of sunflower with sugarcane at different planting geometries under different fertilizer doses was studied at Agricultural Research Institute D.I.Khan during 1995 and repeated at Rakh BiBi farm of the Gomal University D.I.Khan in 1996.

Materials and Methods

The experiments were conducted at Agricultural Research Institute D.I.Khan during 1995 and repeated at Rakh BiBi farm of the Gomal University D.I.Khan during 1996 to study the sugarcane sunflower intercropping systems at different geometrical patterns and NPK levels. To confirm the reliability of the results, the experiment was repeated in 1996. The sugarcane variety used in the experiment was CO-1144 and the sunflower hybrid was obtained from the National Oilseed Development programme of the Agriculture Extension Wing, D.I.Khan.

The experiment was laid out in randomized complete block design with split plot arrangements having three replications. The NPK levels were kept in the main plots, while the geometrical patterns were assigned to the sub plots with a net plot size of 7.2 x 4.5 m^2 during the successive years of studies.

Details of main and sub plots are given below:

Main Plots:

N:P:K (Kg ha^{-1})

1. 140:100:100
2. 160:120:150
3. 180:140:200

Sub-plots:

1. Sole sugarcane (12 rows 60 cm apart)
2. Sugarcane 1 row + sunflower 1 row
3. Sugarcane 2 row strip + sunflower 1 row between the strips (30:90)
4. Sugarcane 2 row strip + sunflower 2 rows between the strips (30:90)
5. Sugarcane 3 row strip + sunflower 2 rows between the strips (30:120)
6. Sugarcane 3 row strip + sunflower 3 rows between the strips (30:120)
7. Sole sunflower (12 rows 60 cm apart)

All the phosphorous, potash and half of the nitrogen were applied before planting, while half was applied immediately after the harvest of sunflower crop. All the agronomic practices except fertilizers were kept normal and uniform for the experiments throughout the entire course of study. Sole

sugarcane was kept as a check treatment. Data on sugarcane parameters such as number of millable canes m^{-1} row length, cane height (m), weight/cane (kg) and cane yield (t ha^{-1}) were recorded. While, data regarding disc diameter (cm), 1000 achene weight (g) and seed yield (kg ha^{-1}) of sunflower were also collected. Weed biomass (g m^{-2}) was obtained for each treatment.

Standard procedures were followed to record observations on the following parameters:

Weeds:

1. Weed biomass (g m^{-2}).

Sunflower:

1. Disc diameter (cm).
2. 1000-achene weight (g).
3. Seed yield (kg ha^{-1}).

Sugarcane:

1. Number of millable canes m^{-1} row length.
2. Stripped canes height (m).
3. Weight per millable cane (kg).
4. Canes yield (t ha^{-1}).

Results and Discussion

Means for the year 1995 & 96 are provided in Table 1 and Table 2 respectively. The results in the autumn crop of 1995 indicate that different NPK levels failed to affect the weed biomass significantly. However, the planting geometries differed significantly ($P=0.05$) in affecting the weed biomass (Table 1). The lowest weed biomass (260 g) was recorded in the planting geometry of 1SC + 1SF which was significantly less than the weed biomass collected in other planting geometries and at par with the weed biomass in the sole crop of sunflower. Almost similar trend was observed in autumn 1996 (Table 2). The reduction in weed biomass in intercrop treatments as compared to sole crop of sugarcane might have been due to the allelopathic effect of SF root exudates.

A perusal through disc diameters means indicate that the highest level of NPK 180:140:200 Kg ha^{-1} produced the largest disc diameter (20.86 cm) which was significantly larger ($P=0.05$) than the disc diameters harvested in the other NPK levels in study. The planting geometries of 2SC + 2SF and 2SC + 1SC gave disc diameters 20.91 and 20.43 cm respectively in 1995 which were the highest as compared to other planting geometries. These geometries behaved similarly

Table 1: Effect of sugarcane-sunflower intercropping system at different geometrical patterns and NPK levels on weed biomass and various parameters of sunflower and sugarcane at Agricultural Research Institute D.I.Khan during autumn 1995.

Planting geometries	Weed biomass (g m^{-2})	Disc dia. (cm)	1000 achene wt.(g)	Seed yield (kg ha^{-1})	Millable canes (no)	Cane height (m)	Wt/cane (kg)	SC yield (t ha^{-1})	Net income Rs. ha^{-1}
Sole SC	528 a	-------	------	-------	31 a	2.54 a	1.41 a	106.50 a	56972
1SC+1SF	260 d	16.70 cd	44.22 c	1275 b	17 c	2.22 b	1.21 cd	86.78 b	51307
2SC+1SF	431 c	20.43 a	57.67 a	648 d	20 b	2.01 cd	1.28 b	86.19 b	42636
2SC+2SF	407 c	20.91 a	56.56 a	852 c	22 b	2.08 bc	1.25 bc	87.22 b	46497
3SC+2SF	513 ab	19.78 ab	55.44 ab	911 c	21 b	2.03 cd	1.12 e	74.96 c	36072
3SC+3SF	459 bc	18.18 bc	53.11 b	881 c	21 b	1.87 d	1.19 d	76.24 c	36375
Sole SF	323 d	15.53 d	44.44 c	1630 a	----	------	-------	-------	16950
$CD_{0.05}$	68.03	1.70	2.52	75.65	2.86	0.16	0.05	3.41	
CV%	17.05	9.50	5.05	7.61	13.37	8.07	4.40	4.10	
NPK levels (kg ha^{-1})									
140:100:100	415	16.82 b	48.28 c	813 c	19 b	1.89 c	1.08 c	69.67 c	-----
160:120:150	410	18.09 b	50.67 b	1062 b	23 a	2.11 b	1.23 b	87.08 b	-----
180:140:200	427	20.86 a	56.78 a	1224 a	25 a	2.38 a	1.42 a	102.21 a	-----
$CD_{0.05}$	NS	1.30	1.67	84.20	2.87	0.11	0.07	4.36	
CV%	17.05	9.50	5.05	7.61	13.37	8.07	4.40	4.10	

[1]SF stand for sunflower, SC stand for sugarcane and figures before SF and SC denote the number of rows in the geometrical pattern.
[2]Means sharing a letter in common in the respective column do not differ significantly by LSD test at 5% level of probability.

Table 2: Effect of sugarcane-sunflower intercropping system at different geometrical patterns and NPK levels on weed biomass and various parameters of sunflower and sugarcane at Faculty of Agriculture, Gomal University D.I.Khan during autumn 1996.

Planting geometries	Weed biomass (g m^{-2})	Disc dia. (cm)	1000 achene wt.(g)	Seed yield (kg ha^{-1})	Millable canes (no)	Cane height (m)	Wt/cane (kg)	SC yield (t ha^{-1})	Net income Rs. ha^{-1}
Sole SC	949 a	-------	------	-----	37 a	2.59 a	1.45 a	98.91 a	50296
1SC+1SF	420 c	17.88 c	44.2 c	1263 b	28 b	2.26 b	1.21 c	86.73 b	51084
2SC+1SF	700 b	19.66 a	56.0 a	655 d	31 b	2.08 cd	1.27 b	88.72 b	44955
2SC+2SF	607 b	19.44 ab	54.7 a	864 c	29 b	2.13 c	1.27 b	88.05 b	47503
3SC+2SF	660 b	18.66 bc	54.4 a	897 c	30 b	2.04 d	1.18 cd	78.25 c	39424
3SC+3SF	660 b	17.00 d	52.0 b	857 c	30 b	1.95 e	1.15 d	78.40 c	38955
Sole SF	439 c	19.22 ab	44.5 c	1709 a	----	------	-------	------	18135
$CD_{0.05}$	135.61	0.81	2.33	49.93	3.45	0.06	0.04	2.78	
CV%	22.38	4.50	4.47	4.98	11.67	3.07	3.42	3.34	
NPK levels (kg ha^{-1})									
140:100:100	646	14.56 c	47.9 c	803 c	30	1.94 c	1.09 c	71.04 c	-----
160:120:150	667	19.72 b	50.2 b	1075 b	30	2.11 b	1.26 b	88.33 b	-----
180:140:200	588	21.67 a	54.7 a	1245 a	32	2.47 a	1.41 a	100.16 a	-----
$CD_{0.05}$	NS	0.97	1.21	62.09	NS	0.09	0.04	4.73	
CV%	22.38	4.50	4.74	4.98	11.67	3.07	3.42	3.34	

[1]SF stand for sunflower, SC stand for sugarcane and figures before SF and SC denote the number of rows in the geodetical pattern.
[2]Means sharing a letter in common in the respective column do not differ significantly by LSD test at 5% level of probability.

in 1996. These findings contradicted the result of Pena *et al.* (1989), who found reduced discs of sunflower in the intercropped treatments.

The data revealed that NPK levels and planting geometries caused significant changes in 1000 achene of sunflower in autumn 1995. The 1000 achene weight of 56.78 g in NPK level of 180:140: 200 Kg ha^{-1} was significantly higher than the 1000 achene weight produced in other fertilizer levels used in this study and the matching behaviour was followed in 1996. Whereas the planting geometries of 2SC + 1SF and 2SC + 2SF produced the highest 1000 achene weight of 57.67 and 56.56 g respectively and were statistically at par with 3SC + 2SF and significantly different from other planting geometries and the sole crop of sunflower. These geometries showed the same behaviour in 1996 (Table 2).

Means of seed yield followed significantly upward trend with increasing NPK levels. The highest seed yield of 1224 Kg ha^{-1} was harvested in the highest level of NPK used in the studies (Table 1). Whereas the lowest seed yield of 813 Kg ha^{-1} was collected in the lowest level of NPK. When planting geometries were considered, the highest seed yield of 1275 Kg ha^{-1} was observed in 1SC + 1SF, which was significantly higher than the seed yield in all the planting geometries except the sole crop of sunflower with seed yield of 1630 kg ha^{-1}. These results negate the findings of Khanzada *et al.* (1989), who obtained increased yield of sunflower when intercropped with autumn planted sugarcane. A similar trend was found in autumn 1996.

The millable canes data depicted that fertilizer levels and planting geometries differed significantly in affecting the millable canes m^{-1} row length. The highest number of millable canes (25) was obtained in NPK level of 180:140:200 kg ha^{-1} and the lowest (19) in the lowest NPK level used in the study. All the planting geometries produced significantly lower millable canes m^{-1} row length as compared to the sole crop of sugarcane which produced 31 canes m^{-1} row length (Table 1). Considering planting geometries, the lowest number of millable canes per meter row length (17) were observed in 1SC + 1SF. Our results are in accordance with Bukhtiar *et al.* (1988) and Govinden & Arnason (1990). In 1996 the NPK level of 180:140:200 kg ha^{-1} gave the highest number of canes m^{-1} row length (32) as compared to other NPK levels but the NPK levels were statistically at par with each other. Whereas the planting geometries behaved as previously (Table 2).

The different NPK levels affected the sugarcane plant height significantly. The highest plant height of 2.38 m was obtained in NPK level of 180:140:200 Kg ha^{-1}. Regarding planting geometries, the highest plant height (2.22m) was obtained. The highest plant height (2.34 m) was produced in the sole crop of sugarcane. These findings agree with the results of Mali *et al.* (1982), who obtained increase in height of sugarcane with increase in NPK levels (Table 1). Similar trend was observed in 1996.

The data depicted that significant difference in single cane weight were brought about by different NPK levels and planting geometries. The heaviest cane of 1.42 kg were harvested in NPK level of 180:140:200 kg ha^{-1} and regarding planting geometries, the heaviest cane of 1.41 kg ha^{-1} was observed in the sole crop of sugarcane followed by 1.28 and 1.25 kg single canes in the planting geometries of 2SC + 1SF and 2SC + 2SF (Table 1). The different treatments had the same behaviour in 1996.

A perusal through Table 1, it is evident that NPK levels and planting geometries significantly differed in affecting the sugarcane yield. The highest yield of 102.21 t ha^{-1} was harvested in the highest level of NPK. In the planting geometries, the sole crop of sugarcane gave the highest yield of 106.50 t ha^{-1} followed by planting geometries of 1SC + 1SF, 2SC + 1SF and 2SC + 2SF which produced sugarcane yields at par with each other but significantly less than the sole crop of sugarcane. The lowest sugarcane yields were achieved in 3SC + 2SF and 3SC + 3SF. These findings are in accord with Khanzada *et al.* (1989), Kathiresan and Rajasekaran (1990), Kannappan *et al.* (1990) and Sathyavelu (1991). Almost similar results were obtained in autumn 1996 (Table 2).

When net returns were computed, the highest net return (Rs. 51084/-) in 1996 were obtained in the planting geometry of 1SC + 1SF followed by the sole crop of sugarcane with net return of Rs. 50296/-. However, the net return in 1995 (Table 1) was the highest (Rs.56972/-) in the sole crop followed by Rs. 51307/- in planting geometry of 1SC + 1SF. The reduction in net income in the planting geometry of 1SC + 1SF in 1995 as compared to 1996 may be attributed to the less number (17) of millable canes m^{-1} row length (Table 1). The over all results depicts that the planting geometry of 1SC + SF produced the highest net income in 1996 and next highest in 1995, showing that this planting geometry is highly feasible and is recommended to the farmers for adoption to get higher net income and helping the country by reducing the import of edible oils.

Therefore, geometry of 1SC + 1SF is recommended to the farmers for adoption for getting higher net income and helping the country by reducing the import of edible oils.

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