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Spring Sugarcane (*Saccharum officinarum* L.) Yield, Quality and Nutrient uptake under different Row Spacing and Intercropping Systems

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ABSTRACT: Sugarcane being a long duration and widely spaced crop having ample scope of intercropping. This holds promise high land utilization efficiency, mid-season income generation and sustaining the productivity of crops in sugarcane based production system. The field experiment was conducted during *spring* seasons of 2019-20 and 2020-21 at ICAR-Indian Institute of Sugarcane Research, Lucknow. The experimental soil was sandy loam with pH (7.6), organic carbon (0.45 %), available N (275.9 kg/ha), P_2O_5 (37.4 kg/ha) and K_2O (233.1 kg/ha) respectively. The treatments comprised of 4 inter cropping systems (sugarcane sole, sugarcane + cluster bean, sugarcane + okra, sugarcane + sesame) with 3 row spacings *viz.* 90 cm (1:1), 120 cm (1:2) and 150 (1:3) cm along with each sole crops. Among intercropping treatments, significantly the highest number of millable canes (132.5 thousand/ha), cane yield (102.1 t/ha) and sugar yield (12.03 t/ha) was recorded with sugarcane (90 cm) + okra (1:1) and was comparable to sole sugarcane. Significantly the highest cane equivalent yield (151.5 t/ha) was recorded under sugarcane (120 cm) + okra (1:2) intercropping system and was found similar to sugarcane (90 cm) + okra (1:1) intercropping. The quality parameters were unaffected due to different treatments, however significantly higher brix value was occurred with sugarcane (90 cm) + sesame (1:1) intercropping system (20.10). Higher N (296.7 kg/ha), P (26.1 kg/ha) and K (347.8 kg/ha) uptake by sugarcane at harvest was obtained under the treatment sugarcane sole at 90 cm row spacing.

Keywords: Cane equivalent yield, intercropping, nutrient uptake, row spacing and sugarcane.

INTRODUCTION

Sugarcane being a cash crop plays key role in Indian economy. This crop is also an important source of ethanol (Soni and Khot, 2011). Sugarcane is a long duration and widely spaced crop. There are excellent opportunities of growing early maturing short duration intercrops to harness the potentiality of environment and use of natural resources for increasing production and net profit per unit area per unit time. These features offer potential scope for intercropping of relatively short duration and quick growing crops to exploit the land resources more efficiently. Different row spacing and nitrogen levels significantly increased the number of millable cane and cane yield Singh *et al.* (2002). Planting of sugarcane is being practised with different row spacing's. Planting in furrows at 90 cm apart is a well-known practice. Paired row planting and wide row planting have been recommended by Sundara, (2003), which can comfortably accommodate intercrops. The information on the effect of wide row planting of sugarcane and accommodating intercrops for enhancing system productivity are meagre for subtropical conditions. Wider row spacing is pre-requisite for mechanical harvesting because most of the mechanical harvesters function only in wide row spaced planted cane *viz*; 120 to 150 cm or so. On the other hand, by adoption of wide row spacing, cane yield is reduced. Hence, it is necessary to devise suitable agronomic interventions which are able to compensate the yield loss due to essential wider row spacing (Shanthy and Muthusamy 2012). Considering above points in view present research work was undertaken with the objectives to find out the performance of sugarcane based intercropping systems under different row spacing's.

MATERIALS AND METHODS

Field experiment was conducted during *spring* seasons of 2019-20 and 2020-21 at Research farm of ICAR-Indian Institute of Sugarcane Research, Lucknow, located at 26°50′N latitude, 80°52′E longitude and 111 m above mean sea level in central part of Uttar Pradesh state of India falling in subtropical belt of sugarcane cultivation.

The soil of experimental site is categorized in order inceptisol under the group *dic Ustochrepts*, The experimental site was upland, well-drained with unvarying topography, homogenous fertility, and undifferentiated textural. The experimental soil was sandy loam with pH (7.6), organic carbon (0.45 %), available N (275.9 kg/ha), P_2O_5 (37.4 kg/ha) and K_2O (233.1 kg/ha) respectively. The average annual rainfall is 983 mm and nearly 85% of the total rainfall is received through north-west monsoons during second fortnight of June to September. The average monthly minimum and maximum temperatures fluctuate from 6.5 to 7.8 and 20.6 to 22.5°C in winter and from 22.8 to 25.6 and 39.5 to 41.6°C in summer, respectively.

Intercropping of sugarcane was done with three different intercrops namely cluster bean, okra and sesame at different row spacing's (90, 120 and 150 cm). Including sole crops replicated thrice. Planting of sugarcane was done with the help of deep furrow maker tractor at the row spacing of 90, 120 and 150 cm wide and 15 to 20 cm depth.

Healthy and well matured setts of sugarcane treated by 0.1 % carbendazim solution and seeds of cluster bean, okra and sesame treated with bavistin @ 2.0 g/kg. In general, 150: 60: 60 kg N-P-K/ha recommended nutrients for sugarcane crop, and 50: 50: 25 kg N-P-K/ha to cluster bean, 40:40:0 N-P-K/ha to okra and 40:60:40 kg N-P-K/ha recommended to sesame are applied uniformly.

RESULTS AND DISCUSSION

A. Effect of intercrops on yield attributes, yield and quality of sugarcane

In general taller, thicker and higher weight canes were observed under wider row spacing. Significantly the highest cane length (277.0 cm) was observed with sugarcane (150 cm) + okra intercropping system however, highest cane diameter (3.22 cm) and single cane weight (1.02 kg) was recorded under sugarcane sole (150 cm). The higher cane length under sugarcane (150 cm) + okra intercropping might be due to interplant competition for light in the system. Significantly higher cane yield (107.40 t/ha) was noted under sole sugarcane (90 cm) which was statistically similar to sugarcane (90 cm row spacing) + okra (102.10 t/ha) and apparently higher over rest of the treatments (Table 1). Singh *et al.* (2000) also reported that sugarcane + summer maize followed by sugarcane + okra and sugarcane + summer maize fodder resulted into higher compatibility in relation to cane yield. These findings clearly showed that the intercrops did not affect yield of sugarcane. Geetha *et al.* (2015) also reported similar results.

The quality parameters (Table 2) were unaffected due to different treatments, however significantly higher brix value was occurred with sugarcane (90 cm) + sesame (1:1) intercropping system (20.10).

Maximum sugar yield (13.36 t/ha) was produced by treatment sugarcane sole at 90 cm row spacing and was comparable to sugarcane (90 cm) + okra (12.03 t/ha) sugar yield. Statistically similar yield under above treatments shows the compatibility of the systems. The findings are in conformity with Singh *et al.* (2009).

B. Growth and yield of intercrops

Growth parameters, yield attributes and yield of different intercrops viz. cluster bean, okra and sesame as depicted by Fig. 1, 2 and 3 clearly indicate that yield of intercrops were affected under intercropping systems.

Table 1: Effect of row spacing's and intercropping systems in yield attributes, yield and cane equivalent yield of sugarcane as affected by various treatments (pooled of 2019-20 & 2020-21).

Treatment	NMC (000/ha)	Cane Yield (t/ha)	Intercropping Yield	CEY (t/ha)	Sugar Yield (t/ha)
Sugarcane sole at 90 cm row spacing	133.4	107.4	-	107.4	13.36
Sugarcane sole at 120 cm row spacing	99.1	85.4	-	85.4	10.10
Sugarcane sole at 150 cm row spacing	81.9	77.7	-	77.7	9.06
Sugarcane at 90 cm row spacing + cluster bean (1:1)	98.0	74.1	6.01	116.0	8.70
Sugarcane at 120 cm row spacing + cluster bean (1:2)	79.6	65.9	8.95	128.4	7.95
Sugarcane at 150 cm row spacing + cluster bean (1:3)	62.1	55.9	8.15	112.7	6.59
Sugarcane at 90 cm row spacing + okra (1:1)	132.5	102.1	7.64	150.6	12.03
Sugarcane at 120 cm row spacing + okra (1:2)	98.4	82.1	10.92	151.4	9.87
Sugarcane at 150 cm row spacing + okra (1:3)	79.3	75.0	9.87	137.6	9.03
Sugarcane at 90 cm row spacing + sesame (1:1)	100.9	77.5	0.25	85.4	9.49
Sugarcane at 120 cm row spacing + sesame (1:2)	82.4	68.7	0.34	79.5	8.16
Sugarcane at 150 cm row spacing + sesame (1:3)	71.3	61.8	0.31	71.5	7.38
Cluster bean sole at 60 cm × 30 cm row spacing	-	-	10.81	75.4	-
Okra sole at 45 cm × 20 cm row spacing	-	-	17.40	110.4	-
Sesame sole at 30 cm × 10 cm row spacing	-	-	0.81	25.5	-
SEm±	4.67	4.6	-	7.66	0.54
CD (P=0.05)	13.40	13.3	-	21.81	1.56

Table 2: Effect of row spacing's and intercropping systems in quality parameters of sugarcane as affected by various treatments (pooled of 2019-20 & 2020-21).

Treatment	Cane length (cm)	Cane diameter (cm)	Single cane weight (kg)	Brix (%)	Pol (%)	Purity (%)	CCS (%)
Sugarcane sole at 90 cm row spacing	255.9	2.78	0.82	20.03	17.89	89.34	12.43
Sugarcane sole at 120 cm row spacing	267.8	3.03	0.89	19.26	17.07	88.65	12.82
Sugarcane sole at 150 cm row spacing	271.4	3.22	1.02	19.11	16.86	88.23	11.65
Sugarcane at 90 cm row spacing + cluster bean (1:1)	211.2	2.72	0.78	19.20	16.96	88.34	11.73
Sugarcane at 120 cm row spacing + cluster bean (1:2)	219.2	2.60	0.87	19.67	17.42	88.64	12.06
Sugarcane at 150 cm row spacing + cluster bean (1:3)	226.9	2.65	0.98	19.21	17.02	88.65	11.79
Sugarcane at 90 cm row spacing + okra (1:1)	257.1	2.90	0.79	19.30	17.04	88.30	11.78
Sugarcane at 120 cm row spacing + okra (1:2)	272.9	2.92	0.85	19.66	17.37	88.39	12.01
Sugarcane at 150 cm row spacing + okra (1:3)	277.0	2.97	0.99	19.90	17.47	87.75	12.04
Sugarcane at 90 cm row spacing + sesame (1:1)	212.0	2.73	0.79	20.10	17.72	88.19	12.24
Sugarcane at 120 cm row spacing + sesame (1:2)	274.5	2.75	0.85	19.63	17.22	87.63	11.86
Sugarcane at 150 cm row spacing + sesame (1:3)	228.9	2.88	0.85	19.55	17.28	88.36	11.95
SEm±	9.36	0.13	0.03	0.24	0.37	1.98	0.24
CD (P=0.05)	26.88	0.37	0.10	0.68	NS	NS	NS

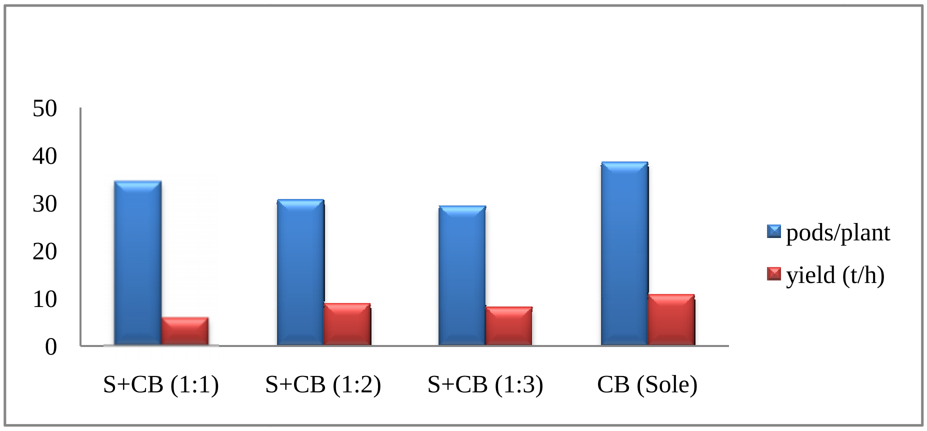

Fig. 1. Number of Pods and green pod yield of Cluster bean.

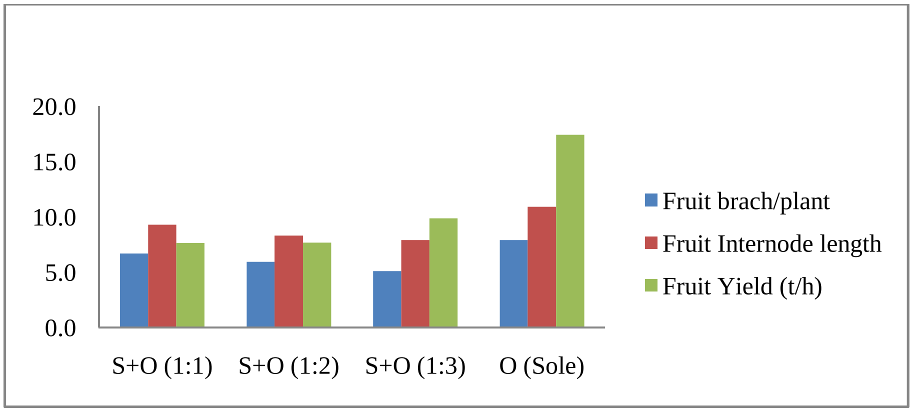

Fig. 2. Growth and Yield of Okra.

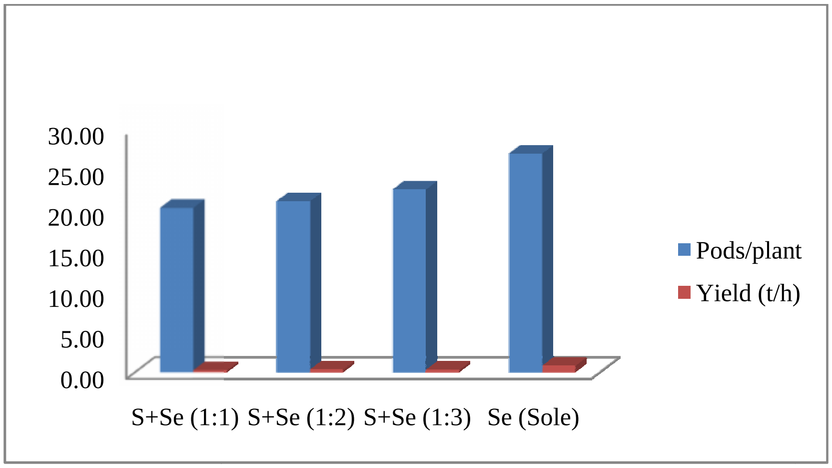

Fig. 3. Number of Pods and Grain yield of Sesame.

Higher yield of each intercrop were recorded under sole cropping systems. The reduced yield under crop combination might be due to varying populations under different planting geometries. Plant population play and important role in yield of crops.

C. Nutrient uptake pattern under different crop combinations

Among Intercropping systems, sugarcane (90 cm) + okra fetched the higher nutrient uptake (267.3 kg N, 26.1 kg P and 288 kg K/ha) (Table 3). Significantly the highest N (296.70 kg/ha), P (26.1 kg/ha) and K (347.8 Kg/ha) uptake was recorded under sugarcane sole (90 cm) cropping. The higher uptake in these treatments might be due to higher yield of sugarcane under closure spacing's. Similar findings were also observed by Devi *et al*. (2005). Intercropping of cluster bean significantly reduced the uptake of nutrients by sugarcane (168.3 kg N, 15.6 kg P and 193 Kg K/ha, respectively). The lower uptake under intercropping systems might be due to heavy intra and interplant completions resulted into low yield of sugarcane. Jyothi *et al.* (2021) also found that nutrient uptake in sugarcane varies under different cultivation practises.

Table 3: Effect of row spacing's and intercropping systems in nutrient uptake as affected by various treatments (pooled of 2019-20 & 2020-21).

Treatment	Nutrient Uptake (kg/ha)		
	N	P	K
Sugarcane sole at 90 cm row spacing	296.7	26.1	347.8
Sugarcane sole at 120 cm row spacing	225.9	20.8	270.8
Sugarcane sole at 150 cm row spacing	210.6	19.7	250.7
Sugarcane at 90 cm row spacing + cluster bean (1:1)	197.3	18.6	211.0
Sugarcane at 120 cm row spacing + cluster bean (1:2)	161.8	16.1	188.3
Sugarcane at 150 cm row spacing + cluster bean (1:3)	141.1	14.1	160.5
Sugarcane at 90 cm row spacing + okra (1:1)	267.3	26.1	288.0
Sugarcane at 120 cm row spacing + okra (1:2)	228.4	20.8	242.1
Sugarcane at 150 cm row spacing + okra (1:3)	198.0	19.8	227.1
Sugarcane at 90 cm row spacing + sesame (1:1)	206.9	19.2	234.3
Sugarcane at 120 cm row spacing + sesame (1:2)	182.8	16.9	207.9
Sugarcane at 150 cm row spacing + sesame (1:3)	168.3	15.6	193.4
SEm±	8.88	1.16	17.36
CD (P=0.05)	25.49	3.33	49.84

CONCLUSION

This may be concluded that intercropping system of sugarcane (90 cm) + okra (1:1) was most effective in harnessing the highest number of millable canes (132.5 thousand/ha), cane yield (102.1 t/ha) and sugar yield (12.03 t/ha). Highest cane equivalent yield (151.5 t/ha) was recorded under sugarcane (120 cm) + okra (1:2) intercropping system and was found similar to sugarcane (90 cm) + okra (1:1) intercropping. The quality parameters were unaffected due to different treatments. Higher N (296.7 kg/ha), P (26.1 kg/ha) and K (347.8 kg/ha) uptake by sugarcane at harvest was obtained under the treatment sugarcane sole at 90 cm row spacing.

FUTURE SCOPE

Wider row spacing is pre-requisite for mechanical harvesting because most of the mechanical harvesters function only in wide row spaced planted cane *viz*; 120 to 150 cm or so. On the other hand, by adoption of wide row spacing, cane yield is reduced.

Hence, it is necessary to devise suitable agronomic interventions which are able to compensate the yield loss due to essential wider row spacing. Moreover, wider row spacing aims at efficient harvest of solar energy through plants which in turn develop rapid leaf area and are able to maintain leaf area index (LAI) for a longer duration. Planting geometry plays an important role in the amount of solar radiation intercepted and water transpired by crop canopy which ultimately affect the photosynthesis process and finally the dry matter produced and sugar accumulated by the plants. Moreover, planting density broadly affects cane diameter, length and weight of plants which contribute to cane yield. Growth and yield of sugarcane under field conditions depend greatly on the size and shape of the land area available to the individual plant. Wide row spacing of sugarcane may help in adoption and mechanization.

Conflict of Interest. None.

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