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Feasibility of mechanical harvesting of sugarcane (*Saccharum* spp. hybrid)

ARVIND MISRA AND B.K. TRIPATHI[1]

Regional Centre, Sugarcane Breeding Institute, Karnal, Haryana 132 001

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ABSTRACT

A field experiment was conducted at the Farm of Regional Centre, Sugarcane Breeding Institute, Karnal, during 1998–99 and 1999–2000, to find out the feasibility of growing sugarcane at row spacing of 150 cm required for mechanical harvesting by austoft harvester. Planting of 172,144 buds/ha in paired rows of 40 : 110 cm, conventional row spacing of 75 cm with setts placed along the rows and wide row spacing of 150 cm with setts placed across the rows (at equal seed rates in all the cases) gave at par cane yield/ha. Intercropping of wheat (*Triticum aestivum* L. emend. Fiori & Paol.), Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson], coriander (*Coriandrum sativum* L.) and onion (*Allium cepa* L.) reduced the cane yield by 17.2, 7.5, 6.9 and 2.0%, respectively, than sole sugarcane, but the significant reduction was recorded with wheat only. Maximum net monetary return of Rs 108,470/ha was obtained from onion + sugarcane system, with higher benefit : cost ratio of 2.90. Based on cane-equivalent yield/ha, closer row spacing of 75 cm with setts placed along the rows recorded comparable cane yield to row spacing of 150 cm coupled with setts placed across the rows (2 budded setts) with onion as an intercrop in both the cases. Thus, mechanical harvesting with austoft harvester is feasible by planting sugarcane at 150 cm spacing by adopting seed rate of 172,144 buds/ha with onion as an intercrop without any economic loss to the growers.

Key words : Mechanical harvesting, Intercropping, Sugarcane-equivalent yield, Sett placement

Due to scarcity of labour availability in time and steep increase in their wages, mechanical harvesting of sugarcane would become essential in the near future. In order to facilitate mechanical harvesting by austoft harvester, the inter-row spacing would have to be increased to nearly 150 cm from the present conventional inter-row spacing of 75/90 cm. Palaniswamy and Nagendran (1997) reported by changing the sett placement from along the row to across the row at 150 cm row spacing, higher cane yield of 27% was obtained in comparison to conventional row spacing of 82.5 cm. Therefore in order to find out the feasibility of wider row spacing for mechanical harvesting under sub-tropical condition, the present investigation was undertaken.

MATERIALS AND METHODS

The experiment was conducted at the Farm of Regional Centre, Sugarcane Breeding Institute, Karnal, during 1998–99 and 1999–2000 on silty-loam soil containing 242, 16.5 and 262 kg available N, P and K/ha respectively. Treatments consisting of 5 inter-row spacing-cum-seed rates, *viz.* T_1, setts planted along the rows at 75 cm @ 172,144 buds/ha; T_2, setts planted along the rows at 150 cm spacing @ 86,072 buds/ha; T_3, setts planted across the rows at 150 cm @ 1,29,108 buds/ha; T_4, setts planted across the rows at 150 cm @ 172,144 buds/ha; and T_5, setts planted along the rows in 40 : 110 cm paired rows @ 172,144 buds/ha, and 4 intercrops, i.e. C_1, 'PBW 343' wheat; C_2, 'Jai Kisan' Indian mustard; C_3, 'Pantnagar Haritima' coriander and C_4, 'Pusa Red' onion, including 1 control, i.e. C_5, sole crop of sugarcane, were tested in strip-plot design with 3 replications. Two-budded setts were planted in all the treatments. Sugarcane 'Co 89003' was planted in the last week of October, while intercrops were sown in the first week of November except onion which was transplanted in the second week of January during both the years. Sugarcane was fertilized with 150 kg N and 50 kg P_2O_5/ha, while intercrops received additional fertilizer based upon their recommended rates of application. Mustard was harvested in the third week of March, coriander in the second week of April, wheat in the third week of April and onion in the mid of May during both the years.

Present address : [1]Ex-Director, Sugarcane Breeding Institute, Coimbatore, Tamil Nadu 641 007

RESULTS AND DISCUSSION

Row spacing

Number of tillers and millable canes/ha decreased significantly with wider rows of 150 cm (irrespective of seed rates) compared to 75 cm spacing and paired row planting. However, cane diameter was better with 150 cm row spacing than 75 cm spacing or paired row planting, differences being significant between 75 cm row spacing with conventional way of setts placement and 150 cm spacing with 50% seed rate with setts placed along the rows (T_2).

By adopting equal seed rates of 172,144, buds/ha, closer row spacing at 75 cm gave similar yield to paired row of 40 : 110 cm with setts placed along the rows. Placement of setts across the row at 150 cm resulted in yield decrease by 11.7 tonnes/ha compared to that with 75 cm spacing; however, this decrease was not significant. Reducing the seed rates to 25% at wider row spacing of 150 cm with setts placed across the rows (129,108 buds/ha) or 50% (86,072 buds/ha) and placing the setts along the rows at 150 cm spacing (T_2) decreased the cane yield significantly in comparison to 75 cm spacing (Table 1). Sugarcane-yield equivalent followed similar pattern to cane yield.

Intercrops

Plant height and millable canes/ha decreased significantly by intercropping with wheat compared to sole sugarcane. Onion intercropping did not affect growth attributes (Table 1).

Sole crop of sugarcane gave higher yield of 96.6 tonnes/ha, followed by sugarcane + onion, sugarcane + coriander, sugarcane + Indian mustard and sugarcane + wheat; however, the difference were significant in case of intercropping of wheat only. The cane yield reductions were of the order of 2.0, 6.9, 7.5 and 17.2% respectively. Higher reduction by growing wheat as an intercrop in sugarcane might have resulted due to taller plants of wheat, dense canopy and standing of wheat crop even during summer months up to third week of April, when temperature remains high. High temperature might have further severely smothered cane plants which led to higher reduction in cane yields/ha than other intercrops. Onion intercrop has lesser competition for light and space resulting in better yield in this crop.

Among the intercropping systems, onion + sugarcane resulted in the highest cane-equivalent yield and it was significantly superior to rest of the cropping systems. Similarly, sugarcane + wheat and sugarcane + coriander recorded cane-equivalent yields 24.31 and 12.40 tonnes/ha, respectively than sugarcane alone (Table 1). This was owing to relatively better yields of wheat and onion than Indian mustard or coriander. Singh *et al.* (1996) reported that planting sugarcane with wheat decreased cane yield significantly but increased income and net profit compared with sugarcane grown alone.

Pol % juice was not affected significantly due to row spacing and intercrops (Table 1). Commercial cane sugar (tonnes/ha) followed the similar trends as the cane yield under different treatments.

Table 1. Effect of row spacing, sett placement and intercrops on growth attributes, juice quality, cane and sugar yield and net returns/ha

Treatments	Tillers ('000/ha)	Cane length (cm)	Cane diameter (mm)	NMC ('000/ha)	Cane yield (tonnes/ha)	Pol (%)	Commercial cane sugar (tonnes/ha)	Inter-crops yield (tonnes/ha)	Cane equivalent yield (tonnes/ha)	Net returns/ha (Rs)	LER	IER	Benefit : cost ratio
Row spacing													
T_1	357.0	205	23.6	131.5	100.9	17.99	12.63		125.22	87,426	1.58	1.12	2.50
T_2	199.2	216	25.4	78.6	76.6	18.27	9.53		103.28	69,070	1.70	1.24	2.10
T_3	210.5	207	25.2	90.8	82.4	18.12	10.35		109.21	74,410	1.72	1.23	2.20
T_4	236.3	207	25.0	99.8	89.2	17.78	11.03		116.49	80.390	1.72	1.22	2.34
T_5	342.0	203	24.0	127.7	101.7	17.69	12.59		125.29	87,838	1.56	1.11	2.53
CD (P=0.05)	19.7	NS	1.8	13.9	12.9	NS	0.96		13.40				
Intercrops													
C_1	251.0	193	23.7	98.7	80.4	17.98	9.96	(6.35*)	120.91	71,300	1.64	1.15	1.90
C_2	262.0	206	24.5	105.5	89.4	18.01	11.17	1.69	107.12	73,516	1.69	1.11	2.18
C_3	262.6	209	24.7	107.3	90.0	17.88	11.19	1.08	109.00	74.550	1.62	1.13	2.16
C_4	287.5	216	25.0	107.0	94.7	18.07	11.93	20.44	145.77	1,08,470	1.67	1.51	2.90
C_5	289.5	215	25.3	110.2	96.6	17.99	12.10		96.60	67,718			2.34
CD (P=0.05)	17.8	18.5	1.7	12.8	10.9	NS	0.86		12.40				

NMC, Number of millable canes; LER, land-equivalent ratio; IER, income equivalent ratio; *Straw yield/ha

Table 2. Interaction effect of row spacing-cum-sett placement and intercrops on cane and cane-equivalent yields

Treatment	Cane yield (tonnes/ha)					Cane equivalent yield (tonnes/ha)				
	Sugarcane + wheat	Sugarcane + Indian mustard	Sugarcane + coriander	Sugarcane + onion	Sugarcane alone	Sugarcane + wheat	Sugarcane + Indian mustard	Sugarcane + coriander	Sugarcane + onion	Sugarcane alone
T_1	88.4	101.3	98.1	107.0	109.7	131.85	117.68	115.25	151.60	109.70
T_2	67.9	78.8	75.6	78.7	81.8	107.29	97.59	95.90	133.80	81.82
T_3	75.5	81.1	83.0	84.6	87.8	113.72	100.42	103.42	140.45	87.80
T_4	77.8	88.2	89.9	96.5	93.7	119.35	107.10	110.55	151.75	93.71
T_5	90.6	97.5	103.6	106.5	110.1	132.36	113.04	119.70	151.25	110.10
CD (P=0.05)						*Cane yield*	*Cane-equivalent yield*			
To compare between 2 row spacings for same intercrop						15.2	18.0			
To compare between 2 intercrops at same row spacing						14.6	16.9			

Details of treatments are given in text

Interaction effect

At 75 cm spacing, sowing of wheat and coriander as intercrops gave significantly higher cane yields than sowing these intercrops at wider row spacing of 150 cm and adopting 50% seed rate (86,072 buds/ha) with setts placed along the rows (Table 2). In case of Indian mustard and onion, decline in cane yield was significant also at 75% seed rate (129,108/ha) with setts planted across the rows (T_3).

Cane-equivalent yield with wheat as an intercrop was significantly higher at 75 cm spacing than wider row spacing of 150 cm with 50 and 75% seed rates, while with onion as an intercrop differences due to row spacing were not significant (Table 2). Closer row spacing of 75 cm with conventional way of setts placement, paired row of 40 : 110 cm with setts planted along the rows and row spacing of 150 cm with setts placed across the rows (seed rate equal in all the cases) recorded similar cane-equivalent yield with onion as an intercrop in all the cases. It showed that austoft mechanical harvester can be used by planting sugarcane at 150 cm row spacing and raising onion as intercrop.

Economics

Paired row planting of 40:110 cm registered the highest net return and benefit : cost ratio followed by conventional planting of sugarcane at 75 cm using equal seed rates in both the cases. Among wider row spacing of 150 cm, planting of 172,144 buds/ha recorded maximum net return with benefit : cost ratio which declined with reducing the seed rates/ha.

All the intercropping systems were more remunerative than cane alone. However, sugarcane + onion appeared more advantageous with higher net return of and benefit : cost, followed by sugarcane + coriander. Porwal *et al.* (1994) also reported that net monetary return was the highest from the intercropping of sugarcane with onion. Net returns were higher by 5.28, 9.2 and 10.8% with wheat, Indian mustard and coriander intercropping, respectively, over sole crop of sugarcane.

Land and income-equivalent ratio

Wider row spacing of 150 cm, irrespective of seed rates, registered higher land-equivalent ratio (LER) and income-equivalent ratio (IER) than closer row spacing of 75 cm and paired row system. The LER and IER values were comparable at 75 cm spacing and paired row system of planting having equal seed rates in both the cases. The LER of all intercropping combinations were better than sole crop of sugarcane. Highest LER and IER were recorded when onion was intercropped with sugarcane (Table 1).

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