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Effect of nitrogen and row spacing on growth, yield and quality of sugarcane (*Saccharum officinarum*) varieties

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ABSTRACT

A field experiment was conducted during the main crop seasons of 1992–94 on sandy-loam soil at Coimbatore, to study the response of 2 early ('Co 85002' and 'Co 85004') and 3 mid-late ('Co 86027, 'Co 86032' and 'Co 86038') sugarcane (*Saccharum officinarum* L.) varieties to 5 levels of N (0, 100, 200, 300 and 400 kg/ha) and 2 row spacings (75 and 90 cm). The number of millable canes, juice-quality characters, yield and yield attributes differed significantly due to row treatments. But row spacings within the variety did not influence the cane and sugar yield. However, increased planting density at 75 cm, spacing resulted in higher cane and sugar yield in 'Co 85002', 'Co 86032' and 'Co 86038'. The different levels of N influenced significantly the number of millable canes, leaf-sheath moisture, cane and sugar yield, but the juice quality was unaffected. The highest cane and sugar yields were recorded at 300 kg N/ha. There was a slight reduction in purity (%) in early varieties at 400 kg N/ha. Significant positive correlation was found between leaf-sheath moisture at formative phase and final cane yield. Quadratic responses to N levels were found significant and based on multiple-regression equation the optimum N ranged from 239 to 300 kg/ha for different varieties.

Sugarcane (*Saccharum officinarum* L.) is a long-duration crop requiring higher levels of soil nutrients and moisture for optimum productivity. Nitrogen is the key element in increasing the productivity and the response of the applied fertilizer depends on the inherent potential of the varieties to absorb and utilise them for the production of dry matter.

Stalk number being the most important yield component, it is more important to study the make up of final yield due to planting density with varieties having different tillering potential. An attempt was made to study the response of some of the genotypes to N levels and row spacings.

MATERIALS AND METHODS

The experiment was laid out during 1992–94 in strip-plot design with 3 replications separately for early and midlate group of varieties, on sandy-loam soils with soil pH, 7.8, low available N (210 kg/ha) available P_2O_5 (28 kg/ha) and medium in available K_2O (400 kg/ha). Two levels of row spacings (75 and 90 cm) were adopted with varieties in the row treatments and 5 levels of N (0,100, 200, 300 and 400 kg/ha) in column treatments. In 75 cm row spacing 89,000 two-budded setts/ha and in 90 cm row spacing 75,000 two-budded setts/ha were planted. Phosphorus at 75 kg P_2O_5/ha (basal application) and K at 120 kg K_2O/ha were common to all the treatments. The different levels of N were imposed in 2 equal splits, at 45 and 90 days after planting.

The crop was harvested at 12 months age. Sugar yields were computed by multi-

Table 1. Response to N levels and spacing of early varieties of sugarcane for growth, yield and quality

Treatment	Shoot population ('000/ha)	Leaf-sheath moisture (%)		No. of millable canes ('000/ha)	Purity (%)	CCS	Single cane weight (kg)	Girth (cm)	Cane yield (tonnes/ ha)	Sugar yield (tonnes/ ha)
		Formative phase	Growth phase							
Variety x Spacing										
'Co 80052', 75 cm	83.25	80.80	77.02	70.1	88.18	12.84	0.80	2.68	48.6	6.27
'Co 85002', 90 cm	69.58	81.30	75.83	59.4	89.71	12.70	0.83	2.82	44.3	5.62
'Co 85004', 75 cm	97.30	80.66	76.17	79.8	85.97	10.96	0.67	2.42	53.4	5.89
'Co 85004', 90 cm	84.85	81.58	75.86	77.7	87.97	11.54	0.71	2.51	54.7	6.34
CD (P = 0.05)	6.00	NS	0.55	5.3	1.21	0.36	NS	0.15	5.68	NS
N (kg/ha)										
0	78.40	79.71	75.16	57.7	87.91	11.94	0.67	2.51	27.9	3.31
100	82.90	80.74	76.37	70.4	87.66	11.93	0.75	2.65	50.6	6.01
200	84.80	81.77	76.16	75.1	87.72	12.02	0.78	2.67	57.4	6.92
300	88.50	82.03	77.00	77.6	89.04	12.49	0.80	2.65	60.3	7.50
400	83.10	81.34	76.33	74.2	87.37	11.66	0.78	2.64	55.1	6.42
CD (P = 0.05)	NS	1.19	0.36	6.7	NS	NS	NS	NS	9.85	1.62

plying commercial cane sugar (%) with cane yield. The responses of cane yield to N levels were worked out for mean cane yield of individual varieties.

RESULTS AND DISCUSSION

Effect of spacing on early varieties

Significantly higher tiller and number of millable canes were recorded at 75 cm spacing compared with 90 cm (Table 1). This higher density of population, however did not reflect in the final cane and sugar yields due to adjustments in single cane weight and number of millable canes. 'Co 85002' recorded higher cane yield at 75 cm spacing whereas 'Co 85004' recorded slightly higher yields at 90 cm but the differences between 2 levels of spacings were not significant.

Effect of spacing on midlate varieties

Significant differences were observed in juice quality, cane and sugar yields due to variety and levels of spacing (Table 2). Co 86032, either at 75 or 90 cm recorded higher cane and sugar yield than other row treatments. In variety 'Co 86027', even though significantly higher tiller population were observed at 75 cm spacing, final cane yield was not significant between 2 levels of spacing, due to higher mortality of shoots at lower spacing. Similarly at 75 cm spacing, 'Co 86032' recorded significantly higher number of millable canes but lower single cane weight and lesser thickness of the cane compared with 90 cm. However, increased planting density at 75 cm spacing resulted in higher number of millable canes, cane and sugar yields in 'Co 86032 and 'Co 86038'. Boole *et al.* (1990) observed varied mean cane yields for the plant crop at 75 cm and 90 cm in 'Co 740', 'Co 7219', 'CoC 671' and 'Co 7527'.

N effect on early varieties

The cane yield increased with an increase in N level from 100 to 300 kg N/ha and declined at 400 kg/ha (Table 1). Similar trends were noticed by Rana and Saini (1991). Nitrogen at 300 kg/ha recorded significantly higher leaf-sheath moisture, number of millable canes, cane and sugar yield compared with 0 and 100 kg N/ha, while the juice quality was not affected. There was significant correlation (0.611*) between leaf sheath moisture at formative phase and cane yield. The increase in cane yield was 49.3, 53.7, 51.4, and 44.9% for 400,300,200 and 100 kg N/ha, respectively over the control (N_0).

N effect on midlate varieties

Different levels of N influenced the shoot population, leaf-sheath moisture, number of millable canes, cane and sugar yields significantly over the control, but juice-quality characters were not affected (Table 2). N at 300 kg/ha recorded the highest cane and sugar yield and resulted in 34.5% increase in cane yield over the control, followed by 200 kg N/ha (31.8%) and 400 kg N/ha (30.5%). Chavan *et al.* (1985) reported that the application of 300 kg N/ha recorded the highest cane yield, which was on par with 250 kg N/ha in mid-late maturing varieties. A significant positive correlation of 0.835, 0.805 and 0.685 for 'Co 86027', 'Co 86032' and 'Co 86038' respectively was observed between leaf-sheath moisture at formative phase and cane yields.

Interaction effects of variety, spacing and nitrogen were not significant. The variety 'Co 85004' in early and 'Co 86032' in midlate group recorded the highest cane and sugar yields at 90 cm row spacing in combination with 300 kg N/ha. Sathyavelu *et al.* (1991) found 375 kg N/ha as sufficient in

Table 2. Response of N levels and spacing on growth, yield and quality of sugarcane (midlate varieties)

Treatment	Shoot population ('000/ha)	Leaf-sheath moisture (%)		No. of millable canes ('000/ha)	Purity (%)	CCS (%)	Single cane weight (kg)	Girth (cm)	Cane yield (tonnes/ha)	Sugar yield (tonnes/ha)
		Formative phase	Growth phase							
Variety Spacing										
'Co 86027', 75 cm	113.3	83.81	76.76	53.0	88.55	13.28	0.83	2.93	52.9	7.01
'Co 86027', 90 cm	95.0	84.16	78.92	55.0	89.28	13.71	1.00	3.00	56.6	7.67
'Co 86032', 75 cm	130.1	83.15	77.83	68.9	87.16	13.18	1.08	2.73	77.1	10.18
'Co 86032', 90 cm	114.3	83.68	77.07	60.8	86.76	13.03	1.24	2.94	75.8	9.91
'Co 86038', 75 cm	89.6	84.21	76.68	53.3	86.64	12.86	0.82	2.80	49.9	6.42
'Co 86038', 90 cm	77.6	83.47	77.28	50.1	86.75	12.96	0.92	2.94	46.1	5.98
CD (P = 0.05)	13.9	0.436	1.134	10.6	1.05	0.39	0.18	0.16	20.5	2.58
N (kg/ha)										
0	93.3	82.85	76.52	43.8	87.39	13.16	0.92	2.87	43.7	5.77
100	103.7	83.60	77.77	57.0	87.26	13.08	1.00	2.90	60.8	7.95
200	104.6	83.81	77.61	59.7	87.98	13.39	0.96	2.88	64.2	8.60
300	106.3	84.22	78.06	63.8	87.65	13.13	1.03	2.93	66.6	8.73
400	108.8	84.20	77.15	59.9	87.34	13.08	0.98	2.89	62.9	8.25
CD (P = 0.05)	13.8	0.350	0.763	6.1	NS	NS	NS	NS	7.22	1.07

CCS, Commercial cane sugar

Table 3. Response equation R^2 and optimum dose for different varieties of sugarcane

Variety	R^2	Response equation	Optimum dose
'Co 85002'	0.9644	$27.09 + 20.9849 X - 3.7657 X^2$	278 kg/ha
'Co 85004'	0.9636	$30.78 + 25.8910 X - 4.7251 X^2$	273 kg/ha
'Co 86027'	0.9907	$43.43 + 12.1687 X - 2.2079 X^2$	275 kg/ha
'Co 86032'	0.9357	$53.98 + 22.5041 X - 3.7493 X^2$	300 kg/ha
'C0 86038'	0.8901	$36.95 + 14.8797 X - 3.1176 X^2$	239 kg/ha

obtaining higher cane yield in garden land conditions for 'Co 6304', spaced at 80 cm row spacing. Since the main effects of variety, nitrogen and 2 factor interaction of variety x spacing were noted highly significant for most of the attributes of yield, the effect of variety with N levles did not show significance. However, the trend of N levels for different varieties was found varying much. Curviliner analysis was attempted by adopting fitting of polynomial regression or constructing second-degree (quadratic) equations. It was also found as the best remedy in view of the expression of high correlations between various nitrogen levels and other corresponding cane yields uniformly in each variety. Significant quadratic responses were found for all the varieties and the levels of N when regressed against mean cane yield gave the response equations (Table 3). By way of adopting the maxima-minima principle of solving of quadratic equations, the optimum doses of N for each variety were estimated.

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