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Effect of nitrogen and spacing on the yield of sugarcane and uptake of nitrogen

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Abstract: A field experiment was conducted at Sugarcane Breeding Institute, Coimbatore during 1993-94 to study the effect of graded levels of N application (0, 100, 200, 300 and 400 kg ha^{-1}) under two different row spacings (75 and 90 cm) in three promising midlate varieties of sugarcane (Co 86027, Co 86032 and Co 86038) on the nitrogen uptake, cane yield and sugar recovery in a sandy loam soil. Though the uptake of nitrogen increased with increased levels of nitrogen application the yield of cane did not show any significant increase beyond 100 kg N ha^{-1}.

Key words : Sugarcane, Nitrogen, Spacing, Uptake, Quality.

ntroduction

Sugarcane, being a long duration and igh tillering crop, row spacing assumes greater mportance. According to Barnes (1953), within ertain limits, variation in spacing between rows id not affect very much the ultimate cane yield. Srinivasan (1987) reported that while in sub-tropics there was an improvement in cane yield with closer spacing, but in tropical regions the response was very little in the varieties Co 6304 and CoC 671. However, genotypes with high tillering potential may respond more to increased row spacing compared to genotypes with low tillering habits especially under tropical situations. The inter row spacing and the amount of NPK applied varies from region to region depending upon the variety and soil nutrient status. The variety, which showed high potential for nutrient uptake, showed a potential for high yield (Achuthan *et al.* 1989). Apart from influence on cane yield, N also plays a major role in influencing the quality of juice. With this background, an experiment was undertaken to study the influence of graded levels of N application under two different row spacings on the yield performance, nutrient uptake and commercial cane sugar (CCS%) in certain promising midlate maturing varieties of sugarcane.

Materials and Methods

A replicated field experiment was conducted during the year 1993-94 at Sugarcane Breeding Institute, Coimbatore in a split-split plot design with varieties (Co 86027, Co 86032 and Co 86038) in the main plots, spacings (75 and 90 cm) in the sub-plots and levels of N (0,100, 200 and 400 kg ha^{-1}) in the sub-sub plots. The soil type was sandy loam with low in available N (220 kg ha^{-1}), medium in available phosphorus (16.5 kg ha^{-1}) and high in available potassium (450 kg ha^{-1}). In case of 75 cm spacing, 89000 two budded setts ha^{-1} were used for planting while in 90 cm, recommended rate of 75000 setts ha^{-1} was employed. The entire quantity of 75 kg P_2O_5 ha^{-1} was applied as basal to all the plots. The nitrogen was top dressed as urea at 45 and 90 days as per the treatment schedule. The K_2O as muriate of potash (120 kg ha^{-1}) was top dressed along with N to all the plots. The crop was raised by adopting recommended practices and harvested at 12 months and cane yield was recorded and expressed as tonnes ha^{-1}. Representative cane samples were taken from all the plots and separated into stem, dry leaves and green leaves. The content of nitrogen (Humphries, 1956), phosphorus and potassium (Jackson, 1973) were estimated. The uptake of N, P and K were estimated by multiplying their content with the respective dry matter production at harvest. The juice samples at harvest were analysed for brix, sucrose and purity through an automatic polarimeter (Sucromat) and Commercial Cane Sugar (CCS%) was worked out.

Results and Discussion

There was a statistically improvement in cane yield due to application of nitrogen upto

Table 1. Cane yield (t ha^{-1}) as affected by different treatments

Treatments	N levels (kg ha^{-1})					
	0	100	200	300	400	Mean
V_1	46.9	57.4	59.5	60.5	58.7	56.5
V_2	57.7	82.4	88.4	90.9	86.7	79.2
V_3	38.7	58.3	57.6	52.4	50.4	51.5
S_1	50.3	71.9	66.0	68.9	69.3	65.3
S_1	45.2	60.2	64.2	67.0	61.3	59.6
V_1S_1	47.6	56.2	57.8	58.2	60.2	55.9
V_1S_2	46.4	58.8	61.2	62.9	57.1	57.3
V_2S_1	61.5	92.0	74.8	91.4	93.8	82.7
V_2S_2	53.8	72.8	81.9	90.3	79.5	75.7
V_3S_1	41.9	67.6	65.7	57.0	53.9	57.2
V_3S_2	35.5	48.9	49.5	47.9	47.2	45.8
Mean	47.8	66.0	65.1	67.9	65.3	62.4

	SEm	CD
N	2.2	8.6
V	7.0	NS
S	5.7	NS
V x N	4.0	NS
V x S	9.9	NS

V_1 = Co 86027; V_2 = Co 86032; V_3 = Co 86038; S_1 = 75 cm; S_2 = 90 cm

Table 2. Total uptake of nitrogen as influenced by treatments at harvest (kg ha^{-1})

Treatments	N levels (kg ha^{-1})					
	0	100	200	300	400	Mean
V_1	75.5	128.0	156.5	172.6	212.4	149.0
V_2	99.2	169.4	164.6	266.9	281.4	196.3
V_3	86.9	140.5	204.4	276.5	245.9	190.8
S_1	77.1	170.0	167.2	241.7	251.7	181.6
S_1	97.3	121.9	183.0	235.6	241.3	175.8
V_1S_1	77.5	146.0	122.9	155.9	211.2	142.8
V_1S_2	73.6	109.5	190.1	189.1	213.5	155.2
V_2S_1	79.2	211.7	174.4	239.6	283.1	201.6
V_2S_2	119.3	127.0	154.7	274.2	279.6	191.0
V_3S_1	74.8	151.9	204.4	309.6	260.9	200.3
V_3S_2	89.8	129.1	204.5	243.4	230.9	181.3
Mean	87.2	146.0	175.1	238.6	246.5	178.7

	SEm	CD
N	3.0	12.1
V	1.9	6.8
S	1.5	5.5
V x N	5.7	16.8
V x S	2.6	9.6

V_1 = Co 86027; V_2 = Co 86032; V_3 = Co 86038; S_1 = 75 cm; S_2 = 90 cm

Table 3. Commercial cane sugar (CCS%) at harvest as influenced by different treatments

Treatments	Levels of nitrogen (kg ha^{-1})					
	0	100	200	300	400	Mean
V_1	13.2	13.6	12.6	13.0	12.8	13.0
V_2	13.0	13.1	13.0	13.4	13.3	13.2
V_3	13.4	13.2	12.6	13.2	12.7	13.0
S_1	13.0	13.6	13.0	13.2	12.8	13.1
S_2	13.4	13.0	12.5	13.3	13.0	13.0
V_1S_1	13.1	13.8	12.9	13.5	13.1	13.0
V_1S_2	13.3	13.4	12.2	12.6	13.5	13.0
V_2S_1	12.7	13.3	13.6	13.6	13.3	13.3
V_2S_2	13.5	13.9	13.6	13.3	13.3	13.0
V_3S_1	13.4	13.7	12.5	12.5	13.0	13.0
V_3S_2	13.5	12.7	12.7	13.9	12.4	13.0
Mean	13.2	13.3	12.7	13.2	12.9	13.0

	SEm	CD
N	0.15	NS
V	0.14	NS
S	0.11	NS
V x N	0.34	NS
V x S	0.20	NS

V_1 = Co 86027; V_2 = Co 86032; V_3 = Co 86038; S_1 = 75 cm; S_2 = 90 cm

00 kg ha^{-1} over the control (N_0) but additional evels of N beyond 100 kg ha^{-1} did not result n significant increase in cane yield (Table 1). Numerical increase in cane yield for N application was observed upto the level of 300 kg ha^{-1} in varieties Co 86032 and Co 86027 while in the variety Co 86038, the yield was observed to decrease beyond 100 kg N ha^{-1}. Variety Co 86032 also recorded the maximum cane yield compared to Co 86027 and Co 86038. The increase in cane yield at 300 kg level was 57.5% over no N application in Co 86032. In case of Co 86027 and Co 86038, the cane yield at 200 kg N level was 26.8 and 48.8% respectively over the control (N0). Achuthan *et al.* (1989) observed that levels of 450 kg, 300 kg and 150 kg N ha^{-1} increased the yield of cane by 38.0%, 27.9% and 9.3% over no nitrogen treatment. Asokan (1981) found that application of N beyond 187 kg ha^{-1} did not further increase the cane yield in Co 6304. Rao *et al.* (1990) also obtained response to applied N only upto 100 kg ha^{-1}. The lowest cane yield of 35.5 t ha-1 was recorded under N0V3S2 treatment while the maximum cane yield of 93.8 t ha-1 was recorded by N4V2S1 treatment. However, the differences between varieties, spacing as well as their interaction were not significant. The reason for non-response to higher levels of nitrogen for yield needs to be studied.

The uptake of N was influenced by varietal interaction with nitrogen and spacing. The uptake of N increased positively upto 400 kg ha^{-1} in Co 86027 and Co 86032 while in Co 86038 the uptake of N was increased only upto 300kg ha^{-1}. The mean N uptake was more in variety Co 86032 which also recorded the maximum cane yield and was significantly superior to Co 86027. The increased uptake of N under different levels of N are mainly due to increased N content found in different components of cane and to a lesser extent due to increased dry matter production. Asokan (1981) and Rajasekaran (1983) also observed similar increased uptake of N without proportionate increase in cane yield. The uptake of N was found to be significantly higher under closer row spacing (75 cm) compared to normal row spacing (90 cm) which may be due to higher dry matter production at closer spacing, than increase in N content itself.

The CCS% was not significantly influenced either by the nitrogen levels or the spacing tried eventhough the CCS% was found to decrease slightly at 400 kg N ha^{-1} in the varieties Co 86027 and Co 86032 (under closer row spacings). Prasad *et al.* (1983) observed significant differences in juice quality under different levels of nitrogen.

It can be concluded that the sugarcane varieties tested did not respond for yield or for CCS% beyond 100 kg N ha^{-1} even though the uptake of N increased progressively with the graded application of nitrogen. The reason for non response to nitrogen beyond 100 kg ha^{-1} for yield by the varieties studied needs to be explored. However, there was no adverse effect of increased N application on the CCS% which is the normal response of sugarcane to very dose of nitrogen application. The adverse effect of N on CCS% may be expected only under high and late application of N especially in soils poor in P and K status. The row spacing tried did not influence significantly the cane yield, CCS% and uptake of nitrogen.

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