RESEARCH PAPER

RESPONSE OF PROMISING MIDLATE MATURING SUGARCANE VARIETIES TO DIFFERENT DOSES OF NITROGEN FERTILIZER

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Abstract

Field trials were conducted at Agricultural Research Station, Perumallapalle, during 2009-10 and 2010-11 to evaluate the response of promising mid-late maturing sugarcane varieties to different doses of nitrogen fertilizer. Four mid-late varieties, viz. 83V15, 97R383, 97R401 and 2002V48 were tested at four nitrogen levels, i.e. 75, 100, 125 and 150% recommended dose of nitrogen (RDN: 224 kg/ha). Application of nitrogen @ 125% RDN produced significantly greater values for number of millable canes, stalk yield and sugar yield. However, the effect of nitrogen levels on juice quality parameters was not significant. Hence, application of nitrogen @ 280 kg/ha is the most economically viable fertilizer level for the plant cane in sandy loam soils of Southern zone of Andhra Pradesh. Among the varieties, 2002V48 and 83V15 responded well to the applied nitrogen and recorded higher cane and sugar yields.

Key words: *Sugarcane midlate varieties, nitrogen levels, cane yield, sugar yield, juice quality*

Introduction

One of the major problems that hinder efficient sugarcane production is the lack of understanding of the varied responses of sugarcane varieties to nitrogen. Nitrogen management is closely associated with sugarcane yield. Its effect on sugar yield is in turn influenced by the soil and climatic variables prevailing in an area. Most of the soils in the southern zone of Andhra Pradesh, where sugarcane is grown, are low in soil nitrogen. This coupled with long term monocropping as a consequence of raising several ratoons year after year and land scarcity justifies continued use of nitrogen fertilizer field. However, nitrogen fertilizer is costly and its indiscriminate management such as inappropriate rate, time and placement may lead to poor crop performance and yield; besides, it may result in such losses as nitrate due to leaching, denitrification and ammonium volatilization with serious environmental pollution. Nitrogen has been considered as the most limiting in sugarcane farming. Different sugarcane varieties have different yield potentials and other specific attributes (Stevenson et al. 1992). The new varieties developed have improved cane and sugar yields, resistance to pests and diseases, good milling qualities and adaptability to local growing conditions. These varieties are expected to yield as per the potential when cultivated in the recommended agro ecological zones and applying appropriate agronomic practices. Variations in the varietal response were reported by Rama Krishna Rao et al (1989) and Srinivas et al (2003). One of the causes of declining sugarcane yield is speculated to be declining soil fertility as a result of depletion of the essential plant nutrients, *viz*. N, P and K (Bell et al. 2001; Gerside and Bell, 2003) with low rates of replenishment. These macronutrients play a major role in sugarcane physiology, growth and development (Malavolta 1994; Rice et al 2002). Nitrogen is essential for photosynthesis, sugar production and growth. This study was undertaken to determine the optimum nitrogen fertilizer rate for increased and sustained cane and sugar yields and to select a high fertilizer use efficient variety suitable for the zone.

Materials and methods

A field experiment was conducted at Agricultural Research Station, Perumallapalle, Andhra Pradesh,

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during 2009-10 and 2010-11. The soils of the experimental field are sandy loam in texture, neutral in pH, normal in EC, low in available nitrogen, medium in available phosphorus and high in available potassium (Table 1).

Table 1 . Physico-chemical properties of experimental site

pH	7.22
EC (dS/m)	0.22
Organic carbon (%)	0.21
Available nitrogen (kg/ha)	196.26
Available phosphorus (kg/ha)	14.80
Available potassium (kg/ha)	285.75
Texture	Sandy loam

The experiment was designed in split plot with three replications, varieties as main plots and nitrogen levels as sub plots. Four promising mid-late maturing varieties, *viz*. 83 V 15, 97 R 383, 97 R 401 and 2002 V48 were included in the study with four levels of nitrogen *viz*. 75%, 100%, 125% and 150% recommended dose of nitrogen (RDN: 224 kg/ha). Nitrogen in the form of urea was applied in two equal splits at 45 and 90 days after planting. Phosphorus and potassium were applied @ 112 kg/ha in the form of SSP and MoP, respectively. Furrows were made at a spacing of 90 cm and three budded setts @ 40,000/ha were planted in the second fortnight of January during both the seasons. Atrazine @ 2 kg a.i./ ha was sprayed as pre emergence on the 3rd day after planting of setts. Irrigations were provided as and when necessary. All other agronomic practices like hand weeding, earthing up, trash twist propping etc were carried out according to recommendations. Yield attributing parameters like number of millable canes, cane length, cane diameter were recorded at the time of harvest. Cane yield was recorded after stripping the leaves and detopping. Juice quality parameters *viz*. Brix, sucrose%, purity% and CCS%, and sugar yield were recorded at harvest by following standard procedures (Spencer and Meade, 1963). Brix was recorded by using hydrometer and sucrose was estimated by recording pol % using polarimeter. Purity % was calculated by using the formula: (Sucrose% x 100) / Brix. CCS % was calculated by using the formula: (1.022 S) - (0.292 B). Sugar yield (t/ha) was computed by using the formula: Cane yield (t/ha) x CCS % /100. Nutrient content in index leaf was estimated by following standard procedures (Tandon 1993). Data collected were statistically analyzed and the results were compared.

Results and discussion

Results pertaining to yield, yield attributes and juice quality parameters are presented and discussed below.

Number of millable canes (NMC '000/ha)

The number of millable stalks is a major constituent of cane yield. Tillering which provides the plant with the optimum number of stalks needed for a good yield is known to be affected by the availability of various nutrients. The number of millable canes at harvest increased with increased level of nitrogen application (Table 2). Nitrogen @ 150% RDN i.e. 336 kg N/ha gave significantly higher NMC over other doses of nitrogen and it was statistically at par with 125% RDN (280 kg N/ha). Among the varieties, 2002V48 produced the highest NMC followed by 83V15. Significantly higher number of millable canes at higher nitrogen levels indicated higher conversion efficiency of tillers into millable canes. A variation in varieties for their response to nitrogen was also reported by Srinivas et al (2003).

Cane length and diameter

Plant height is also a major parameter of growth and yield. Although length, thickness and shape of the internodes are varietal characteristics, the rate of elongation and length of internodes are also influenced by the nutrient availability and hence plant height provides information about the general condition of the crop. Among the varieties, 83V15 recorded the highest cane length followed by 97R401. The tallest canes were recorded when nitrogen is applied @ 150% RDN followed by 125% RDN (Table 2). The results are in accordance with Naga Madhuri et al (2011) for promising early maturing sugarcane varieties.

Applied nitrogen did not have significant influence on cane diameter of the sugarcane varieties. The variety 2002V48 had recorded the highest cane diameter followed by 97R383 which produced thicker canes compared to 83V15.

Cane yield

Cane yield showed significant difference due to increasing levels of nitrogen application. A significant progressive increase in cane yield was observed with

the increase in the dose of nitrogen from 75% to 150% RDN (Table 2). Application of nitrogen @ 150% RDN (336 kg N/ha) resulted in significantly higher cane yield over 100% and 75% RDN but it was statistically on par with 125% RDN.

Table 2. Yield and yield attributes of promising sugarcane varieties under different nitrogen levels

Varieties	NMC ' 000/ha	Length of millable cane (cm)	Diameter of millable cane (cm)	Yield (t/ha)
83V15	100.57	324.99	2.45	142.46
97R383	94.27	321.99	3.41	151.76
97R401	105.99	328.40	3.42	154.72
2002V48	108.80	333.28	3.51	158.15
SEd	0.88	0.77	0.04	1.29
LSD(0.05)	2.80	2.45	0.12	4.12
Doses				
75%	89.29	301.55	2.88	135.48
100%	95.20	314.89	3.01	147.80
125%	104.89	331.01	3.28	158.69
150%	110.24	341.12	3.34	163.12
SEd	1.04	1.49	0.05	3.48
LSD(0.05)	2.21	3.17	0.11	7.41
VxF	NS	Sig*	NS	Sig*

The highest cane yield was recorded by 2002V48 followed by 97R401. The variety 2002V48 responded very well to the applied nitrogen from 75% to 150 % RDN (Table 3). Highest shoot population coupled with efficient conversion of tillers into millable canes at harvest could have contributed to higher cane yield. Significant response up to 375 kg N/ha for variety 83R23 has been reported by Srinivas et al. (2003) and for variety 2003V46 by Naga Madhuri et al (2011).

Table 3 . Interaction between varieties and nitrogen levels for cane yield

	Nitrogen Levels (RDN)				
Varieties	75%	100%	125%	150%	MEAN
83V15	121.48	135.17	153.22	160.02	142.46
97R383	132.49	149.92	157.58	167.05	151.76
97R401	141.65	150.48	160.37	163.38	154.72
2002V48	146.29	155.65	163.61	167.06	158.15
MEAN	135.48	147.80	158.69	163.12	151.79
VxF	SEd	1.29			
	LSD(0.05)	4.12			
FxV	SEd	3.48			
	LSD(0.05)	7.41			

Juice quality parameters

For sugarcane, the quality of the crop is assessed by the sugar produced per tonne of cane, and of the major elements essential for cane growth, nitrogen has the greatest influence on cane growth, ripening and juice quality (Hussain et al 1990). The quality parameters which include Brix, sucrose, % purity and % CCS were not affected by increasing nitrogen application (Table 4). This could be due to the early application of nitrogen (12 weeks after planting). Thus the detrimental effect of high nitrogen on juice quality was minimized before the maturity age of the cane (Gana et al 2007). Yanam et al (1997) reported that the use of NPK does not have any significant influence on juice quality parameters such as Brix and purity. According to them, juice quality mainly depends on genetic nature of the variety. Neman et al. (1995) reported increased juice cation, chlorine and nitrogen content with application of nitrogen. However, when applied in excess or late in growth period, N impaired juice quality and the recoverable sugar % was reduced. High application of nitrogen fertilizers generally results in luxurious growth and high percentage of reducing sugars but as crop ages and matures, it is expected that nitrogen content will be reduced and there is an increasing conversion of the reducing sugars to sucrose (Hussain et al 1990).

Table 4. Quality parameters of promising sugarcane varieties under different nitrogen levels

	% Sucrose	% Purity	% CCS	CCS Yield(t/ha)
Varieties				
83V15	18.09	85.39	11.82	16.55
97R383	15.68	82.79	10.49	15.93
97R401	16.47	88.42	11.72	18.09
2002V48	18.46	90.68	12.63	20.02
SEd	0.77	1.56	0.32	0.57
LSD (0.05)	2.44	4.98	1.25	1.81
DOSES				
75%	15.96	86.33	11.74	15.29
100%	16.53	87.55	11.41	16.87
125%	16.11	87.27	11.65	18.25
150%	16.81	87.88	11.44	18.94
SEd	0.48	1.56	0.59	0.84
LSD (0.05)	NS	NS	NS	1.84

Sugar yield

Since the sugar yield is dependent on cane yield, it followed the same pattern as the cane yield as discussed above. The highest sugar yield was recorded with 2002V48 followed by 83V15 (Fig 1) which was attributed to the high cane yield.

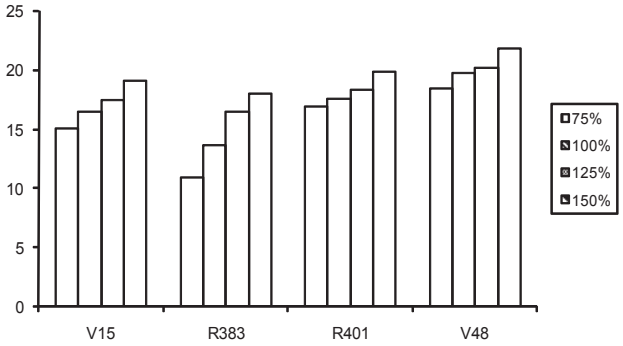

Fig 1. Effect of Nitroge levels on CCS Yield of varieties

Plant nutrient concentration

Data in Table 5 presents NPK concentration in index tissue at six months age of cane in all the varieties. This

is the grand growth stage of sugarcane crop. The mean leaf nitrogen percentage increased slightly when the nitrogen dose was increased. The leaf nitrogen increases due to nitrogen application to sugarcane were reported in previous findings (Wawire et al 2006). However, the leaf nitrogen concentration in all the treatments was within the sufficiency level.

Table 5: Nutrient concentration in index tissue of sugarcane at different nitrogen levels at six months age

Nitrogen level	% Nitrogen	% Phosphorous	% Potassium
75% RDN	1.99	0.25	1.23
100% RDN	2.12	0.15	1.93
125% RDN	2.36	0.14	1.91
150% RDN	2.38	0.10	1.88
Mean	2.21	0.16	1.74

The highest phosphorus concentration was associated with the lowest level of nitrogen, while comparatively lower phosphorus concentration was found in the higher level of nitrogen. This could be due to the imbalance caused by the high nitrogen application. N difference in potassium concentration was observed in index tissue due to application of increased rates of nitrogen in all the varieties.

Conclusion

The statistical analysis for the plant cane revealed significant differences between the application of nitrogen at 75% RDN and 150% RDN on cane yield and sugar yield. The results further revealed that the application of nitrogen @ 125% RDN i.e. 280 kg N/ha is optimum and economical for obtaining optimum cane and sugar yield. Hence, application of nitrogen @ 280 kg/ha is the most economically viable fertilizer level for the plant cane in sandy loam soils of Southern zone of Andhra Pradesh. Among the varieties, 2002V48 and 83V15 responded well to the applied nitrogen and recorded the highest cane and sugar yield.

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