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Quality and productivity of promising sugarcane *(Saccharum officinarum)* genotypes under various planting seasons and nitrogen levels in subtropical India

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ABSTRACT

A field experiment was conducted during 1995–97 and 1996–98 to study the effect of different genotypes ('CoS 90269', 'CoPant 90223' and 'CoS 86218) of sugarcane (*Saccharum officinarum* L.) with various planting seasons (autumn, spring and summer) and nitrogen levels (112.5, 150 and 187.5 kg N/ha) on cane quality, productivity and economics of sugarcane production system. Genotype 'CoPant 90223' gave the highest commercial cane sugar equivalent yield (12.2 and 12.8 tonnes/ha in December and February respectively), cane equivalent yield (100.68 tonnes/ha), net returns (Rs 48,068/ha) and benefit : cost (1.8). Intercropping of Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] with autumn sugarcane was found advantageous over sole cane planting and resulted maximum cane-equivalent yield (94.0 tonnes/ha), CCS equivalent (11.9 tonnes/ha) and net return (Rs 38,262/ha). Increasing nitrogen levels during both the seasons increased cane yield and net return.

Key words : Sugarcane, Planting seasons, Intercropping, Cane-equivalent yield, Commercial cane sugar

Sugarcane is mostly planted in spring and summer seasons in subtropical part of India. Intercropping with autumn sugarcane has been found economical, although slight reduction in cane yield occurred (Lal and Shukla, 1998). They advocated intercropping for early additional income, crop diversification and higher net profit. However, it could not get maximum acreage due to several other reasons. Autumn sugarcane is superior to spring and summer canes in terms of yield and quality (Shukla *et al.*, 1998).

The quality of different genotypes varies with harvesting periods. Nitrogen management is important for maintaining sugarcane quality. Higher nitrogen levels decrease juice quality (Hunsigi, 1993). Sugar accumulation is temperature-dependent phenomenon.

Keeping above points in view, an experiment was conducted to evaluate the quality, yield and economics of different sugarcane genotypes under various planting seasons and nitrogen levels.

MATERIALS AND METHODS

An experiment was conducted for 2 cropping seasons (1995–97 and 1996–98) to evaluate the quality and yield of 3 sugarcane genotypes ('CoS 90269', 'CoPant 90223' and 'CoS 86218') under various planting seasons (autumn sole cane, autumn cane + Indian mustard, spring cane and summer cane) with 3 nitrogen levels (112.5, 150 and 187.5 kg N/ha). The soil was clay loam with pH 7.8, low in available N, and medium in phosphorus and potassium. The experiment was laid out in split-plot design keeping combinations of genotypes and planting seasons in main plots and nitrogen levels in subplots. In all, there were 36 treatments which were replicated 3 times. Five canes from each plot were randomly selected for juice analysis in December and February. Juice quality was presented in terms of brix, pol % and purity. Mustard crop was harvested in March and yield was recorded. Cane-equivalent yield was calculated after conversion of Indian mustard yield in terms of cane yield on market price of mustard (Rs,1,200 and 1,300/q for first and second year respectively) and sugarcane (Rs 74/q during both the years). On the basis of cane-equivalent yield and commercial cane sugar content (CCS%), CCS equivalent yield of different treatment combinations was worked out.

Cost of production for autumn sugarcane (sole), autumn cane + mustard, spring and summer canes at different nitrogen levels was calculated. After that gross and net returns were obtained on market price of sugarcane and component crop. Benefit : cost was also worked out.

RESULTS AND DISCUSSION

Genotypes

Indian mustard yield with autumn sugarcane was not significantly influenced by sugarcane genotypes (Table 2). It was due to similar degree of competition for nutrient, moisture and light caused by different sugarcane genotypes to Indian mustard when grown in association. Cane and cane equivalent yield of 'CoPant 90223' was significantly higher than 'CoS 90269'.

Sugarcane quality is greatly influenced by the different genotypes. Higher cane juice quality was observed in February as compared to December (Table 1). Among 3 genotypes 'CoS 90269' showed its superiority to others. The variations in quality on variety level could be ascribed due to the basic differences in inherent capacity (Singh *et al.*, 1993). However, in December, 'CoS 90269' and 'CoS 86218' were at par. Higher commercial cane sugar (CCS) was recorded from 'CoS 86218' (12.83%) but genotype 'CoPant 90223' gave the maximum CCS-equivalent yield (12.22 tonnes/ha). Higher CCS equivalent of 'CoPant 90223' was due to increased cane yield and cane-equivalent yield (Table 2). Higher number of millable canes with increased length, diameter and weight improved the cane yield as well as cane-equivalent yield. The CCS equivalent yield also followed similar treand.

Table 1. Juice quality of sugarcane as influenced by planting seasons and nitrogen in December and February during both cropping seasons

Treatment	December					February				
	Brix (%)	Pol (%) juice	Purity (%)	CCS (%) cane	CCS equivalent (tonnes/ha)	Brix (%)	Pol (%) juice	Purity (%)	CCS (%) cane	CCS equivalent (tonnes/ha)
Genotype										
'Co S 90269'	19.32	17.97	93.01	12.72	10.44	19.9	18.67	93.81	13.27	10.89
'Co Pant 90223'	18.28	17.1	93.54	12.14	12.22	19.55	18.04	92.28	12.73	12.82
'Co S 86218'	19.12	18.02	94.24	12.83	11.04	19.49	17.91	91.89	12.61	11.23
CD (P = 0.05)	0.5	0.23	NS	0.39	0.68	0.68	NS	NS	0.4	0.6
Planting season										
Autumn cane (sole)	18.84	17.51	92.94	12.39	9.64					
Autumn cane + Indian mustard	18.96	17.85	94.14	12.71	11.94					
Spring						19.5	17.95	92.05	12.65	8.3
Summer						19.79	18.45	93.23	13.07	6.86
CD (P = 0.05)	NS	NS	NS	NS	0.98	NS	NS	NS	NS	0.84
N (kg/ha)										
112.5	18.8	17.67	93.99	12.57	10.26	19.74	18.34	92.9	12.98	10.6
150	18.89	17.76	94.01	12.49	11.29	19.63	18.13	92.36	12.8	11.57
187.5	19.03	17.66	92.8	12.49	12.1	19.56	18.13	92.69	12.82	12.42
CD (P = 0.05)	NS	NS	NS	NS	0.38	NS	NS	NS	NS	0.46

In February, juice quality (brix, pol and purity) of sugarcane genotypes did not differ significantly except slight improvement in pol% juice and purity of 'CoS 90269.' where a significant increase in CCS content was obtained. The CCS equivalent yield of 'CoPant 90223' was 14.15 and 17.72% higher than 'CoS 86218' and 'CoS 90269' respectively.

Production cost (Table 3) of sugarcane genotypes did not vary. However, the maximum gross return was obtained with 'Co Pant 90223'. The same genotype also produced highest net return and benefit : cost. Higher net return produced by 'Co Pant 90223' was associated with maximum cane-equivalent yield.

Planting season

Autumn cane (sole) gave 11.2 and 24.3% higher cane yield (Table 2) than intercropped cane and spring cane respectively. Summer planting resulted in the lowest cane yield. Adverse climatic conditions such as higher temperature during germination, poor tillering and lower cane growth (length, diameter and weight) were the reasons behind its low productivity. These findings corroborate the results of Singh *et al.* (1990) and Shukla *et al.* (1998). Intercropping of Indian mustard with autumn cane gave 20.8% higher cane-equivalent yield than pure autumn cane. It showed economic feasibility of intercropping of Indian mustard with autumn cane. Shukla and Pandey (1999) also demonstrated the similar trend with genotypes of Indian mustard. Nature and behaviour of sugarcane genotypes vary with planting seasons.

Intercropping of Indian mustard with autumn cane slightly improved juice

Table 2. Cane yield and cane-quivalent yield as influenced by different treatments (mean data of 1995–97 and 1997–98)

Treatment	Cane yield (tonnes/ha)	Mustard yield (q/ha)	Cane-equivalent yield (tonnes/ha)
Genotype			
'CoS 90269'	57.65	14.66	82.06
'Co Pant 90223'	75.48	14.85	100.68
'Co S 86218'	64.1	12.89	86.06
CD (P=0.05)	2.35	NS	3.60
Planting season			
Autumn cane (sole)	77.85		65.65
Autumn cane +mustard	70.01		94.02
Spring	62.65		65.65
Summer	52.46		52.46
CD (P = 0.05)	2.73		4.70
N (kg/ha)			
112.5	61.2	12.06	81.67
150	65.8	14.48	90.40
187.5	70.2	15.87	96.90
CD (P = 0.05)	0.52	1.69	1.60

quality (0.34 unit pol and 1.2 unit purity) in December (Table 1). However, these differences were found statistically non-significant. Commercial cane sugar of intercropped cane was also higher than autumn sole cane. Intercropping of Indian mustard with autumn sugarcane resulted in 23.8% higher CCS equivalent yield, whereas it was 43.8% and 74.0% higher than spring and summer canes respectively. Delay in planting resulted poor tillering, growth and cane yield which ultimately affected CCS equivalent yield adversely . In February, the juice quality of spring and summer-planted canes did not differ significantly. It showed that juice quality and crop maturity under subtropical conditions are temperature-dependent phenomenon and age of crop did not influence the maturity. These results confirm the findings of Singh *et al.* (1993).

Cost of production varies with planting season. Autumn cane + Indian mustard required highest cost of production for management of both the crops, being Rs 6,646 higher than autumn sole cane (Table 3). Spring cane required slight lesser cost than autumn cane. Less interculture operations required for spring crop as compared to autumn crop favoured production cost. The summer planting was costlier (Rs 1,230) than autumn sole cane because of higher seed rate and cost of setts preparation. Intercropping of Indian mustard with autumn cane gave the highest gross as well as net returns. The higher benefit : cost was observed under autumn sole cane than autumn cane + Indian mustard intercropping system.

Nitrogen

Increasing N levels influenced cane yield, Indian mustard yield and cane-equivalent yield significantly (Table 2). It

Table 3. Economics of different treatments (average data of 2 years)

Treatment	Cost of production (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit : cost ratio
Genotype				
'CoS 90269'	26,435	60,724	34,289	1.30
'Co Pant 90223'	26,435	74,503	48,068	1.82
'Co S 86218'	26,435	63,684	37,249	1.41
Planting season				
Autumn - Cane (sole)	24,667	57,609	32,942	1.30
Autumn cane + mustard	31,313	69,575	38,262	1.22
Spring	23,861	48,581	24,720	1.04
Summer	25,897	38,820	12,923	0.50
N (kg/ha)				
112.5	26,155	60,436	34,281	1.31
150.0	26,435	66,896	40,461	1.53
187.5	26,715	71,706	44,991	1.68

Cost of sugarcane : Rs 74/q; mustard Rs 1,200/q (first year) and Rs 1,300 (second year)

was due to presence of N in chlorophyll and protein formation and their requirement in plant metabolism which resulted higher tillering, growth attributes (cane length, dimeter and weight) and increase in cane and cane-equivalent yield. There was increase of 14.7% in cane yield with the increase of 75 kg N/ha. Increasing N levels to sugarcane also increased the yield of Indian mustard significantly. It showed that initial dose of N applied to sugarcane also favoured growth and yield of Indian mustard crop. Increase in Indian mustard yield owing to higher N application was also observed by Singh *et al.* (1994). Cane-equivalent yield increased by 18.6% with application of additional dose of 75 kg N/ha.

Different nitrogen levels could not influence juice quality parameters (brix,pol, purity and CCS%) significantly during both the cropping seasons (Table 1). However, significant increase in CCS equivalent yield was observed with increasing N dose. Higher CCS equivalent yield was associated with increased cane and cane-equivalent yields. Mahadevaswamy (1997) also found higher cane yield owing to increase in N levels. In December there was increase of 17.93 % in CCS-equivalent yield with the application of 187.5 kg/ha over 112.5 kg N/ha. In February, CCS-equivalent yield increased by 0.28 to 0.34 tonne/ha at different N levels. Mean increase of 0.32 tonne/ha was observed in February as compared to December. Higher sugar content in February than in December was associated with bimodal sugar-recovery pattern owing to higher atmospheric temperature. Srivastava *et al.* (1988) also confirmed these findings.

There was an increase of Rs 280 in the cost of production with the increase of every 37.5 kg N/ha but the gross return increased by Rs 6,460 at first increase in N and Rs 4,810 with the next increase in N levels (Table 3). Net return at first and second stages increased by Rs 6,180 and Rs 4,530 respectively. Higher benefit : cost (1.82) was obtained at higher N level (187.5 kg/ha). There was increase of 28.2% in benefit : cost and 31.2% in net return with additional nitrogen of 75 kg over 112.5 kg/ha.

Thus an intercropping of Indian mustard cv. 'Varuna' with autumn sugarcane genotype 'Co Pant 90223' under application of 187.5 kg/ha gave the highest cane-equivalent yield, CCS-equivalent yield, net return/ha and it was found one of the best treatment combinations tried in the investigation.

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