Productivity and sustainability of sugarcane (*Saccharum officinarum*) genotypes under various planting seasons and fertility levels in South-East Rajasthan.

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ABSTRACT: A field experiment was conducted during cropping seasons of 2008-09 to 2010-11 at Kota to evaluate different sugarcane genotype (COPK-05191, COPK-05192 & CO-05011 under three levels of NPK (150:45:30, 200:60:40 & 250:75:50) in three season (spring and summer). Genotype COPK-05191 recorded highest cane yield and commercial cane sugar (CCS) across the season. Individual cane weight increased significantly upto 200:60:40 NPK/ha. Genotype COPK-05191 gave better yield and net profit, hence could be adopted in the region for optimizing sugar productivity and regulating crushing schedule at factory level. Fertility level of 200:60:40 NPK/ha was optimum for growth and cane yield during spring as well as summer planting.
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Key words : Sugarcane, genotype season, commercial cane sugar, NPK level, net return.

INTRODUCTION

Sugar is the second largest agro-processing industry accounts for 2.2 per cent of country's total cropped area. Three biggest sugar producers in world are Brazil, India and European (EU), each producing between 18 and 23 million tons per year. However, these producers differs greatly in their level of self sufficiency in terms of sugar consumption and alternatively diverting their resources for ethonal production. Ethanol produced from

Sugarcane being used as bio-fuel which is environment-friendly and blended with gasoline. In Brazil 20-24 per cent of ethanol is blended with gasoline while in USA it is 10 per cent in India, 5 per cent blending was made mandatory to reduce the imports of crude petroleum and hence it need to produce 500 million litre of ethanol per annum.

In subtropical India sugarcane (*Saccharum officinarum*) under various planting seasons and fertility levels is planted in autumn, spring and summer season. Productivity of different genotype is greatly influenced by genetic make up and agro techniques. Role of nitrogen in increasing tillers and growth is well recognized. Heavy application of nitrogen decreases the juice quality. Optimum nutrient management for sugarcane plant crop plays key role as it establishes vigorous stubble, which affects the ratoon yield (Shukla, 2007). In India, ideally sub tropical sugarcane could be grown in Feb.-March season but for improved yield & quality identification of optimum time of sowing which fits well to the local climatic and weather variable is very important. Tillering period in sugarcane is the most important growth phase which governs the cane yield in subtropical India. Normally sugarcane germination under subtropical conditions is 30-35% as compared to 80-85% in tropical part of the country. When sugarcane planting is delayed from February to April/May, it gets lesser time for tillering and reduces productivity (Pandey and Shukla, 2001). Thus, time of planting is a key component for obtaining high sugarcane productivity. Climatic and agronomic practices required for cultivation of sugarcane in subtropical condition is not well known and have selection of suitable subtropical sugarcane genotype, which is liable to change as per genotypes and environment under different planting seasons and nutrient levels needs to be identified in subtropical India.

MATERIALS & METHODS

A field experiment was conducted during 2008-09 to 2010-11 at Agricultural Research Station, Ummedganj, Kota (Raj.) (25^{o}13 latitude N & 75^{o}25 longitude E Altitude of 258 m above MSL) using three sugarcane genotypes viz COPK- 05191, COPK-05192 & CO-0501 and three NPK levels 150:45:30, 200:60:40 & 250:75:50 kg/ha, to identify suitable genotypes under various planting seasons. Clay loam soil of experiment with pH 8.0, organic carbon 0.55%

and available nitrogen (355 kg/ha), available P_2O_5 (23.6 kg/ha), available K_2O (287 kg/ha). Nine treatment combination were tested in a 3 times replicated randomized block design. Separate trials were conducted for spring and summer seasons. Planting of spring (Fubruary planted) and summer season (April planted) was done at 75 cm row spacing. The sowing were taken up as per the technical programme. Farm yard manure at 10 ton/ha was incorporated uniformly over the field before last plouging. NPK were applied as per the treatments. Rest of nitrogen was topdressed on 30 & 60 DAP except basal dose of nitrogen as per treatment.

Five canes were randomly selected for each plot for estimation of growth attributes, yield and quality parameters. Juice purity and commercial cane sugar (CCS) were calculated. Sucros content in juice was determined (chen & chou) 1993 . Milable Cane stalk were counted in December for spring and summer crops. Cane growth attributes were measured before harvesting at the time of juice analysis. Variances were subjected to Bartlett's test for homogeneity of variance. As variances were found to be homogenous pooled data for 3 consecutive years for spring and summer were presented.

Sustainability yield index (SYI) was calculated for different treatments taking yield as dependent variable. Mean yield of each treatment (Yt) and standard deviation (S) over years were calculated using the yield data from 2008 to 2011 (spring and summer) for arriving at SYI using the equation $h_1 = (Yt\text{-}S)/Ymax$- where h_1 is sustainability index of h treatment over a period of n years and Ymax is the maximum yield.

The experimental location experiences sub tropical climate with dry summer extending from march to August. A perusal of 50 year weather data of the site reveals that the area received a mean annual rainfall of 772.6 mm distributed in 43.6 rainy days. The mean annual maximum and minimum temp ranged from 22.3 to 43.96 ^{o}C and 5.44 to 27.4 ^{o}C, respectively. The mean relative humidity ranged from 38.96 to 80.26 per cent. The mean pan evaporation per day ranged for 1.6 to 16.9 mm (Table 1).

Table 1 : Mean monthly maximum and minimum temp, RH, evaporation and total rain fall.

S. No.	Month	Temp ^{o}C						RH %			Rainfall (mm)			Evaporation		
		Maximum			Minimum											
		2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
1	Jan.	22.10	21.8	22.2	5.03	5.4	5.9	76.1	73.7	68.0	-	6.6	2.6	1.5	1.37	1.7
2	Feb.	25.1	23.6	25.8	5.23	5.6	10.7	71.6	69.2	68.9	-	3.4	1.4	2.8	2.4	3.2
3	March	33.7	32.3	33.5	13.1	10.9	10.7	59.8	59.3	55.1	4.2	-	-	5.5	5.2	4.7
4	April	38.1	35.2	36.9	17.7	14.2	14.85	41.5	42.5	32.9	32.2	-	-	6.2	4.9	6.5
5	May	40.3	43.6	41.4	18.2	17.5	17.85	43.2	43.6	44.5	-	3.0	-	12.6	10.2	12.5
6	June	42.5	44.8	44.6	27.2	28.2	8.8	48.8	50.5	50.3	70.0	6.4	23.2	18.5	14.6	17.6
7	July	36.6	28.6	35.6	28.3	26.5	27.4	64.7	66.9	66.8	160.3	111.7	156.8	4.9	2.8	3.2
8	Aug.	33.8	29.3	32.7	24.3	23.8	25.1	79.8	80.0	81.0	115.4	70.2	256.2	3.8	3.3	2.8
9	Sept.	32.3	32.8	33.5	26.6	27.2	25.62	72.7	74.5	74.4	53.0	3.2	104.5	4.2	3.8	4.9
10	Oct.	34.5	33.4	35.2	28.3	20.5	20.62	64.3	64.8	48.1	4.8	-	-	3.9	3.3	5.3
11	Nov.	29.0	26.8	28.0	14.8	14.2	15.95	76.2	75.3	74.9	4.5	8.8	37.5	1.1	1.4	2.1
12	Dec.	22.0	27.3	23.8	7.2	7.5	7.85	64.7	64.7	65.1	-	2.7	2.5	1.3	1.0	1.2

Results and discussion

Growth yield and quality of plant crop:

Spring planting:

Mean data of 3 cropping season indicated that genotype CO-05011 showed higher germination (41%) than COPK-05192 and COPK-05191 i.e. 40.2 % and 33.8 per cent respectively (Table No. 2). Maximum number of tillers and milable were found with COPK-05191 owing to its higher tillering capacity. Over all mean individual cane weight (892.33 gm.) of COPK 05191 and COPK-05192 (811 gm) were at par. It showed that although COPK-05192 produced thicker cane than COPK-05191, contribution of cane length in cane weight compensated the effect of diameter so COPK-05192 was at par with COPK-05191. Higher cane yield was harvested with genotypes COPK-05191. Owing to higher number of millable canes and optimum cane weight. Genotype (COPK-05191) showed the highest brix (21.36%) and pol (18.35 %) reading at 10 month stage in spring cane (Table 2). It was observed that maximum benefit from higher sugar genotype COPK-05191 could be harvested in December under spring planting situation.

Germination of spring plant crop remained unaffected due to fertility levels. Number of tillers 8 millable canes increased significantly up to 200:60:40 NPK kg/ha. Moreover, higher dose of NPK also reduced the tiller mortality indicating the besides production of millable canes higher nutrition level helped in maintaining retention of tillers. The role of nitrogen in chlorophyll formation and carbohydrate metabolism and positive interaction of nitrogen and phosphorus and nitrogen with potassium is well known. It was main reason in improving millable canes, growth and vigour of sugarcane plant. Higher cane weight was obtained up to 200:60:40 NPK kg/ha, as it had positive effect on growth and development processes (Pandey and Shukla 2001). Thus cane yield and CCS were also higher at this fertility level. CCS was the function of cane yield and quality. The higher cane yield contributed greater share in improving CCS than cane quality parameters.

Table 2 : Influence of genotype and fertility levels applied in spring & summer crop on growth yield and commercial cane sugar (CCS) of sugarcane crop (Pooled data of 3 cropping season).

S.No.	Treatment	Germination (%)	Tillers (000/ha)	NMC (000/ha)	Cane weight (gm)	Cane yield (t/ha)	Pol % Juice	CCS ton/ha.	Nutrient uptake (kg/ha)		
									N	P	K
Spring planted crop											
Genotypes											
1	COPK-05191	33.8	134.81	99.40	892.33	81.20	18.35	9.82	263.8	17.9	210.5
2	COPK-05192	40.2	130.87	93.98	871.0	74.20	17.58	9.55	230.7	16.2	175.3
3	CO-05011	41.0	125.36	90.31	839.33	71.46	17.25	9.58	244.5	15.2	190.8
4	SEm	1.4	0.23	0.45	11.46	0.21	0.34	0.08	4.2	0.78	3.6
5	CD (P=0.05)	4.2	0.69	1.33	33.42	0.63	1.08	0.25	12.6	2.35	10.8
Fertility level NPK kg/ha											
1	150:45:30	37.5	128.17	91.95	849.66	75.23	17.53	9.47	230.4	12.5	153.1
2	200:60:40	41.3	131.60	95.65	885.00	75.90	18.06	10.08	255.8	18.2	213.3
3	250:75:50	36.2	131.27	96.08	868.0	75.73	17.58	9.40	253.2	18.6	210.2
4	SEm	1.4	0.23	0.45	11.46	0.21	0.34	0.08	4.2	0.78	3.6
5	CD (P=0.05)	NS	0.69	1.33	33.46	0.64	NS	0.25	12.6	2.35	10.8
Summer season											
Genotypes											
1	COPK-05191	29.4	121.54	85.05	934.75	65.43	18.53	8.45	240.4	15.3	175.8
2	COPK-05192	35.6	114.79	80.43	897.70	65.00	17.12	8.21	234.8	15.4	163.9
3	CO-05011	29.0	100.49	77.75	855.68	57.7	16.66	8.06	239.5	17.3	174.5
4	SEm	0.67	0.81	1.52	6.43	0.85	0.23	0.13	1.5	0.63	2.1
5	CD (P=0.05)	2.03	2.42	4.55	19.20	2.55	0.70	0.39	4.6	1.9	6.3
Fertility level NPK kg/ha											
1	150:45:30	33.9	106.88	79.12	855.55	61.23	17.34	7.87	230.9	14.9	158.5
2	200:60:40	32.9	113.41	83.31	905.53	63.90	17.72	8.60	244.8	17.8	165.9
3	250:75:50	27.2	116.88	80.81	897.04	63.00	17.45	8.25	239.0	15.3	189.8
4	SEm	0.67	0.81	1.52	6.43	0.85	0.22	0.13	1.5	0.63	2.1
5	CD (P=0.05)	NS	2.42	4.55	19.20	2.55	NS	0.39	4.6	1.93	6.3

Summer planting :

Summer (April) planted crop exhibited lower germination (31.33%) than spring-planted one (38.33) COPK-05192 maintained its superiority for higher germination during both the seasons. Summer cane produced lesser number of tillers over the period due to less time available for tillering. These results are in close conformity with the results obtained by Pandey and Shukla (2003). COPK-05191 produced the highest number of millable canes. Cane yields of COPK-05191 and COPK-05192 were at par during summer planting, indicating better competitive ability of former genotypes when planted in summer season compared to spring season. It may be due to favourable weather condition for the better germination and initial growth of subtropical spring season sugarcane. Sowing under spring season crop growth performance was better than the summer sowing. The total amount of dry matter production in spring season sugarcane is responsible in total amount of radiation intercepted. High plant establishment (drycott et al. 1974). Provided better leaf growth per unit area throughout the growing season. Highest CCS was obtained with COPK-05191. It was owing to higher cane yield and quality of COPK-05191. Planting of various high sugar genotypes in summer (April) exhibited variation in sucrose accumulation pattern over spring cane so through selection of genotypes the high sugar of good quality could be harvested even in the summer season under north Indian conditions.

Various Fertility levels could not influence germination of sugarcane significantly (Table 2 production of tillers millable canes and cane length increased significantly. Higher cane weight and cane yield were obtained up to 200:60:40 NP and K/ha. Higher cane yield was obtained because of production of millable canes and cane weight and it led to finally higher CCS at similar fertility level. Nutrient application beyond 200:60:40 NP and K/ha could not show significantly impact on cane yield and CCS in summer planted cane.

Correlation coefficient among various major growth and yield contributing indicated highly positive relationship between these character (r = 0.75) and millable cane to cane yield (r = 0.73), indicating higher contribution of milable cane and cane length in cane yield. Millable cane contribution was higher to that of cane weight, which showed importance of earlier formed tiller in increasing cane productivity in north Indians conditions. Cane yield & CCS in spring planting were positively correlated (r = 0.808). It was due to increase in cane quality parameters in all the genotype.

Sustainability yield Index :

Sustainability yield index (XYI) was highest (0.570) in genotype COPK-05191 followed by COPK-05192 (0.535) & CO-05011 (0.453) in the different planting system (spring & summer). This was followed by recommended dose of fertilizer (200:60:40 NPK kg/ha). SYI was maximum (0.536) in 200:60:40 NPK kg/ha and lowest (0.501) in 150:45:30 NPK kg/ha. Sohlenius (1990) observed a reduction in Protozoa biomass following the decreasing or increasing the application of in organic fertilizer.

Nutrient uptake and economics :

Nutrient uptake by spring and summer crops determined (Table 2) at harvest stage showed that COPK-05191 removed the maximum NPK from soil during both the cropping seasons. Spring-planted crop analyzed higher mean values (246.4 kg N, 16.43 kg P_2O_5 and 192.2 kg K_2O/ha) of nutrient removal compared to counterpart summer planted cane (238.2, 16.0, and 171.4 kg NPK/ha) due to higher tonnage harvested. Increasing levels of NPK showed increase in nutrient removal through spring and summer cane. However, greater differences were observed in plant cane than in ratoon cane. Nutrient removal through planting spring and summer canes depicted positive balance with N and P in soil and negative balance with K. Spring cane (plant crop) showed higher nutrient uptake than its summer the trend was reversed in summer-planted cane. Singh and Yadav (1992) also reported similar results.

The increase in uptake of phosphorus might be due to the complexing properties of organic material which prevented the precipitation and fixation of nutrient and kept them in soluble form. These results are in accordance with those of Swarup (1993). Plant crop recorded significantly higher potassium uptake than the summer crop. Significant difference were noticed among treatments. The up take of K was season dependent, being low in cool winter month (Vijaya Shankar Babu, 2007).

Table 3 : Effect of genotype and fertility levels on sustainability yield index, economic and B:C ratio under different planting system (pooled for spring and summer, three cropping seasons).

S. No.	Treatment	Yield ton/ha (Spring & summer pooled)	Sustainability yield Index (SYI)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Genotypes						
1	COPK-05191	73.31 (29.92)	0.570	146620	95500	2.86
2	COPK-05192	69.60 (28.40)	0.535	139200	88080	2.72
3	CO-05011	64.58 (26.54)	0.453	129160	78040	2.52
4	SEm	0.55	-	-	-	-
5	CD	1.65	-	-	-	-
Fertility levels						
6	150:45:30	68.23 (27.85)	0.501	136460	85340	2.66
7	200:60:40	69.90 (28.53)	0-536	139800	88680	2.73
8	250:75:50	69.36 (28.29)	0.521	138720	87600	2.71
9	SEm	0.55	-	-	-	-
10	CD	1.65	-	-	-	-

Figures in the parenthesis are SD of mean.

Cost of production of spring and summer plant cane 51120 Rs/ha..

Higher benefit :

Higher benefit cost ratio was observed with COPK-05191 under both the plant and summer. In spring plant cane, benefit : cost ratio increased up to 200:60:40 kg N, P and kg/ha. The maximum benefit: cost ratio was found in COPK-05191 (2.86).

REFERENCES:

Draycott, A.P. Durrant, M.J. and Webb, D.J. 1974. Effect of plant density, irrigation and potassium sodium fertilizers on sugar beet. J. Agric. Science Camb., 82 : 251-259.

Pandey, M.B. and Shukla. S.K. 2001. Response of sugarcane (*Sacharum spp. Hybrid complex*) to planting seasons and nitrogen levels, Indian Journal of Agricultural Sciences 71 (4) : 261-263.

Pandey, M.B. and Shukla. S.K. 2003. Growth-cum-tillering pattern and its effect on productivity of sugarcane ((*Sacharum spp. Hybrid complex*) genotypes under different planting seasons and nitrogen levels in subtropical India. Indian Journal of Agricultural Sciences 73 (1) : 23-28.

Shukla, S.K. 2007. Growth, yield and quality of high sugarcane (*Sacharum officinarum*) genotype as influenced due to planting seasons and fertility levels. Journal of Agricultural Sciences 77 (9) : 569-573.

Singh, G.B. and Yadav, D.V., 1992. Integrated nutrient supply system in sugarcane and sugarcane-based cropping system. Fertilizer News 37 : 15-22.

Shukla, S.K. 2007. Productivity and economics of high-sugar genotype of sugarcane (*Sacharum officinarum Hybrid complex*) in plant ratoon system under various planting seasons and fertility levelsm, Indian Journal of Agronomy 52 (2) : 164- 167.

Swarup, A 1993. Integrated nutrient supply management system for sustained crop production in Alkali Soil. Fertilizer News 38 : 27-34.

Sohlenius, B. 1990. Influence of cropping system an nitrogen input on soil fauna and micro-organism in a Swedish arable soil. Biology and fertility of soils 9 : 168-171.

Tripathi, B.K. 1998. Breeding strategy and varietal planting for improving ratio yield in sugarcane (*Sacharum spp. Hybrid complex*). (In) Abstracts of National Seminar of Sugarcane Ratoon Management, held at Indian Institute of Sugarcane Research, Lucknow, during 8-10 August, 1998, pp. 19.

Vyaya Shankar Babu, M. Mastan Reddy, C. Subramanyam, A. and Balaguravaiah, D. 2007. Effect of infegrated use of organic and inorganic fertilizer on productivity of sugarcane ratoo in Bangladesh. Suger. Tech. (2&3) : 20-23.

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