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Evaluation of growth, yield and quality of sugarcane genotypes under varying fertilizer levels

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Abstract
Field experiment entitled "Evaluation of Growth, Yield and Quality of Sugarcane Genotypes under Varying Fertilizer Levels" was conducted at Vasantdada Sugar Institute, Pune under the AICRP programme during the year 2024-25, to evaluate the performance of promising sugarcane genotypes under different fertilizer levels. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications, comprising two fertilizer levels, *viz.*, 100% RDF and 125% RDF, and twelve sugarcane genotypes. The results revealed that application of 125% RDF significantly improved tiller count, millable cane population, growth attributes and cane yield compared with 100% RDF. The highest cane yield (101.82 t ha^{-1}) was recorded with 125% RDF, while its effect on CCS yield and juice quality parameters was non-significant. Among genotypes, Co 18013 recorded the highest tiller count (117.00 thousand ha^{-1}), whereas Co 18003 recorded the highest millable cane population (87.75 thousand ha^{-1}). Co 18012 recorded the highest cane yield (115.50 t ha^{-1}), while Co 18003 recorded the highest CCS yield (16.90 t ha^{-1}). Co 18003 also recorded superior juice quality with respect to Brix (23.83°) and sucrose (22.39%). The highest benefit: cost ratio was recorded in CoVc 18061 (1.58). The interaction between fertilizer levels and genotypes was non-significant for all the parameters, indicating a uniform response of genotypes to fertilizer levels. Overall, 125% RDF improved cane productivity, while Co 18012 and Co 18003 were superior for cane yield and CCS yield, respectively, demonstrating the importance of suitable fertilizer management and genotype selection for enhancing sugarcane productivity and profitability.

Keywords: Sugarcane, genotypes, fertilizer levels, yield, juice quality, economics

Introduction
Sugarcane is one of the world's most important commercial crops, contributing significantly to sugar, ethanol, and bioenergy production. India is one of the leading sugarcane-producing countries and plays a vital role in the global sugar industry. Being a long-duration and high biomass-producing crop, sugarcane requires a continuous and adequate supply of essential plant nutrients for optimum growth, development, cane yield, and sugar production. Among the major nutrients, nitrogen, phosphorus, and potassium play a crucial role in regulating vegetative growth, root development, tillering, photosynthetic activity, assimilate translocation, and overall crop productivity (Kumar *et al.*, 2020). Fertilizer management is one of the important agronomic practices for enhancing sugarcane productivity and maintaining efficient nutrient utilization. Imbalanced or inadequate nutrient supply can adversely affect crop growth and yield, while excessive application of fertilizers may reduce nutrient-use efficiency and increase production costs. Therefore, application of fertilizers at optimum levels according to crop requirement is essential for achieving higher cane and sugar productivity. The fertilizer requirement of sugarcane may also vary among genotypes due to differences in nutrient uptake, utilization efficiency, growth potential, and yield response. Evaluation of elite sugarcane genotypes under different fertilizer levels is therefore important for identifying genotypes with superior nutrient responsiveness and yield potential (Tayade *et al.*, 2024) [8]. Different fertilizer levels can influence important agronomic traits such as tiller production, millable cane population, cane yield, sugar yield, and quality attributes. The interaction between genotype and fertilizer level is particularly important because superior genotypes may respond differently to increased nutrient availability. Hence,

selection of suitable genotypes along with an appropriate fertilizer level can contribute to improved resource-use efficiency and sustainable sugarcane production. Therefore, the present study was undertaken to evaluate the elite sugarcane genotypes under different fertilizer levels by assessing their growth, yield, and quality attributes. The findings will aid in identifying promising genotype × fertilizer combinations for enhancing cane and sugar productivity under the prevailing agro-climatic conditions.

Materials and Methods

The present investigation entitled "Evaluation of Growth, Yield and Quality of Sugarcane Genotypes under Varying Fertilizer Levels" Was conducted at Vasantdada Sugar Institute, Pune under the AICRP programme. The experimental soil was medium deep black soil with pH 8.2, electrical conductivity of 0.30 dS m^{-1} and organic carbon content of 0.99 per cent. Initial soil analysis indicated available nitrogen, phosphorus and potassium of 232.1, 71.7 and 653.5 kg ha^{-1}, respectively.

The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications, comprising two fertilizer levels and twelve sugarcane genotypes. The fertilizer treatments consisted of F_1: 100% RDF and F_2: 125% RDF, while the genotypes included Co 18001, Co 18002, Co 18003, Co 18009, Co 18012, Co 18013, Co 18024, CoVc 18061, CoN 18071, CoN 18072, CoVSI 18121 and zonal check Co 09004. The crop was planted at a wider row spacing of 150 cm following the recommended package of practices for Suru sugarcane. The recommended fertilizer dose of 250:115:115 kg $N:P_2O_5:K_2O$ ha^{-1} was applied at 100 and 125 per cent of RDF. Nitrogen was applied in four splits, whereas P_2O_5 and K_2O were applied in two splits, with 50 per cent at planting and the remaining 50 per cent at earthing-up. The observations on growth, yield, juice quality and economic parameters were subjected to analysis of variance appropriate for FRBD.

Results

Effect of Fertilizer Levels

The results presented in Tables 1 to 3 revealed that fertilizer levels significantly influenced the growth and yield performance of sugarcane. Application of 125% RDF recorded significantly higher tiller count (97.67 thousand ha^{-1}) at 120 DAP and millable cane population (77.21 thousand ha^{-1}) compared with 100% RDF. The higher tillering and millable cane population under 125% RDF could be attributed to improved nutrient availability, which promoted vigorous vegetative growth and better tiller establishment and survival. Similar findings were reported by Shukla (2010) [6] and Kumar *et al.* (2014) [4], who observed improved tillering and millable cane population with higher fertility levels. The higher millable cane population together with improved cane growth resulted in significantly higher cane yield (101.82 t ha^{-1}) under 125% RDF. The superiority in cane yield was associated with significantly higher internodal girth (10.27 cm), plant height (293.59 cm) and single cane weight (1.68 kg). Higher nutrient availability under 125% RDF probably enhanced vegetative growth and assimilate accumulation, resulting in better cane development and individual cane weight. Similar improvement in growth and yield attributes with higher fertility levels was reported by Kumar *et al.* (2014) [4] and Singh *et al.* (2014) [7]. The number of internodes was not significantly influenced by fertilizer levels, indicating that this trait may be comparatively less responsive to nutrient application and more influenced by genetic and environmental factors. Although the highest CCS yield (14.98 t ha^{-1}) was recorded with 125% RDF, the differences among fertilizer levels were non-significant. Similarly, fertilizer levels did not significantly influence juice-quality parameters, suggesting that quality traits were relatively less responsive to increased fertilizer application under the present conditions. Singh *et al.* (2014) [7] and Tayade *et al.* (2024) [8] also reported non-significant effects of fertility levels on major juice-quality parameters of sugarcane. The higher cane yield obtained with 125% RDF resulted in the highest benefit:cost ratio (1.38), indicating that the additional fertilizer investment was economically compensated through increased productivity. Overall, application of 125% RDF proved superior to 100% RDF by improving tillering, millable cane population, growth attributes, cane yield and economic returns, without causing a significant change in juice quality.

Effect of Genotypes

The data presented in Tables 1 to 3 revealed that different sugarcane genotypes significantly influenced tiller count, millable cane population, cane yield, CCS yield, growth and yield attributes, juice quality and benefit:cost ratio, indicating considerable genetic variability among the tested genotypes. At 120 DAP, Co 18013 recorded the highest tiller count (117.00 thousand ha^{-1}), which was statistically at par with Co 18003 (112.25 thousand ha^{-1}). The higher tiller production in these genotypes may be attributed to their inherent genetic potential for tillering and early vigour. Similarly, Co 18003 recorded the highest millable cane population (87.75 thousand ha^{-1}), which was statistically at par with Co 18001 (82.75 thousand ha^{-1}) and Co 18013 (81.25 thousand ha^{-1}). The higher millable cane population may be associated with better establishment and survival of productive tillers. Similar genotypic variation in tillering and millable cane population was reported by Pujer *et al.* (2024) [5] and Nirmal *et al.* (2022) [2]. The highest cane yield (115.50 t ha^{-1}) was recorded in Co 18012, which was statistically at par with CoVc 18061 (113.13 t ha^{-1}), Co 18003 (104.57 t ha^{-1}) and Co 18001 (101.85 t ha^{-1}). The higher cane yield may be attributed to the better performance of yield-contributing traits in these genotypes. Among the growth and yield attributes, CoVc 18061 recorded the highest number of internodes (27), plant height (323.58 cm) and single cane weight (1.97 kg), whereas CoVSI 18121 recorded the highest internodal girth (11.71 cm). Co 18012 recorded maximum (317.00 cm) plant height and (1.91 kg) single cane weight. Similar genotypic variation in cane yield and its contributing characters was reported by Pujer *et al.* (2024) [5]. The highest CCS yield (16.90 t ha^{-1}) was recorded in Co 18003 followed by Co 18012 (16.62 t ha^{-1}). Juice quality parameters were also significantly influenced by genotypes, with Co 18003 recording the highest Brix (23.83°), sucrose (22.39%) and CCS (16.14%), followed by Co 18002 for Brix (23.77°), sucrose (21.53%) and CCS (15.27%). The superior juice quality of Co 18003 may be attributed to its inherent genetic potential for sugar accumulation and recovery. Similar genotypic variation in Brix, sucrose and CCS was reported by Tayade *et al.* (2024) [8]. The economic analysis revealed that CoVc 18061 recorded the highest benefit: cost ratio

(1.58) followed by Co 18012 (1.55), which may be associated with their favorable cane yield and yield-contributing characters. Overall, Co 18012 was superior for cane yield, Co 18003 for CCS yield and juice quality, while CoVc 18061 recorded the highest benefit: cost ratio, indicating the importance of genotype selection for improving sugarcane productivity, sugar recovery and economic returns under the prevailing conditions.

Table 1: Tiller count, millable cane count and cane yield as affected by different fertilizer levels and genotype

Treatment	Tiller count at 120 DAP (000'/ha)	NMC at harvest (000'/ha)	Yield (t/ha)	
			Cane	CCS
F1: 100% RDF	88.13	68.67	96.22	14.04
F2: 125% RDF	97.67	77.21	101.82	14.98
Sem±	1.18	1.02	1.43	0.33
C.D. @ 5%	3.45	2.98	4.17	NS
V1: Co 18001	95.75	82.75	101.85	14.25
V2: Co 18002	89.00	74.75	96.94	14.69
V3: Co 18003	112.25	87.75	104.57	16.90
V4: Co 18009	75.75	62.75	95.30	14.18
V5: Co 18012	86.75	70.00	115.50	16.62
V6: Co 18013	117.0	81.25	90.66	13.22
V7:Co 18024	84.25	64.50	94.26	13.24
V8: CoVc 18061	105.00	78.75	113.13	14.60
V9:CoN 18071	88.00	63.50	89.05	13.06
V10: CoN 18072	95.25	77.00	95.40	13.98
V11: CoVSI 18121	83.00	62.00	94.61	13.82
V12: Co 09004	82.75	70.25	96.97	15.56
Sem±	2.90	2.50	3.50	0.80
C.D. @ 5%	8.45	7.31	10.23	2.34
Interaction effect				
Sem±	4.10	3.54	4.95	1.13
C.D. @ 5%	NS	NS	NS	NS

Table 2: Growth & yield attributes of sugarcane as influenced by different fertilizer levels and genotype

Treatment	No. of internodes	Girth of internodes (cm)	Total plant height (cm)	Single cane wt. (kg)
Factor A: Fertilizer levels				
F1: 100% RDF	23.95	9.71	269.40	1.39
F2: 125% RDF	25.16	10.27	293.59	1.68
Sem±	0.43	0.12	5.02	0.05
C.D. @ 5%	NS	0.34	14.65	0.14
Factor B: Genotype				
V1: Co 18001	24.83	9.79	258.41	1.35
V2: Co 18002	24.83	9.91	291.50	1.59
V3: Co 18003	24.16	9.66	294.58	1.36
V4: Co 18009	23.00	9.80	288.67	1.56
V5: Co 18012	25.58	10.42	317.58	1.91
V6: Co 18013	25.75	9.04	260.00	1.10
V7:Co 18024	22.83	10.25	224.08	1.32
V8: CoVc 18061	27.00	10.25	323.58	1.97
V9:CoN 18071	21.25	10.21	265.33	1.47
V10: CoN 18072	25.58	9.50	292.00	1.58
V11: CoVSI 18121	24.25	11.71	279.47	1.78
V12: Co 09004	25.66	9.37	282.75	1.40
Sem±	1.06	0.29	12.30	0.12
C.D. @ 5%	3.10	0.84	35.91	0.35
Interaction F×V				
Sem±	1.50	0.41	17.40	0.17
C.D. @ 5%	NS	NS	NS	NS

Table 3: Quality parameters and economics as affected by different fertilizer levels and genotype

Treatment	Brix (%)	Sucrose (%)	CCS (%)	B: C ratio
Factor A: Fertilizer levels				
F1: 100% RDF	22.36	20.50	14.62	1.33
F2: 125% RDF	22.80	20.73	14.72	1.38
Sem±	0.22	0.26	0.20	-
C.D. @ 5%	NS	NS	NS	-
Factor B: Genotype				
V1: Co 18001	21.83	19.78	14.03	1.39
V2: Co 18002	23.77	21.53	15.27	1.32

V3: Co 18003	23.83	22.39	16.14	1.43
V4: Co 18009	22.74	20.82	14.83	1.30
V5: Co 18012	22.53	20.32	14.38	1.58
V6: Co 18013	21.63	20.32	14.65	1.24
V7:Co 18024	22.01	19.85	14.05	1.29
V8: CoVc 18061	20.92	18.35	12.82	1.55
V9:CoN 18071	22.99	20.70	14.64	1.22
V10: CoN 18072	22.88	20.60	14.57	1.30
V11: CoVSI 18121	21.82	20.32	14.59	1.29
V12: Co 09004	24.06	22.37	16.06	1.33
Sem±	0.55	0.63	0.50	-
C.D. @ 5%	1.61	1.83	1.45	-
Interaction F×V				
Sem±	0.78	0.89	0.70	-
C.D. @ 5%	NS	NS	NS	-

Conclusion

The application of 125% RDF (i.e**.,** 25% extra fertilizer dose over RDF**)** recorded the maximum cane yield (101.82 t/ha) and CCS yield (14.98 t/ha)**.** However, the increase was found to be non-significant. With respect to genotypic performance, the genotype Co 18012 produced the highest cane yield (115.50 t/ha)**,** while Co 18003 recorded the maximum CCS yield (16.90 t/ha)**,** surpassing the rest of the genotypes evaluated.

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