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Evaluation of the quantitative and qualitative traits of elite sugarcane genotypes in the peninsular zone of Maharashtra under varying fertilizer levels

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Abstract
Study was carried out at the Vasantdada Sugar Research Institute (VSI), Manjari, Pune, in 2023–24 to evaluate the performance of elite sugarcane genotypes under the peninsular zones of Maharashtra. The growth and yield characteristics, cane yield, and quality performance of twelve sugarcane genotypes were assessed, in addition to three local checks. Throughout the trial, there was variation in the genotypes' behavior with respect to cane yield, yield components, and quality. According to data, the maximum cane yield (108.36 t/ha) and CCS yield (16.01 t/ha) were achieved with the use of 25% more fertilizer dose than RDF. On the other hand, genotype Co 17002 showed the highest germination rate (66.75%), genotype Co 17005 registered 78.00 thousand/ha of millable cane at harvest. In comparison to the other genotypes, genotype Co 17001 recorded the highest CCS yield (19.63 t/ha), while genotype Co 17004 recorded the maximum Cane yield (126.71 t/ha). Co 17005 (23.95^{0}) showed superior brix quality, while genotypes Co 17001 showed the highest levels of sucrose (21.84%) and CCS (15.62%). It was discovered that genotype 17004 has the highest B:C ratio (1.73).

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

Introduction

Sugarcane (*Saccharum officinarum* L.) is the main sources of sugar in India and holds a prime position as a cash crop. The major challenges faced by the crop are lower productivity, low sugar recovery and higher cost of production. Elite genotypes play a pivotal role in increasing sugarcane yield. Use of inferior genotypes affects the sugarcane production negatively (Mian, 2006) [11]. Higher cane yield is the function of the higher genetic potential of a variety reported by Nazir *et al*. (1997) [12]. Sugarcane crop has a great potential if the high yielding improved varieties are evolved with proper agronomic operations through research and experimentation. Efforts are made to increase cane production by introducing high-yielding varieties and adopting improved crop production techniques (Gill, 1995) [5]. scope for the expansion of area under sugarcane is limited due to industrialization of cultivable land, the production has to be enhanced only through improved sugarcane genotypes and good management practices such as optimum plant spacing, nutrient management and *in-situ* trash management. Chattha *et al*. (2001) [3] reported the average cane yield of Punjab as 43 to 47 t/ha as compared with the average cane yield of improved varieties (90 to 100 t ha^{-1}) and its potential yield of 105 to 154 t/ha. Productivity of a genotype in favorable environment does not indicate its adaptability and stability. Whereas, performance of a genotype in diverse environments is a true evaluation practice of its inherent potential for adaptation (Kang and Miller, 1984). Selection of a proper variety to be planted in a particular agroecological zone is a primary requisite to explore its yield and sugar recovery potential. The productivity of sugarcane in India is quite low owing to several factors *viz.* poor management of crop, poor soil condition, abiotic and biotic stresses, etc. Adoption of balanced and judicious use of nutrients can help in improving cane productivity and enhancement of sugar recovery by rendering resistance against biotic and abiotic stresses and better synthesis and storage of sugar (Yadav, 1993) [18].

Besides, genotype, adequate nutrition plays important role in increasing sugarcane productivity. Sugarcane is crop of high response to its added inputs, soils often unable to match the supply during peak period of its demand, hence supplementing nutrition by organic or inorganic sources is obvious for producing targeted yield. (Singh *et al*. 2008) [15]. Sugarcane is a long duration crop it is a heavy feeder of nutrients. On an average a tonne of sugarcane removes 5, 1.15 and 5.25 kg of N, P_2O_5 and K_2O respectively from soil. Soil alone cannot supplement such a huge quantity of nutrients required. Hence, nutrient demand has to be met at different stages of crop growth in a steady pace. Balanced use of plant nutrients is essential for sustaining the productivity of crops and soil. Yadav *et al*. (2014) [19].

Given the significance of the research, the current studies were conducted to evaluate how sugarcane genotypes performed in terms of yield and yield attributes under the agro climatic conditions of the peninsular zone.

Materials and Methods

The experiment was conducted at the Research Farm of Vasantdada Sugar Institute, Manjari, Pune. The experiment consists of two fertilizer levels *viz.* 100% RDF and 125% RDF and twelve genotypes *viz.* Co 17001, Co 17002, Co 17003, Co 17004, Co 17005, Co 17010, Co 17012, Co 17013, CoVC 17061, CoN 17072, MS 17082 and CoT17366 with three zonal check Co 86032, CoC 671, Co 09004 were evaluated in the factorial Randomized block design (RCBD) with three replications. The sugarcane genotypes were received under AICRP program. The soils of experimental area having pH 8.12, EC 0.52 dSm^{-1}, 1.08% of organic carbon, 307.30 kg ha^{-1} of available nitrogen, 66.10 kg ha^{-1} of available phosphorus and 622.20 kg/ha of available potassium. The genotypes were planted in first week of February (suru planting) by adopting all recommended agronomical practices. Two budded sets were planted in single wider row system. Recommended dose of fertilizer to *suru* season sugarcane crop were applied as per the treatment. (250: 115: 115 kg N, P_2O_5 and K_2O/ha). The application of nitrogen in four splits & P_2O_5 and K_2O application 50% at planting and 50% at final earthing up. The growth and yield performance and yield attributed characters were recorded as per schedule. The observations were taken in field on germination percentage, plant height, tiller count, single cane weight, length of nodes, diameter of cane and CCS yield tonnes per hectare and other quality parameters *viz*. $brix^0$, sucrose, CCS per cent. The data on cane yield and yield parameters were analyzed statistically and interpreted as suggested by Panse and Sukhatme (1978) [14] and economics were worked out.

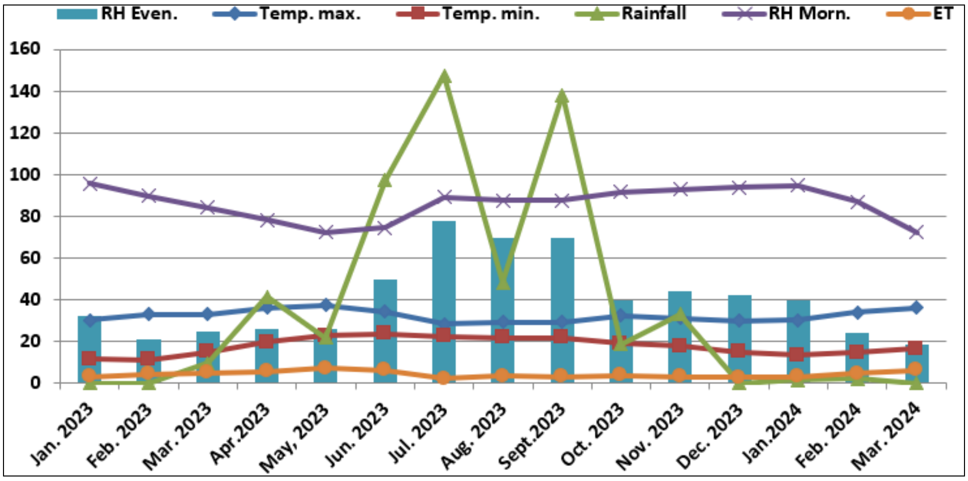

Fig 1: Weather parameters of experimental location

Results

The results presented in Tables 1, 2, and 3 showed the effects of different genotypes and fertilizer levels on growth, yield attributing characteristics, cane and CCS yield, juice quality and economics.

Effect of fertilizer levels

With the exception of tiller count at 120 DAP and CCS yield, the fertilizer application at 100 and 125% of recommended showed no effect on growth attributing characteristics, cane, and juice quality. In comparison to 100% RDF (86.37 thousand/ha), 125% RDF had the noticeably the highest tiller count (99.03 thousand/ha) at 120 DAP. The CCS yield in 125% RDF was found to be considerably higher (16.01 t/ha) than in 100% RDF (15.38 t/ha). According to the benefit cost ratio in Table 3, applying a 25% additional dose of RDF resulted in the maximum (1:1.48) B:C ratio. However, regardless of the genotypes of sugarcane grown in the suru season, higher results were found for the numerically suggested 125% fertilizer dose. The slight variation in growth and yield-related features suggested that adding more fertilizer than recommended dosage is not a good idea in order to maximize production. These results are corroborated with those of Thakur, *et al*. (1991) [16] and Bharathalakshmi *et al*. (2003) [2].

Effect of genotypes

The genotypes of sugarcane showed notably greater development and yield values attributed to individual traits.

The study analyzed the development and yield values of sugarcane genotypes, focusing on individual traits rather than their combined effects. The results showed that genotype Co 17002 had a significantly higher germination percentage (66.75%), followed by Co 17005 (61.75%), Co 17010 (59.75%), Co 17012 (61.38%), CoVC 17061 (62.63%), CoN 17072 (60.50%), MS 17082 (64.13%) and CoT 17366 (61.25%) respectively. However, genotype Co 17002 had no significant influence on tiller count at 120 DAP. The growth and yield attributes of the cane were significantly influenced by different genotypes. The number of internodes was non-significant, but genotype Co 17005 had a significantly higher plant height (283.83 cm) and a higher single cane weight (1.88 kg). The girth of the internode was found to be superior in genotype CoN

17072 (12.46 cm).

The millable cane population was significantly higher (78.00 thousand/ha) in genotype Co 17005. The cane yield was significantly higher in genotype Co 17004 (126.71 t/ha), while the CCS yield was higher (19.63 t/ha) in genotype Co 17001. The brix of genotype Co 17005 was higher (23.95^0), with genotype Co 17005 showing superior sucrose (21.32 %) and CCS percentages (14.99%). The maximum benefit cost ratio was secured by genotype Co 17004 (1:1.73) and Co 17001 (1:1.71).

This might be because of the variations in growth qualities, cane, CCS yield, and juice quality was the genotype's innate traits, which are unaffected by fertilizer treatment. This implied that all sugarcane genotypes varied genetically and that there was a significant degree of variability among them; as a result, these genotypes would benefit from selection. Genetic makeup is acknowledged to have a significant impact on sugarcane types (Junejo, *et al*., 2010 and El-Geddaway, *et al*., 2002) [6, 4]. The genetic differences across the kinds may be the cause of the variance in cane yield and yield components (Varghese *et al*., 1985; Mali and Singh, 1995) [9]. Panhwar, *et al*. (2008) [13] and Memon, *et al*. (2005) [10] noted significant variation in cane yield between sugarcane genotypes.

Interaction

It was discovered that the genotype and fertilizer level interaction had no significant effect on growth attributes such as cane, CCS yield and juice quality. These findings showed that fertilizer and the innate traits of sugarcane genotype independently control the growth, cane, CCS yield, and juice quality characteristics.

Table 1: Germination percentage, tiller count, millable cane population, cane and CCS yield as affected by different fertilizer levels and genotypes

Treatment	Germination At 30 DAP (%)	Tiller count at 120 DAP (000'/ha)	NMC at harvest (000'/ha)	Cane yield (t/ha)	CCS yield (t/ha)
Factor A: Fertilizer levels					
F_1: 100% RDF	56.73	86.37	69.20	106.96	15.38
F_2: 125% RDF	58.41	99.03	70.86	108.36	16.01
Sem±	0.91	4.37	1.48	0.83	0.18
C.D. @ 5%	NS	12.64	NS	NS	0.53
Factor B: Genotypes					
V_1: Co 17001	48.75	98.25	68.25	125.50	19.63
V_2: Co 17002	66.75	95.00	75.50	109.08	15.04
V_3: Co 17003	45.88	98.50	76.25	107.39	16.56
V_4: Co 17004	57.38	107.25	72.00	126.71	18.86
V_5: Co 17005	61.75	103.25	78.00	119.99	17.93
V_6: Co 17010	59.75	79.75	70.50	99.21	14.37
V_7: Co 17012	61.38	100.75	66.75	95.11	13.48
V_8: Co 17013	50.88	82.00	58.75	99.41	13.33
V_9: CoVC 17061	62.63	98.25	72.50	97.73	13.15
V_{10}: CoN 17072	60.50	86.25	54.00	92.79	12.98
V_{11}: MS 17082	64.13	88.75	58.75	103.13	14.23
V_{12}: CoT 17366	61.25	99.00	76.50	108.77	15.51
V_{13}: Co 86032	57.88	92.00	83.50	118.21	17.32
V_{14}: CoC 671	54.88	86.25	67.50	94.45	14.94
V_{15}: Co 09004	49.88	75.25	71.75	117.45	18.18
Sem±	2.49	11.97	4.06	2.29	0.50
C.D. @ 5%	7.23	NS	11.75	6.63	1.43
Interaction F×V					
Sem±	3.53	16.93	5.74	3.24	0.71
C.D. @ 5%	NS	NS	NS	NS	NS

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

Treatment	No. of internodes	Girth of internodes (cm)	Total plant height (cm)	Single cane wt. (kg)
Factor A: Fertilizer levels				
F_1: 100% RDF	22.24	10.25	230.29	1.44
F_2: 125% RDF	22.55	10.31	233.23	1.48
Sem±	0.40	0.13	4.59	0.04
C.D. @ 5%	NS	NS	NS	NS
Factor B: Genotypes				
V_1: Co 17001	21.33	11.12	257.92	1.82
V_2: Co 17002	20.25	9.92	260.75	1.41
V_3: Co 17003	21.25	10.08	211.75	1.35
V_4: Co 17004	23.00	10.54	246.58	1.88
V_5: Co 17005	22.42	9.62	283.83	1.55
V_6: Co 17010	22.25	9.33	240.91	1.32
V_7: Co 17012	22.42	10.37	214.91	1.37
V_8: Co 17013	21.33	9.67	182.41	1.13
V_9: CoVC 17061	25.66	9.71	240.50	1.32
V_{10}: CoN 17072	20.92	12.46	214.00	1.55
V_{11}: MS 17082	24.17	10.67	217.00	1.66
V_{12}: CoT 17366	22.75	10.09	232.50	1.38

V_{13}: Co 86032	21.42	10.38	212.91	1.42
V_{14}: CoC 671	22.25	10.21	198.25	1.17
V_{15}: Co 09004	24.58	10.08	262.17	1.61
Sem±	1.10	0.38	12.59	0.11
C.D. @ 5%	NS	1.10	36.42	0.33
Interaction F×V				
Sem±	1.56	0.53	17.80	0.16
C.D. @ 5%	NS	NS	NS	NS

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

Treatment	Brix (0^0)	Sucrose (%)	CCS (%)	B: C ratio
Factor A: Fertilizer levels				
F_1: 100% RDF	22.11	20.20	14.38	1.46
F_2: 125% RDF	22.20	20.56	14.72	1.48
Sem±	0.10	0.15	0.15	-
C.D. @ 5%	NS	NS	NS	-
Factor B: Genotypes				
V_1: Co 17001	23.69	21.84	15.62	1.71
V_2: Co 17002	21.53	19.46	13.79	1.49
V_3: Co 17003	23.01	21.45	15.41	1.47
V_4: Co 17004	22.29	20.73	14.88	1.73
V_5: Co 17005	23.95	21.32	14.99	1.64
V_6: Co 17010	22.13	20.30	14.48	1.35
V_7: Co 17012	20.85	19.65	14.18	1.30
V_8: Co 17013	20.78	18.90	13.43	1.36
V_9: CoVC 17061	21.55	19.20	13.51	1.33
V_{10}: CoN 17072	20.87	19.46	13.99	1.27
V_{11}: MS 17082	22.04	19.62	13.80	1.41
V_{12}: CoT 17366	21.96	20.02	14.24	1.49
V_{13}: Co 86032	21.18	20.29	14.75	1.61
V_{14}: CoC 671	23.22	21.91	15.82	1.29
V_{15}: Co 09004	23.38	21.63	15.48	1.60
Sem±	0.29	0.43	0.42	-
C.D. @ 5%	0.85	1.25	1.22	-
Interaction F×V				
Sem±	0.41	0.61	0.59	-
C.D. @ 5%	NS	NS	NS	-

Conclusion

The maximum cane (108.36 t/ha) and CCS yield (16.01 t/ha) were achieved with the use of 25% more fertilizer dose than RDF. On the other hand, genotype Co 17002 showed the highest germination rate (66.75%), genotype Co 17005 registered 78.00 thousand/ha of millable cane at harvest. In comparison to the other genotypes, genotype Co 17001 recorded the highest CCS yield (19.63 t/ha). The genotype Co 17004 recorded the maximum Cane yield (126.71 t/ha). Co 17005 (23.95^0) showed superior brix and genotypes Co 17001 showed the highest sucrose (21.84%) and CCS (15.62%). The highest B:C ratio was found in genotype 17004 (1.73).

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