International Journal of Environment and Climate Change

Volume 13, Issue 10, Page 2764-2772, 2023; Article no.IJECC.105000
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Response of Sugarcane Cultivars to Different Irrigation Regime under Peninsular Zone of Maharashtra, India

A. S. Patil [a++], G. R. Pawar [a++*] and B. S. Thorat [a#]

[a] *Department of Agriculture Science and Technology, Vasantdada Sugar Institute, Pune, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI:10.9734/IJECC/2023/v13i102940

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/105000

Original Research Article

Received: 18/06/2023
Accepted: 23/08/2023
Published: 09/09/2023

ABSTRACT

A field experiment was conducted during the years 2019-20, 2020-21 and 2021-22 suru seasons with eight sugarcane cultivars and two irrigation regimes were evaluated in the strip plot design with three replications. The impact of water stress on various morphological characters such as plant height, leaf area, leaf area index and tiller count was recorded at 0.3 and 1.0 IW/CPE irrigation regime. Drought treatment caused an average reduction of 11.10, 33.47, 29.08, 15.33, 22.14 and 18.78 % in plant height, leaf area index, specific leaf weight, dry matter, root dry matter at 200 DAP and cane yield respectively. Cultivar VSI 08005 and CoM 0265 transpired less water and showed relatively higher photosynthetic rate with significant improvement in growth attributes, viz., plant height, leaf area index, specific leaf weight, dry matter accumulation and root dry weight as well as single cane weight and cane yield. Yield and its parameters showed remarkable changes due to inadequate water availability during the formative phase. Water stress led to a reduction in cane and sugar yield to the tune of 23.00 and 29.05 percent.

[++] *Scientific Officer;*
[#] *Research Associate;*
**Corresponding author: E-mail: p.ganesh138@gmail.com;*

Keywords: Sugarcane; irrigation regimes; cultivars, growth; physiological behavior; cane yield.

1. INTRODUCTION

Water stress is the single most important factor limiting the productivity of sugarcane and it affects yield by 50%. The total water requirement of sugarcane varies from 1850 to 2500 mm. It has been estimated that the sugarcane crop consumes about 250 tons of water per Tons of cane produced. Nearly 60% of the total sugarcane area suffers from water stress. Water stress especially during summer months coincides with the formative phase of the crop which affects the final yield through a reduction in tiller productivity, number of millable canes, individual cane weight, cane height, cane girth and finally the cane yield and juice quality [1]. The increasing demand of sugar production and the scope for further increase in area under sugarcane cultivation being limited and the evolution of drought-resistant varieties has become a major research priority. The morphological and physiological responses lead to some adaptations to drought stress and may vary considerably among species [2]. The degree of tolerance to environmental stress varies not only between species but in different varieties of the same species. The effects of water stress on plants are complex and the plants generally respond with protective adaptations. An understanding of the physiological processes in relation to production is essential for identifying physiological criteria for the evolution of drought-resistant varieties [3]. Drought is a major abiotic constraint for sugarcane as it is a highly water demanding crop. Superior varieties must hence be selected and evaluated under moisture stress environment wherein the competitive advantage for one cultivar over another is likely to be greater under stress [4]. This study goals to gain an early selection of sugarcane promising cultivars to provide early knowledge about the promising cultivars which could be used in sugarcane breeding programs as well as stable cane production under drought tolerance. Thus, eight sugarcane cultivars were tested under two water regimes to select at early stage of growth and development.

2. MATERIALS AND METHODS

The experiment was conducted at the research & development farm (B-16) of Vasantdada Sugar Institute, Manjri, Pune (Latitude: 18.52. Longitude: 73.97). The experimental treatment consisted of eight cultivars namely V_1- CoM0265, V_2- VSI 08005, V_3- Co86032, V_4-CoVSI18121and V_5- VSI12003, V_6- CoVSI03102, V_7-CoVSI13020 and V_8- VSI434 and two irrigation regimes (I_1: 0.3 IW/CPE and I_2: 1.0 IW/CPE) were evaluated in the Strip plot design with three replications. Each plot size was 8.00 m (L) X 5.40 m having 4 rows at 1.35 meters row to row distance. The cultivars were planted the second week of February (suru planting) by adopting all recommended agronomical practices. Two eye bud sets were planted in a single row system. Recommended dose of suru season sugarcane crop were applied i.e., 250: 115: 115 Kg N, P_2O_5 and K_2O/ha. The application nitrogen in four splits & P_2O_5 and K_2O application- 50% at planting and 50% at final earthing up. The nutrient status of soil tested before planting of crop gives 7.90 pH (slightly alkaline), 0.33 EC, high Organic Carbon (0.90), low nitrogen (264.10) and very high phosphorus (54.21) and potassium (628.46) having medium deep black. The growth and yield performance and other yield-attributed characters were observed as per the schedule and at the time of maturity. The observations taken in the field are plant height, leaf area index, specific leaf weight, dry matter, root dry matter, single cane weight, length of nodes, diameter of cane and yield quintal per hectare and other quality parameters viz. brix, sucrose and purity percentage. Commercial cane sugar percentage and CCS yield (tha^{-1}) was also recorded. The juice quality will be analyzed as per the procedure outlined by Spencer and Meade [5]. The data on cane yield and yield parameters were analyzed statistically using analysis of variance and LSD test was applied to discriminate the superiority of the means of different varieties as suggested by Gomez and Gomez [6].

3. RESULTS AND DISCUSSION

3.1 Effect of Irrigation Levels on Growth, Yield Attributes and Quality of Sugarcane

Reduction in tiller count, leaf area index, specific leaf weight, dry matter and root dry matter due to drought was found to be significant among irrigation regimes (Table 1 and 2). A perusal of data revealed that the significantly highest tillers count (0.55, 1.31lakh/ha) at 90 & 120 DAP and higher value (1.26 lakh/ha) of tiller was found at 150 DAP in treatment application of irrigation at 1.0 IW/CPE ratio. While, any of the treatment does not exert any significant effect on tiller count at 60 DAP. It was Indicated that different irrigation levels manifest their significant effect on leaf area index at 100, 150 and 200 DAP, but it was non-significant at 50 DAP. Among the treatments irrigation at 1.0 IW/CPE ratio recorded significantly the highest (0.64, 1.41, 2.33) leaf area index at 100, 150 & 200 DAP respectively. Hoang et al. [7] 2019 and Gaber et al. [8] 2021 showed that the leaf area was reduced in drought-stressed plants compared with the well watered plants so, this trait might be grateful for improving drought tolerance in sugarcane. The result showed that different irrigation levels manifest their significant effect on sp. leaf wt. at 100, 150 and 200 DAP, but it was non-significant at 50 DAP. Among the treatments irrigation at 1.0 IW/CPE ratio recorded significantly highest (76.86, 126.07, 238.87 g/m^2) sp leaf wt. at 100, 150 & 200 DAP respectively. In sugarcane, the inhibited stalk and leaf growth and enhanced deep large roots are the first morphological adaptation after sugarcane plants are exposed to minor or moderate water deficit conditions [9]. Likewise, under water deficit conditions roots become clumped and hence the facility of water uptake [10].

The result furnished in Tables 1 and 2 showed that different irrigation levels manifest their significant effect on dry matter accumulation at 100, 150 and 200 DAP, but it was non-significant at 50 DAP. Among the treatments irrigation at 1.0 IW/CPE ratio recorded significantly highest (14.72, 30.01 & 44.16 t/ha) dry matter accumulation at 100, 150 & 200 DAP respectively. Drought stress hampers plant growth and developmental processes including leaf area, leaves number and dry matter production, due to impaired cells elongation and division by limited turgor [9]. These significantly decreases in the shoot weight of drought stressed sugarcane may attribute to that, water deficit reduced the photosynthetic rate comparing to non-stressed plants [7]. Because that, water deficit stress is highly affected on sugarcane by the intense growth stage [11]. The limited vegetative growth and development by drought stress may be due to water shortage inhibiting cells division and elongation [9]. Therefore, Farooq et al [12] reported that, water is necessary for plant nutrients uptake and transportation. The different irrigation levels exert their significant effect on root dry weight at 100, 150 and 200 DAP, but it was non-significant at 50 DAP. Among the treatments irrigation at 1.0 IW/CPE ratio recorded significantly highest (17.64, 22.48 & 29.71 g/stool) root dry weight at 100, 150 & 200 DAP respectively.

The mean data on yield attributes like No. of internodes, length of internodes, girth of internodes, millable cane height, total cane height, Numbers of millable cane at 12 MAP, single cane wt., cane yield, juice extraction percentage and quality parameter as influenced by different irrigation levels were presented in Table 3. Among the treatments irrigation at 1.0 IW/CPE ratio recorded significantly highest internode length (12.52cm), girth (11.23 cm), millable cane height (253.58 cm), total cane height (278.20) and single cane wt. (1.67 kg), but no. of internodes found to be non-significant. The results suggested that cane height under drought situation is determined by the length of the internodes rather than the number.

The results of juice quality parameters viz. brix%, sucrose%, CCS% and juice extraction percentage recorded after harvest were indicated that, different irrigation levels failed to exert its significant effect. It opined that a different irrigation level significantly affects the cane yield. Treatment (I_2) application of irrigation water at 1.0 IW/CPE ratio gave significantly the highest cane yield (122.42 t/ha) over application of irrigation water at 0.3 IW/CPE ratio. It was revealed that different irrigation levels positively impacted on CCS yield. Treatment (I_2) application of irrigation water at 1.0 IW/CPE ratio recorded the significantly highest CCS yield (19.83 t/ha).

3.2 Effect of Cultivars on Growth, Yield Attributes and Quality of Sugarcane

The presented data given in table 1 and 2 regarding tiller count, leaf area index, specific leaf weight, dry matter and root dry matter showed significant differences among the cultivars. Cultivar Co 86032 registered significantly higher tiller count (0.52, 0.70, 1.40 & 1.36 lakh/ha) at 60, 90, 120 & 150 DAP, but more or less at par with cultivars CoM 0265, VSI 08005, CoVSI18121 & VSI 12003. Whereas significantly minimum tiller count (0.31, 0.39, 1.17 & 1.12 lakh/ha) registered by VSI 434 during 60, 90, 120 & 150 DAP respectively.

The result confirmed that different cultivars exert their significant effect on leaf area index at 100, 150 and 200 DAP, but it was non-significant at 50 DAP. Significantly higher leaf area index (0.67, 1.42, and 2.23) was observed under cultivar VSI 08005 at 100, 150 & 200 DAP respectively, but remained at par with CoM 0265, Co 86032, CoVSI18121 at 100 & 150 DAP and cultivars CoM 0265, Co 86032, CoVSI18121 & CoVSI13020 found at par at 200 DAP. The differences in their ability to maintain leaf area and leaf area index might be associated with drought tolerance through the maintenance of high leaf water potential. Results of the correlation analysis of plant characteristics with yield also indicated that LAI was significantly and positively correlated with yield under drought stress conditions. Hence, the maintenance of better LAI is an indicator of drought tolerance. Continuous water stress decreased the leaf expansion thus suggesting the mechanism of leaf size determination under water stress. This was in confirmation with earlier reports that expansion and growth were severely affected by moisture stress [13]. The result presented in Table 2 showed that different cultivars exert a significant effect on sp. leaf wt. at 50, 100, 150 and 200 DAP. cultivars CoVSI 03102 recorded maximum value (36.86 g/m^2) at 50 DAP but at 100, 150 & 200 DAP cultivars VSI 08005 gained significantly higher values 78.69, 132.21 & 240.70 g/m^2 respectively which was statistically at par with CoM 0265, Co 86032 & CoVSI 18121 at 50 & 100 DAP, with CoVSI 03102 at 150 DAP and at 200 DAP CoM 0265, Co 86032, CoVSI 03102 & CoVSI18121 found at par. Whereas, significantly lower sp. leaf wt. 29.19, 65.67, 103.38 g/m^2 at 50, 100 & 150 DAP respectively was observed under cultivars VSI 434 but sp. leaf wt. at 200 DAP was found lower 178.36 g/m^2 in the variety VSI 12003.

The result presented in Table 3 showed that different cultivars exert their significant effect on dry matter accumulation at 50, 100, 150 and 200 DAP. Cultivar CoVSI18121 recorded maximum dry matter accumulation (3.31 t/ha) at 50 DAP, while at 150 DAP cultivar CoM 0265 received higher (32.71 t/ha) dry matter accumulation, but at 100 & 200 DAP cultivar VSI 08005 gained significantly higher dry matter accumulation 15.70 & 47.27 t/ha respectively which was more or less statistically on same line with CoM 0265, VSI 08005, Co 86032 & CoVSI18121. Apparently, significantly minimum dry matter accumulation 2.51, 9.04, 20.24 & 32.36 t/ha at 50, 100, 150 & 200 DAP respectively was observed under cultivar VSI 434.The different cultivars exert their significant influence on root dry weight at 50, 100, 150 and 200 DAP. Cultivar VSI 08005 recorded significantly higher root dry weight (9.70, 28.60, 33.25 g/stool) at 50, 150 & 200 DAP respectively, while at 100 DAP cultivar CoM 0265 received higher (22.12 g/stool) root dry weight. Whereas, significantly minimum root dry weight 5.03, 11.47, 20.03 g/stool at 50, 100 & 200 DAP respectively was observed under cultivar VSI 434, while cultivar CoVSI 13020 registered lower root dry weight 16.27 g/stool at 150 DAP.

In the present study, cane girth and number of internodes did not show appreciable reduction due to water stress. The mean data pertaining to No. of internodes, length of internodes, girth of internodes, millable cane height, total cane height, Numbers of millable cane at 12 MAP, single cane wt., cane yield, juice extraction percentage and quality parameter are presented in table 3. Revealed that, No. of internodes and length did not influence by cultivars, but cultivar VSI 08005 registered significantly maximum girth (11.90 cm), millable cane height (254.83 cm), total cane height (290.50 cm) & single cane weight (1.97 kg) but statistically not different from CoM 0265, Co 86032, CoVSI18121 & CoVSI 03102. While, cultivar VSI 434 showed lower cane girth 10.28 cm and single cane wt. 1.17 kg, whereas lower millable cane height 202.83 cm and total cane height 232.17 cm observed under cultivar CoVSI 13020. These observations were in accordance with Naidu and Venkataramana [1] who have observed a reduction in cane yield and millable cane number due to drought treatment during the formative phase.

Drought is a major limiting factor for sucrose accumulation and stress at the formative phase affects sucrose synthesis [1]. Brix representing total soluble solids present in juice showed a general mean of 23.30 in control and 22.17 under drought. The mean data on juice quality as influenced by varieties are presented in Table 3. Showed that, any of the variety does not pose any significant effect on juice quality, but the maximum juice extraction percentage (44.53%) noted in VSI 08005 and brix (23.58), sucrose (22.02%) and CCS (15.80%) was observed in VSI 434. An adequate quantity of water is essential for the formation of sucrose and its transport to the stem. Small changes in the moisture content of green leaves affected the equilibrium between simple sugar and sucrose%. In the present study, under drought treatment, Co86032 recorded the lowest sucrose and purity of 20.53% and 94.04% and VSI434 recorded the highest sucrose and purity (22.81% and 95.24%). This could also be due to the differences in sucrose accumulation and translocation from source to sink, as water supply determines the

Table 1. Tiller Count at 60, 90, 120 and 150 DAP and leaf area index and specific leaf wt., at 50 and 100, 150 and 200DAP as affected by irrigation levels and cultivars

Treatment details	Tiller Count at 60 DAP (lakh/ha)	Tiller Count at 90 DAP (lakh/ha)	Tiller Count at 120 DAP (lakh/ha)	Tiller Count at 150 DAP (lakh/ha)	Leaf area index at 50 DAP	Leaf area index at 100 DAP	Leaf area index at 150 DAP	Leaf area index at 200 DAP	Specific leaf wt. at 50 DAP (g/m^2)	Specific leaf wt. at 100 DAP (g/m^2)	Specific leaf wt. at 150 DAP (g/m^2)	Specific leaf wt. at 200 DAP (g/m^2)
Irrigation levels												
I_1: 0.3 IW/CPE	0.39	0.48	1.23	1.17	0.20	0.44	1.00	1.55	31.89	70.90	104.95	169.40
I_2: 1.0 IW/CPE	0.41	0.55	1.31	1.26	0.21	0.64	1.41	2.33	32.10	76.86	126.07	238.87
SEm±	0.006	0.010	0.009	0.014	0.002	0.025	0.03	0.10	0.31	0.52	2.03	10.23
C.D. @ 5%	NS	0.06	0.057	0.087	NS	0.15	0.21	0.65	NS	3.18	12.35	62.25
Cultivars												
V_1: CoM0265	0.46	0.56	1.38	1.34	0.25	0.60	1.34	2.12	35.13	73.95	125.70	238.53
V_2: VSI 08005	0.43	0.56	1.33	1.25	0.23	0.67	1.42	2.23	33.60	78.69	132.21	240.70
V_3:Co86032	0.52	0.70	1.40	1.36	0.23	0.59	1.21	2.04	34.15	75.24	112.46	208.05
V_4:CoVSI18121	0.46	0.62	1.36	1.33	0.26	0.62	1.27	2.08	35.41	76.91	116.68	212.41
V_5: VSI12003	0.34	0.55	1.30	1.24	0.20	0.52	1.12	1.84	31.19	74.83	117.18	178.36
V_6: CoVSI03102	0.39	0.43	1.16	1.15	0.17	0.53	1.11	1.81	36.86	78.32	118.02	214.65
V_7:CoVSI13020	0.34	0.44	1.16	1.13	0.19	0.50	1.14	1.96	30.49	72.42	113.67	193.29
V_8: VSI434	0.31	0.39	1.17	1.12	0.19	0.45	1.07	1.59	29.19	65.67	103.38	187.82
SEm±	0.03	0.04	0.039	0.045	0.020	0.040	0.07	0.11	0.63	1.26	4.89	13.61
Interaction (I X C)												
C.D. @ 5%	0.09	0.12	0.11	0.13	NS	0.12	0.22	0.33	1.93	3.74	14.85	41.30
SEm±	0.03	0.07	0.089	0.12	0.021	0.078	0.09	0.21	1.08	1.25	8.19	20.53
C.D. @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Dry matter accumulation and root dry wt., at 50, 100, 150 and 200 DAP as influenced by irrigation levels and cultivars

Treatment details	Dry matter accumulation at 50 DAP (t/ha)	Dry matter accumulation at 100 DAP (t/ha)	Dry matter accumulation at 150 DAP (t/ha)	Dry matter accumulation at 200 DAP (t/ha)	Root dry weight at 50 DAP (g/stool)	Root dry weight at 100 DAP (g/stool)	Root dry weight at 150 DAP (g/stool)	Root dry weight at 200 DAP (g/stool)
Irrigation levels								
I_1: 0.3 IW/CPE	3.00	11.65	27.53	37.39	7.57	13.85	18.26	23.13
I_2: 1.0 IW/CPE	3.15	14.72	30.01	44.16	7.13	17.64	22.48	29.71
SEm±	0.034	0.18	0.36	0.30	1.08	0.41	0.50	0.68
C.D. @ 5%	NS	1.10	2.24	1.87	NS	2.53	3.05	4.16
Cultivars								

Treatment details	Dry matter accumulation at 50 DAP (t/ha)	Dry matter accumulation at 100 DAP (t/ha)	Dry matter accumulation at 150 DAP (t/ha)	Dry matter accumulation at 200 DAP (t/ha)	Root dry weight at 50 DAP (g/stool)	Root dry weight at 100 DAP (g/stool)	Root dry weight at 150 DAP (g/stool)	Root dry weight at 200 DAP (g/stool)
V_1: CoM0265	3.23	13.73	32.71	45.72	7.68	22.12	25.97	31.29
V_2: VSI 08005	3.11	15.70	31.82	47.27	9.70	20.57	28.60	33.25
V_3:Co86032	3.18	12.43	28.55	41.52	7.32	16.59	22.41	28.33
V_4:CoVSI18121	3.21	14.00	30.11	38.75	6.24	15.12	21.17	28.63
V_5: VSI12003	2.96	13.24	28.59	36.63	7.77	13.92	19.20	23.66
V_6: CoVSI03102	3.31	14.76	28.67	41.00	7.74	13.29	16.82	24.13
V_7:CoVSI13020	3.07	12.62	29.56	42.99	7.34	12.93	16.27	23.30
V_8: VSI434	2.51	9.04	20.24	32.36	5.03	11.47	16.62	20.03
SEm±	0.064	0.28	0.34	0.47	0.86	0.92	0.87	0.97
C.D. @ 5%	0.19	0.83	1.05	1.45	2.63	2.81	2.64	2.94
Interaction (I X C)								
SEm±	0.089	0.45	0.49	0.77	1.94	1.10	0.92	1.56
C.D. @ 5%	NS	NS	NS	2.35	NS	NS	2.81	NS

Table 3. No. of internodes, length of internodes, girth of internodes, millable cane height, total cane height, Numbers of millable cane at 12 MAP, single cane wt., cane yield, juice extraction percentage and quality parameter as influenced by irrigation levels and cultivars

Treatment details	No. of internodes	Length of internodes (cm)	Girth of internodes (cm)	Millable cane height (cm)	Total cane height (cm)	Numbers of millable cane at 12 MAP	Single cane wt.(kg)	Cane yield (t/ha)	CCS yield (t/ha)	Juice extraction percentage	Brix (%)	Sucrose (%)	CCS (%)
Irrigation levels													
I_1: 0.3 IW/CPE	21.00	12.18	10.61	208.83	239.62	0.82	1.41	94.26	14.07	40.08	21.94	20.66	14.92
I_2: 1.0 IW/CPE	21.83	12.52	11.23	253.58	278.20	0.91	1.67	122.42	19.83	43.49	22.83	21.87	15.89
SEm±	0.27	0.03	0.03	6.43	3.96	0.012	0.020	3.98	0.30	1.70	0.36	0.23	0.16
C.D. @ 5%	NS	0.21	0.18	39.17	24.15	0.076	0.12	24.22	1.88	NS	NS	NS	NS
Cultivars													
V_1: CoM0265	21.04	12.31	11.16	236.50	257.33	0.93	1.94	136.45	20.73	41.04	22.10	21.13	15.27
V_2: VSI 08005	21.66	14.04	11.90	254.83	290.50	0.91	1.97	137.48	21.61	44.53	22.30	21.31	15.47
V_3:Co86032	22.00	12.36	11.13	239.50	264.83	0.93	1.66	104.97	18.24	42.91	23.29	21.38	15.26
V_4:CoVSI18121	21.28	13.37	11.18	242.50	270.17	0.90	1.70	110.45	17.05	42.28	22.69	21.39	15.44
V_5: VSI12003	20.73	11.19	10.78	212.50	238.83	0.84	1.47	104.14	16.12	44.18	22.03	21.19	15.42
V_6: CoVSI03102	22.66	12.57	10.91	247.33	275.33	0.82	1.73	100.44	15.71	40.92	22.57	21.49	15.75
V_7:CoVSI13020	20.79	11.12	10.95	202.83	232.17	0.84	1.27	99.64	15.31	39.65	22.51	21.14	15.23
V_8: VSI434	21.16	11.89	10.28	213.67	240.17	0.79	1.17	81.19	12.07	38.81	23.58	22.02	15.80
SEm±	0.63	0.72	0.38	11.09	12.16	0.028	0.15	10.53	1.53	1.84	0.52	0.49	0.39

Treatment details	**No. of internodes**	**Length of internodes (cm)**	**Girth of internodes (cm)**	**Millable cane height (cm)**	**Total cane height (cm)**	**Numbers of millable cane at 12 MAP**	**Single cane wt.(kg)**	**Cane yield (t/ha)**	**CCS yield (t/ha)**	**Juice extraction percentage**	**Brix (%)**	**Sucrose (%)**	**CCS (%)**
C.D. @ 5%	NS	NS	1.14	33.63	36.88	0.086	0.47	31.94	4.66	NS	NS	NS	NS
Interaction (I X C)													
SEm±	1.34	0.62	0.56	13.88	14.37	0.023	0.20	12.35	1.89	2.97	0.98	0.98	0.74
C.D. @ 5%	NS	NS	NS	NS	NS	NS	NS	37.46	5.76	NS	NS	NS	NS

Table 4. Interaction effects of irrigation levels and cultivars on dry matter accumulation at 200 DAP, Root dry weight at 150 DAP, cane yield and CCS yield

Irrigation levels	**I_1: 0.3 IW/CPE**	**I_2: 1.0 IW/CPE**	**I_1: 0.3 IW/CPE**	**I_2: 1.0 IW/CPE**	**I_1: 0.3 IW/CPE**	**I_2: 1.0 IW/CPE**	**I_1: 0.3 IW/CPE**	**I_2: 1.0 IW/CPE**
	Dry matter accumulation at 200 DAP (t/ha)		**Root dry weight at 150 DAP (g/stool)**		**Cane yield (t/ha)**		**CCS yield (t/ha)**	
Cultivars								
V_1: CoM0265	41.21	50.24	23.98	27.86	119.28	144.46	17.46	22.97
V_2: VSI 08005	42.53	52.01	25.95	31.25	108.59	152.31	17.15	23.07
V_3:Co86032	38.15	44.88	20.29	24.53	102.61	122.76	15.89	20.12
V_4:CoVSI18121	34.98	42.52	16.97	17.37	99.97	102.28	15.28	15.94
V_5: VSI12003	33.00	40.25	15.11	23.28	87.17	99.69	12.03	16.98
V_6: CoVSI03102	40.07	41.94	13.31	20.32	96.20	100.91	14.80	16.26
V_7:CoVSI13020	39.84	46.14	15.17	17.37	76.99	104.64	11.29	16.52
V_8: VSI434	29.36	35.37	15.37	17.87	63.31	99.07	9.08	15.02
SEm±	0.77		0.92		12.35		1.89	
C.D. @ 5%	2.35		2.81		37.46		5.76	
CV%	3.29		7.88		19.74		19.40	

translocation efficiency of assimilates. Lower juice sucrose might be due to greater production of immature internodes and maximum juice weight during maturity following release of moisture stress. A similar reduction in juice quality was observed in sugarcane [1,14,15].

An appraisal of data (Table 3) confirmed that, cultivar VSI 08005 registered significantly higher cane yield (137.48 t/ha), but in the same line with the CoM 0265 & CoVSI 18121. Cultivar VSI 434 recorded lower cane yield (81.19 t/ha). However, VSI 08005 and CoM 0265 showed higher cane and sugar yields under both stress and unstressed situations which might be attributed to its tolerant nature by way of maintenance of physiological, morphological and biochemical activities even under stress. Similarly, Yadav and Prasad [16] observed more reductions in cane yield at 25% available soil moisture regime in certain cultivars under sub-tropical conditions. The data indicated in table 3 showed that, cultivar VSI 08005 registered significantly maximum CCS yield (21.61 t/ha), but in the same line with the CoM 0265, CoVSI 18121 and Co 86032. The minimum CCS yield (12.07 t/ha) was registered by variety VSI 434 [17].

3.3 Interaction Effect between Irrigation and Cultivars

According to data furnished in Tables 1 to 3 revealed that, the interaction between irrigation levels and cultivars failed to exert its significant effect on growth parameters. A glimpse of data indicated that, the interaction between irrigation levels and cultivars on leaf area index and specific leaf weight at 50, 100, 150 & 200 DAP was found non-significant.

The data given in Table 4 revealed that, the interaction between irrigation levels and cultivars on dry matter accumulation was found to significant at 200 DAP. Treatment combination of application of irrigation water at 1.0 IW/CPE ratio and cultivar VSI 08005 registered significantly maximum (52.01 t/ha) dry matter accumulation, followed by treatment combination irrigation water at 1.0 IW/CPE ratio and cultivar CoM 0265 (50.24 t/ha). Whereas lowest dry matter accumulation (29.36 t/ha) recorded in treatment combination of application of irrigation water at 0.3 IW/CPE ratio and cultivar VSI 434. The interaction between irrigation levels and cultivars on root dry weight was found to significant at 150 DAP. The treatment combination of application of irrigation water at 1.0 IW/CPE ratio and cultivar VSI 08005 registered significantly highest (31.25 g/stool) root dry weight, followed by treatment combination irrigation water at 1.0 IW/CPE ratio and cultivar CoM 0265 (27.86 g/stool). Whereas the least root dry weight (13.31 g/stool) was recorded in treatment combination of application of irrigation water at 0.3 IW/CPE ratio and cultivar CoVSI 03102.

The interaction between different irrigation levels and varieties on juice quality parameters was non-significant. The interaction effect between irrigation levels and cultivars was found to be significant as presented in table 4 revealed that treatment combination of application of irrigation water at 1.0 IW/CPE ratio and variety VSI 08005 registered significantly maximum (152.31 t/ha) cane yield, which was remained at par with treatment Combination I_1V_1, I_2V_1, I_2V_3. Whereas lower cane yield (63.31 t/ha) was recorded in treatment Combination of application of irrigation water at 0.3 IW/CPE ratio and variety VSI 434.The interaction effect between irrigation levels and varieties was found to be significant that treatment combination of application of irrigation water at 1.0 IW/CPE ratio and variety VSI 08005 registered significantly maximum (23.07 t/ha) CCS yield, which remained on same line with treatment combination I_1V_1, I_2V_1, I_2V_3. Whereas lower CCS yield (9.08 t/ha) was recorded in treatment combination of application of irrigation water at 0.3 IW/CPE ratio and variety VSI 434.

4. CONCLUSION

Apparently, it can be concluded that, for maintaining high crop performance (plant population, improved growth attributes, physiological attributes) and securing maximum cane productivity, irrigation should be given at 1.0 IW/CPE ratio and with respect to varieties VSI 08005, CoM 0265, Co 86032 & CoVSI18121 showed elevated performance under irrigated as well as water deficit condition.

ACKNOWLEDGEMENT

We are thankful to Mr. Sambhaji Kadupatil, Director General, Vasantdada Sugar Institute, Pune for his encouragement during this research work and giving permission to publish this article. Authors are also thankful to scientists and supporting staff of crop production division for their help during the field experimentation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Naidu KM, Venkataramana S. Sugar yield and harvest index in water stressed cane varieties. Sugarcane. 1989;6:5-7.
2. Souza RP, et al. Photosynthetic gas exchange, chlorophyll fluorescence and some associated metabolic changes in cowpea during water stress and recovery. Env. Exp. Bot. 2004;51:45-56.
3. Gururaja Rao PN Adaptive response of sugarcane genotypes to water stress. Dissertation. Madras University, India; 1994.
4. Hurd EA Plant breeding for drought resistance. In. (Kozlowski TT, ed.). Water deficit and plant growth. Academic press. New York. 1976;317-353.
5. Spencer GI, Meade GP. Cane sugar hand book. 9th ed, G. P. Meade, John Wiley and Sons. Inc. New York; c1963;35-80.
6. Gomez KA, Gomez AA. Statistics for agricultural research (3rd ed.) John Willey and Sons, New York; c1984;142.
7. Hoang DT, Hiroo T, Yoshinobu K. Nitrogen use efficiency and drought tolerant ability of various sugarcane varieties under drought stress at early growth stage, Plant Production Science. 2019;22:(2): 250-261.
8. Gaber AA, Abou-Hadid AF, El-Gabry YA, Ebid MHM .Morphological and physiological study for sugarcane early selection to drought ecnTreloT. Plant Archives 2021;21(1):1935-1944.
9. Anjum SA, Ashraf U, Zohaib A, Tanveer M, et al. Growth and developmental responses of crop plants under drought stress: A review. Zemdirbyste Agriculture. 2017;104(3):267–276.
10. Couso LL, Fernández RJ. Phenotypic plasticity as an index of drought tolerance in three Patagonian steppe grasses. Annals of Botany. 2012;110(4):849-857.
11. Dos Santos CM, Endres L, da Silva ACS . Water relations and osmolite accumulation related to sugarcane yield under drought stress in a tropical climate. Int. J. Plant Prod. 2019;13:227–239.
12. Farooq M, Wahid A, Kobayashi N, Fujita D, Basra SMA . Plant Drought Stress: Effects, Mechanisms and Management. In: Lichtfouse E, Navarrete M, Debaeke P., Véronique S, Alberola C. (eds) Sustainable Agriculture. Springer, Dordrecht; 2009. Available:https://doi.org/10.1007/978-90-481-2666-8_12
13. Vasantha S, Gururaja Rao PN, Ramanujam TR. Effect of moisture stress on sucrose synthesizing enzymes in promising genotypes of sugarcane. J. Plant Bio. 2003;30(1):15-18.
14. Gururaja Rao PN, Singh S. Relationship of growth characteristics with yield and quality in sugarcane (*Saccharum officinarum* L.). Indian J. Plant Physiol. 1989;32:206-211.
15. Vasantha S, Alarmelu S, Hemeprabha G, Shanthi RM Evaluation of promising sugarcane genotypes for drought. Sugar Tech. 2005;(2& 3):82-83.
16. Yadav RC, Prasad SR Moisture use characteristics of sugarcane genotypes under different available soil moisture regimes in alluvial entisols. J. Agric. Sci. Camb. 1988;110:5-11.
17. Salim BBM, et al. Evaluation of some sugarcane genotypes under drought condition. Scientific Journal of Agricultural Sciences. 2021;3(2):123-132.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/105000