ORIGINAL RESEARCH PAPER

Agricultural Science

WATER REQUIREMENT OF SUGARCANE UNDER DIFFERENT METHODS OF IRRIGATION

KEY WORDS: Sugarcane, Irrigation water requirement, Cane yield, IW/CPE, SBI soil moisture indicator, Flood irrigation

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ABSTRACT

A field trial was taken up on quantification of irrigation water requirement of sugarcane during 2022-23 at Regional Agricultural Research Station, Anakapalli, Andhra Pradesh in sandy clay loam soils with seven methods of irrigation in randomized block design replicated thrice. Number of millable canes and cane yield were the highest with furrow irrigation followed by Alternate Furrow irrigation. Quality parameters (per cent sucrose and CCS) and sugar yield did not differ with the irrigation treatments. Highest irrigation water applied and lowest WUE was with flood irrigation and lowest irrigation water applied and highest WUE was with drip irrigation based on SBI soil moisture indicator. Irrigations with SBI moisture indicator was able to save the number of drip irrigations and was more efficient than drip irrigation based on IW/CPE.

INTRODUCTION

Water requirement is the total amount of water needed for raising a crop successfully. In the case of sugarcane, it includes the amount of water for meeting the needs of evapotranspiration and metabolic activities (known as consumptive use), losses during application of water and water needed for land preparation as pre-planting irrigation (Srivastava and Johari,1979). Water loss from the soil takes place through surface evaporation, transpiration by plants and percolation beyond the root zone. Under field conditions, water requirement is met effectively by rainfall, contribution from groundwater (if the water table is within the reach of the root system) and irrigation. It varies from place to place depending on weather conditions, texture of soil and development of crop (Verma,2004). Water is a major factor in sugarcane cultivation and moreover, sugarcane is one of the most water-demanding crops after rice. For example, depending on the zone, it may take more than 1000 millimeters, i.e. 10,000 cubic meters of water, for a yield of 100 tons per hectare. Depending upon the agroclimatic conditions and sugarcane yield sugarcane water requirement varies. Number of irrigations in sugarcane depends upon the climatic conditions, type of soil, method of planting and use of manures and fertilizers. On an average 1 ton cane needs about 60-70 tons of water. The present study was taken up as quantification based on method of irrigation and scheduling were not studied for North Coastal zone of Andhra Pradesh using varied methods of irrigation.

MATERIAL AND METHODS

A field trial was taken up on quantification of irrigation water requirement of sugarcane during 2022-23 at Regional Agricultural Research Station, Anakapalli, Andhra Pradesh in sandy clay loam soils with seven methods of irrigation in randomized block design replicated thrice. The meteorological data recorded at the meteorological observatory of Regional Agricultural Research Station, Anakapalli during the crop-growing season is presented in Fig. 1. The soil of the experimental field was sandy clay loam, neutral (pH 7.22), with normal electrical conductivity (EC)(0.19 dS cm^{-1}) with organic carbon of 0.59), available N of 242 kg/h), available P of 27 kg/hand available K of 248 Kg/ha. The The treatments consisted of seven different methods of irrigation Viz., T_1- Drip irrigation based on SBI soil moisture indicator, T_2- Drip irrigation at IW/CPE of 1.0 T_3- Drip irrigation at IW/CPE of 0.8, T_4- Drip irrigation at IW/CPE of 0.6 + trash mulching, T_5- Furrow irrigation (once in 7-10 days during formative stage and once in 15 days during maturity) T_6- Alternate Furrow irrigation (once in 7-10 days during formative stage and once in 15 days during maturity) T_7-Flood irrigation (once in 7-10 days during formative stage and once in 15 days during maturity). Sugarcane was planted on 31st March 2022 with variety Sarada (93A145) with three budded setts and harvested during 8th March'2023. For each experimental plot double bunding was made and a buffer of 2.4 m was maintained between the replications. Furrow irrigation was used for the experiment and a Parshal flume installed to measure the quantity of water entering the field plots. In case of alternate furrow irrigation, even number of furrows will be irrigated first and then odd number of furrows was irrigated in rotation. Data was recorded on growth parameters, cane yield, quality parameters and water applied to each of the treatments from which water use efficiency was calculated. Irrigation was scheduled with SBI soil moisture indicator whenever the red color indicator bulb was illuminated. based The weather conditions that prevailed during the growth period of sugarcane during this year was congenial for the crop growth. A rainfall of 1081 mm during the crop growth period was received in 64 rainy days. Nitrogen @ 164 kg/ha was applied in two equal splits–half at 45 DAP along with 100 kg P_20_5/ha and 120 kg K_20/ha and another half of nitrogen at 90 DAP. Pre-emergence application of herbicide Atrazine at the rate of 2.5 kg per ha was carried out at 3 days after planting (DAP)of sugarcane. Line weeding was taken up at 90 DAP after the harvest of all the intercrops. Earthing up was carried out at 120 DAP.To compute irrigation water applied, waterhead was measured on parshall flume installed at start of water channel and time was noted to fill the experimental units to the pre-marked levels. Total water applied during whole crop growing season was calculated by cumulating the irrigation-wise depth of water delivered and number of irrigations applied. Profile water use was worked by subtracting the water left in soil profile at harvest from the water content at time of planting. Cane yield was recorded after topping and trash stripping given as t/ha. Ten millable canes were taken at random from each plot for determining cane length girth and internode number. The growth, yield and quality pararameters were recorded are subjected to statistical analysis (Panse and Sukhatme, 1985). Juice-quality analysis was done after weighing and crushing through 3roller miller. A sub sample of crushed cane juice was analyzed for brix (total solids) by a brix hygrometer. Sucrose %, Commercial Cane Sugar (CCS) and sugar yield (CCS t/ha) was calculated as per Sastry and Chari (1960).

$$\text{Sucrose \%} - \left((\text{Pol value} \times 0.26) - \frac{(\text{Pol value} \times (\text{brix-x}))}{1000}\right) - 0.02$$

$$\text{Commercial cane sugar \%} - (\text{Sucrose \%} \times 1.022) - (\text{Brix \%} \times 0.2922)$$

$$\text{Sugar yield} \quad - \frac{\text{CCS (\%)} \times \text{cane yield (t/ha)}}{100}$$

RESULTS AND DISCUSSION

The results of the trial conducted during 2022-23 revealed that tiller population at 120 and 240 days, and girth of cane among growth parameters and did not differ among the irrigation methods. At both the stages of observation there was no significant difference among the irrigation treatments which clearly indicated that varied irrigation treatments have not influenced the tiller count as compared to conventional flooding method of irrigation.

Length of millable canes was the highest with drip irrigation at IW/CPE of 0.8 and was comparable with drip irrigation at IW/CPE of 1.0, drip irrigation at IW/CPE of 0.6 +trash mulching and furrow irrigation. The shortest length of millable canes was recorded with flood irrigation and is significantly inferior to drip irrigation at IW/CPE of 0.8. However, the girth of the cane did not differ significantly among the different irrigation treatments. Number of internodes per length of cane were the highest with Alternate furrow irrigation and was at a par with all the irrigation treatments except flood irrigation and drip irrigation based on SBI soil moisture indicator. Thus, all these growth parameters were the highest with sugarcane applied with drip irrigation at IW/CPE of 0.8.

Number of millable canes (NMC) per hectare is a direct indicator of cane yield in sugarcane. In the present trial NMC varied significantly with different irrigation treatments, number of millable canes were the highest with drip irrigation at IW/CPE of 1.0 which was comparable with all other treatments except with drip irrigation at IW/CPE of 0.6 + trash mulching which recorded the lowest number of millable canes, which indicated that moisture stress has directly influenced the millable cane production reduced the millable canes significantly in this treatment. This might also be due to less amount of water supplied to this treatment especially during the formative and grand growth stages. Even though sufficient rainfall was received at these stages it was not able to meet the crop water requirement.

Cane yield was the highest with furrow irrigation due to highest number of millable canes among all the treatments and it was comparable with all the irrigation treatments and was significantly superior to drip irrigation at IW/CPE of 0.8 and drip irrigation at IW/CPE of 0.6 + trash mulching, which recorded the lowest cane yield among all the treatments. This indicated that there is yield reduction either with drip irrigation scheduled at IW/CPE 0.8 or 0.6. However, scheduling drip irrigation with SBI soil moisture indicator clearly indicated that water can be saved using this method without decrease in cane yield. Experimental results by Surendran et al (2016) showed that low-cost drip irrigation recorded 118.6 t ha^{1} of cane yield and it was on par with the single row conventional drip irrigation (120.4 t ha^{1}) and are found to be significantly superior to flood irrigation (94.40 t ha^{1}). Results by Kuldeep Singh et al (2023) revealed that under surface drip and sub surface drip, the mean cane yield 75.4 to 92.7 t ha^{1} during 2017–18 (plant crop) and 72.9 to 79.9 t ha^{1} during 2018–19 (ratoon crop) were superior over standard practices. Drip fertigation at 100% CPE with 80% N recorded 31.9 to 46.2% higher water productivity and 49.0 to 44.7% lesser irrigation water than controls. In a trial by Kuldeep Singh and Brar (2015) cane and sugar yields increased significantly with successive increase in frequency of irrigation from 0.5 to 1.0 IW: CPE, while reverse trend was observed for water productivity. The highest cane and sugar yields were recorded in paired-row trench-planted crop irrigated at 1.0 IW: CPE. According to Navnit Kumar et al (2013) higher cane yield was recorded at 1.00 IW: CPE ratio andit declined by 8.5 and 23.1% when the crop was irrigated at 0.75 and 0.50 IW: CPE ratio respectively. Since cane yield is the result of additive and complementary effect of plant growth and yield-attributing characters and the growth and yield attributes had better expression at optimum irrigation owing to adequate quantity and balanced proportion of water supply during the crop growth stages, there was significant increase in cane yield. Gulati and Nayak (2002) also reported similar results. Irrigation regimes did not bring significant improvement in sucrose content juice. Similar trend of results was also obtained byBhullar et al. (2008) and Gupta et al. (2004).

Quality parameters (per cent sucrose and CCS) and sugar yield did not differ with the irrigation treatments. Similar results in quality parameters were also reported by Ashwin et al (2017), Levene (1960) and Nair et al (2002). Highest irrigation water applied and lowest WUE to sugarcane was the with flood irrigation and lowest irrigation water applied and highest WUE was with drip irrigation based on SBI soil moisture indicator.

Based of daily evaporation, a total of 163 irrigations were given for T_1, 253 each for T_2, T_3 and T_4 and 17 traditional methods of irrigations were scheduled for T_5,T_6 and T_7 were scheduled. Irrigations with SBI moisture indicator was able to save 90 drip irrigations and hence was more efficient than drip irrigation based on IW/CPE. Highest irrigation water applied and lowest WUE to sugarcane was the with flood irrigation and lowest irrigation water applied and highest WUE was with drip irrigation based on SBI soil moisture indicator. The Water use efficiency with soil moisture indicator was higher by 4.62 times (78.40%) and water saving was to the tune of 7636 mm (79.27%). In a trial by Nogueira et al (2016) irrigation water productivity and water productivity were obtained in 35.8 to 146.0 kg m-3 and 18.0 to 70.9 kg m-3, respectively. Research by Sarala et al (2014) concluded that Surface and subsurface drip irrigation methods gave 18 – 20% higher cane yield and greater water economy of 24% saving in irrigation water over conventional furrow method of irrigation. Sugarcane being a long duration crop produces huge amount of biomass, and requires large quantity of water (1100–2200 mm) and is mostly grown as an irrigated crop using surface irrigation. The drip irrigation adoption in sugarcane increases water use efficiency (60–200%), saves water (20–60%), reduces fertilization requirement (20–33%) through fertigation, produces better quality crop and increases yield (7–25%) as compared with conventional irrigation (Kaushal Arun et al., 2012).

CONCLUSION:

Number of millable canes and cane yield were the highest with furrow irrigation followed by Alternate Furrow irrigation. Quality parameters (per cent sucrose and CCS) and sugar yield did not differ with the irrigation treatments. Highest irrigation water applied and lowest WUE was with flood irrigation and lowest irrigation water applied and highest WUE was with drip irrigation based on SBI soil moisture indicator. Irrigations with SBI moisture indicator was able to save the number of drip irrigations and was more efficient than drip irrigation based on IW/CPE. Hence it can be concluded that irrigations based on SBI moisture indicator gave the highest WUE and comparable yield with that of furrow irrigation and was more efficient than drip irrigation based on IW/CPE.

Table: Growth, yield and quality of sugarcane as influenced by different irrigation methods

Treatments	Tillers at120 days (No ha^{-1})	Tillers at 240 days (No ha^{-1})	LMC (cm)	Girth (cm)	No. of inter nodes	NMC (No ha^{-1})	Cane Yield (t ha^{-1})	Sucrose (%)	CCS (%)	Sugar yield (t ha^{-1})	Ir. Water Applied (m^3)	WUE (kg m^{-3})
T_1-Drip irrigation based on SBI soil moisture indicator	90065	73844	219.00	1.70	17.97	67475	75.88	16.91	11.47	8.70	1996.34	38.01
T_2- Drip irrigation at IW/CPE of 1.0	84732	80918	239.00	1.79	20.57	72326	79.62	15.96	10.96	8.68	3962.18	20.10
T_3- Drip irrigation at IW/CPE of 0.8	76326	70808	240.67	1.76	20.93	66475	73.02	16.52	11.53	8.45	3330.44	21.92
T_4- Drip irrigation at IW/CPE of 0.6 + trash mulching	80548	59994	228.67	1.65	20.37	56846	72.47	14.86	9.98	7.73	2698.70	26.85
T_5- Furrow irrigation	85732	80066	223.33	1.86	19.90	71660	83.29	16.45	11.38	9.46	8499.15	9.80
T_6- Alternate Furrow irrigation	79733	76992	206.83	1.72	21.20	69697	81.21	16.10	10.79	8.76	6799.32	11.94
T_7- Flood irrigation	77066	67475	210.83	1.92	18.77	69882	79.10	14.64	9.76	7.72	9632.37	8.21
SEm+/-	5327	5719	6.73	0.099	0.66	2521.7	3.37	0.84	0.61	0.44		
CD (%)	NS	NS	20.28	NS	1.99	7600	10.17	NS	NS	NS		
CV (%)	11.70	13.30	5.2	9.67	5.74	6.45	7.43	9.2	9.8	9.05		

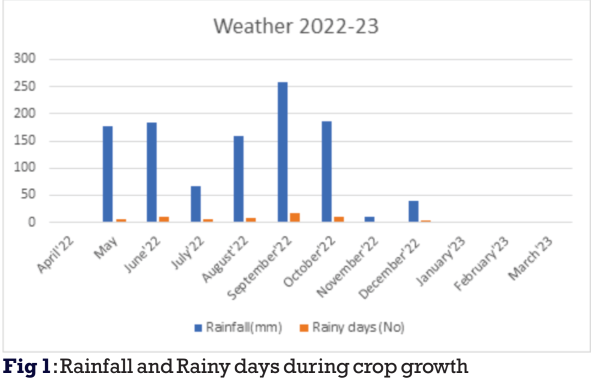

Fig 1: Rainfall and Rainy days during crop growth

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