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Effect of drip fertigation levels on growth, yield and quality of *adsali* sugarcane

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Abstract
A field experiment was conducted during 2019-20 and 2020-21 at Agricultural Research Station, Hukkeri (Dist. Belagavi) in strip block design with three drip irrigation levels as vertical strip and three fertigation levels as horizontal strip along with two control treatments i.e., farmers' practice of drip irrigation and surface irrigation as per recommended package of practice. Irrigation treatments were drip irrigation at 0.6 ET_o at germination + 0.85 ET_o at tillering + 1.0 ET_o at canopy establishment + 1.15 ET_o at grand growth + 0.85 ET_o at maturity stage (I_1), drip irrigation at 0.6 ET_o at germination + 1.0 ET_o at tillering + 1.5 ET_o at canopy establishment + 1.5 ET_o at grand growth + 0.85 ET_o at maturity stage (I_2) and drip irrigation at 0.8 ET_o at germination+ 1.0 ET_o at tillering+ 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage (I_3). Fertigation levels were *viz.*, 100% RDF (Recommended dose of fertilizer) through fertigation (F_1), 150% RDF through fertigation (F_2) and 200% RDF through fertigation (F_3) and two control treatments *i.e.*, RPP and farmers' practice. Drip irrigation at 0.8 ET_o at germination+ 1.0 ET_o at tillering+ 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage (I_3) recorded significantly higher cane yield (275.98 t ha^{-1}). Application of fertilizers at 150% RDF through fertigation recorded significantly higher cane yield (251.11 t ha^{-1}). Interaction of drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth + 1.0 ET_o at maturity stage along with 150% RDF through fertigation (I_3F_2) recorded significantly higher cane yield of 297.40 t ha^{-1} with yield increase of 60.5 and 74.0%, respectively over RPP (185.5 t ha^{-1}) and farmers' practice (170.70 t ha^{-1}).

Keywords: Drip irrigation, fertigation, recommended dose of fertilizer and cane yield

Introduction
Sugarcane is an important crop globally not only for sugar production, but also as a bioenergy crop due to its remarkable dry matter production capacity. It is one of the world's major C4 crops that mainly grows in the tropic and subtropic regions. It flourishes under a long, warm growing season with a high incidence of radiation and adequate moisture, followed by a dry, sunny and relatively calm but frost-free ripening and harvesting period. Sugarcane crop constitutes 29% of the total world crop production (Gerbens-Leenes and Hoekstra, 2012) [5]. In crop like sugarcane the application of precise quantity of irrigation water at the right time not only ensures a higher efficiency of water use by the crops but also reduces nutrient losses through leaching, results in better aeration of the soil and improvement in crop yield and farm productivity. Adoption of modern frontier technologies would become necessary to overcome many of the problems faced by sugarcane farmers. Under the circumstances, drip irrigation with fertigation will have to be put to use on farm level for enhancing production with improved water and nutrient use efficiency. *Adsali* sugarcane cultivation is marked by the fact that crop requires large quantity of water as well as nutrients. Along with this, the other constraint is that the grand growth stage of the crop coincides with relatively dry and hot months of the calendar, where evaporative demand of crop will be high. Additionally huge quantity of fertilizer application during initial growth and lesser number of splits for application of fertilizer creates gap between demand and supply at grand growth stage. To address this, stage wise water demand should be met along with split application of nutrients through drip fertigation to ensure

synchronicity between crop demand and supply of resources like water and nutrients.

Materials and Methods

A field investigation to study the response of sugarcane to drip fertigation was carried out in *adsali* season during 2019-20 and 2020-21.

The field experiment was laid out at ARS, Hukkeri, Belagavi, Karnataka in strip block design with three drip irrigation levels as vertical strip and three fertigation levels as horizontal strip along with two control treatments *i.e.*, farmers' practice of drip irrigation (C_1) was based on survey and surface irrigation as per recommended package of practice (C_2). Drip irrigation (DI) levels *viz.*, DI at 0.6 ET_o at germination + 0.85 ET_o at tillering + 1.0 ET_o at canopy establishment + 1.15 ET_o at grand growth + 0.85 ET_o at maturity stage (I_1), DI at 0.6 ET_o at germination + 1.0 ET_o at tillering + 1.5 ET_o at canopy establishment + 1.5 ET_o at grand growth + 0.85 ET_o at maturity stage (I_2) and DI at 0.8 ET_o at germination+ 1.0 ET_o at tillering+ 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage (I_3). Fertigation levels are, 100% RDF (250:75:190 kg N, P_2O_5 and K_2O per ha) through fertigation (F_1), 150% RDF (375:112.5:285 kg N, P_2O_5 and K_2O per ha) through fertigation (F_2) and 200% RDF (500:150:380 kg N, P_2O_5 and K_2O per ha) through fertigation (F_3). Two control treatments were farmers' practice (470:172.5:222.5 kg N, P_2O_5 and K_2O per ha and drip irrigation) and RPP (250:75:190 kg N, P_2O_5 and K_2O per ha and surface irrigation). General green manure (sun hemp) crop was grown *in situ* and incorporation was done before planting of cane followed by application of FYM @ 25 t ha^{-1}. Micronutrient *viz.*, $FeSO_4$ and $ZnSO_4$ @ 25 kg ha^{-1} and biofertilizers *viz.*, *Azospirillum* and PSB @ 10 kg ha^{-1}each for all treatments were applied.

Fertigation schedule was, in initial 45 days after planting (0-45 DAP) 15:10:10% N, P_2O_5 and K_2O of RDF was applied, as 10:10:10% N, P_2O_5 and K_2O was basal dose and 5:0:0% N, P_2O_5 and K_2O was given through fertigation. From 46-135 DAP, 35:35:15% N, P_2O_5 and K_2O of RDF was applied through fertigation in equal splits at 15 days interval. Similarly, from 136-225 DAP (50:55:35% N, P_2O_5 and K_2O of RDF) and from 226-380, (0:0:40% N, P_2O_5 and K_2O of RDF) in equal splits were applied. Sugarcane was irrigated as per treatments based on actual evapo-transpiration (AET) from pan data values at four days intervals. Irrigation was done through drip method in control C_1 at four days interval throughout the crop growth stage and through surface method of irrigation (according to UAS Dharwad POP) in C_2. In RPP, surface irrigation was gives by following the schedule *i.e.*, during 0 – 45 DAP (once in 7 days), during 46- 225 DAP (once in 10 days), during 226- 405 DAP (once in 7 days) and during 406 – 495 DAP (once in 15 days). Drip irrigation was given for 3 hours in four days interval and during summer months (March, April and May) surface irrigation was given once in 15 days (Based on survey) in farmers' practice treatment.

The experimental field was sandy loam in texture which was medium in organic carbon (0.65%). The soil is normal in reaction (pH 8.13), low in available nitrogen (248.3 kg ha^{-1}), medium in available phosphorus (41.5 kg ha^{-1}) and high in available potassium (455.2 kg ha^{-1}). At the harvest stage of the crop, biometric observation *viz.*, leaf area, leaf area index and total drymatter production were recorded. Number of millable cane and single cane weight were recorded as yield parameters along with yield. Sugarcane juice quality parameters *viz.*, percent brix, pol, purity, CSS and CSS yield were recorded.

Results and Discussion

Growth parameters: In irrigation regimes, drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage (I_3) recorded significantly higher leaf area (496.06 dm^2 $clump^{-1}$), leaf area index (5.51) and total drymatter production (7.19 kg $clump^{-1}$) over drip irrigation (I_1) at 0.6 ET_o at germination + 0.85 ET_o at tillering + 1.0 ET_o at canopy establishment + 1.15 ET_o at grand growth + 0.85 ET_o at maturity stage (380.32 dm^2 $clump^{-1}$, 4.23 and 6.14 kg $clump^{-1}$, respectively). The leaf area expansion is dependent on leaf turgor potential and further, it is well known fact that cell enlargement is very sensitive to water deficit and water plays an important role in maintaining the leaf turgor potential. The higher leaf area and LAI recorded at higher irrigation levels could be related to favourable soil water balance due to high frequency irrigations under the drip system. Average absorbed photosynthetic active radiation (PAR) by leaf area during the entire crop growth was the key factor for determining the total dry matter accumulation in the sugarcane. The dry matter accumulation in sugarcane was associated with plant and cane height, number of tillers, leaf area and LAI persisted during growth of crop and increased cane diameter, number of internodes and internodal length during the reproductive period. Thus, higher water availability with I_3 influenced total dry matter production.

Among the fertigation levels, 150% RDF (F_2) recorded significantly higher leaf area, leaf area index and total drymatter production (484.67 dm^2 $clump^{-1}$, 5.39 and 6.88 kg $clump^{-1}$) over 100% RDF (F_1, 475.28 dm^2 $clump^{-1}$, 4.21 and 6.21 kg $clump^{-1}$, respectively). Maintenance of adequate nutrient status by frequent nutrient supply matching with crop growth demand might have favoured faster cell division and elongation (Fanish *et al.*, 2011) [4]. The promoting effect of N on these growth parameters can be explained based on the fact that, the N supply increases the number of meristematic cells. It also acts as a key component in the number of metabolites, including amino acids, chlorophylls, co-enzymes, enzymes, proteins, purines and pyrimidines (Lea and Guadry, 2001 and Marschner, 2002) [7, 9]. Furthermore, N application is known to increase the levels of cytokinin, which affects cell wall extensibility (Arnold *et al.*, 2006) [2]. It is, therefore, logical to speculate that N was involved directly or indirectly in the enlargement and division of new cells and production of tissues which in turn were responsible for the increase in growth characteristics.

The interaction effect of, drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage along with 150% RDF (I_3F_2) through fertigation recorded significantly higher leaf area (541.19 dm^2 $clump^{-1}$), leaf area index (6.01) and total dry matter production (7.55 kg $clump^{-1}$) and was on par with drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage along with 200% RDF through fertigation (I_3F_3, 529.23 dm^2 $clump^{-1}$, 5.88 and 7.42 kg $clump^{-1}$, respectively). Additional quantum of water and nutrients added at canopy establishment and grand growth stages and split application of nutrients ensured the balance in demand and supply of water and nutrients to the crop. Interaction effect of the water and nutrients catalysed faster cell division and elongation which had shown positive response on higher leaf area and leaf area index. The higher leaf area index contributed for better light interception and crop growth. Application of water-soluble fertilizers through fertigation and to supplement the translocation process, sufficient quantity of water resulted in continuous supply of nutrients besides maintaining optimum water availability led to higher uptake of nutrients and led to higher dry matter accumulation.

Among the control treatments, RPP recorded higher leaf area (305.70 dm^2 $clump^{-1}$, leaf area index (3.40) and total dry matter production (5.80 kg $clump^{-1}$) and was on par with farmers' practice (300.40 dm^2 $clump^{-1}$, 3.34 and 5.70 kg $clump^{-1}$, respectively).

Yield parameters and yield

Drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage (I_3) recorded significantly higher number of millable cane (NMC) (1,13,634 ha^{-1}), single cane weight (2.92 kg) and cane yield (275.98 t ha^{-1}) over drip irrigation (I_1) at 0.6 ET_o at germination + 0.85 ET_o at tillering + 1.0 ET_o at canopy establishment + 1.15 ET_o at grand growth + 0.85 ET_o at maturity stage (99,333 ha^{-1}, 2.36 kg and 197.76 t ha^{-1}, respectively).

Application of fertilizers @ 150% RDF through fertigation (F_2) recorded significantly higher NMC (1, 10, 141 ha^{-1}) single cane weight (2.78 kg) and cane yield (251.11 t ha^{-1}) over 100% RDF (F_1) through fertigation (1, 01, 141 ha^{-1}, 2.55 kg and 212.49 t ha^{-1}, respectively). Yield increment with F_2 and F_3 was 18.4 and 15.5% over F_1. There was a slight reduction in the yield under F_3 over F_2 (2.27%) which can be interpreted by the fact that, the additional 50% nutrients added in 200% RDF over 150% RDF through fertigation created the favourable crop conditions for incidence of the pest (internode borer) during the grand growth stage of the crop. Incidence of the internode borer with 200% RDF was prominent in all the irrigation regime treatment combinations. It was observed that, buds in the lower portion of the stalks sprouted creating the stress situation by breaking the source and sink translocation process and reducing the growth of the crop. Effect of this was prominently noticed with the reduction in NMC, single cane weight and cane yield. Higher NMC could be attributed to the increased level of fertigation and adequate moisture given at right time to meet the crop need at different growth stages. These results follow the findings of Mahendran *et al*. (2005) who reported that drip irrigation @ 125% RDF under two row planting system registered higher NMC. Fertigation ensures that essential nutrient is supplied precisely at the area of most intensive root activity according to the specific requirements of sugarcane crop and type of soil resulting in higher cane yield and sugar recovery (Shinde *et al*., 2005) [14].

Among the interaction, drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage along with 150% RDF through fertigation (I_3F_2) recorded significantly higher NMC (1,19,882 ha^{-1}) single cane weight (3.02 kg) and cane yield (297.40 t ha^{-1}) and was on par with drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage along with 200% RDF (I_3F_3) through fertigation (1,16,487 ha^{-1}, 2.95 kg and 288.57 t ha^{-1}, respectively).

However, RPP recorded on par and higher NMC (95,167 ha^{-1}), single cane weight (2.11 kg) and cane yield (185.50 t ha^{-1}) compared with farmers' practice (94,600 ha^{-1}, 1.95 kg and 170.70 t ha^{-1}). The significantly lower yields with farmers' practice could be because of the fact that, nutrient ratio was not maintained leading to imbalanced application of fertilizers. During the initial growth stage of the crop, large quantity of fertilizers were applied without considering the crop demand. This was coupled with higher water application rate which resulted in more leaching losses of nutrients, creating huge nutrient demand during the grand growth stage.

Quality parameters

Non-significant variations were recorded for percent brix, pol, purity and CSS due to drip irrigation and fertigation levels. However, CSS yield varied significantly due to the drip irrigation and fertigation levels.

Drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage (I_3) recorded significantly higher CSS yield (38.2 t ha^{-1}). Whereas, significantly lower CSS yield was recorded with drip irrigation (I_1) at 0.6 ET_o at germination + 0.85 ET_o at tillering + 1.0 ET_o at canopy establishment + 1.15 ET_o at grand growth + 0.85 ET_o at maturity stage (26.6 t ha^{-1}). Application of fertilizers at 150% RDF (F_2) through fertigation (33.3 t ha^{-1}) recorded significantly higher CSS yield and was on par with 200% RDF (F_3) through fertigation (32.9 t ha^{-1}). Significantly lower CSS yield was recorded with 100% RDF (F_1) through fertigation (30.9 t ha^{-1}).

Interaction between irrigation and fertigation levels was significant. Application of drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage along with 150% RDF through fertigation (I_3F_2) recorded significantly higher CSS yield (39.64 t ha^{-1}) compared to rest of the interactions. However, it was on par with drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage along with 200% RDF (I_3F_3) through fertigation (38.82 t ha^{-1}). The sugar yield followed the similar trend of cane yield. Similar observations were also made by Shinde *et al*. (2000) [15]; Bhoi *et al*. (2001) [3] and Goel *et al*. (2005) [6].

Table 1: Leaf area, leaf area index and total dry matter production of *adsali* sugarcane as influenced by drip irrigation and fertigation

Treatment		Leaf area (dm^2 $clump^{-1}$)	Leaf area index	Total dry matter production (kg $clump^{-1}$)
Drip irrigation levels (I)				
I_1	DI at 0.6,0.85,1.00,1.15 & 0.85 ET_o at G, T, CE, GG & M stage, respectively	380.32^b	4.23^b	6.14^b
I_2	DI at 0.6, 1.00,1.50,1.50 & 0.85 ET_o at G, T, CE, GG & M stage, respectively	462.81^a	5.14^a	6.54^b
I_3	DI at 0.8,1.00,1.75, 2.00 &1.00 ET_o at G, T, CE, GG & M stage, respectively	496.06^a	5.51^a	7.19^a
	S. Em. ±	7.71	0.09	0.10
Fertigation levels (F)				
F_1	100% RDF (through fertigation)	379.23^b	4.21^b	6.21^b
F_2	150% RDF (through fertigation)	484.67^a	5.39^a	6.88^a
F_3	200% RDF (through fertigation)	475.28^a	5.28^a	6.78^a
	S. Em. ±	9.40	0.10	0.13

	Interaction (IxF)			
I_1F_1	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 100% RDF	338.22^{cd}	3.76^{cd}	5.85^{c}
I_1F_2	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 150% RDF	403.61^{b}	4.48^{b}	6.32^{bc}
I_1F_3	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 200% RDF	399.12^{b}	4.43^{b}	6.25^{bc}
I_2F_1	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 100% RDF	381.71^{bc}	4.24^{bc}	6.19^{bc}
I_2F_2	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 150% RDF	509.21^{a}	5.66^{a}	6.76^{b}
I_2F_3	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 200% RDF	497.5^{a}	5.53^{a}	6.66^{b}
I_3F_1	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 100% RDF	417.76^{b}	4.64^{b}	6.58^{b}
I_3F_2	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 150% RDF	541.19^{a}	6.01^{a}	7.55^{a}
I_3F_3	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 200% RDF	529.23^{a}	5.88^{a}	7.42^{a}
C_1	Recommended package of practice – SI	305.7^{d}	3.40^{d}	5.80^{c}
C_2	Farmers' practice- DI	300.4^{d}	3.34^{d}	5.70^{c}
	S. Em. ±	16.34	0.18	0.20

C- Control, DI-Drip irrigation, ET_o-Actual evapotranspiration (mm), G-Germination, T-Tillering,
CE-Canopy establishment, GG-Grand growth, M-Maturity
RDF-Recommended dose of fertilizer (250:75:190 kg N, P_2O_5 and K_2O per ha) and SI-Surface irrigation.
Means followed by the same alphabet (s) within a column do not differ significantly by DMRT (P= 0.05)

Table 2: Number of millable cane, single cane weight and cane yield of *adsali* sugarcane as influenced by drip irrigation and fertigation

Treatment		**No. of millable canes (per ha^{-1})**	**Single cane weight (kg)**	**Cane Yield (t ha^{-1})**
	Drip irrigation levels (I)			
I_1	DI at 0.6,0.85,1.00,1.15 & 0.85 ET_o at G, T, CE, GG & M stage, respectively	99333^{b}	2.36^{b}	197.76^{c}
I_2	DI at 0.6, 1.00,1.50,1.50 & 0.85 ET_o at G, T, CE, GG & M stage, respectively	105823^{ab}	2.80^{a}	235.31^{b}
I_3	DI at 0.8,1.00,1.75, 2.00 &1.00 ET_o at G, T, CE, GG & M stage, respectively	113634^{a}	2.92^{a}	275.98^{a}
	S. Em. ±	1473	0.02	4.03
	Fertigation levels (F)			
F_1	100% RDF (through fertigation)	101141^{b}	2.55^{b}	212.49^{b}
F_2	150% RDF (through fertigation)	110141^{a}	2.78^{a}	251.11^{a}
F_3	200% RDF (through fertigation)	107508^{a}	2.74^{ab}	245.44^{ab}
	S. Em. ±	1579	0.03	5.23
	Interaction (IxF)			
I_1F_1	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 100% RDF	96195^{c}	2.25^{de}	182.60^{de}
I_1F_2	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 150% RDF	101575^{bc}	2.43^{cd}	207.27^{cd}
I_1F_3	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 200% RDF	100230^{bc}	2.4^{cd}	203.40^{cd}
I_2F_1	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 100% RDF	102693^{a-c}	2.64^{bc}	212.90^{c}
I_2F_2	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 150% RDF	108967^{a-c}	2.90^{a}	248.67^{b}
I_2F_3	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 200% RDF	105808^{a-c}	2.87^{ab}	244.37^{b}
I_3F_1	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 100% RDF	104533^{a-c}	2.77^{ab}	241.97^{b}
I_3F_2	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 150% RDF	119882^{a}	3.02^{a}	297.40^{a}
I_3F_3	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 200% RDF	116487^{ab}	2.95^{a}	288.57^{a}
C_1	Recommended package of practice – SI	95167^{c}	2.11^{ef}	185.50^{de}
C_2	Farmers' practice- DI	94600^{c}	1.95^{f}	170.70^{e}
	S. Em. ±	3307	0.08	8.58

C- Control, DI-Drip irrigation, ET_o-Actual evapotranspiration (mm), G-Germination, T-Tillering,
CE-Canopy establishment, GG-Grand growth, M-Maturity
RDF-Recommended dose of fertilizer (250:75:190 kg N, P_2O_5 and K_2O per ha) and SI-Surface irrigation.
Means followed by the same alphabet (s) within a column do not differ significantly by DMRT (P= 0.05)

Table 3: Juice quality parameters of *adsali* sugarcane as influenced by drip irrigation and fertigation

Treatment		**Quality parameters (%)**		
		Brix	**Pol**	**Purity**
	Drip irrigation levels (I)			
I_1	DI at 0.6,0.85,1.00,1.15 & 0.85 ET_o at G, T, CE, GG & M stage, respectively	20.4^{a}	18.8^{a}	92.1^{a}
I_2	DI at 0.6, 1.00,1.50,1.50 & 0.85 ET_o at G, T, CE, GG & M stage, respectively	20.8^{a}	19.0^{a}	91.4^{a}
I_3	DI at 0.8,1.00,1.75, 2.00 &1.00 ET_o at G, T, CE, GG & M stage, respectively	20.8^{a}	18.9^{a}	91.2^{a}
	S. Em. ±	0.17	0.10	0.39
	Fertigation levels (F)			
F_1	100% RDF (through fertigation)	20.9^{a}	18.9^{a}	90.6^{a}
F_2	150% RDF (through fertigation)	20.5^{a}	18.8^{a}	91.8^{a}
F_3	200% RDF (through fertigation)	20.5^{a}	19.0^{a}	92.4^{a}
	S. Em. ±	0.15	0.05	0.43
	Interaction (IxF)			
I_1F_1	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 100% RDF	20.60^{a-c}	18.90^{a-c}	91.79^{a-c}
I_1F_2	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 150% RDF	20.27^{bc}	18.58^{c}	91.67^{a-c}
I_1F_3	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 200% RDF	20.27^{bc}	18.82^{bc}	92.93^{ab}
I_2F_1	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 100% RDF	20.60^{a-c}	18.89^{a-c}	91.78^{a-c}

I_2F_2	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 150% RDF	20.43[bc]	18.95[ab]	92.76[a-c]
I_2F_3	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 200% RDF	21.43[a]	19.22[a]	89.68[cd]
I_3F_1	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 100% RDF	21.43[a]	18.9[a-c]	88.21[d]
I_3F_2	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 150% RDF	20.93[ab]	19.02[ab]	90.86[b-d]
I_3F_3	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 200% RDF	19.93[c]	18.85[bc]	94.60[a]
C_1	Recommended package of practice - SI	19.93[c]	18.84[bc]	94.52[a]
C_2	Farmers' practice- DI	20.43[bc]	18.85[bc]	92.3[a-c]
	S. Em. ±	0.28	0.11	0.96

C- Control, DI-Drip irrigation, ET_o-Actual evapotranspiration (mm), G-Germination, T-Tillering,
CE-Canopy establishment, GG-Grand growth, M-Maturity.
RDF-Recommended dose of fertilizer (250:75:190 kg N, P_2O_5 and K_2O per ha) and SI-Surface irrigation.
Means followed by the same alphabet (s) within a column do not differ significantly by DMRT (P= 0.05)

Table 4: Juice quality parameters of *adsali* sugarcane as influenced by drip irrigation and fertigation

Treatment		**Quality parameters**	
		CCS (%)	**CCS yield (t ha^{-1})**
Drip irrigation levels (I)			
I_1	DI at 0.6,0.85,1.00,1.15 & 0.85 ET_o at G, T, CE, GG & M stage, respectively	13.2[a]	26.6[c]
I_2	DI at 0.6, 1.00,1.50,1.50 & 0.85 ET_o at G, T, CE, GG & M stage, respectively	13.4[a]	32.3[b]
I_3	DI at 0.8,1.00,1.75, 2.00 &1.00 ET_o at G, T, CE, GG & M stage, respectively	13.3[a]	38.2[a]
	S. Em. ±	0.06	0.61
Fertigation levels (F)			
F_1	100% RDF (through fertigation)	13.2[b]	30.9[b]
F_2	150% RDF (through fertigation)	13.3[ab]	33.3[a]
F_3	200% RDF (through fertigation)	13.4[a]	32.9[ab]
	S. Em. ±	0.03	0.70
Interaction (IxF)			
I_1F_1	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 100% RDF	13.3[ab]	25.62[ef]
I_1F_2	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 150% RDF	13.07[b]	27.08[e]
I_1F_3	DI at 0.6, 0.85, 1.00, 1.15 & 0.85 ET_o at G, T, CE, GG & M with 200% RDF	13.32[ab]	27.09[e]
I_2F_1	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 100% RDF	13.29[ab]	30.97[d]
I_2F_2	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 150% RDF	13.4[a]	33.31[cd]
I_2F_3	DI at 0.6, 1.00, 1.50, 1.50 & 0.85 ET_o at G, T, CE, GG & M with 200% RDF	13.38[a]	32.71[d]
I_3F_1	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 100% RDF	13.06[b]	36.07[bc]
I_3F_2	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 150% RDF	13.32[ab]	39.64[a]
I_3F_3	DI at 0.8, 1.00, 1.75, 2.00 & 1.00 ET_o at G, T, CE, GG & M with 200% RDF	13.45[a]	38.82[ab]
C_1	Recommended package of practice - SI	13.43[a]	23.41[fg]
C_2	Farmers' practice- DI	13.3[ab]	22[g]
	S. Em. ±	0.08	1.05

C- Control, DI-Drip irrigation, ET_o-Actual evapotranspiration (mm), G-Germination, T-Tillering,
CE-Canopy establishment, GG-Grand growth, M-Maturity.
RDF-Recommended dose of fertilizer (250:75:190 kg N, P_2O_5 and K_2O per ha) and SI-Surface irrigation.
Means followed by the same alphabet (s) within a column do not differ significantly by DMRT (P=0.05)

Conclusion

With the results obtained from the trial, it was concluded that**,** drip irrigation at 0.8 ET_o at germination + 1.0 ET_o at tillering + 1.75 ET_o at canopy establishment + 2.0 ET_o at grand growth +1.0 ET_o at maturity stage along with 150% RDF through fertigation (I_3F_2) found effective in sugarcane leading higher leaf area, leaf area index, dry matter production, number of millable canes, single cane weight, cane yield (297.40 t ha^{-1}) and sugar yield (39.64 t ha^{-1}).

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