Mysore J. Agric. Sci., 50 (2) : 290-293, 2015

Performance of Sugarcane under Varied Levels of Irrigation and Nutrients through Subsurface Drip Fertigation

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ABSTRACT

A field experiment was conducted at Zonal Agriculture Research Station, V.C. Farm, Mandya during 2014-15 to know the performance of sugarcane under varied levels of irrigation and nutrients through drip fertigation. The experiment was laid out in split-plot design with three replications comprising of three levels of irrigation in main plots *viz.*, Sub-surface drip irrigation at 75 per cent E_{pan}, sub-surface drip irrigation at 100 per cent E_{pan} and furrow irrigation in wider row planting and four levels of fertilizers in sub plots *viz*.,. 125, 100, 75 and 50 per cent of recommended dose of fertilizer, respectively. Results indicated thatsubsurface drip irrigation at 100 per cent pan evaporation (E_{pan}) recorded significantly higher cane yield and yield parameters *viz.*, millable canes (25.71 m^{-1}), cane length (226.6 cm), internodes $cane^{-1}$ (20.03), cane girth (2.91 cm), single cane weight (1.76 kg) and cane yield (217 t ha^{-1}). Similarly, fertilizer level @ 125 per cent of RDF recorded higher yield and yield parameters *viz.*, millable canes (26.29 m^{-1}), cane length (227.3 cm), internodes $cane^{-1}$ (19.50), cane girth (2.90 cm), single cane weight (1.74 kg) and cane yield (218 t ha^{-1}) and was on par with 100 per cent of RDF (197 t ha^{-1}). However, interaction between irrigation and fertilizer levels was not significant with respect to cane yield.This clearly indicated that adoption of drip fertigation in sugarcane enhance the yield by 39 per cent over surface irrigation besides saving 25 per cent recommended dose of fertilizer.

SUGARCANE (*Saccharum officinarum* L.), one among the major cash crops in India has a unique role in sustaining agro industrial economic growth of our country. India is the world's second largest producer of sugarcane in terms of area (5.3 m ha) and production (366 m t) with a productivity of 69t ha^{-1}contributing 19.98 per cent of world's total (27.1 m t sugar) sugar production (Anonymous, 2015). Globally, it is cultivated on 24.5 m ha with an annual production of 1850 m t and an average productivity of 75.5 t ha^{-1} (FAO, 2015). In Karnataka, it is cultivated on 0.50 m ha with a production of 47 m t with an average productivity of 94.0 t ha^{-1} (Anonymous, 2015).

One of the main reasons of low yield is scarcity of water and inefficient management of nutrients. Sugarcane being a long duration crop produces huge amount of biomass, and requires large quantity of water and is mostly grown as an irrigated crop. Water requirement of cane under traditional method of cultivation varies from 2000-2500 mm depending upon soil and climate (Arulkar *et al.*, 2004 and Rajegowda *et al.*, 2004). This conventional method of cane production not only leads to water wastage but also reduces fertilizer use efficiency. It is important to judiciously use the already existing water resources by adopting appropriate irrigation technology that not only increases sugarcane production per unit area but also per unit of water and nutrients used (Kadam, 2009).Thus a scientific and efficient management of water is needed to conserve the available water resources and to enhance water use efficiency and cane yield which is possible through drip fertigation.

Keeping this in view, present study was conducted to know the performance of sugarcane under varied levels of water and nutrients through subsurface drip fertigation.

The experiment was conducted at Zonal Agriculture Research Station, V. C. Farm, Mandya during 2014-15. Soil of the experimental site was sandy clam loam with low OC (0.46 per cent), medium available N (292.5 kg ha^{-1}), available P_2O_5 (38.2 kg ha^{-1}) and available K_2O (178.3 kg ha^{-1}). The experiment was laid out in split-plot design with three replications comprising of three levels of irrigation in main plots and four levels of fertilizers in sub plots.

The irrigation levels were:Sub-surface drip irrigation at 75 per cent E_{pan}, sub-surface drip irrigation at 100 per cent E_{pan} and furrow irrigation in wider row planting and fertilizer levels were: 125 , 100 , 75 and 50 per cent of recommended dose of fertilizer (RDF-250:100:125 Kg NPK ha^{-1}), respectively. The land was prepared by ploughing with tractor drawn disc plough followed by disc harrow and passing cultivator twice to bring the soil to fine tilth. Gross plot size was 15.0 X 8.0 m. Drip irrigation system was installed which included pump, filter units, main line and sub line. The laterals were placed at 1.95 m apart. The drip line was passed in between paired rows at 20 cm below the surface of soil. Inline emitters were placed 40 cm apart with discharge rate of 4 lph. Recommended FYM (25 t ha^{-1}) was applied two week before planting of setts. Out of recommended dose of fertilizer (250: 100: 125 kg of NPK ha^{-1}), 50 per cent of P was applied as basal dose and remaining P applied at 105 days after planting (DAP) while earthing-up for drip irrigated plots wherein, entire dose of N and K is applied through drip irrigation at 48 equal splits, twice in a week. For surface irrigated plots, 10 per cent of N, 50 % of P and entire K were applied as basal, remaining P was applied at 105 DAP. Whereas, remaining 20 % N was applied at45 DAP, 30 % at 75 DAP and 40 % at 105 DAP as top dressing.

Surface irrigation was uniformly given to all the treatments immediately after planting to ensure uniform germination of setts. Healthy and viable two budded setts were planted in a zig-zag manner in paired rows with spacing of (165+30) X 30 cm. The variety used in experiment was Co- 86032 (Nayana). Drip irrigation was scheduled once in two days based on cumulativepan evaporation (E_{pan}) data. Surface irrigation was given as per the recommended practice of irrigation.

Weed management was done through Metribuzin 70 % @ 600 g ha^{-1} at 2-3 days after planting. Optimum plant population was maintained by filling the gaps at 30 DAP. Hand weeding was done at 45 and 90 days after planting to keep plots weed free. Earthing up was carried by tractor drawn implement. Crop was intercropped with sunhemp as green manure and cover crop. Healthy crop stand was maintained by adopting need based plant protection and recommended package of practices. Five plants were selected randomly and tagged for recording growth and yield parameters as per standard procedures. The data pertaining to the experiment were subjected to statistical analysis in split-plot using ANOVA by following the method of Gomez and Gomez (1984).

Yield parameters of sugarcane were significantly influenced by irrigation levels (Table 1). Significantly higher millable canes (25.71m^{-1}), cane length (226.6 cm), internodes $cane^{-1}$ (20.03), cane girth (2.91 cm) and single cane weight (1.76 kg) were observed with drip irrigation at 100 % of E_{pan}as compared to those with surface irrigation with wider row spacing which recorded least millable canes (23.49m^{-1}), cane length (210.9 cm), internodes $cane^{-1}$ (17.55), cane girth (2.72 cm) and single cane weight (1.34 kg). This variation in yield parameters under drip irrigation in comparison with surface irrigation was mainly due to early vigorous growth (Gurusamy *et al*., 2013) of the plant with availability of required quantity of water and nutrients. Continuous supply of water with plant nutrients might have resulted in higher growth and thereby yield and yield attributes.

Among fertilizer levels, application of fertilizers at 125 per cent RDF recorded significantly higher milllable canes (26.29m^{-1}), cane length (227.3 cm), internodes $cane^{-1}$ (19.50), cane girth (2.90 cm) and single cane weight (1.74 kg) and was on par with 100 per cent RDF. However, least number of milllable canes(22.42m^{-1}), cane length (212.1 cm), internodes $cane^{-1}$ (17.81), cane girth (2.76 cm) and single cane weight (1.44 kg) were found with 50 per cent RDF. This better performance of cane under increased level of nutrients is attributed to lesser dilution of nutrients in unit soil solution and higher uptake and translocation. These findings are in accordance with Raina *et al.*(2011). However, interaction of irrigation and fertilizer levels were found non significant for number of internodes and cane girth.

Significantly higher cane yield was recorded with drip irrigation at 100 per cent of E_{pan}(217 t ha^{-1}) which was 39 per cent higher when compared to surface irrigation with wider row spacing (156 t ha^{-1}). However,

TABLE I

Effect of levels of irrigation and fertilizer on yield and yield components of sugarcane

Treatment	No. of millable canes m^{-1}	Cane length(cm)	No. of internodes $cane^{-1}$	Cane girth (cm)	Cane weight (kg)	Cane yield (t ha^{-1})
Irrigation levels						
I_1: 75 % E_{pan}	24.64	220.5	18.40	2.84	1.65	205
I_2:100 % E_{pan}	25.71	226.6	20.03	2.91	1.76	217
I_3: Surface	23.49	210.9	17.55	2.72	1.34	156
S.Em ±	0.50	4.28	0.23	0.01	0.06	6.15
CD (*p*=0.05)	1.95	16.74	0.89	0.05	0.24	24.09
Fertlizer levels						
F_1 :125 %	26.29	227.3	19.50	2.90	1.74	218
F_2 :100 %	25.56	219.5	18.96	2.83	1.62	197
F_3 : 75 %	24.20	218.4	18.38	2.80	1.54	188
F_4 : 50 %	22.42	212.1	17.81	2.76	1.44	166
S.Em ±	0.93	2.78	0.50	0.04	0.11	8.40
CD (*p*=0.05)	2.77	8.23	1.47	0.12	0.32	24.89
Interactions						
I_1F_1	26.47	227.8	19.33	2.92	1.80	230
I_1F_2	26.27	220.7	18.53	2.88	1.66	209
I_1F_3	23.64	219.7	18.45	2.84	1.61	198
I_1F_4	22.20	213.8	17.29	2.71	1.52	182
I_2F_1	27.53	237.4	21.07	2.99	1.91	249
I_2F_2	26.00	227.1	20.40	2.89	1.85	226
I_2F_3	25.84	225.6	19.38	2.87	1.73	216
I_2F_4	23.47	216.2	19.29	2.87	1.56	177
I_3F_1	24.87	216.6	18.10	2.79	1.49	176
I_3F_2	24.40	210.7	17.95	2.72	1.33	156
I_3F_3	23.11	210.1	17.30	2.70	1.29	151
I_3F_4	21.60	206.2	16.85	2.69	1.23	139
S.Em ±	1.62	4.81	0.86	0.07	0.19	14.56
CD (*p*=0.05)	4.79	14.26	NS	NS	0.56	NS

Note :

I_1: Sub-surface drip irrigation at 75 % E_{pan}

I_2: Sub-surface drip irrigation at 100 % E_{pan}

I_3: Furrow irrigation (Wider row planting)

F_1: 125 % recommended dose of fertilizer (RDF; 250:100:125 kg NPK ha^{-1})

F_2: 100 % recommended dose of fertilizer

F_3: 75 % recommended dose of fertilizer

F_4: 50 % recommended dose of fertilizer

this increase yield was on par with drip irrigation at 75 % of E_{pan}. Among fertilizer levels, application of fertilizer at 125 per cent RDF registered significantly higher cane yield (218 t ha^{-1}) over 75 per cent (188 t ha^{-1}) and 50 per cent (166 t ha^{-1}). This increased yield level under drip fertigation was mainly due to efficient water and nutrient absorption and accumulation of nutrients by crop and maintenance of excellent soil-water-air relationship with oxygen concentration in the root zone. These outcomes are in accordance with Sharma *et al.* (2013). But, interaction effects were not significant with respect to cane yield.

In conclusion the yield levels under application of 100 per cent RDF through drip fertigation were statistically on par with 75 per cent RDF, there would be a saving of 25 per cent of nutrients without hampering on yield levels. In addition, drip irrigation has resulted in 39 per cent higher cane yield over surface irrigation by saving considerable amount of irrigation water.

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(Received : May, 2016 **Accepted :** June, 2016**)**