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Effect of Duration and Levels of Subsurface Drip Fertigation on Yield and Yield Parameters of Sugarcane

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Abstract

A field experiment was conducted at ZARS, V.C. Farm, Mandya during 2014-15 to study the performance of sugarcane as influenced by duration and levels of subsurface drip fertigation. Results revealed that fertigation scheduling up to 9.5 months recorded significantly higher yield and yield parameters *viz.*, millable canes m^{-1} row length (26.45), cane length (2.30 m), internodes $cane^{-1}$ (19.77), cane girth (3.23 cm), single cane weight (1.70 kg) and cane yield (250 t ha^{-1}). Yield and yield parameters significantly not influenced by fertigation levels. The interaction between duration of fertigation and fertigation levels were significant. Fertigation up to 9.5 months with 125 per cent RDF recorded significantly higher yield and yield parameters *viz*., millable canes m^{-1} row length (26.67), cane length (2.31 m), internodes $cane^{-1}$ (19.90), cane girth (3.26 cm), single cane weight (1.73 kg) and cane yield (255 t ha^{-1}) than normal method of sugarcane cultivation with surface irrigation with 100 per cent RDF soil application 147 t ha^{-1} and was on par with fertigation upto 9.5 months with 100 per cent of RDF (249 t ha^{-1}) and fertigation upto 9.5 months with 75 per cent of RDF (246 t ha^{-1}). Thus results clearly indicated that 25 per cent of the recommended dose of fertilizer could be saved with 75 per cent higher cane yield through sub surface drip irrigation over normal practice of sugarcane cultivation.

Sugarcane (*Saccharum officinarum* L.), one of 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 69 t ha^{-1} contributing 19.98 per cent of world's total (27.1 m t) sugar production (Anon., 2015). Globally, sugarcane is cultivated in an area of about 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 in an area of about 0.50 m ha with a production of 47 m t with an average productivity of 94.0 t ha^{-1} (Anon., 2015).

Adoption of modern frontier technologies would become necessary to overcome many of the problems faced by sugarcane farmers. Under the circumstances, the technologies namely drip irrigation and fertigation etc. will have to be put to use on farm level for enhancing productivity with improved water and nutrient use efficiency. Sugarcane being a long duration crop, its normal irrigation water requirement is relatively higher compared to other crops, which ranges from 1400 to 3000 mm ha^{-1} depending on crop yield and climate. Traditional, flood irrigation often results in leaching of mobile nutrients which in turn leads to pollution of water bodies and deterioration of soil health. On the other hand, drip fertigation facilitates the optimum utilization of water and nutrients. Combined application of water and fertilizers is ideal for proper crop growth, as the irrigation water is acting as a carrier for the nutrients required by crops. In this way the soluble fertilizers are conveyed directly to the feeding zone through frequent application in small quantities through drip irrigation system. When properly managed, it opens up new avenues for growing crops under conditions similar to those of nutrient solution. This approach reduces nutrient losses, mainly N, due to leaching and as a result fertilizer recovery or use efficiency is relatively high. The amount of fertilizers lost through leaching can be as low as 10 per cent in fertigation. In the traditional system, 50 per cent loss is quite typical. Further, the ratios of fertilizers can be adjusted easily through the drip system. Considering all these points, a field experiment was conducted to study the performance of sugarcane under subsurface

drip irrigation with varied fertigation scheduling and fertigation levels.

The experiment was conducted at ZARS, VC, Farm Mandya, during 2014-15. Soil of the experimental site was red sandy loam with low organic carbon (0.46 %), 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}). Experiment was laid out in factorial randomized complete block design, replicated thrice consisting of two factors-fertigation scheduling upto 3.5, 5.0, 6.5, 8.0 and 9.5 months and fertigation levels of 75, 100 and 125 per cent RDF with soil application of 100 per cent RDF with surface irrigation (control). The land was prepared by ploughing with tractor drawn disc plough followed by disc harrowing and passing cultivator twice to bring the soil to fine tilth. Layout was prepared with gross plot size of 15.0 X 9.0 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 30 cm apart paired row 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 one month before planting of sets. Out of the recommended dose of fertilizer (250: 100: 125 kg NPK ha^{-1}), 50 percent P was applied as basal dose and remaining P was applied at 105 days after planting (DAP) while earthing up for drip irrigated plots wherein, entire dose of N and K was applied through subsurface drip fertigation at different duration of 3.5, 5.0, 6.5, 8.0 and 9.5 months with three fertigation levels of 75, 100 and 125 per cent RDF consisting 28, 40, 52, 64 and 76 splits of fertigation respectively, twice in a week and drip irrigation was scheduled for every two days. Soil application of recommended dose of fertilizer, (250: 100: 125 kg of NPK ha^{-1}) with surface irrigation was considered as normal method of cultivation (control).

Viable and healthy two budded sugarcane sets were planted in a zig-zag manner in paired row method of planting with spacing of (165+30) X 30 cm. Co-86032 variety was used for planting. Weed management was done through Metribuzin 70 per cent @ 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 out by tractor drawn implement. In each plot five plants were selected randomly and tagged for recording growth and yield observations as per standard procedures. The data was statistically analyzed by following the method of Gomez and Gomez (1984).

Yield and yield parameters of sugarcane were significantly influenced by duration of fertigation (Table I). Fertigation up to 9.5 months recorded significantly higher yield and yield parameters *viz.*, millable canes m^{-1} row length (26.45), cane length (2.30 m), internodes $cane^{-1}$ (19.77), cane girth (3.23 cm), single cane weight (1.70 kg) and cane yield (250 t ha^{-1}). But the yield and yield parameters of sugarcane were not significantly influenced by fertigation levels. This variation in yield and yield parameters under subsurface drip fertigation was mainly due to early vigorous growth which was attributed to required availability of water and nutrients due to better wetting pattern, water distribution in soil and relative water use by the crop throughout the crop growth stage which meets the crop demand (Deshmukh *et al.,* 2001). The interactions between duration of fertigation and fertigation levels were significant. The fertigation up to 9.5 months with 125 per cent RDF recorded significantly higher yield and yield parameters *viz*., millable canes m^{-1} row length (26.67), cane length (2.31 m), internodes $cane^{-1}$ (19.90), cane girth (3.26 cm), single cane weight (1.73 kg) and cane yield (255 t ha^{1}). The increase in yield and yield parameters under subsurface drip irrigation might be due to efficient water and nutrient utilization, higher absorption and accumulation of nutrients by crop and maintenance of excellent soil water relationship in the root zone of the sugarcane (Dhotre *et al.* 2008).

The conventional method of cane cultivation recorded the lowest yield of 147 t ha^{-1}. This might be due to considerable wastage of plant nutrients due to alternate drying and wetting with loss of nutrients through deep percolation below root zone and volatilization particularly nitrogen resulting in

TABLE I

Yield and yield parameters of sugarcane as influenced by duration and levels of subsurface drip fertigation

	Millable canes m^{-1} row length	Cane length (m)	Internodes $cane^{-1}$	Cane girth (cm)	Single cane weight (kg)	Cane yield (t ha^{-1})
Duration of fertigation						
T_1	24.01	2.08	17.92	2.88	1.40	192
T_2	25.23	2.15	18.61	2.97	1.46	206
T_3	25.69	2.19	18.97	3.08	1.54	220
T_4	25.98	2.24	19.39	3.16	1.61	234
T_5	26.45	2.30	19.77	3.23	1.70	250
S.Em±	0.67	0.05	0.52	0.08	0.04	6.06
CD (p=0.05)	1.94	0.15	1.51	0.24	0.11	17.50
Levels of fertigation						
L_1	25.18	2.17	18.68	3.03	1.51	216
L_2	25.51	2.19	19.00	3.06	1.55	220
L_3	25.72	2.21	19.13	3.10	1.57	225
S.Em±	0.52	0.04	0.41	0.06	0.03	4.69
CD (p=0.05)	NS	NS	NS	NS	NS	NS
Interaction						
T_1L_1	23.22	2.04	17.16	2.83	1.37	189
T_1L_2	24.15	2.08	18.24	2.88	1.41	192
T_1L_3	24.65	2.12	18.37	2.93	1.42	195
T_2L_1	24.97	2.13	18.48	2.94	1.44	201
T_2L_2	25.29	2.14	18.61	2.96	1.45	206
T_2L_3	25.45	2.16	18.74	3.01	1.49	210
T_3L_1	25.57	2.17	18.83	3.04	1.52	216
T_3L_2	25.69	2.20	18.99	3.08	1.55	219
T_3L_3	25.83	2.21	19.10	3.11	1.56	224
T_4L_1	25.91	2.23	19.26	3.14	1.58	230
T_4L_2	25.99	2.24	19.38	3.16	1.61	234
T_4L_3	26.03	2.26	19.53	3.19	1.63	239
T_5L_1	26.23	2.28	19.65	3.21	1.65	246
T_5L_2	26.43	2.29	19.77	3.23	1.71	249
T_5L_3	26.67	2.31	19.90	3.26	1.73	255
Control	21.05	1.96	17.05	2.79	1.28	147
S.Em±	1.16	0.09	0.91	0.14	0.06	10.50
CD (p=0.05)	3.36	0.26	2.62	0.41	0.19	30.32

Duration of fertigation
T_1: Fertigation up to 3.5 Months
T_2: Fertigation up to 5.0 Months
T_3: Fertigation up to 6.5 Months
T_4: Fertigation up to 8.0 Months
T_5: Fertigation up to 9.5 Months

Levels of fertigation
L_1: 75% RDF, L_2: 100% RDF, L_3: 125% RDF
Control: Soil application of 100% RDF with surface irrigation.
RDF: 250: 100: 125 kg of NPK ha^{-1}

imbalance in soil water metabolism and nutrient environment (Ridge and Hewson, 2002). Similar findings were also reported by Lin Xu *et al.* (2010).

Thus, subsurface drip fertigation helps to increase cane yield by 67-73 per cent besides saving water and 25 per cent nutrients over conventional method of sugarcane cultivation.

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