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Influence of Fertigation Intervals and Fertilizer Levels on Yield and Quality Parameters of Subsurface Drip Irrigated Sugarcane

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ABSTRACT

A field experiment was conducted at ZARS, V. C. Farm, Mandya during 2015-16 to know the effect of subsurface drip fertigation intervals and fertilizer levels on yield and quality of sugarcane. The treatments consisted of two factors viz., three fertigation intervals (fertigation once in 2, 4, and 6 days) and four fertilizer levels (75, 100, 125 and 150 % of recommended dose of fertilizer) along with conventional method of sugarcane cultivation. The results revealed that the Fertigation once in 2 days has given on par results on the quality parameters viz., brix (20.46 %), pol (19.18 %), purity (93.28%) and CCS (13.63 %) with lesser reducing sugars (2.83 %) but recorded significantly higher cane yield and sugar yield (281.4 and 38.38 t ha^{-1} respectively) than other fertigation intervals. Similar results was also observed under fertilizer levels, application of 125 per cent RDF through subsurface drip fertigation recorded higher quality parameters viz., brix (20.89%), pol (19.48%), purity (94.83%) and CCS production (13.81%) with lesser reducing sugar (2.86%) but cane and sugar yield was higher in 150 per cent of RDF (283.1 and 39.11 t ha^{-1}). The interaction between fertigation intervals and fertilizers levels was not-significant on quality parameters but significantly higher cane yield and sugar yield (308.30 and 42.17 t ha^{-1}) was recorded with fertigation once in 2 days with 150 per cent of recommended dose of fertilizer compare to conventional method of sugarcane cultivation (158 and 21.31 t ha^{-1}). The brix, pol, purity and CCS per cent were increased with increase in fertilizer levels up to 125 per cent RDF then declined by further increased in fertilizer level.

Key words: *Yield, Fertigation intervals, Quality, Subsurface drip fertigation, Sugarcane.*

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a versatile crop that provides sugar, bio-fuel, fiber and manure besides many by products. The crop is grown mainly to manufacture sugar and for making *gur* and *khandasari*. It is one of the important commercial crops of sugar in the world. Globally it is cultivated over an area of 24.5 m. ha with a production of 1850 m.t and productivity of 75.5 t ha^{-1} [4].

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In India, sugarcane is grown under diverse agro climatic situations covering an area of 4.51 m. ha producing 309 m. t of sugarcane with the productivity of 67.57 t ha^{-1} with the distinction of being the second largest producer of sugar after Brazil, and the world's biggest consumer of the sweetener (22.5 m. t)**.** Karnataka ranks third in area (0.42 m ha), fourth in production (35 m t) and third in productivity of 84 t ha^{-1} [1].

A fertigation scheduling plan is often compounded by the changing demands of fertilizer requirements of growing plants. Nevertheless, fertigation should be carried out, not to adversely alter the solute dynamics in the root zone, but should provide optimum concentration of nutrients in the rhizosphere. Hence, accurate prediction of when and how much fertilizer to be applied is of critical for fertigation management. The amount of fertilizer to be applied depends on the plant requirement. The frequency of application of fertilizers depends on the soil type and the length of the growing season. According to Ravikumar *et al*.[8], the frequency of fertigation is usually as critical as achieving the right rate of fertilizer application at a given crop stage. Butler, *et al*.[2], have adopted a growth curve nutrition approach for fertigation scheduling in sugarcane.

Numerical simulations of water flow and urea ammonium- nitrate reactions and transport in the vadose zone, while accounting for root water and nutrient uptake, can help in understanding of the dynamic processes in the vadose zone. Specifically, it would be possible to account for the carry-over of nutrients from previous periods to the current fertigation period. Keeping these facts in mind, the present investigation was taken to know the effect of fertigation intervals and fertilizer levels on yield and quality of subsurface drip irrigated sugarcane.

MATERIALS AND METHODS

The experiment was conducted at Zonal Agricultural Research Station, V. C. Farm, Mandya, during 2015-16. The Soil of the experimental site was red sandy loam with low organic carbon (0.4%), medium available N (344.9 kg ha^{-1}), available P_2O_5 (36.2 kg ha^{-1}) and available K_2O (162.3 kg ha^{-1}). The experiment was laid out in randomized complete block design with factorial concept and replicated thrice. The treatments consisted of two factors *viz.,* three fertigation intervals (I_2: Fertigation once in 2 days, I_4: Fertigation once in 4 days and I_6: Fertigation once in 6 days) and four fertilizer levels (75, 100, 125 and 150 per cent of RDF) along with conventional method of sugarcane cultivation (soil application of recommended dose of fertilizer 250-100-125 kg N, P_2O_5 and K_2O ha^{-1} with surface irrigation). 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 15.6 m × 8.0 m. Drip irrigation system (pump, filter units, main line and sub line) was installed. 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 soil surface. 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. 50 per cent P was applied as basal dose and remaining P was applied at 105 days after planting. N and K were applied through subsurface drip fertigation as per the fertigation in the intervals of once in 2days, 4days and 6 days in 136, 68 and 45 equal splits respectively up to 9 months. Drip irrigation was scheduled uniformly for every two days to all the treatments. Soil application of recommended dose of fertilizer (250: 100: 125 kg N, P_2O_5 and K_2O ha^{-1}) with surface irrigation was considered as conventional method of cultivation of sugarcane.

Viable and healthy two bud setts of variety Co- 86032 were planted in a zig-zag manner in paired row method of planting with spacing of 30/165 cm and intra row spacing of 30 cm. Atrazine 50 per cent WP at 1.0 kg ai ha^{-1} was sprayed 2 days after planting and two hand weeding were done at 45 and 90 days after planting to control weeds. Optimum plant population was maintained by filling the gaps at 30 days after planting. Earthing up was

carried out twice by tractor drawn implement. During harvest five canes from each plot were cut randomly and juice was extracted. Juice samples were analyzed for brix, pol, purity per cent and reducing sugar content as per the standard procedure[3]. The data was statistically analyzed by following the method of Gomez and Gomez[5].

RESULTS AND DISCUSSION

Quality parameters and CCS production of sugarcane was not affected when grown under subsurface drip fertigation with different intervals (Table 1). Fertigation once in 2 days has given on par results on the quality parameters *viz* brix (20.46 %), pol (19.18 %), purity (93.28%), and CCS (13.63 %) with lesser reducing sugars (2.83 %). Similar results was also observed under fertilizer levels, application of 125 per cent RDF through subsurface drip fertigation recorded higher quality parameters *viz.*, brix (20.89%), pol (19.48%), purity (94.83%), reducing sugar (2.86%) and CCS production (13.81%). The brix, pol, purity and CCS per cent were increased with increase in fertilizer levels up to 125 per cent RDF then declined by further increased in fertilizer level; the results are conformity with More *et al*[7]. The interaction effect between fertigation intervals and fertilizer levels was also followed the same trend, irrespective of fertigation intervals and fertilizer levels subsurface drip fertigation once in 2 days intervals with 125 per cent RDF recorded higher quality parameters [brix (21 %), pol (19.62%), purity (94.98%), CCS production (13.92%) with lower reducing sugar (2.83%)] compared to the conventional method of sugarcane cultivation [brix (19.50%), pol (18.69%), purity (92.33%), CCS (13.46%) with higher reducing sugar (3.05%)]. This might be due to split application of required fertilizer doesn't affect the quality parameters[9].

The results revealed that, juice quality declined beyond the application of fertilizer 125 per cent RDF. The possible reason for this might be, with increased dose of nitrogen and increased activity of enzymes, which is responsible for degradation of sucrose and changing into glucose and fructose. This is in accordance with, Singh and Mohan[12] but they reported the poor quality of juice beyond 300 kg N ha^{-1}. The higher brix, sucrose (pol %) and CCS per cent of sugarcane was obtained in the treatment which received fertigation once in 2 days with 125 per cent RDF than the other fertigation intervals and levels of fertilizers. Similar findings were reported by Singandhupe *et al*.[11].

Fertigation once in 2 days, irrespective of levels of fertilizer, resulted in significantly higher cane yield and sugar yield (281.4 and 38.38 t ha^{-1} respectively) than fertigation once in 6 days (235 and 32.03 t ha^{-1} respectively). Irrespective of fertigation intervals, application of 150 per cent of RDF (F_4) through drip fertigation produced significantly higher cane yield and sugar yield (283.1 and 39.11 t ha^{-1}) than the application of 100 (F_2) and 75 (F_1) per cent RDF through drip fertigation and was on par with 125 per cent of RDF through drip fertigation (271.4 and 37.81 respectively). Increased sugarcane yield with increase in fertilizer level through subsurface drip fertigation was also reported by Hemalatha and Chellamuthu[6].

Interactions between fertigation intervals and fertilizer levels on cane and sugar yield were significant. Significantly higher cane yield and sugar yield (308.30 and 42.17 t ha^{-1}) was recorded with fertigation once in 2 days with 150 per cent RDF. The conventional method of cane cultivation (soil application of recommended dose of fertilizer- 250-100-125 kg N-P_2O_5-K_2O ha^{-1} with surface irrigation) recorded the lowest cane and sugar yield (158 and 21.31 t ha^{-1}). This might be due to considerable wastage of plant nutrients to alternate drying and wetting with loss of nutrients through deep percolation below root zone and volatilization of nitrogen resulting in imbalance in soil water metabolism and nutrient environment[10]. Sugar yield is a product of CCS and cane yield, it was increased with increasing yield levels and brix values under drip fertigation.

Table 1: Cane yield, sugar yield and quality parameters of sugarcane as influenced by fertigation intervals and fertilizer levels

Treatments	Cane yield (t ha^{-1})	Juice extraction (%)	Brix (%)	Pol (%)	Purity (%)	CCS (%)	Reducing sugars (%)	Sugar yield (t ha^{-1})
Fertigation intervals (I)								
I_2	281.4	65.23	20.46	19.18	93.65	13.63	2.83	38.38
I_4	267.5	64.93	20.29	19.05	93.38	13.62	2.87	36.25
I_6	235.0	65.04	20.33	19.14	93.28	13.52	2.88	32.03
S.Em ±	5.17	1.21	0.09	0.07	0.45	0.07	0.02	0.66
CD (p=0.05)	15.15	NS	NS	NS	NS	NS	NS	1.93
Fertilizer levels (F)								
F_1	231.9	64.20	19.94	18.80	93.77	13.39	2.84	31.04
F_2	254.0	64.71	20.39	19.03	94.35	13.49	2.83	34.26
F_3	273.7	65.38	20.89	19.48	94.83	13.81	2.86	37.81
F_4	285.4	65.98	20.22	19.18	92.80	13.70	2.88	39.11
S.Em ±	5.96	1.39	0.010	0.08	0.52	0.08	0.03	0.76
CD (p=0.05)	17.49	NS	0.31	0.23	NS	0.23	NS	2.23
Interactions (I×F)								
I_2F_1	251.20	64.39	20.00	18.82	93.56	13.39	2.84	33.60
I_2F_2	272.70	64.90	20.50	19.10	92.68	13.53	2.77	36.88
I_2F_3	293.57	65.47	21.00	19.62	94.98	13.92	2.83	40.87
I_2F_4	308.30	66.15	20.33	19.19	93.89	13.68	2.89	42.17
I_4F_1	242.47	63.88	19.83	18.68	93.69	13.30	2.89	32.24
I_4F_2	261.70	64.46	20.33	18.87	92.30	13.35	2.87	34.91
I_4F_3	278.20	65.47	20.83	19.41	92.70	13.75	2.87	38.26
I_4F_4	287.70	65.92	20.17	19.22	94.80	13.75	2.86	39.58
I_6F_1	202.30	64.31	20.00	18.91	94.05	13.49	2.90	27.28
I_6F_2	227.77	64.77	20.33	19.11	93.51	13.60	2.86	30.98
I_6F_3	249.37	65.20	20.83	19.41	92.70	13.75	2.89	34.30
I_6F_4	260.43	65.87	20.17	19.13	94.35	13.66	2.88	35.58
Conventional method	158.00	63.05	19.50	18.69	92.33	13.46	3.05	21.31
S.Em ±	9.95	2.33	0.19	0.15	0.88	0.14	0.05	1.26
CD (p=0.05)	29.03	NS	NS	NS	NS	NS	NS	3.69

Fertigation Intervals
I_2: Fertigation once in 2 days
I_4: Fertigation once in 4days
I_6: Fertigation once in 6days

Fertilizer levels
F_1: 75 % RDF
F_2: 100 % RDF
F_3: 125 % RDF
F_4: 150 % RDF

Conventional method: Soil application of 100 % RDF with surface irrigation.
(RDF-250:100:125 N P_2O_5 K_2O kg ha^{-1})

CONCLUSION

The brix values, pol and purity percentage determines the quality of cane. The cane quality is good if it contains 12- 13 per cent of sucrose and purity with minimum amount of reducing sugar. In the present study, the quality parameters were affected due to excess application of fertilizer, *i.e* more than 125 per cent of RDF. Finally concluded that, sub surface drip fertigation once in 2 days intervals with 150 per cent RDF able to enhance the cane and sugar yield, but with respect to quality parameters fertilization is restricted to 125 per cent RDF through subsurface drip fertigation in Southern Dry Zone of Karnataka.

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