Mysore J. Agric. Sci., 51 (2) : 397-401, 2017

Effect of Subsurface Drip Fertigation Intervals and Fertilizer Levels on Yield and Economics of Sugarcane

G. K. Ningaraju and B. C. Shankaralingappa
Department of Agronomy, College of Agriculture, UAS, GKVK, Bengaluru-560 065
E-mail: rajuagron@gmail.com

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 sugarcane. Results revealed that fertigation once in 2 days recorded significantly higher cane yield (281.4 t ha^{-1}), millable canes m^{-1} row length (39.4), cane length (222.7 cm), internodes $cane^{-1}$ (21), cane girth (10.1 cm) and single cane weight (2.57 kg) than fertigation once in 6 days, but was on par with fertigation once in 4 days in respect of cane yield, millable canes m^{-1} length and single cane weight. Among the fertilizer levels of drip fertigation, 150 per cent RDF recorded significantly higher cane yield (283.1 t ha^{-1}), millable canes m^{-1} row length (41.3), cane length (234.9 cm), internodes $cane^{-1}$ (22.3), cane girth (10.07 cm), single cane weight (2.94 kg), than other fertilizer levels but was on par with 125 per cent RDF in case of cane yield. Higher cane yield (308.3 t ha^{-1}) and higher net returns (₹ 5,16,149 ha^{-1}) with B : C ratio (3.18) were recorded with fertigation interval once in 2 days with 150 per cent RDF through WSF that increased the cane yield by 95 per cent over surface irrigation with 100 per cent RDF and subsurface fertigation with 75 per cent of RDF once in two days interval recorded higher net returns (₹ 4,01,822 ha^{-1}) and increase in yield of 59 per cent over conventional method with saving of 25 per cent of fertilizers.

Keywords: Subsurface, drip fertigation, WSF, fertigation intervals, fertilizer levels and yield

Sugarcane is an important commercial sugar crop which requires more water and nutrients for its growth and development. In India, it is cultivated in an area of 5.3 mha with a production of 366.0 mt and productivity of 69 t ha^{-1}. Karnataka ranks third in area (0.50 m ha), fourth in production (47.0 mt) and third in productivity of 94 t ha^{-1} (Anon., 2015). For the normal growth and yield of sugarcane crop, optimum soil moisture condition with availability of nutrients in the root zone throughout its growing period is very much essential. One of the methods that is adopted to increase the water and nutrient use efficiency besides increasing productivity is drip fertigation.

Sugarcane being a long duration crop requires considerable quantity of water to the extent of 2000–2500 mm in the subtropics (Solomon, 2012). Its peak water requirement coincides with the crucial water deficit period. Providing optimum soil moisture condition throughout its growing period, however, is of paramount importance to realize higher yields. Drip fertigation, one of the potential technologies offers the great scope to increase cane productivity up to 200-220 t/ha (Senthil Kumar, 2009), by saving 40-50 per cent irrigation water and enhances nutrient efficiency by 40 per cent. Fertigation offers the possibility to optimize the water and nutrient distribution over time and space (Nanda, 2010).

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 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*. (2011), the frequency of fertigation is usually as critical as achieving the right rate of fertilizer application at a given crop stage.The present study was therefore, conducted to determine the yield response of sugarcane to various fertigation intervals and different fertilizer levels under subsurface drip fertigation.

Material 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 2 days, 4 days and 6 days in136, 68 and 45 equal splits, respectively upto 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 $aiha^{-1}$ 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 DAP. Earthing up was carried out twice by tractor drawn implement. In each plot, five plants were selected randomly and tagged for recording growth and yield observations as per standard procedures and B : C ratio was calculated by using net returns and cost of cultivation. The data was statistically analyzed by following the method of Gomez and Gomez (1984).

Results and Discussion

Yield and yield attributes of sugarcane were significantly influenced by fertigation intervals and levels of fertilizer and were not significantly influenced by interactions between fertigation intervals and levels of fertilizer (Table I).

Fertigation once in 2 days, irrespective of levels of fertilizer, resulted in significantly 19.8 per cent higher cane yield (281.4 t ha^{-1}) than fertigation once in 6 days (235.0 t ha^{-1}) and was on par with fertigation once in 4 days(267.5 t ha^{-1}). Significantly maximum cane yield with fertigation once in 2 days (I_2) over fertigation once in 6 days (I_6), higher cane length (222.7 cm compared to 209.5 in I_6), more number of internodes $cane^{-1}$ (21.0 compared to 18.7 in I_6) resulting in significantly higher single cane weight (2.57 kg compared to 2.12 kg in I_6).

Irrespective of fertigation intervals, application of 150 per cent of RDF (F_4) through drip fertigation produced significantly higher cane yield (283.1 t ha^{-1}) than application of 100 (F_2) and 75 (F_1) per cent RDF through drip fertigation (251.7 and 229.7 t ha^{-1}, respectively) and was on par with 125 per cent of RDF through drip fertigation (271.4 t ha^{-1}). Increased sugarcane yield with increase in fertilizer level through subsurface drip fertigation was also reported by Gururaj Kombali *et al*. (2015). Significantly higher cane yield with 150 per cent RDF over 100 and 75 per cent RDF was attributed to significantly more number of millable canes m^{-1} row length (41.3 compared to 36.56 in F_2 and 35.54 in F_1), higher cane length (234.9 cm compared to 205.4 cm in F_2 and 201.5 cm in F_1), more number of internodes $cane^{-1}$ (22.3 compared to 18.9 in F_2 and 18.0 in F_1) and maximum cane girth (10.1 cm compared to 8.9 cm in F_2 and 8.5 cm in F_1). Increased number of millable canes with increase in dose of N, P and K fertilizers from 75 to

TABLE I

Yield and yield parameters of sugarcane as influenced by fertigation intervals and fertilizer levels in subsurface drip fertigation

Treatments	Millable canes m^{-1} row length	Cane length (cm)	Internodes $cane^{-1}$	Cane girth (cm)	Single cane weight (kg)	Cane yield (t ha^{-1})
			Fertigation intervals (I)			
I_2	39.40	222.7	21.0	10.11	2.57	281.4
I_4	37.96	212.3	19.4	8.76	2.40	267.5
I_6	36.23	209.5	18.7	8.60	2.12	235
S.Em±	0.58	3.27	0.25	0.01	0.08	5.17
CD (p=0.05)	1.70	9.61	0.72	0.29	0.24	15.15
			Fertigation (F)			
F_1	35.54	201.5	18.0	8.47	1.77	229.7
F_2	36.56	205.4	18.9	8.85	2.20	251.7
F_3	38.04	218.7	19.6	9.23	2.53	271.4
F_4	41.30	234.9	22.3	10.07	2.94	283.1
S.Em±	0.67	3.13	0.28	0.11	0.09	5.96
CD (p=0.05)	1.96	9.17	0.83	0.33	0.28	17.49
			Interactions (I x F)			
I_2F_1	37.27	208.5	19.5	9.38	1.95	251.2
I_2F_2	38.07	212.6	20.1	9.98	2.33	272.7
I_2F_3	39.27	225.4	20.7	10.33	2.79	293.6
I_2F_4	43.00	247.7	23.9	10.67	3.19	308.3
I_4F_1	35.47	199.6	17.6	8.06	1.80	242.5
I_4F_2	36.80	201.4	18.5	8.38	2.27	261.7
I_4F_3	38.23	217.8	19.3	8.76	2.59	278.2
I_4F_4	41.33	230.6	22.3	9.82	2.96	287.7
I_6F_1	33.90	196.4	16.9	7.97	1.56	202.3
I_6F_2	34.80	202.3	18.1	8.13	2.02	227.8
I_6F_3	36.63	213.1	18.9	8.60	2.21	249.4
I_6F_4	39.57	226.3	20.9	9.70	2.67	260.4
S.Em±	0.38	5.42	0.49	0.20	0.16	10.33
CD (p=0.05)	NS	NS	NS	NS	NS	NS
Conventional method	22.83	186.6	14.33	8.16	1.54	158.0

Note:

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})

TABLE II

Economics of sugarcane cultivation as influenced by fertigation intervals and fertilizer levels in subsurface drip fertigation

Treatments	Cost of cultivation (₹ $^{-1}$)	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B : C ratio
I_2F_1	150818	552640	401822	2.66
I_2F_2	154582	599940	445358	2.88
I_2F_3	158346	645920	487574	3.08
I_2F_4	162111	678260	516149	3.18
I_4F_1	147418	533500	386082	2.51
I_4F_2	151182	575740	424558	2.71
I_4F_3	154946	612040	457094	2.85
I_4F_4	158711	632940	474229	2.89
I_6F_1	144018	445060	301042	2.09
I_6F_2	147782	501160	353378	2.39
I_6F_3	151546	548680	397134	2.62
I_6F_4	155311	572880	417569	2.69
Conventional method	113982	347600	236618	2.07

Note :

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 $NP_2O_5K_2O$ kg ha^{-1})

(Market price of sugarcane ¹ 2200 t^{-1})

150 per cent RDF through water soluble form under subsurface drip fertigation was also reported by Christy *et al*. (2016).

Interactions between fertigation intervals and fertilizer levels on cane yield were not significant. However higher cane yield (308.30 t ha^{-1}) was recorded with fertigation once in 2 days with 150 per cent RDF. Increased yield and yield parameters of sugarcane under subsurface drip fertigation was attributed to required availability of water and nutrients due to better wetting pattern, water distribution in soil and relative water and nutrient use by the crop throughout the crop growth stage (Deshmukh *et al.,* 2001).

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 yield of 158 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 (Ridge and Hewson, 2002).

Thus, subsurface drip fertigation once in 2 days with application of 150 per cent RDF through water soluble fertilizers recorded 95 per cent higher cane yield than surface irrigation with 100 per cent RDF in sugarcane. Subsurface drip fertigation once in 2 days with 75 per cent RDF through water soluble fertilizers produced 59 per cent higher cane yield over conventional method, there by 25 per cent of fertilizers

could be saved by subsurface drip fertigation once in 2 days.

The cost of production of sugarcane was high in subsurface drip fertigation (₹ 1,44,018 to 1,62,111 ha^{-1}) as compared to that in conventional method of cultivation (₹ 1,13,982 ha^{-1}) (Table II). High cost of production in subsurface drip fertigation was mainly due to high cost of drip fertigation installation and high cost of water soluble fertilizers. But higher net returns (₹ 5,16,149 ha^{-1}) with higher B:C ratio (3.18) was realised with subsurface drip fertigation once in 2 days with application of 150 per cent RDF through water soluble fertilizers as compared to that in drip fertigation once in 4 and 6 days with application of 75, 100 and 125 per cent RDF and conventional method of cane cultivation (₹ 2,36,618 ha^{-1} with B:C ratio of 2.07). Higher net returns with fertigation once in 2 days with application of 150 per cent RDF was attributed to 95 per cent increase in cane yield over conventional method of sugarcane cultivation.

All drip fertigation treatments recorded higher net returns with higher B : C ratio as compared to conventional method of cultivation. Subsurface drip fertigation once in 2 days with 75 per cent RDF through water soluble fertilizers (I_2F_1) gave additional net returns of ₹ 1,65,204 ha^{-1} over conventional method of cultivation. Higher additional net returns in I_2F_1 over conventional method was due to increased cane yield by 59 per cent.

Finally it can be concluded that subsurface drip fertigation once in 2 days with 150 per cent RDF through water soluble fertilizers produced significantly 95 per cent higher cane yield with higher net returns and B: C ratio than conventional method of sugarcane cultivation.

REFERENCES

ANONYMOUS, 2015, Directorate of Economics and Statistics.*http:/www. Indiastat.com.*

CHRISTY, N. M. P., JEYASHEELAN, P. AND ANITHA, R., 2016, Best suited fertigation schedule and its effect on growth, yield, quality and uptake of nutrients of sugarcane (*Saccharum officinarum* L.) under Sustainable Sugarcane Initiative method. *Res. Crops*, **17** (3) : 616 - 621.

DESHMUKH, A. S., SHINDE, P. P., KATAKE, S. S., PHONDE, D. B. AND IMAS, P., 2001, Effect of various levels of potash application through drip irrigation on yield and quality of sugarcane. *Potash Res. Inst. of India*, p. 1 - 7.

GOMEZ, K. A. AND GOMEZ, A. A., 1984, Statistical procedures for for agricultural research (Ed). A Wiley Inter Science Publication, New York (USA).

GURURAJ KOMBALI, SHESHADRI, T., NAGARAJU, THIMME GOWDA, M. N., BASAVARAJA, P. K. AND MALLIKARJUNA, G. B., 2015, Performance of sugarcane under varied levels of irrigation and nutrients through subsurface drip fertigation. *Mysore J. Agric. Sci.*, **50** (2) : 290 - 293.

NANDA, R. S., 2010, Fertigation to enhance farm productivity. *Indian J. Fertilizers*, **6** (2) : 13 - 6.

RAVIKUMAR, V., VIJAYAKUMAR, G., SIMUNEK, J., CHELLAMUTHU, S., SANTHI, R. AND APPAVU, K., 2011, Evaluation of fertigation scheduling for sugarcane using a vadose zoneflow and transport model, *Agric. Water Manag.*, **98** (1) : 1431 - 1440.

RIDGE, D. R. AND HEWSON, S. A., 2002, Drip irrigation management strategies. Proceedings of the Australian Society of Sugarcane Technologies, **17** : 8 - 15.

SENTHIL KUMAR, R., 2009, Feasibility of drip irrigation in sugarcane. M.Sc. project work submitted to Tamil Nadu Agric. Univ., Coimbatore.

SOLOMON, S., 2012, Cost effective and input efficient technologies for productivity enhancement in sugarcane. In: 25th meeting of sugarcane research and development workers of A. P. held at Visakhapatnam on 20 - 21st July, 2012, p. 1 - 10.

(*Received :* May, 2017 *Accepted :* June, 2017**)**