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Operational research project on drip fertigation in sugarcane

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Abstract
On farm experiment under Operational Research Project on improved water management technologies in sugarcane were conducted in farmers fields one each at head, middle and tail reaches of Kugalur distributory of Lower Bhavani Project canal command areas during 2014-2015 and 2015-2016. The objectives of the experiment were to test verify drip fertigation in sugarcane at farmers holdings. The experiment consisted of improved water management technology (drip irrigation once in 3 days at 80 per cent PE, fertigation of N and K (275 kg ha^{-1} and 112.5 kg ha^{-1}) in 14 equal splits, with 15 days interval from 15 DAP) and conventional method (0.75 IW/CPE ratio). Drip irrigation laterals were laid with 150 cm lateral spacing and sugarcane sets were planted in paired row planting, 60 cm between rows and 90 cm between 2 pairs of rows. The discharge rate of the dripper was 4 lph and the irrigation was given once in three days and fertigation was given once in 15 days from 15 DAP. The results of this study revealed that drip fertigation recorded lower water use of 1740 mm and higher WUE of 84.1 kg $hamm^{-1}$ and 28.3 per cent water saving. The higher yield of sugarcane 146.3 tonnes ha^{-1} was recorded in drip fertigation technology which was 58.9 per cent higher than conventional method. The B:C ratio (2.87) was higher in drip fertigation treatment compared to conventional method. Drip irrigation once in 3 days at 80 per cent PE and fertigation of N and K (275 kg ha^{-1} and 112.5 kg ha^{-1}) in 14 equal splits with 15 days interval from 15 DAP recorded lower water use, higher WUE, yield and economics in sugarcane.

Keywords: Sugarcane, drip fertigation, cane yield, water use efficiency, economics

Introduction
In India, sugarcane is the second largest crop cultivated by 35 million farmers in 5 million ha (M ha) of land with an annual production of 350 million tonnes of sugarcane. Based on the recent projections, the country would need to produce 415 million tonnes of sugarcane from an area of 4.5 M ha with a sugar recovery of 11 per cent to meet the per capita requirement of 35 kg sweetness per year by 2020 A.D. Tamil Nadu is one of the leading sugarcane producing states of the country with an average productivity of 105 t ha^{-1}. About 30 million tonnes of cane is produced annually from an area of 2.86 lakh hectares (Vijayakumar and Mohamed Haroon, 2014) [15]. The conventional irrigation and fertilizer application methods in sugarcane lead to considerable loss of water and leaching of nutrients resulting in low productivity. Subsurface drip irrigation is an efficient means for applying water and nutrients below the surface soil to conserve water, control weeds and minimize run off. Among the different irrigation systems, the subsurface irrigation is reported for its improvement in yield and quality and shorter growing season together with substantial saving in water and energy.
The field experiments were conducted at Agricultural Research Station, Bhavanisagar under AICRP- Irrigation Water Management project resulted better performance of drip fertigation compared to conventional method of irrigation in sugarcane. To test verify that proven technology of drip fertigation in sugarcane, on farm experiments were conducted at farmers holdings in the Kugalur distributory of LBP canal area.

Materials and Methods
On farm experiment under Operational Research Project on improved water management technologies in sugarcane were conducted in farmers fields one each at head, middle and tail reaches of kugalur distributory of Lower Bhavani Project canal command areas during 2014-2015 and 2015-2016 under All India Co-ordinated Project on Irrigation Water Management. The experiment consisted of improved water management technology (drip irrigation once in 3 days at 80 per cent PE, fertigation of N and K (275 kg ha^{-1} and 112.5 kg ha^{-1}) in 14 equal

splits, with 15 days interval from 15 DAP) and conventional method (0.75 IW/CPE ratio). The entire quantity of phosphorus (62.5 kg ha^{-1}) applied basally in drip fertigation study. The major soil type of the study area was sandy loam in nature and the soil fertility status was medium in available nitrogen, high in available phosphorus and potash. Two methods of sugarcane cultivation viz., drip fertigation and conventional method were compared by using the variety CO 86032. The season of planting of cane in the study area was mainly mid season (February- March). Drip irrigation laterals were laid with 150 cm lateral spacing and sugarcane sets were planted in paired row planting, 60 cm between rows and 90 cm between 2 pairs of rows. The discharge rate of the dripper was 4 lph and the irrigation was given once in three days and fertigation was given once in 15 days from 15 DAP. For conventional method of cultivation, planting was carried out in ridges and furrows with a spacing of 80 cm solid rows and apply 275 kg of N and 112.5 kg of K in three equal splits at 30, 60 and 90 days. Apply super phosphate (62.5 kg ha^{-1}) along the furrows and incorporate with hand hoe. The total water use was calculated by adding irrigation water applied and effective rainfall. The details of test verification in the study area are furnished in Table 1. Sugarcane yield was recorded and total water used, water use efficiency (WUE) and economics were worked out and presented.

Table 1: Details of ORP on drip fertigation in the kugalur distributory

Particular	2014-2015	2015-2016
Area of demonstration (ha)	3.0	3.0
No of farmers (Head, middle, tail)	3	3
Name of the farmers	K.S. Balakrishnan K.S. Ganesan S. Chittrasu	P. Karuppanna M. Perumal gounder A.S. Moorthy
Name of the villages	Kullampalayam Bommanaikanpalayam Kogalur	Kullampalayam Kulavzhi karadu Aandipalayam
Total rainfall during the cropping period (mm)	863.7	714.1
Sugarcane variety used	CO86032	CO86032

Results and Discussion

Effect of irrigation and fertigation on total water used and water use efficiency

The water use studies of both the cultivation methods clearly indicated the beneficial effect of drip fertigation in terms of water saving and higher Water Use Efficiency (WUE) (Table 2). The mean total water use under drip fertigation was 1740 mm which was considerably lesser than conventional method which utilized 2233 mm water. Thus a substantial quantity of water saving by 28.3 per cent was noticed due to the adoption of drip fertigation. The higher cane yield coupled with enormous quantity of water saving under drip fertigation resulted in higher water use efficiency in both the years of experimentation. The results were in accordance with the results of the similar experiment conducted at Agricultural Research Station, Bhavanisagar. The mean WUE of drip fertigation was 84.1 kg $hamm^{-1}$ while it was only 41.3 kg $hamm^{-1}$ in conventional method of sugarcane cultivation. The increase in WUE under drip fertigation was mainly due to better performance of the crop and improvement in yield by effective utilization of available water and nutrients applied at regular intervals throughout the crop period to meet the crop demand. Similar increase in WUE by 65 per cent under 120 cm lateral spaced sub surface drip fertigated sugarcane was also reported by Mahesh (2009) [7]. The higher water use efficiency, water saving in drip ferigation compared to conventional method were reported by Banger and Chaudhari, 2004 [1], Dhotre *et al*., (2008) [3], Mahesh *et al*., 2013 [8].

Effect of drip fertigation on sugarcane yield

In the present study, cane yield of sugarcane was substantially increased due to the adoption of drip fertigation (Table 2). Averaging over locations, drip fertigation registered a mean cane yield of 146.3 t ha^{-1} which was significantly higher than surface irrigation and normal fertilizer application (92.2 t ha^{-1}). Similar significant yield increase for drip fertigation was obtained in the experiment conducted at Agricultural Research Station, Bhavanisagar. Veeraputhiran *et al*. (2012) [14] reported that subsurface drip fertigation registered a cane yield of 113.9 t/ha which was significantly higher (30.8 per cent) than conventional method. The average yield increment by drip fertigation was 58.9 per cent over conventional method of cultivation. Higher cane yield under drip fertigation was mainly due to the availability of sufficient sunlight with better aeration coupled with adequate availability of soil moisture and nutrients throughout the crop growth period. Similar results of 46.6 and 44.0 percent higher cane yield under SSDF with 120 and 180 cm lateral spacing respectively than surface irrigation was reported by Mahesh (2009) [7], Khadagave (2005) [5], Kumari *et al*. (2008) [6] and Sharala *et al*. (2010) [11].

Table 2: Comparison of cane yield, water use and economics of sugarcane under drip fertigation (DF) and conventional method (Conv.)

Particular	2014-2015		2015-2016		Mean	
	DF	Conv.	DF	Conv.	DF	Conv.
Cane yield (kg ha^{-1})	147.7	95.3	145.0	89.0	146.3	92.2
Percent yield increase	54.9	-	62.9	-	58.9	-
Total water use (mm)	1730	2245	1750	2220	1740	2233
Percent water saving by drip fertigation	29.8	-	26.9	-	28.3	-
Water Use Efficiency (kg $hamm^{-1}$)	85.4	42.5	82.9	40.1	84.1	41.3
Cost of cultivation (Rs ha^{-1})	127000	114933	121033	112250	124017	113592
Gross income (Rs ha^{-1})	358830	231660	352350	216270	355590	223965
Net income (Rs ha^{-1})	231830	148747	225287	104020	228558	126383

Additional net income in DF (Rs ha^{-1})	83083	-	121267	-	102175	-
B:C ratio	2.83	2.02	2.91	1.93	2.87	1.98

Economics of drip fertigation in Sugarcane

The economic analysis of both the methods of cultivation (Table.2) revealed that though the cost of cultivation was comparatively higher under drip fertigation it was found to be economically better than conventional method of cultivation. Drip fertigation fetched a mean gross income of Rs. 3,55,590 ha^{-1} as against Rs 2,23,965 ha^{-1} under conventional method. In addition, higher net income and benefit cost ratio were also associated with drip fertigation. Higher net income and Benefit Cost ratio of Rs 2,28,558 ha^{-1} and 2.87 were registered by drip fertigation as compared to Rs 1,26,383 ha^{-1} and 1.98 respectively under conventionally irrigated and fertilized sugarcane. Thus it is evident that adoption of drip fertigation gained an additional mean net income of Rs 1,02,175 ha^{-1} than conventional method. The extra expenditure needed to meet the cost of drip fertigation over conventional method of sugarcane cultivation was very well compensated by the enhanced cane yield. The economic superiority of drip fertigation over conventionally cultivated sugarcane was also documented by Dhanalakshmi (1999) [2], Shinde *et al.* (2001) [12] and Sathyaraj (2010) [9]. Economic feasibility of adoption of drip fertigation on other wide spaced crops like hybrid cotton (Veeraputhiran and Chinnusamy, 2005) [13], chilli (Selvakumar, 2006) [10] and tomato Kavitha *et al.* (2007) [4] are also in line with the findings of this investigation.

Conclusion

The results of the experiment conducted at Agricultural Research Station, Bhavanisagar clearly indicated the advantage of drip fertigation over conventional method of irrigation. From the verification studies conducted at farmers field also proved that drip fertigation is more productive and economically feasible as it improves the yield, fetches higher monetary benefits besides saving substantial quantity of irrigation water and enhanced WUE for kugalur distributory of Lower Bhavani Project canal.

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