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RESEARCH ARTICLE :

Water soluble fertilizers and economics of sustainable sugarcane cultivation under subsurface drip fertigation system

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SUMMARY : A field experiment was carried out at AICRP-Water Management Research Block, Department of Agronomy, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai during the year 2013-14. The soil of the experimental field was sandy clay loam in texture with pH- 7.4, Organic carbon - 0.48 %, EC - 0.42 dS m^{-1} .The study was designed in RBD with three replications. The treatments consisted of F_1- Surface application with soil application of RDF (275:62.5:112.5 kg/NPK/ha), F_2- Drip fertigation of 100% RDF(P as basal, N and K through drip as urea and MOP), F_3-Drip fertigation of 100% RDF with Urea, MOP and SOP, Drip fertigation of 75%, (F_4) and 100% (F_5) RDF with Urea, Map and SOP upto 120 DAP + Ultrosol from 121 to 210 DAP, Drip fertigation of 75% (F_6) and 100% (F_7) RDF with Ultrosol, MAP and Urea, Drip fertigation of half of the 75 % (F_8) and 100 % (F_9) RDF (50 % NPK as basal) with Urea, SSP and MOP). Among the treatments enhancing yield was Subsurface drip fertigation of 100 per cent RDF with ultrasol, MAP and urea (F_7) recorded the maximum cane yield of 175.56 t ha^{-1} and The economics result revealed (Table 2) maximum gross income of Rs.4,65,234.00 ha^{-1} was recorded under drip fertigation of 100 per cent RDF with ultrasol, MAP and urea (F_7) but regard to benefit cost ratio of SSI cane cultivation under subsurface drip fertigation system, the maximum BC ratio of 3.70 was accounted with drip fertigation of 100 per cent RDF (P as basal, N and K through drip as urea and MOP-F_2 due to its lesser cost of cultivation contributed by lower cost of commercial fertilizers. Even though the highest net return (Rs.3,13,090 ha^{-1}) was realized under drip fertigation of 100 per cent RDF with ultrasol, MAP and urea (F_7). However, the additional cost towards WSF was largely compensated by higher net return obtained by higher yield of sugarcane.

KEY WORDS :
Drip fertigation, Water soluble fertilizers, Cane yield

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BACKGROUND AND OBJECTIVES

Sugarcane is the major commercial crop cultivated to in an area of 3.50 lakh ha with a total production of 46.7 million tonnes of sugarcane and 16.23 million tonnes of sugar per annum in Tamil Nadu. The sugarcane productivity has increased over the last two decades however, the marginal increase in productivity of cane and sugar recovery have

to be improved by maximizing yield and quality of sugarcane by adopting balanced fertilization (Bakiyathu Saliha *et al*., 2009). In subsurface drip fertigation, nutrient use efficiency could be more than 90 per cent compared to 40-60 per cent in conventional fertilizer application methods. The amount of fertilizer lost through leaching can be less than 10 per cent in fertigation whereas it is 50 per cent in case of soil application. Adoption of subsurface drip fertigation (SSDI) system may help to increase the water use efficiency and productivity of crops.

RESOURCES AND METHODS

A field experiment was carried out at AICRP-Water Management Research Block, Department of Agronomy, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai during the year 2013-14. The soil of the experimental field was sandy clay loam in texture, taxonomically classified as Typic Udic Haplustalf with pH- 7.4, Organic carbon - 0.48 %, EC - 0.42 dS m^{-1} and Soil samples were analyses initial soil samples and Post-harvest soil samples of the field. The study was designed in RBD with three replications. The treatments were F_{1-} surface irrigation with soil application of RDF, F_{2-} drip fertigation of 100 % RDF (P as basal, N and K through drip as urea and MOP), F_{3-} drip fertigation of 100 % RDF with urea, MAP and SOP, F_{4-} drip fertigation of 75 % RDF with urea, MAP and SOP up to 120 DAP + Ultrasol from 121 to 210 DAP, F_{5-} drip fertigation of 100 % RDF with urea, MAP and SOP up to 120 DAP + with Ultrasol from 121 to 210 DAP, F_{6-} drip fertigation of 75 % RDF with Ultrasol, MAP and urea, F_{7-} drip fertigation of 100 % RDF with Ultrasol, MAP and urea, F_{8-} drip fertigation of 75 % RDF (50 % NPK as basal, balance with Ultrasol, MAP and urea), F_{9-} drip fertigation of 100 % RDF (50% NPK as basal, balance with Ultrasol, MAP and urea). The test crop variety Co - 86032 and RDF: 275: 62.5: 112.5 kg NPK ha^{-1}. The water soluble fertilizers source as Urea. MOP (White Potash), Ultrasol (9:5:33 % NPK), MAP (Mono Ammonium Phosphate), SOP (Sulphate of Potash) and as basal for Single super phosphate.Cost of production and gross return for all the treatments were worked out on the basis of the prevailing input cost and price of sugarcane at the time of experimentation. Economics were calculated as per the standard procedure.

The water source is an open well. Water was

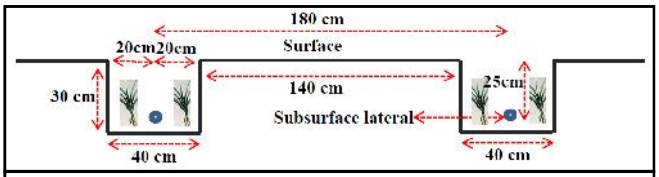

Fig. A : Design and layout subsurface drip fertigation system

pumped through 7.5 hp submersible motor and it was conveyed to field using PVC pipes of 90 mm after filtering through sand and screen filters. From the main line water was taken to the field through sub mains of 75 and 63 mm diameter PVC pipes. From the sub main, 16 mm size 15 mill low cost laterals (drip tap) with discharge rate of 1.29 lph were fixed at a spacing of 1.8 m, The laterals were placed in the center of the trenches at 25cm depth from the surface soil.and the end of laterals were connected to collecting sub main PVC pipe (40mm). The operating pressure was maintained at 0.75 kg cm^{-2}. The subsurface drip irrigation system was well maintained by flushing and cleaning the filters.

Fertigation :

The recommended fertilizer dose of 275: 62.5: 112.5 kg NPK ha^{-1} was followed in the experiment. Fertigation was given as per the treatment schedule. Fertigation was scheduled once in seven days starting from 15 to 210 DAP, The nutrients have supplied based on the crop growth demand.

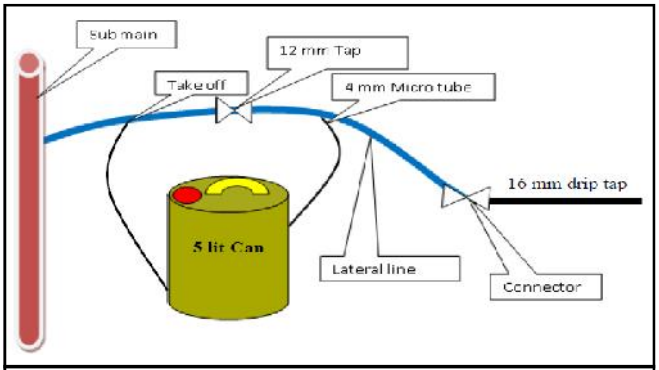

Fig. B : Mini fertigation unit for fertigating individual row

The required quantity of N, P and K fertilizers as urea,Ultrasol, MAP, SOP as per the treatments were dissolved separately in plastic buckets. Required quantity of fertilizer solution was given to each mini fertigation cane fixed with each laterals near the sub main and injected through subsurface drip system.

Each plot consists of five laterals for irrigating five row of cane crop. A tap was provided at the beginning of each lateral for giving controlled fertigation. Subsurface drip fertigation was carried out in three consecutive steps *viz.*, slightly wetting the root zone before fertigation, fertigating to the field and flushing the nutrients with water.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Cane yield :

The perusal of results (Table 1) obtained from the experiment clearly indicated the positive influence of subsurface drip fertigation levels as well as sources of nutrients on the cane yield. Subsurface drip fertigation of 100 per cent RDF with ultrasol, MAP and urea (F_7) recorded the maximum cane yield of 175.56 t ha^{-1}, which was followed by drip fertigation of 100 per cent RDF with urea, MAP and SOP upto 120 DAP + with ultrasol from 121 to 210 DAP (F_5) with the cane yield of 166.21 t ha^{-1}. The lowest cane yield of 107.87 t ha^{-1} was obtained under surface irrigation with soil application of RDF (F_1).

Subsurface drip fertigation positively influenced the cane yield of SSI.NPK fertigation as WSF through subsurface drip irrigation system boosted the tiller production, recorded higher survival per cent, yield contributing parameters like number of millable canes, cane length, individual cane weight, internode length, grand growth and biological efficiency of the cane. Drip fertigation of 100 per cent RDF with ultrasol, MAP and urea (F_7) registered significantly higher cane yield (175.56 t ha^{-1}) which amounted to 62.75 per cent yield increase over surface irrigation with soil application of RDF (F_1). It also recorded 33.9 per cent higher cane yield then the fertigation with commercial fertilizers at same level (F_2).

The highest cane yield under subsurface drip fertigation was mainly due to the availability of adequate

Table 1: Effect of different water soluble fertilizers and yield of SSI under subsurface drip fertigation system

Treatments		Yield (t ha^{-1})
F_1	Surface irrigation with soil application of RDF	107.87
F_2	Drip fertigation of 100 % RDF (P as basal, N&K through drip as urea and MOP)	130.98
F_3	Drip fertigation of 100 % RDF with Urea, Mono ammonium phosphate (MAP) and sulphate of potash (SOP)	160.39
F_4	Drip fertigation of 75 % RDF with Urea, MAP and SOP upto 120 DAP + with Ultrasol from 121 to 210 DAP	103.57
F_5	Drip fertigation of 100 % RDF with Urea, MAP and SOP upto 120 DAP + with Ultrasol from 121 to 210 DAP	166.21
F_6	Drip fertigation of 100 % RDF with Ultrasol, MAP and urea	117.23
F_7	Drip fertigation of 75 % RDF (50% NPK as basal, balance with Ultrasol, MAP and Urea)	175.56
F_8	Drip fertigation of 75 % RDF (50% NPK as basal, balance with Ultrasol, MAP and Urea)	94.86
F_9	Drip fertigation of 100 % RDF (50% NPK as basal, balance with Ultrasol, MAP and Urea)	155.95
	S.E.±	4.31
	C.D. (P=0.05)	8.62

Table 2 : Effect of different water soluble fertilizers and economics of SSI under SSDF (Rs. ha^{-1})

Treatments	Cost of cultivation	Gross income	Net income	BCR
F_1	130115.27	285855.50	155740.23	2.19
F_2	93770.77	347097.00	253326.23	3.70
F_3	93770.77	347097.00	253326.23	3.70
F_4	88756.68	274460.50	185703.82	3.09
F_5	141319.44	440456.50	299137.06	3.12
F_6	104721.36	310659.50	205938.14	2.97
F_7	152144.42	465234.00	313089.58	3.06
F_8	84842.10	251379.00	166536.90	2.96
F_9	132280.19	413267.50	280987.31	3.12

nutrients and water through the crop growth period. This favourable condition resulted in better and earlier conversion of tillers to millable canes and the early vigour was maintained throughout the crop growth period due to better survival of tillers, which in turn resulted in taller stalks and improved stalk weight at harvest (Khandagave *et al.*, 2005).

The higher cane yield under subsurface drip fertigation compared to conventional method of cultivation in sugarcane was earlier reported Dhotre *et al.* (2008); Mahesh (2009) and Devi (2013).

Economics :

The economics result revealed (Table 2) maximum gross income of Rs.4,65,234.00 ha^{-1} was recorded under drip fertigation of 100 per cent RDF with ultrasol, MAP and urea (F_7). The minimum gross income of Rs.2,85,855.50 ha^{-1} was recorded under surface irrigation with soil application of RDF (F_1).

Recommended level 100 per cent NPK fertigation through WSF under subsurface drip irrigation system recorded higher net income compared to surface irrigation. Among the fertigation treatments, the maximum net income of Rs. 3,13,089 ha^{-1} was realized in fertigation of 100 per cent RDF with ultrasol, MAP and urea (F_7), whereas the minimum net income of Rs.1,55,740.23 ha^{-1} was registered in surface irrigation with soil application of RDF(F_1).

With regard to benefit cost ratio of SSI cane cultivation under subsurface drip fertigation system, the maximum BC ratio of 3.70 was accounted with drip fertigation of 100 per cent RDF (P as basal, N and K through drip as urea and MOP-F_2 followed by drip fertigation of 100 per cent RDF with urea, MAP and SOP. The minimum BC ratio of 2.19 was observed under surface irrigation with soil application of RDF (F_1).

Though drip fertigation of 100 per cent RDF with ultrasol, MAP and urea(F_7) increased the cost of cultivation, the gross income obtained under this treatment was higher which was closely followed by drip fertigation of 100 per cent RDF with urea, MAP and SOP upto 120 DAP with ultrasol from 121 to 210 DAP(F_5).

Drip fertigation of 100 per cent RDF with ultrasol, MAP and urea (F_7) resulted in higher net return Rs.3,13,090 ha^{-1}. The next best economically viable treatment was drip fertigation of 100 per cent RDF with urea, MAP and SOP upto 120 DAP + with ultrasol from 121 to 210 DAP (F_5).

Even though the gross and net return were higher under drip fertigation of 100 per cent RDF with ultrasol, MAP and urea (F_7), the B: C ratio (3.06) was numerically lower than (F_2) drip fertigation of 100 per cent RDF (P as basal, N and K through drip as urea and MOP).The high cost of high analytical WSF in addition to the drip system cost resulted in higher cost of cultivation which ultimately led to lower B: C ratios. The same economic trend has been already reported in sugarcane cultivation by Dhanalakshmi (1999); Mahesh (2009); Packialakshmi (2011) and Devi (2013).

Conclusion :

The highest net return (Rs.3,13,090 ha^{-1}) was realized under drip fertigation of 100 per cent RDF with ultrasol, MAP and urea (F_7). The next best treatment in increasing the net return was drip fertigation of 100 per cent RDF with urea, MAP and SOP upto 120 DAP + with ultrasol from 121 to 210 DAP (F_5). But drip fertigation of 100 per cent RDF (P as basal, N and K through drip as urea and MOP) under subsurface drip irrigation system registered the highest B: C ratio (3.70) owing to its lesser cost of cultivation contributed by lower cost of commercial fertilizers.

Fertigation through subsurface drip irrigation system is an innovative technology for maximizing the cane yield. Though the unit cost of drip irrigation system was high, considering longer life period of drip irrigation system, the benefit accrued out of drip irrigation will be for longer period. Fertigation with water soluble fertilizers involved an additional cost. However, the additional cost towards WSF was largely compensated by higher net return obtained by higher yield of sugarcane.

Detailed list of key words		
SSI	:	Sustainable sugarcane initiative
SSDI	:	Subsurface drip irrigation
SSDF	:	Subsurface drip fertigation
WSF		Water soluble fertilizer
RDF	:	Recommended dose of fertilizer

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