Multispecialty Water Soluble Fertilizers and Sulphur Enhances the Yield and Quality of Sugarcane under Subsurface Drip Fertigation System

A. Gurusamy, P.P. Mahendran, S. Krishnasamy and R.Babu

Abstract - The simultaneous delivery of water and fertilizers to the active root zone through subsurface drip irrigation system ensures optimum growth and yield of sugarcane. Field experiment was carried out at Agricultural College and Research Institute, Madurai, Tamil Nadu during 2009-11 to study the influence of water soluble fertilizers (WSF) and sulphur on growth and yield of cane under subsurface drip fertigation system. The experimental soil is clay loam in nature with low N and medium P and K content. The experiment was laid out in a randomized block design with three replications. The sugarcane variety Si-7 was used as test crop. The treatments comprised of F1-Soil application of recommended P and K and the N through drip, F2 - 75 per cent recommended dose of P and K-(50 % P and K as basal, balance nutrients through WSF), F3- 100 per cent recommended dose of P & K (50 % P and K as basal, balance nutrients through WSF), F4-125 per cent recommended dose of P and K (50 % P and K as basal, balance nutrients through WSF), F5 - F1 + Sulphur 30 kg / ha as soil application, F6 - F2 + Sulphur 30 kg / ha as soil application, F7 - F3 + Sulphur 30 kg / ha as soil application, F8 - F4 + Sulphur 30 kg/ha as soil application, F9 -surface irrigation with soil application of RDF (275:62.5:112.5 kg NPK ha-1) as control. Subsurface drip irrigation was scheduled at 100 % PE once in three days and fertigation was given once in seven days as per the treatments. Observations on growth, yield attributes, yield and quality of plant and ratoon sugarcane were recorded.

Plant height and tiller production of both plant and ratoon sugarcane were significantly higher in drip fertigation of 125 per cent recommended dose of P & K (50 % P and K as basal, balance nutrients through WSF) combined with soil application of Sulphur @ 30 kg/ha. The yield attributes viz., number of millable canes, number of internodes, internode length and individual cane weight were also higher in drip fertigation of 125 per cent recommended dose of P and K (50 % P and K as basal and remaining nutrients through WSF) along with soil application of gromore sulphur @ 30 kg/ha. The maximum cane (193.6 and 234.5 t ha-1) and sugar yield (18.91 and.22.93 t ha-1) were also recorded with above treatment in both plant and ratoon crop.

Keywords - Subsurface drip fertigation, water soluble fertilizers, sulphur, cane yield

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I. INTRODUCTION

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. Since, sugarcane is the large consumer of water, the subsurface drip fertigation technology has most significant role in achieving higher productivity and water use efficiency [3].

Water soluble fertilizers are fully water soluble solid fertilizers having high content of primary nutrients with low salt index. These water soluble fertilizers can be utilized for fertigation. The simultaneous delivery of water and fertilizers to the crop through subsurface drip irrigation system ensures that plant nutrients are directed to the active root zone. Water soluble fertilizers require keen attention as it is a new concept of subsurface drip fertigation in sugarcane [4]. With the objective of maximizing sugar cane yield through sub surface drip fertigation the present study was conducted.

II. MATERIALS AND METHODS

The field experiment was laid out in the Agricultural College and Research Institute, Madurai. The experimental soil is clay loam in nature with low N and medium P and K content. The field was well ploughed and brought to fine tilth before taking up layout of sub surface drip irrigation system. Trenches were taken at 1.8 m distance with 40 cm x 30 cm dimensions and the sub surface drip irrigation system was laid out with following specification.

Sub surface drip fertigation system (SSDFS)

Lateral spacing = 1.8 mTrench dimension = 40 cm width and 30 cm depth Laterals = 13 mil trip tap (turbo slim chappins - low cost material) Drippers spacing = 30 cm Discharge rate = 1.29 lph at 0.70 kg/cm2 pressure Treatments F_1 - Soil application of recommended P and K and the N through drip F_2 - 75 per cent recommended dose of P & K - (50 % P and K as basal, balance nutrients through WSF)
F_3 - 100 per cent recommended dose of P & K - (50 % P and K as basal, balance nutrients through WSF) F_4 - 125 per cent

recommended dose of P & K - (50 % P and K as basal, balance nutrients through WSF)

F_5 - F1 + Sulphur 30 kg / ha as soil application

F_6 - F2 + Sulphur 30 kg / ha as soil application

F_7 - F3 + Sulphur 30 kg / ha as soil application

F_8 - F4 + Sulphur 30 kg / ha as soil application

F_9 - Control - surface irrigation with recommended nutrient management

The experiment was laid out in randomized block design with three replications and the test variety was Si 7. Drip irrigation was given once in three days at 100 per cent PE. The recommended dose of fertilizers was 275:62.5:112.5 kg NPK ha-1. The basal application of P and K was done through DAP and MOP. Fertigation was started from 15 DAP with an interval of 6 days up to 210 DAP and the nutrients were supplied based on the crop growth stages. The liquid bio fertilizers viz., azospi, phosphofix and potash activa were applied @ 750 ml/ha on 30. 60 and 90 DAP. Calcium nitrate @ 62.5 kg/ha and humic acid @ 2.5 lit/ha were injected in three equal splits on 30, 60 and 90 DAP.

III. Results And Discussion

TABLE I
. GROWTH AND YIELD ATTRIBUTES OF PLANT CANE UNDER SUB SURFACE DRIP FERTIGATION SYSTEM

Treatments	Tiller prodn./ m	Plant height (cm)	NMC/ m	Individual cane weight(kg)
F_1 - Recd. P as soil application. N and K through drip as Urea & MOP	15.2	276.8	15.2	1.402
F_2 - 75 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	15.4	283.3	15.4	1.505
F_3 - 100 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	16.4	293.7	16.2	1.675
F_4 - 125 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	17.9	299.8	16.9	1.75
F_5 - F_1 + Gromore Sulphur 30 kg / ha as soil application	17.5	293.0	15.8	1.85
F_6 - F_2 + Gromore Sulphur 30 kg / ha as soil application	18.7	315.9	16.7	1.95
F_7 - F_3 + Gromore Sulphur 30 kg / ha as soil application	20.8	326.7	17.3	2.025
F_8 - F_4 + Gromore Sulphur 30 kg / ha as soil application	21.4	345.1	18.4	2.126
F_9 - Absolute control with surface irrigation with RDF	11.7	217.0	13.7	1.28
SEd	0.52	9.18	0.66	0.05
CD(0.05)	**1.29**	23.56	1.44	0.15

IV. Growth Of Cane Under Subsurface Drip Fertigation System

The tiller production and plant height of both plant and ratoon sugarcane was significantly influenced by the sub surface drip fertigation levels. The maximum number of tillers (21.4 and 34.8 /m) and plant height (345.1 and 306.8 cm) was recorded under drip fertigation of 125 per cent recommended dose of P & K - (50 % P and K as basal, balance nutrients through WSF) combined with soil application of Gromore sulphur @ 30 kg / ha and it was closely followed by 100 per cent recommended dose of P & K (50 % P and K as basal, balance nutrients through WSF + Gromore sulphur 30 kg / ha as soil application). The soil moisture kept above the field capacity by the frequent irrigation (once in 3 days) and nutrient supply match with the crop growth demand along with the soil good aeration throughout the crop growth period under SSDF might have favoured the faster cell division and cell elongation which ultimately resulted in higher tiller production and plant height. Similar finding was reported earlier [2]. The reduced tiller production and plant height in surface irrigation was also due to the inadequate supply of the required plant nutrients and irrigation water [6].

TABLE II
GROWTH AND YIELD ATTRIBUTES OF FIRST RATOON CANE UNDER SUB SURFACE DRIP FERTIGATION SYSTEM

Treatments	Tiller prodn./ m	Plant height (cm)	NMC/ m	Indl. cane weight(kg)
F_1 - Recd. P as soil application. N and K through drip as Urea & MOP	30.08	262.5	20.62	1.82
F_2 - 75 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	29.56	256.3	19.12	1.75
F_3 - 100 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	32.24	271.2	23.72	1.89
F_4 - 125 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	34.34	295.8	24.62	2.01
F_5 - F_1 + Gromore Sulphur 30 kg / ha as soil application	31.94	265.4	21.42	1.89
F_6 - F_2 + Gromore Sulphur 30 kg / ha as soil application	30.72	263.5	20.76	1.83
F_7 - F_3 + Gromore Sulphur 30 kg / ha as soil application	32.72	279.8	24.38	1.93
F_8 - F_4 + Gromore Sulphur 30 kg / ha as soil application	34.78	306.8	25.02	2.13
F_9 - Absolute control with surface irrigation with RDF	25.2	262.5	16.23	1.58
SEd	1.06	11.9	0.86	0.07
CD(0.05)	2.32	24.5	1.98	0.14

V. Yield attributes and cane yield

The yield attributes viz., number of millable canes and individual cane weight and cane yield were favourably influenced by subsurface drip fertigation treatments. Among the treatments, drip fertigation of 125 per cent recommended dose of P & K - (50 % P and K as basal and remaining nutrients through WSF + Gromore sulphur 30 kg / ha as soil application) resulted in higher yield attributes. Further sub surface drip fertigation treatments also significantly influenced the cane and sugar yield. The cane and sugar yield were found to be maximum in the treatment with 125 per cent recommended dose of P & K (50 % P and K as basal, balance nutrients through WSF + Gromore sulphur 30 kg/ha as soil application). The minimum cane and sugar yield were recorded under control (F9). The increase in cane and sugar

yield was mainly due to increased individual cane length, girth and number of internodes and this favourable influence was due to better and adequate supply of a required quantity of water and nutrients at the right time at right place due to sub surface drip fertigation. These results were in accordance with the findings of [1] and [3].

TABLE III
YIELD AND QUALITY OF PLANT CANE UNDER SUB SURFACE DRIP FERTIGATION SYSTEM

Treatments	CCS (%)	Brix value	Cane yield (t/ha)	Sugar yield (t/ha)
F_1 - Recd. P as soil application. N and K through drip as Urea & MOP	7.81	15.44	105.5	8.24
F_2 - 75 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	8.05	15.61	114.7	9.23
F_3 - 100 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	8.40	15.93	134.3	11.28
F_4 - 125 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	8.59	16.09	146.4	12.58
F_5 - F_1 + Gromore Sulphur 30 kg / ha as soil application	8.85	16.43	144.7	12.81
F_6 - F_2 + Gromore Sulphur 30 kg / ha as soil application	9.09	16.89	161.2	14.65
F_7 - F_3 + Gromore Sulphur 30 kg / ha as soil application	9.52	17.11	173.4	16.51
F_8 - F_4 + Gromore Sulphur 30 kg / ha as soil application	9.77	17.46	193.6	18.91
F_9 - Absolute control with surface irrigation with RDF	7.77	15.13	86.8	6.74
SEd	0.21	0.45	5.8	0.36
CD(0.05)	0.68	1.27	12.45	0.89

TABLE IV
YIELD AND QUALITY OF FIRST RATOON CANE UNDER SUB SURFACE DRIP FERTIGATION SYSTEM

Treatments	CCS (%)	Brix value	Cane yield (t/ha)	Sugar yield (t/ha)
F_1 - Recd. P as soil application. N and K through drip as Urea & MOP	9.44	19.9	165.12	15.59
F_2 - 75 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	9.16	19.5	152.22	13.94
F_3 - 100 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	9.33	20.9	187.26	17.47
F_4 - 125 % recd. dose of P & K - (50 % P and K as basal and balance nutrients through WSF)	9.59	22.3	217.74	20.88
F_5 - F_1 + Gromore Sulphur 30 kg / ha as soil application	9.56	20.1	178.13	17.03
F_6 - F_2 + Gromore Sulphur 30 kg / ha as soil application	9.22	19.7	162.16	14.95
F_7 - F_3 + Gromore Sulphur 30 kg / ha as soil application	9.44	21.4	197.03	18.60
F_8 - F_4 + Gromore Sulphur 30 kg / ha as soil application	9.78	22.7	234.49	22.93
F_9 - Absolute control with surface irrigation with RDF	8.87	18.6	122.80	10.89
SEd	0.39	0.73	7.8	0.62
CD(0.05)	0.86	1.83	18.8	1.5

VI. QUALITY PARAMETERS

Important juice quality components viz., juice brix per cent and commercial cane sugar per cent were determined during harvest. Among the treatments, fertigation of 125 per cent recommended dose of P & K (50 % P and K as basal, balance nutrients through WSF) along with soil application of gromore sulphur @ 30 kg/ha recorded the maximum quality parameters of cane. This favourable increase in quality of cane under subsurface drip fertigation system was mainly due to the enhanced and continuous supply of nutrients including gromore sulphur through subsurface drip fertigation system up to 210 DAP along with required quantity of water needed for the crop growth [5].

TABLE V
ECONOMICS OF SUGARCANE CULTIVATION UNDER SUBSURFACE DRIP FERTIGATION SYSTEM

Treatments	Cost of cultivation (Rs)	Gross income(Rs)	Net income(Rs)	B:C ratio
F1	99,482	3,21,984	2,22,502	3.2
F2	1,05,351	2,96,829	1,91,478	2.8
F3	1,22,443	3,65,157	2,42,714	3.0
F4	1,37,894	4,24,593	2,86,699	3.1
F5	1,04,146	3,47,354	2,43,208	3.3
F6	1,09,829	3,16,212	2,06,383	2.9
F7	1,26,861	3,84,209	2,57,348	3.0
F8	1,44,824	4,57,256	3,12,431	3.2
F9	71,877	2,39,460	1,67,584	3.3

VII. ECONOMICS

The maximum gross income and net return were associated with and sub surface drip fertigation of 125 per cent recommended dose of P & K (50 % P and K as basal, balance nutrients through WSF) along with soil application of gromore sulphur @ 30 kg/ha. But when we compare the B:C ratio it was comparable with drip fertigation of 125 per cent recommended dose of P & K (50 % P and K as basal, balance nutrients through WSF) alone and surface irrigation and soil application of RDF. The initial investment towards drip irrigation system and the high cost of water soluble fertilizers might have resulted in lower B:C ratio.

From the above results it can be concluded that sub surface drip fertigation of 125 per cent recommended dose of P & K (50 % P and K as basal, balance nutrients through WSF) along with soil application of gromore sulphur @ 30 kg/ha is an ideal practice for getting maximum cane and sugar yield under sub surface drip fertigation system.

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REFERENCE

[1] Ghugare, R.V., M. C . Bankar and T.A . Mane. 1994. Effect of drip and surface methods of irrigation on yield and quality of suru sugarcane. India Sugar. 40: 415-418.

[2] Lahav, E. and D. Kalmar. 1988. Response of banana to drip irrigation, water amounts, and fertilization regimes. Commun. in Soil Sci. Plant Anal. 19: 25-46.

[3] Mahendran. S, S. Ramanathan, A.C. Prabagar, J. Stephen Arul, P. Rajarathinam and R. Yeyasrinivas. 2005. Drip and fertigation for higher cane yield. 37th Meeting of sugarcane research and development workers of Tamil Nadu. Rajshree sugars and chemicals Ltd., Theni district. August 26th and 27th.

[4] Obreza, T.A. and C.S. Vavrina. 1995. Fertilization scheduling for improved nutrient use efficiency of microirrigated bell pepper in sandy soil. In: Proc. Dahha Greidinger International Symposium on Fertigation, March 26-April –1, Israel: 247-256.

[5] Selvaraj, P.K., N. Asokaraja and P. Manicksundaram. 1997. Drip irrigation for sugarcane. Indian Fmg., pp: 17-21.

[6] Sharma,O.L. and P.C. Gupta. 1991. Effect of levels of irrigation, nitrogen and methods of planting on growth and yield of sugarcane. Indian sugar, 40(5): 313-315.