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Optimization of Irrigation and Fertigation Scheduling for Sustainable Sugarcane Initiative (SSI) through Subsurface Drip Irrigation in Western Zone of Tamil Nadu

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Abstract

Sustainable Sugarcane Initiative (SSI) under Sub Surface Drip Irrigation (SSDI) is gaining momentum among the farmers because of more output with less input. Eventhough the benefits of SSI under SSDI are realized by farmers, development of optimal irrigation and fertigation schedule is need of the hour for Western Agro-climatic zone of Tamil Nadu. Field trials were carried out at Agricultural Research Station, Bhavanisagar during 2014 to 2017 to develop an optimal irrigation and fertigation schedule for SSI for Western Agro climatic zone. The experiment was taken in randomized block design with three replications. The experiment consisted of eight treatments of which six treatments comprised of SSDI with three irrigation regimes of 100, 80 and 60 percent pan evaporation and two fertigation levels of 100 and 75 percent of recommended N & K and two treatments in surface drip irrigation (SDI) with 100 percent pan evaporation (PE) + 100 percent RD and 100 percent PE + 75 percent RD of N&K through fertigation. The results of this study revealed that SSDI with 60 per cent

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PE + 100 per cent RD of N&K through fertigation recorded lower water use (1004 mm) and higher WUE (113 kg/ha mm). However, significantly higher and comparable yield of sugarcane (148 t / ha) was recorded in SSDI with 100 percent PE + 100 pe cent RD of N&K through fertigation and surface drip irrigation with 100 percent PE + 100 percent RD of N&K through fertigation. The net return (Rs. 2,09,405 per ha) and B:C ratio (2.6) were higher in SSDI with 100 percent PE + 100 percent RD of N&K through fertigation treatment.

Introduction

Sugarcane is one of the chief cash crops of India. India produced 22.82 percent sugarcane of the world and ranked second in area (20.4%) and production (18.6%). Sugarcane is grown on around 2.8 per cent of Gross Cropped Area of India. Sugarcane is cultivated in an area of 50.67 lakh ha producing about 362 lakh tones with an average productivity of 71.51 t / ha.[1] Whereas in Tamil Nadu, it is cultivated in an area of about 26.31 lakh ha producing about 28.1 lakh tones with an average productivity of 106.8 t / ha.[2] Western zone farmers of Tamil Nadu are more interested to cultivate sugarcane crop due to high return. Though average productivity of sugarcane in Tamil Nadu is higher than national average, greater yield and maximum water and fertilize use efficiency can be obtained if improved package of practices of sugarcane are adopted. In this way, Sustainable Sugarcane Initiative (SSI) is yet another practical approach to sugarcane production, which is based on the principles of 'more output with less input'. SSI enhances the water productivity, land and labourall at the same time, while reducing the overall pressure on input resources. Drip irrigation plays a vital role in maximizing water use efficiency when compared to furrow irrigation.[3] Introduction of drip fertigation increases the yield of crops by three times and saving of fertilizer by 30 percent.[4,5] Sub Surface Drip Irrigation (SSDI) is becoming popular now a days because most favorable moisture and nutrient environment can be maintained in the root zone in SSDI. Because of long standing crop, SSDI is being increasingly adopted to sugarcane. Though benefits of SSI under SSDI are realized by farmers, very limited research work has been carried to optimize irrigation and fertilizer levels for SSI under SSDI. Hence this study was envisaged to optimize the irrigation and fertigation levels for SSI under SSDI for Western Agro climatic zone of Tamil Nadu for adoption.

Materials and Methods

Field experiment was conducted to develop an optimal irrigation and fertigation schedule for SSI for Western Agro climatic zone during 2014 - 2015, 2015 - 2016 and 2016 - 2017 at Agricultural Research Station (ARS), Tamil Nadu Agricultural University (TNAU), Bhavanisagar, Tamil Nadu, India.The soil of the experimental field was sandy loam with a pH of 7.8 and electrical conductivity of 0.27 dS/m. The infiltration rate of the soil was 2.10 cm/hr, field capacity 22.5 percent, permanent wilting point 11.1 percent, bulk density 1.60 mg/m^3 and the organic carbon content 0.21 percent. The nutrient content of the soil was high in available nitrogen (326 kg/ha) and available potassium (285 kg/ha) and medium in available phosphorus (15 kg/ha).

The experiment consisted of eight treatment of which six treatments comprised of SSDI with three irrigation regimes of 100, 80 and 60 percent pan evaporation (PE) and two fertigation levels of 100 and 75 percent of recommended N & K and two treatments in surface drip irrigation (SDI) with 100 percent PE + 100 percent RD and 100 percent PE + 75 percent RD of N & K through fertigation. Drip irrigation laterals were laid with 150 cm lateral spacing and sugarcane seedlings raised in portrays were planted with 60 cm spacing along the laterals. The discharge rate of the dripper was 4lph and the irrigation was given once in three days. Sugarcane variety used in this experiment was Co.86032 with the seed rate of 12,500 seedling/ha.Sugarcane seedlings raised in protrays were planted 60 cm spacing along the laterals after saturating the soil with drip system. 100 percent recommended dose of fertilizers for sugarcane is 275: 62.5: 112.5 kg NPK/ha. Entire Phosphorous (P) was applied in single dose as basal. Nitrogen (N) and Potassium (K) were applied through fertigation in drip system once in 6 days commencing from 30 DAP. The crop was

raised with all recommended package of practices except irrigation and fertilizer application. Treatment wise sugarcane yield was recorded and total water used, water use efficiency (WUE) and economics were worked out and presented here.

Results and Discussion

Effect of Irrigation and Fertigation on Total Water Used and Water Use Efficiency

Different irrigation levels exerted significant difference on WUE of sugarcane (Figure 1). Among the different treatments, subsurfacedrip irrigation at 60 percent of PE (T_5) recorded lower water use (1273, 809 and 931mm) and higher WUE (95.03, 139.61 and 105.66 kg/ha mm) on all the three season crops. It is followed by subsurface drip irrigation at 80 percent of PE (T_6). The increase in WUE recorded under subsurface drip fertigation system was mainly due to efficient utilization of available water and nutrients that were supplied at even intervals throughout the crop period to meet the crop needs thatbrings in the increased yield.[6] The irrigation water use efficiency was increased to the extent of 52.33 percent in subsurface drip irrigation compared to surface irrigation method.[7]

Higher water saving up to 34.84 percent and higher water use efficiency up to 161.40 kg/ha mm registered under subsurface drip irrigation system in sugarcane.[8,9] Higher water use efficiencies in drip irrigation treatments of 80, 60 and 40 percent PE once in 2 days as compared to surface irrigation treatment.[10,11]

Effect of Irrigation and Fertigation On Sugarcane Yield

Irrigation and fertigation levels at surface and subsurface drip irrigation studied in this experiment had made significant variation on the crop yield in all the years. Comparable sugarcane yield was reported under subsurface and surface drip irrigation treatments (Table 1). Among the different treatments subsurface drip irrigation (SSDI) with 100 percent pan evaporation (PE) + 100 percent recommended dose (RD) of N&K through fertigation (T_1) and surface drip irrigation (SDI) with 100 percent PE + 100 percent RD of N & K (T_7) reported significantly higher and comparable yield. Moderate and comparable yield was recorded in SSDI with 100 percent PE + 75 percent RD of N&K (T_2) &SSDI with 80 percent PE + 100 percent RD of N&K (T_3). Cane yield was distinctly lower in SSDI with 60 percent PE + 75 percent RD of N&K (T_6) and was at par with SSDI with 60 percent PE + 75 percent RD of N&K (T_5) and SSDI with 100 percent PE + 75 percent RD of N&K (T_8). The reason for getting higher yield in subsurface drip irrigation (SSDI) with 100 percent PE + 100 percent recommended dose might be due to minimum crop growth competition, less water stress, high water spread across the bed and optimum nutrient uptake. Higher water and fertilizer use efficiency with effect from water and fertilizer applied directly to the root zone of crop based on their crop needs at various growth stages might have contributed for higher cane yield under subsurface drip fertigation.[12,13,7]

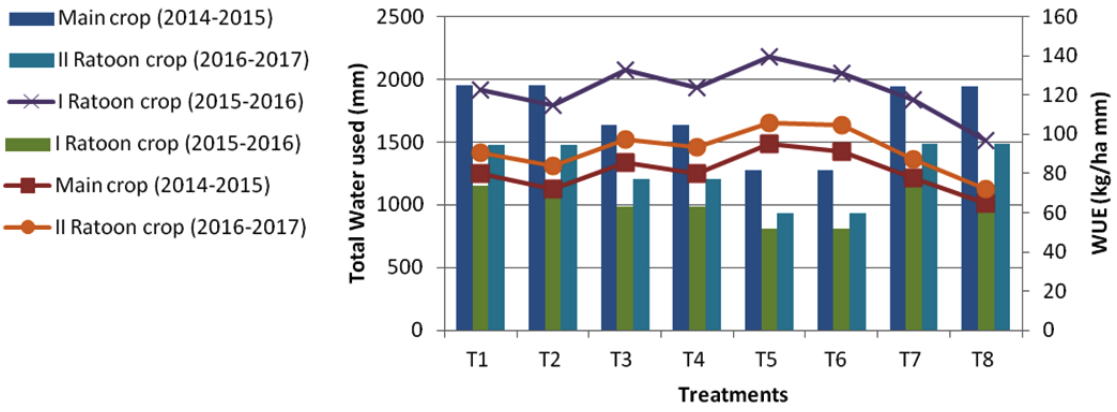

Figure 1. Effect of different irrigation and fertigation levels on total water used and WUE for sugarcane

In subsurface drip fertigation, irrigation at 100 percent pan evaporation recorded higher yield of 153 t / ha at 150 cm lateral spacing.[8,12] Subsurface drip fertigation registered a cane yield of 113.9 t / ha which was significantly higher than conventional method.[15,16]

Economics of Drip Fertigation

The economic evaluation of the results revealed that gross return and net return were higher under subsurface and surface drip fertigation treatments of 100 percent pan evaporation with 100 percent RD treatments (Table 2). Cost of cultivation was higher in 100 per cent RD treatments and lower in 75 RD treatments. Net return was higher in T_1 (SSDI 100PE,100RD) and lower in T_5 and T_6 (SSDI 60PE,100RD and SSDI 60PE,75RD). T_1 (SSDI 100PE,100RD) recorded higher B: C ratio of 2.6 and lower in T_5 and T_6 (SSDI 60PE,100RD and SSDI 60PE,75RD).

Table 1: Effect of irrigation and fertigation on sugarcane yield

Treatment	Sugarcane yield (t / ha)			
	Main crop (2014-2015)	I Ratoon crop (2015-2016)	II Ratoon crop (2016-2017)	Pooled data
T_1	156.31	141.6	144.78	147.77
T_2	140.58	132.09	133.41	135.89
T_3	140.36	130.31	128.56	134.08
T_4	130.71	121.47	123.39	125.07
T_5	120.98	112.93	110.85	115.25
T_6	116	106.04	109.92	112.85
T_7	151.07	136.36	139.93	142.88
T_8	125.51	112.22	116.26	118
SEd	4.23	3.36	3.75	3.41
CD (p=0.05)	9.07	7.2	8.04	7.32

Table 2: Effect of different irrigation and fertigation levels on economic of sugarcane

Treatment	Cost of Cultivation (Rs. / ha)	Main crop (2014 - 2015)			I Ratoon crop (2015 - 2016)			II Ratoon crop (2016 - 2017)		
		Gross return (Rs. / ha)	Net return (Rs. / ha)	B:C Ratio	Gross return (Rs. / ha)	Net return (Rs. / ha)	B:C Ratio	Gross return (Rs. / ha)	Net return (Rs. / ha)	B:C Ratio
T_1	1,30,000	3,59,516	2,29,516	2.8	3,25,680	1,95,680	2.5	3,33,019	2,03,019	2.6
T_2	1,28,000	3,23,329	1,95,329	2.5	3,03,804	1,75,804	2.4	3,06,839	1,78,839	2.4
T_3	1,30,000	3,22,818	1,92,818	2.5	2,99,716	1,69,716	2.3	2,95,692	1,65,692	2.3
T_4	1,28,000	3,00,636	1,72,636	2.3	2,79,373	1,51,373	2.2	2,83,800	1,55,800	2.2
T_5	1,30,000	2,78,249	1,48,249	2.1	2,59,747	1,29,747	2	2,54,962	1,24,962	2
T_6	1,28,000	2,66,800	1,38,800	2.1	2,43,902	1,15,902	1.9	2,52,820	1,24,820	2
T_7	1,30,000	3,47,453	2,17,453	2.7	3,13,618	1,83,618	2.4	3,21,846	1,91,846	2.5
T_8	1,28,000	2,88,676	1,60,676	2.3	2,58,111	1,30,111	2	2,67,400	1,39,400	2.1

Conclusion

The results of the three year's research revealed that SSDI with 60 percent pan evaporation + 100 percent recommended dose of N&K through fertigation for lower water use and higher WUE. Subsurface drip irrigation with 100 percent pan evaporation + 100 percent recommended dose of N&K through fertigation for higher yield and economics in SSI for Western Zone of Tamil Nadu.

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Conflict of Interest

Authors declare no conflict of interest.

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