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Drip Irrigation and Fertigation for Sugarcane in Deep Black Soils

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Abstract. An experiment was conducted at Water Management Research Centre, Parbhani on Sugarcane Variety CO-7714, during 2000-2001 on medium deep clayey soil for finding out optimum water requirement, water use efficiency under drip and fertilizer use efficiency. The treatments consisted of three irrigation schedules through drip I_1 (0.6, 0.8, 1.0 and 0.8 ETc) I_2 (0.8, 1.0, 1.2 and 0.6 ETc) and I_3 (1.0, 1.2, 0.6 and 0.8 ETc) compared with surface irrigation at 1 IW/CPE with 70 mm depth and recommended dose of fertilizer (Soil application) as control, with three fertigation treatments

i) F_1 soil application 100 per cent

ii) F_2 100 per cent recommend dose through drip

iii) F_3 80 per cent recommend dose through drip

iv) F_4 60 per cent recommended dose of fertilizer through drip.

As regards irrigation treatments scheduling of irrigation as per I_2 treatment recorded highest cane yield (179.96 t/ha) the other two irrigation treatments I_1 (165.86 t/ha) and I_3 (165.57 t/ha) were at par. The saving in irrigation water under I_1, I_2, I_3 schedule was 29.57, 20.72 and 21.40 per cent. Application of 80 per cent (7 splits) recommended dose of fertilizer through drip gave highest sugarcane yield (182.84 t/ha) and found significantly superior over rest of treatments. Interaction effect fertilizer X irrigation was found significant. The irrigation schedule I_1 coupled with 80 per cent recommended dose gave significantly higher cane yield of 199.48 t/ha. The fertilizer level F_4 (60 per cent) recommended dose of fertilizer through drip recorded highest fertilizer use efficiency of 57.56 X 10^{-2} tons/kg of NPK. Fertilizer use efficiency was lowest in control treatment as compared to rest of all.

Keywords. ETC (Pan evaporation X KC), Fertigation, Irrigation Efficiency, Fertilizer use efficiency

Introduction

Sugarcane is an important cash crop of India. In Maharashtra State sugarcane crop is grown on 5.162 Lac hectares yielding 418.05 Lac tonnes. Farmers use 300 to 400 ha. cm of water to grow sugarcane crop. But according to scientific findings the water requirement of sugarcane crop varies from 120 to 300 cm in different parts of country.

Scientific water management aims at maintaining the soil moisture in the root zone at optimum level. Drip irrigation for sugarcane is in practice in many countries of the world. 14 per cent or more yield was observed under drip irrigated sugarcane than furrow method of irrigation.

Drip irrigation with fertigation results in higher water and fertilizer use efficiencies Irrigation at fixed IW/CPE through the growth period does not fully meet the crop water requirement during grand growth stage, and therefore present studies were undertaken with a view to study the crop response, water saving, fertilizer use efficiency, water use efficiency during 2000-2001 in medium deep black cotton soils.

Safety Emphasis

You are urged to discuss the effects of your research, concept, design, technique, material, etc., on personal safety, if applicable. In what ways did you consider safety in your project? How will your work improve safety? What precautions do you plan or recommend to eliminate the adverse effects?

Material and Methods

An experiment was conducted at water Management Research Centre, Marathwada Agricultural University, Parbhani (India) during 2000-2001. The soil was medium deep clayey in texture and Alkaline in reaction. It was low in organic carbon and Nitrogen, medium in phosphorus and rich in potassium. The moisture content at 0.33 and 15 bars were 34.5 and 15.5 per cent respectively. The bulk density of soil was 1.32 g/cm^3 EC 0.3 dsm^{-1}.

Sugarcane variety CO-7714 was planted on 6th February 2000, with paired planting (70 + 140 cm), seed rate used was 25000 sets/ha. Randomized block design was adopted, with three replications and plot size was 8.4 x 10.0 m. Three irrigation schedules for drip irrigation were followed. Pan evaporation values (monthwise) of the region and crop coefficient values were taken into consideration and values of ETc (pan evaporation x crop coefficient) were worked out. The details are given below.

The details of irrigation schedules.

Crop stage in (growth period days)	Schedule		
	I_1	I_2	I_3
0 – 40	Common Irrigation		
41 – 90	0.6 Etc	0.8 ETc	1.0 ETc
91 – 160	0.8 Etc	1.0 ETc	1.2 ETc
161 – 250	1.0 Etc	1.2 ETc	0.6 ETc
251 – 350	0.8 Etc	0.6 ETc	0.8 ETc

The drip irrigation treatment was compared with surface irrigation at 1 IW/CPE with 70 mm depth and recommended dose of fertilizers through soil application (Convential method of irrigation and fertilizer application)

Fertilizer treatments

The details are as below

1. F_1 – 100 per cent recommended dose of fertilizer (RDF) i.e. 250 kg N + 115 kg P_2O_5 + 115 K 20/ha through soil application (4 splits) and irrigation through drip.
2. F_2 – 100 per cent RDF through drip
3. F_3 – 80 per cent RDF through drip
4. F_4 – 60 per cent RDF through drip

Details of fertilizer splits through drip were as follows :

Percentage of RDF	Application (Day's after planting)
10	At planting
20	30
10	60
20	90
10	120
20	150
10	180

Fertilizer splits for soil application were

1. 10 per cent at planting
2. 40 per cent 60 days after planting
3. 10 per cent 90 days after planting
4. 40 per cent at earthing up.

For mulation of fertilizer were

i) Urea

ii) 18 : 18 : 10 (kg/N, P & K)

iii) Phosphoric acid

iv) Murate of potash

Drip layout

Drip layout was done as per the specific norms of the system. One lateral line was provided for a pair of two rows. On line emitter of 4 LPH capacity were fixed at every 60 cm on lateral the experimental plots were separated by independent manifolds with control values.

Water applied for various treatments in mm is given in table – 4

Table – 1 : Cane yield of sugarcane as influenced by different treatments

	* I_1	I_2	I_3	Mean
** F_1	136.86	193.68	180.59	170.48
F_2	167.72	179.42	157.80	186.507
F_3	199.48	183.37	165.67	182.84
F_4	159.08	167.58	170.63	165.76
Mean	165.66	179.96	168.57	171.40
Control 86.89	-	-	-	164.84

* I_1, I_2, I_3 – Irrigation levels

** F_1, F_2, F_3, F_4 – Fertilizer levels

Form table – 4, it can be observed that there was 29.57 per cent, 20.72 per cent and 21.40 per cent water saving in irrigation treatments I_1, I_2 and I_3 over control.

The data on millable cane yield as influenced by different treatment is given in Table – 2.

Table – 2 : Cane yields (t/ha) as influenced by different treatments

Fertilizer schedule	Fertilizer use (NPK)	Cane yield (t/ha)	Fertilizer use efficiency t/kg NPK 10^{-2}
F_1	480	170.48	35.52
F_2	480	166.507	34.69
F_3	384	182.84	47.61
F_4	288	165.76	57.56
Control 100% RDF through Soil	480	164.84	34.34

A) Irrigation Schedule

The data from table – 1 indicates that scheduling of irrigation as per I_2 (0.8, 1.0, 1.2 and 0.6 ETc) treatment recorded highest cane yield (179.96 t/ha) and proved significantly superior over I_1 (0.6, 0.8, 1.0, 0.8 ETc) yielding 165.66 t/ha. The treatment I_1 and 1_3 were at par.

B) Fertilizer effect

Application of 80 per cent (7 splits) recommended dose of fertilizer through drip (F_3) gave highest cane yield (182.84 t/ha) and found significantly superior over rest of the treatments F_1 i.e. (100 per cent recommended dose, soil application) 170.48 t/ha F_2 (100 per cent dose through drip) 186.507 t/ha and F_4 (60 per cent recommended dose through drip) recording 165.76 t/ha. (Table – 2)

C) Interaction effects

The scheduling of irrigation as per I_1 coupled with fertilizer application at the rate of 80 per cent recommended dose of fertilizer through drip (F_3) gave significantly highest cane yield of 199.48 t/ha than rest of treatment combinations except I_2F_1 (Table – 1)

Fertilizer use efficiency

The highest fertilizer use efficiency of 57.56 t/kg NPK 10^{-2} was observed in F_4 treatment (60 per cent RDF through drip) i.e. 47.61 t/kg NPK 10^{-2} it was lowest in control i.e. 34.34 t/kg NPK 10^{-2}. (Table – 2)

Water use efficiency

Water use efficiency was highest in I_1 i.e. 9.428 t/ha mm (10^{-2}) and was lowest in control treatment i.e. 3.523 t/ha mm (10^{-2}). (Table – 3)

Table 3 : Effect of water expense components in Sugarcane

Irrigation schedule	Irrigation water Applied (mm)	Cane yield t/ha	Water use efficiency t/ha mm (10^{-2})
Drip system 1_1	1757.04	165.66	9.428
1_2	1955.09	179.96	9.205
1_3	1938.50	168.57	8.696
Gravity flow at 1/W/CPE	2466.17	86.89	3.523

Table 4 : Water application for Sugarcane (mm)

Sr. No.	Growth period		P.E.	ETc	I_1	I_2	I_3	Control
1	0 -	Feb-26	6.6	2.886	75.036	75.036	75.036	171.60
	40 – days	Mar-14	8.58	2.896	40.544	40.544	40.544	120.12
2.	41 -	Mar-17	8.58	2.896	29.546	39.389	49.232	145.86
	90 days	Apr-30	11.58	10.133	182.370	243.180	303.990	347.40
		May-3	15.78	13.808	24.855	33.138	41.424	47.34
3.	91 -	May-28	17.78	13.808	309.288	386.624	463.932	441.84
	160 days	Jun-30	6.62	5.793	139.02	173.790	208.560	198.60
		Jul-12	5.00	5.688	54.600	68.256	81.912	60.00
4.	161	Jul-19	5.00	5.688	108.072	129.349	92.659	135.78
	250 days	Aug-31	4.38	4.983	154.473	185.349	92.659	135.78
		Sept-30	5.50	6.257	187.710	225.240	112.620	165.00
		Oct-10	6.10	6.939	69.39	83.260	41.630	61.00
5.	251	Oct-21	6.10	6.939	116.571	87.423	116.571	128.10
	350 days	Nov-30	4.80	5.460	131.040	98.280	131.040	144.00
		Dec-31	4.10	2.870	71.176	53.382	71.176	127.10
		Jan-18	4.30	3.010	43.344	32.508	43.344	77.40
	Total water requirement mm				1737.035	1955.093	1938.498	2466.14
	Water saving over control				29.57 %	20.72 %	21.40 %	

Table – 5 : Salt distribution (dsm^{-1}) under point source of application of drip irrigation.

Treatment	Soil depth (cm)	Lateral distance (cm) from dripper		
		0	20	40
L_1	0-15	0.66	0.78	0.87
	15-30	0.88	0.90	0.73
	30-45	0.88	0.90	0.86
	Average I_1	**0.81**	**0.86**	**0.82**
I_2	0-15	0.66	0.86	0.87
	15-30	0.82	0.91	0.83
	30-45	0.90	0.86	0.80
	Average I_2	**0.79**	**0.87**	**0.83**
I_3	0-15	0.76	0.93	0.78
	15-30	0.80	0.82	0.74
	30-45	0.85	0.85	0.82
	Average I_3	**0.80**	**0.86**	**0.78**
Control	0-15	0.55	0.75	--
	15-30	0.75	0.90	--
	30-45	0.75	1.00	--
	Average Control	**0.68**	**0.88**	**--**

Salt distribution

The data from table 5 indicates that in general salt concentration was comparatively low at point source and slightly increased upto 20 cm laterally. It was low in surface layer and increased with depth under all irrigation schedules.

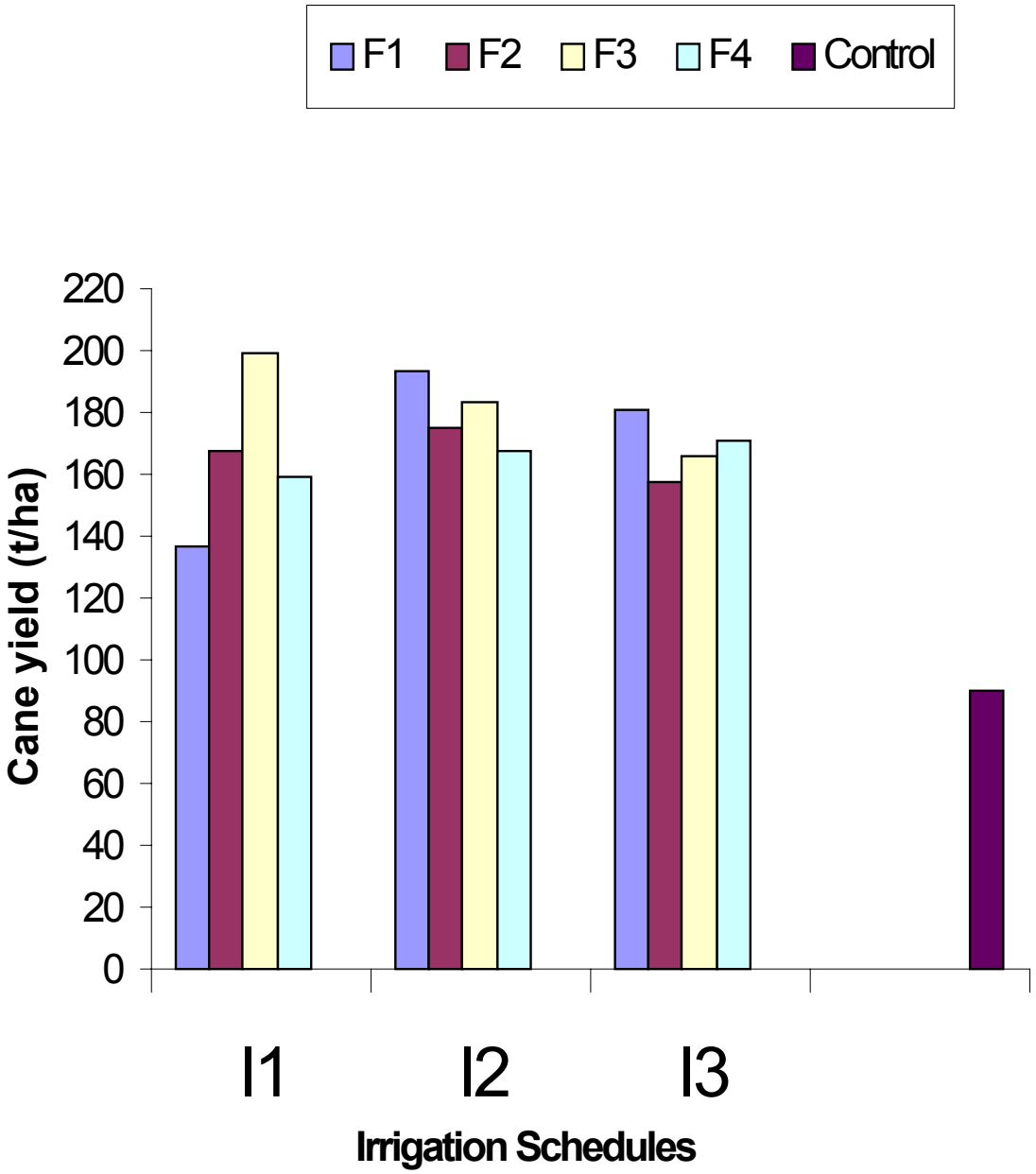

Figure 1. Cane Yield (t/ha) of sugarcane as influenced by different irrigation and fertilizer treatements.

Conclusion

The experiment on drip irrigation for sugarcane in medium black deep cotton soils was carried out during the year 2000-2001. It was observed that there was 29.57 per cent, 20.72 per cent and 21.40 per cent water saving in different drip treatments. (I_1, I_2, I_3) compared with control i.e. surface irrigation (a) 1 IWICPE ratio. Scheduling of irrigation as per I_2 treatment (0.8, 1.0, 1.2 and 0.6 ETc) recorded highest cane yield i.e. 179.98 t/ha and was significantly superior over I_1 and I_3. Treatments I_1 and I_3 were at par. Application of 80 per cent recommended fertilizer dose in 7 splits through drip gave highest cane yield (182.84 t/ha) and was significantly superior over rest of the treatments. Scheduling of irrigation as per I_1 with fertilizer application @ 80 per cent

recommended dose gave significantly highest cane yield of 199.48 t/ha. The highest water use efficiency of 9.428 t/ha mm (10_{-2}) was observed in irrigation treatment I_1, and was lowest in control treatment i.e. 3.523 t/ha mm (10_{-2}).

In nut shell considerable saving in fertilizer and irrigation water was observed in the experiment.

Acknowledgements

Acknowledgements, if any, are placed here under a Heading 2.

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Appendix or Nomenclature

This optional section can include lists of nomenclature or abbreviations, reference data, or tables that are too long to include in the body of the article.