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Effects of Irrigation on Yield, Water Use Efficiency and Some Yield Contributing Parameters of Sugarcane

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ABSTRACT

A field experiment was carried out at the Bangladesh Sugarcane Research Institute (BSRI) farm to investigate the effect of irrigation on yield, water use efficiency and some yield contributing parameters of sugarcane during the cropping year 1989-90. This study was further aimed to develop an irrigation schedule for successful sugarcane cultivation. A high yielding sugarcane variety Isd 16 was grown on a sandy loam soil under six irrigation treatments replicated thrice in a randomized block design. Irrigation treatment showed significant effects on yield, millable cane, internode number, plant height, tillering and tiller mortality. The highest yield (107.2 t ha^{-1}) was obtained from I5 treatment at IW/CPE ratio of 1.0 with three irrigations totaling 30 cm of the water applied once at 24h after plantation and the rest at 30 and 92 d after plantation. The lowest yield (60.74 t ha^{-1}) was obtained from the control plot. The highest water use efficiency (0.51t ha^{-1} cm^{-1}) was recorded from the I5 treatment with IW/CPE ratio of 1.0 from the control. The number of irrigation, however increased the yield, crop water use and water use efficiency of sugarcane variety Isd 16. The results thus suggest that three irrigations, one live irrigation within 24h after plantation and the remaining two at 30 and 92 d after plantation would give higher cane yield at BSRI farm, Ishurdi.

Key Words: Sugarcane, Yield, Effect of irrigation, Water use efficiency

INTRODUCTION

Sugarcane is an important cash crop in Bangladesh . It occupies about o.16 million hactare of cultivable land with an average production of 42 ton ha-1(Ali *et al.*,1989). In Hawaii and Australia, the yield of sugarcane are 222 ton ha^{-1} and 74 ton ha^{-1} respectively (Hossain *et al.* 1990). The low yield of sugarcane is mainly due to improper and poor land preparation, untimely planting, poor intercultural operations such as weeding, disease and pest control and inadequate supply of fertilizer and irrigation water. Satisfactory sugarcane growth and agricultural production is not possible without timely application of adequate irrigation water.

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Generally a few farmers apply irrigation to the sugarcane crop in Bangladesh. During the period from 1984 to1990 only about 5.5% of the total sugarcane area of Bangladesh was under irrigation (Anonymous,1987-1991). Planting of sugarcane is usually done during October to February utilizing residual soil moisture. The water requirement of this crop is estimated to 152 cm per year if rainfall is evenly distributed throughout the growing period (Hossain *et. al*, 1990). In sugarcane growing zone of Bangladesh, rainfall ranges from 120 cm to 202 cm per year. It is assumed that available amount of rainfall is very much satisfactory for growing sugarcane. But rainfall is not evenly distributed throughout the year and 70% of the total rainfall occurs between July to September causing water stagnation in the field which results loss of sugarcane yield and reduction of quality. On the other hand, during winter and early part of summer (germination and tillering stages of sugarcane) the rainfall is very scanty. In some months, there is no rainfall at all and the situation is more common during December to February.

In places where rainfall is low, application of irrigation water is very much necessary for obtaining higher yield of sugarcane. And for this purpose, an irrigation schedule could be used as guide line. Application of irrigation water without proper planning and actual requirement of the crop results not only in wastage of irrigation water but also hampers crop growth and yield (Sekhon *et al*, 1968). At present there is no irrigation schedule for sugarcane in Bangladesh. There is a wide scope for increasing production of sugarcane if proper irrigation and other inputs are made available. In the present investigations sugarcane variety Isd 16 was used as standard crop to determine the effects of irrigation on yield and yield contributing factors and also for scheduling irrigation for extensive cultivation of sugarcane all over Bangladesh.

MATERIALS AND METHODS

The experiment was conducted at Bangladesh Sugarcane Research Institute (BSRI) farm during 1989-90 using two budded pre-germinated 30 days old soil bed settlings of sugarcane variety Isd 16. The experiment was laid out in randomized block design with six treatments and three replications. The individual plot size was 8m x 12m. The irrigation treatments were as follows:

I_0 = No irrigation (control).

I_1= One irrigation after 30 days of plantation.

$I_2 = I_1$+ later irrigation at $\frac{IW}{CPE} = 0.25$

$I_3 = I_1$+ later irrigation at $\frac{IW}{CPE} = 0.50$

$I_4 = I_1$+ later irrigation at $\frac{IW}{CPE} = 0.75$

$I_5 = I_1$+ later irrigation at $\frac{IW}{CPE} = 1.00$

where, IW= Irrigation water , a fixed irrigation depth (10 cm) up to saturation.

CPE= Cumulative open pan evaporation from USWB class-A open pan minus rain since previous irrigation including one irrigation within 24h of plantation.
Recommended doses of Fertilizers like urea, triple super-phosphate and muriate of potash were applied @ 370.5, 276.6 and 276.6 kg ha-1, respectively. Urea and muriate of potash were applied into three equal splits viz., at planting, tillering and grand growth stages. Furadan-5G was applied at the rate of 39.5 kg ha-1 to control top shoot borer during the month of April.

One live irrigation was applied in all plots within 24h of plantation and later irrigation were applied as per treatments of irrigation schedule.
Furrow method of irrigation was practiced in the field. The average depth of water applied during an irrigation was calculated from the following relationship (Michel,1978).

$$d = \frac{q \times 360 \times t}{w \times L}$$

Where, d = average depth of water applied (cm)
q = stream size (liter per second)
t = duration of irrigation (elapsed time, hours)
w = furrow spacing (meters)
L = Furrow length (meters)

Soil moisture in the experimental plots was determined (gravimetrically) at 15, 30, 45 and 60 cm depths before and after application of each irrigation and finally at harvest of sugarcane. Drainage was calculated from Barrow table for flat cultivated absorbent soils with average or varying rainfall no continuous down pour (Khushalane and Khushalani,1984). In our condition drainage was considered to be 10% of the total rainfall.

Evapotranspiration was calculated using the following formula:

$$E_t = I + P + \Delta SM - D$$

Where, E_t = Evapotranspiration or crop water use (cm).
I = Total irrigation applied (cm)
P = Precipitation (cm)
ΔSM = Change of soil moisture from plantation to harvest (cm).
D = Drainage.

Meteorological data were collected from BSRI weather yard.

RESULTS AND DISCUSSION

The effect of irrigation on the cane yield and other parameters of sugarcane varieties are shown in Table 1. It was found that moisture stress had significant effect on the crop yield of sugarcane.

Table 1. Mean effects of irrigation levels and yield and yield components of sugarcane variety Isd 16.

Irrigation treatments	Plant Mortality (%)	Tiller (10^3 ha^{-1})	Plant height (m)	Internode (no). cane^{-1}	Millable cane (10^3 ha^{-1})	Weight cane^{-1} (kg)	Recovery (%)	Yield t ha^{-1}
I_0	14.33	135.o5b	1.72c	12.00c	62.37c	0.99a	8.83a	60.74c
I_1	4.67	170.17a	1.88b	12.67bc	80.01b	1.00a	9.21a	80.01b
I_2	8.33	172.14a	1.98ab	12.67bc	80.33b	1.07a	9.27a	85.96b
I_3	6.33	183.10a	1.95ab	13.00bc	84.35ab	1.10ab	9.25a	92.47b
I_4	8.33	177.75a	2.01ab	13.33b	82.83ab	1.01a	9.32a	83.55b
I_5	7.67	183.40a	2.06a	14.67a	93.23a	1.15a	10.57a	107.22a

Any two values of the same parameters for various treatments are not significantly different from each other (P£0.05). Sugarcane yield increased due to increased number of irrigation. Yield showed significantly different (P£0.05) response to irrigation treatments and control. Maximum yield of 107.22 tons ha^{-1} was obtained from I5 treatment with three irrigation (10 cm each) including one live irrigation applied 24hr after transplanting and the other two at 30 and 92 d after transplanting. Sandhu et al. (1980) noted that irrigation during the summer months increased mean cane yield.

The lowest yield (60.74 tons ha^{-1}) was obtained in the control treatment (I0) which indicate that irrigation played a vital role in sugarcane production. Ali et al. (1980) reported that in the year 1986-87, the yield of sugarcane at SRTI farm, Ishurdi, and at Joypurhat Sugar Mills farm were significantly higher under irrigated condition.

It was also observed that the percentage of plant mortality was higher (14.33%) in control compared to irrigated plots. The result indicates that irrigation is essential to ensure higher survival rate of seedling. The higher number of tiller population (183.40 x 100 ha-1) was found from I5 treatment that was 36% higher than control. The plant height increased significantly due to irrigation application of water. The shortest plant height (1.72m) was achieved from the control I0) and the tallest (2.06 m) was from I5 treatment. The maximum number of internodes per cane stalk was noticed in I5 treatment (14.67) which was 22.25% higher than control plots. Millable cane number showed significantly different response to I5 treatment (93.23x 1000 ha^{-1}) than the control (62.3 x 1000 ha^{-1}). Rahman et al.,1989 observed that higher number of millable canes were obtained from irrigation application than rainfed condition. Irrigation did not show significant effect on weight per cane stalk. The recovery percentage of sugar did not indicate significantly different response between irrigation treatments and control.

Results indicated that yield, number of millable cane (x1000 ha^{-1}), internode per cane stalk and plant height are significantly affected by irrigation at (P£ 0.05),but the other characters were not affected.

Table 2 explains about the different components of evapotranspiration /water balance in the sugarcane experimental field. It was observed that the crop received sufficient rainfall than the cumulative evaporation and was partially enough for sugarcane. It was also observed that only 1.09 cm of rainfall occurred during the month of December but no rainfall in the month of January.

Table 2. Components of evapotranspiration and water use efficiency of sugarcane variety Isd 16 under different irrigation treatments.

Parameter	I_0	I_1	I_2	I_3	I_4	I_5
Rainfall (cm)	188.89	188.89	188.89	188.89	188.89	188.89
Irrigation (cm)	10	20.00	20.00	20.00	20.00	30.00
Total number of irrigation (No)	1	2	2	2	2	3
The interval of irrigation from the date of planting(days)	1	1,30	1,30	1,30	1,30	1,30,92
Seasonal open pan evaporation (cm)	126.66	126.66	126.66	126.66	126.66	126.66
Sugarcane yield (t ha^{-1})	60.74	80.01	85.96	92.47	83.55	107.22

The rainfall was concentrated mainly during June to October and crop received all the irrigations depending on treatments before starting monsoon.

Yield and water use relation:

Table 3 explains the crop water use and water use efficiency and yield at different irrigation treatments. It is reveled from the results that the crop water use and the water use efficiency increased progressively with the increase of number of irrigation. The highest crop water use (207.18 cm) was obtained in I_5 treatment where three irrigation (total 30 cm) were applied in addition to 188.89 cm rainfall during the total growing season. The minimum crop water use (186.19 cm) was obtained in control (I_0). The maximum water use efficiency was obtained in treatment I_5 (0.52 $t.ha^{-1}cm^{-1}$) and the minimum in the control (I_0) treatment (0.32 t ha^{-1} cm^{-1}) this might be due rainfed condition i.e no irrigation.

Table 3. Yield, crop water use and water use efficiency of sugarcane variety Isd 16.

Irrigation treatments	Irrigation water (cm)	ΔSM (cm)	Drainage (cm)	Crop water use(cm)	Yield (t ha^{-1})	Water use efficiency (t $ha^{-1}cm^{-1}$)
I_0	10	6.19	18.89	186.19	60.74	0.3262
I_1	20	5.04	18.89	195.04	80.01	0.41016
I_2	20	5.28	18.89	195.28	85.96	0.44018
I_3	20	5.98	18.89	195.98	92.47	0.47183
I_4	20	6.01	18.89	196.01	83.55	0.4268
I_5	30	7.18	18.89	207.18	107.22	0.5175

Relationship between irrigation water and yield of sugarcane is shown in Fig. 1. It has been observed that there is a linear relationship exists between irrigation water and yield of sugarcane (Fig.1)

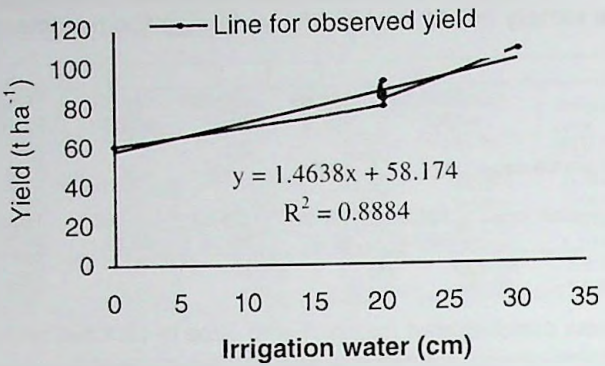

Figure 1. Relation between irrigation and yield of sugarcane

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