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Irrigation Scheduling of Sugarcane for High Ganges Flood Plain

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ABSTRACT

To develop an efficient irrigation scheduling of sugarcane for obtaining higher cane yield, an experiment was conducted for three years (1988-91) in farmers field at Darsana, Chuadanga. Sugarcane variety Isd 16 was grown conventionally as test crop against seven irrigation levels with three replications. Irrigation significantly increased germination (%), tiller, millable cane, yield, and height of cane. The highest cane yield (106.45 TCH) was obtained when five irrigations were applied (46 cm water depth) compared to control (74. 04 TCH). Almost identical net economic benefit was obtained from five and six irrigation, the cost benefit ratio of irrigation came to 1: 6.4. Thus the study leads to recommend the application of five irrigations (48.5 cm) for obtaining higher cane yield and economic return.

INTRODUCTION

Sugarcane is predominantly an upland crop grown in North West and South-West parts of Bangladesh and second important cash crop which occupies about 0.18 million hectares of cultivable land with an average yield of 42 TCH. But the average yield per unit area produced by potential cane growers has been found around 65 TCH which is also far below the potential yield (more than 100 TCH) of sugarcane in Bangladesh. Ali *et al.* (1989) reported that the average sugarcane productivity in Hawaii and Australia has been found around 222 and 72 TCH respectively. The underlying reasons behind low productivity are many including improper management and inadequate input supply. Irrigation is one of the important input which greatly influence sugarcane yield . Imam (1984) observed that irrigation always produced high yield of cane and intercrops and the competition between cane and intercrops was higher for moisture than for nutrients. Sugarcane is still being considered as a drought tolerant rainfed crop, and being cultivated under rainfed condition utilizing residual soil moisture. Traditionally no irrigation is applied in the farmers field. Planting is usually done between October to February utilizing residual soil moisture. The moisture requirement of this crop is estimated to 152 cm per year (Rashid *et al.* 1987) which is almost equivalent to amount of rainfall received even in low rainfall belt of Bngladesh. It is reported elsewhere that around 136 cm water is required for optimum production of cane (Anon, 1981). Similar water requirement was also reported by Hargreaves (1959). In Bangladesh, time of occurrence of rainfall is more important than actual amount received. Around 70% of

the total rainfall is received between May to September causing serious water-logging problem in majority areas.

Available soil moisture at the early stages of the crop tremendously influences the performance of the crop. Insufficient soil moisture causes germination failure, low tiller production and nutrient uptake restricting growth and physiological activeties of the crop. So, the pre-monsoon irrigation greatly influences the crop through setting a good initial stand. Banawari lal (1988) noticed that five pre-monsoon irrigations at an interval of 29 days significantly increased the cane yield which was higher by 50 and 38% over two irrigations at 60 and three irrigations at 90 days interval respectively.

Soils of high Ganges River Floodplain cannot retain moisture for longer period due to its poor texture. Early planted sugarcane in this area suffers from moisture deficiency beween November to April.and proceeds with initial poor stands. Irrigation contributes tremendously to improve the crop condition. Farmers of this soil zone such as Darsana, Chuadanga adopted irrigation exercising their common sense with no scientific basis. Applications of such irrigation improved the crop condition but simultaneously there was huge wastage of irrigation water due to application at improper stage and planning. Application of irrigation water without planning based on actual repuirement of the crops results not only in wastage of irrigation water but also hampers crop growth and yield (Sekhon *et al.* 1968).

In view of the above circumstances the present study was under taken to develop irrigation scheduling for obtaining good cane yield through efficicent water use in high Ganges River (calcareous) Floodplain soils.

MATERIALS AND METHODS

For scheduling irrigation to sugarcane an experiment was conducted in the farmers field at Darsana (Chuadanga) during the crop seasons 1988-89 to 1990- 91. The soil represented the high Ganges river calcareous brown floodplain of AEZ 11. Some physical and chemical properties of the experimental plots are given in the Table 1.

The experiment was laid out in a Randomized Complete Block Design with seven irrigation treatments, and three replications in the 3rd week of November of every crop season. The irrigation treatments were as follows:

T_0 - No irrigation (rainfed).

T_1 - One irrigation at planting (3rd week of November).

T_2 - T_1 + one irrigation in the 3rd week of December.

T_3 - T_2 + one irrigation in the 3rd week of January.

T_4 - T_3 + one irrigation in the 3rd week of February.

T_5 - T_4 + one irriagtion in the 3rd week of March.

T_6 - T_5 + one irrigation in the 3rd week of April.

The three budded setts planted conventionally in trench following end to end method of sett placement at one meter row spacing. The individual plot size was 7m X 11m. Each plot was isolated by polythene sheets to a depth of 75 cm between two plots to prevent the seepage of water between the adjacent plots. Each plot was fertilized equally with recommended fertilizer dose of 376 kg Urea, 276 kg TSP, 276 kg MP, 185 kg Gypsum and 30 kg $ZnSO_4$ per hectare (Karim *et al.* 1989).

The soil moisture status at various depths of non-irrigated plots from plantation to harvest were recorded and shown in the Figure 1. The initial moisture percentage of control plots during plantation (3rd week of Nov.) at 15, 30 45 and 60 cm depths were 18.00, 19.9, 21.6 and 22.9 respectively, and at harvest was 17.3 to 20%. The lowest moisture (13.5 -14.5%) was found during March and April (Figure 1).

The amount of water applied each time to raise soil moisture upto field capacity at effective root zone (45-60 cm) was determiend by monitoring soil moisture of intended depth by gravimetric method. Irrigation was applied when soil moisture depletion reached to 50% of total available water in root zone as per recommendation of Ahmad and Heermann (1988). The moisture level of irrigated plots were determined just before, and 24 h after each irrigation. To bring the soil moisture at field capacity (27.8%) irriagtion water equivalent to consumptive use was appiled. The gross depth of Irrigation was calculated assuming field application efficiency of 70%.

The quantity of irrigation water applied to field as per schedule date are shown in the Table 2. Furrow method of irrigation was done following the relationship developed by Michael (1978).

$$d = \frac{QX360Xt}{WXL}$$

where :

d= average depth of irrigation (cm),

t= duration of irrigation (elasped time, hours),

W= furrow spacing (m),

L= furrow length (m),

Q= discharge of water (LPS).

In the experimental condition furrow length (L) and spacing (W) were known and depth of supplimentary irrigation applied to the field was determined gravimetrically just before irrigation. By measuring discharge rate time of irrigation to the experimental plots were calculated. All agronomical practices were done as and when required..Data on germination (%), tillering, millable cane formation were taken at

appropriate stages and yield of cane per plot with other parameters summarized in Tables 3.1 and 3.2 were recorded at harvest. Three years relevant meteorological data were collected and shown in Appendixes 1.a and 1.b.

RESULTS AND DISCUSSION

To maintain soil moisture at field capacity in the effective root zone, time of application of irrigation and amount of water applied on the basis of moisture depletion studies are produced in the Table 2. Data on the yield and yield contributing parameters viz: germination (%), tiller, millable cane, yield are furnished in Tables 3.1 and 3.2. Germination (%), tiller, millable cane, yield and cane height were found to be influenced significantly due to irrigation. Banawari lal (1988) reported that millable canes, average cane weight and height of individual cane were significantly increased due to five irrigations at 20 d interval over two and three pre-monsoon irrigations.

Table 1. Some physical and chemical properties of the soils of experimental plots.

Crop season	Soil texture	Soil pH	Field capacity	Bulk density (gm/cc)				Average Bulk density
				15cm	30 cm	45 cm	60 cm	
1988-89	Silty loam	7.6	25.5	1.38	1.44	1.46	1.52	1.44
1989-90	Clay Loam	7.8	29.5	1.39	1.35	1.30	1.27	1.33
1990-91	Loamy	7.7	28.5	1.37	1.35	1.32	1.27	1.33
Average of Three years		7.7	27.8	1.38	1.37	1.36	1.35	1.37
Method of analysis	Hydrometer method	Core sampler method	Field method	Core sampler method				

Table 2. Amount of irriagation water applied as per schedule date.

Treatments	Date and amount of irrigation (cm)						Total Water supplied (cm)
	3rd week of Nov.	3rd week of Dec.	3rd week of Jan.	3rd week of Feb.	3rd week of Mar.	3rd week of Apr.	
T_0 (No irrigation)	-	-	-	-	-	-	-
T_1 (One irrigation)	6.0	-	-	-	-	-	6.0
T_2 (Two irrigations)	6.0	7.0	-	-	-	-	13.0
T_3 (Three irrigations)	6.0	7.0	8.5	-	-	-	21.5
T_4 (Four irrigations)	6.0	7.0	8.5	11.0	-	-	32.5
T_5 (Five irrigations)	6.0	7.0	8.5	11.0	13.5	-	46.0
T_6 (Six irrigations)	6.0	7.0	8.5	11.0	13.5	13.0	59

Irrigations significantly increased 21-30% germination of sugarcane buds over non-irrigated cane. Higher germination percentage in irrigated plots was possible due to adequate moisture supply during germination phase. Better germination requires ample moisture, long days and warm temperature (Anon, 1981). However, frequency of irrigation showed statistically identical response in respect of germination. This might be due to fact that germination of sugarcane buds continued even upto 60 DAP. During this period one to two irrigations were applied in all irrigated plots but irrigation at 60 d after planting could not influence germination of sugarcane buds as germination phase was already over.

It is revealed from the Table 3.1 that irrigation induced significantly higher number of tillers compared to non-irrigated cane. Four to six irrigations produced statistically identical number of tillers (199 to 209 x 10^3/ha) which were significantly higher over other treatments (T_0, T_1, T_2, T_3). This finding corresponds with other report published elsewhere (Anon. 1981). The highest tillers (208.6 x 19^3/ ha) were found in the treatment where six irrigations were applied, and the lowest (137.9 x 10^3/ha) in control plots. The six irrigations (total= 59 cm water) produced 51.2% higher tillers over control (no irrigation) at 180 DAP.

Table 3.1. Cumulative effects of irrigation on different yield parameters of sugarcane.

Treatments	Irrigation quantity (cm)	Germination (%)	Tiller production (000/ha)	Millable cane production (000/ha)	Yield (TCH)	Sucrose content (%)	Yield increase over control (%)
To (Control)	0	32. b*	137.9e	63.5 b	74.0 d	8.6a	-
T_1 (One Irrigartion)	6.0	41.5 a	182.7 cd	75.8 ab	85.3 c	8.6a	15.2
T_2 (Two Irrigations)	13.0	40.9 a	174.7 d	77.2 a	95.1 a	8.5a	28.4
T_3 (Three Irrigations)	21.5	39.7 a	189.7 bc	81.9 a	101.6ab	8.6a	37.3
T_4 (Four Irrigations)	32.5	39.8a	198.7 ab	83.7 a	106.5 a	8.7a	43.8
T_5 (Four Irrigations)	46.0	41.4 a	205.5 a	83.6 a	106.5 a	8.7a	43.8
T_6 (Six Irrigattions)	59.0	42.3 a	208. 5a	85..5 a	109.8 a	8.6a	48.3

*Figures accompanied by same letters do not differ significantly at 0.05 level as per DNMR test.

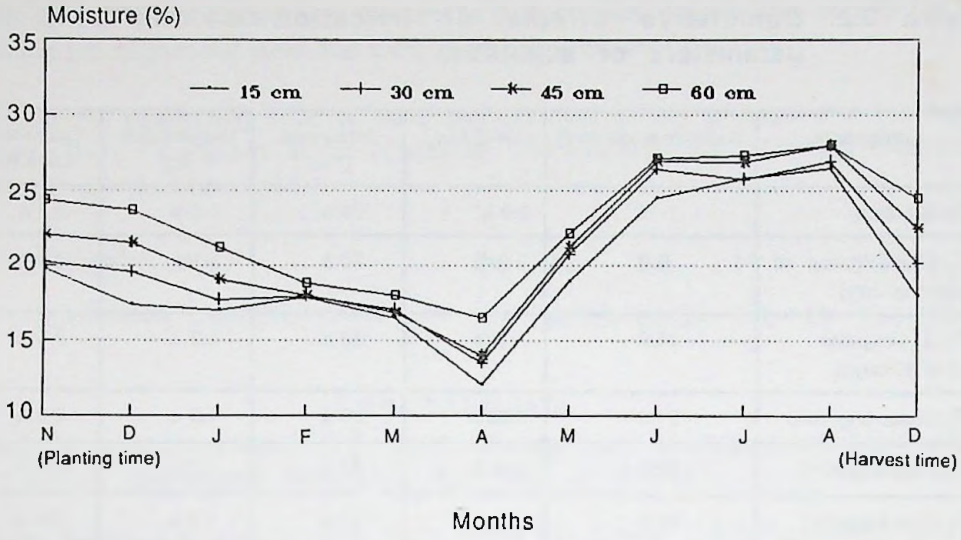

Figure 1. Average soil moisture status of non-irrigated plots during 1988–89 to 1990–91 cropping seasons.

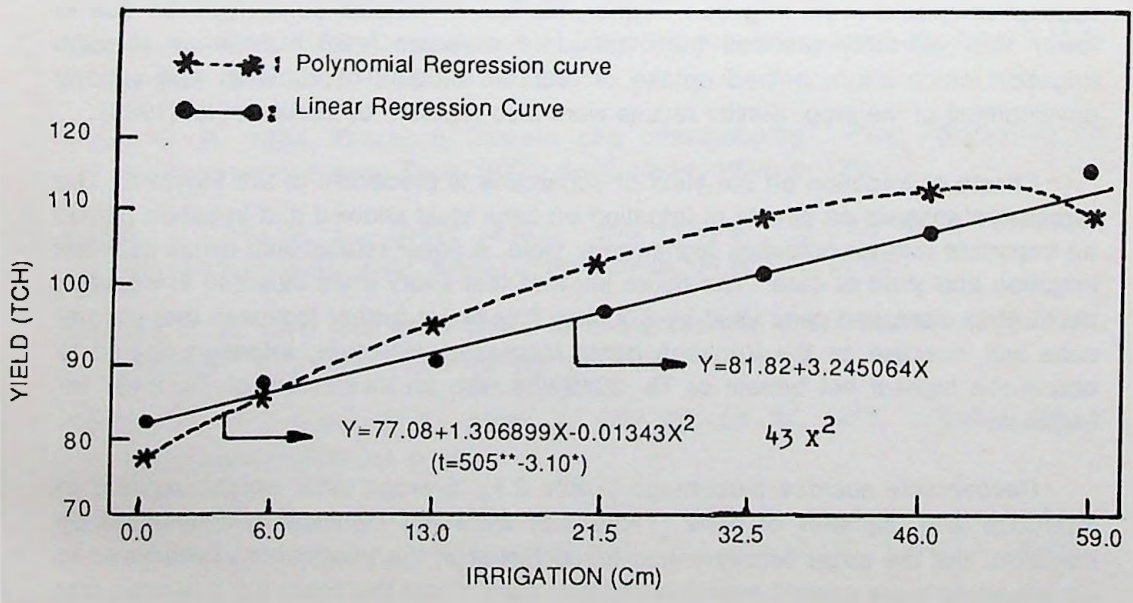

Figure 2. Relation between yield of cane and irrigation.

Table 3.2. Cumulative effects of irrigation on different yield parameters of sugarcane.

Treatments	Irrigation water (cm)	Height (m)	Internode (No.)	Weight/stalk (kg)	Diameter of cane (cm)
To (Control)	0	2.9 b*	28 a	1.2 a	2.4 a
T_1 (One irrigation at planting only)	6.0	3.2ab	30 a	1.1 a	2.5 a
T_2 (T_1 +irrigation after 30 days)	13.0	3.2ab	29 a	1.2 a	2.5 a
T_3 (Three irrigation)	21.5	3.2ab	29 a	1.3 a	2.5 a
T_4 (Four irrigation)	32.5	3.4 a	31 a	1.2 a	2.5 a
T_5 (Five irrigation)	46.0	3.4 a	30 a	1.3 a	2.5 a
T_6 (Six irrigation)	59.0	3.4 a	31 a	1.3 a	2.6 a

*Figures accompanied by same letters do not differ significantly at 0.05 level as per DNMR test.

Significantly higher number of millable cane (76-86 x 10^3 /ha) was obtained in irrigation treatment compare to non-irrigated plots. Although statistically identical number of millable canes were produced in different irrigated treatments, about ten thousand higher millable stalks were obtained where five and six irrigations were applied compared to no irrigation. Higher mumber of millable cane might be due to lower tiller mortality resulted from adequate moisture level maintained through irrigation which inturn helped uptake of required amount of nutrients and canopy development of the crop. Similar results were also reported by Banawari lal (1988).

Effects of irrigation on the yield of sugarcane is presented in the Figure 2. The regression analysis on effects of irrigation on cane yield showed that irrigation played an important role for obtaining higher cane yield. A linear relationship exists between irrigation and yield of cane. The figure showed that every units incerase in irrigation depth (cm) increased cane yield by 3.3 t/ha. This figure further indicates that yield of cane will incerase as the irrigation depth increases. However, irrigation helped to obtain the highest net benefit of Tk. 30450/ha with an investment of Tk. 5487 for irrigation.

Recoverable sucrose percentage (Table 3.1), average stalk weight, number of internode and diameter of cane (Table 3.2) were not significantly influenced by irrigation. But the sugar recovery was found higher in the treatments where three to six irrigations were applied over non-irrigated cane. From the Table 3.2 it is seen that cane height was significantly increased by 23-46 cm due to irrigation compared to

control. It may be concluded from the results that irrigation substantially contributed in improving the sugarcane yield and yield contributing parameters.

Thus, for miximizing yield of early planted (November) sugarcane in the high Ganges River Floodplain areas (Darsana, Chuadanga), the following irrigation schedules are recommended:

Depth of irrigation (cm) :	6.9	7.0	8.5	11.0	13.5
Time of application (Days after planting) :	1-7	30-35	60-65	120-125	150-155

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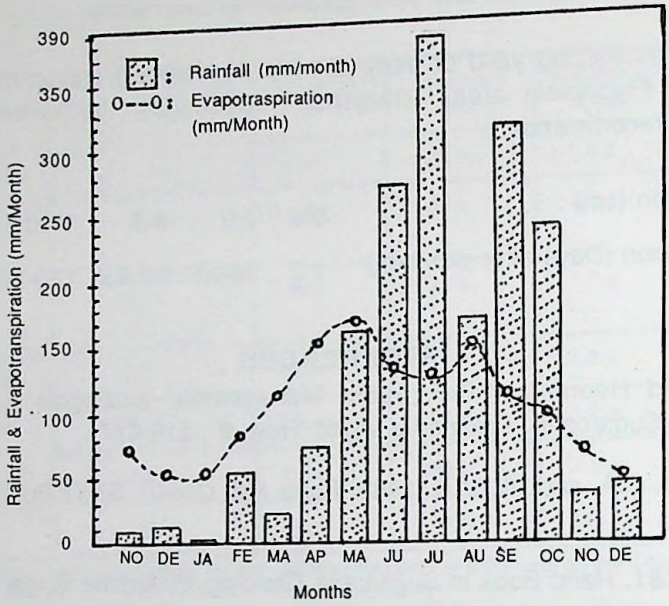
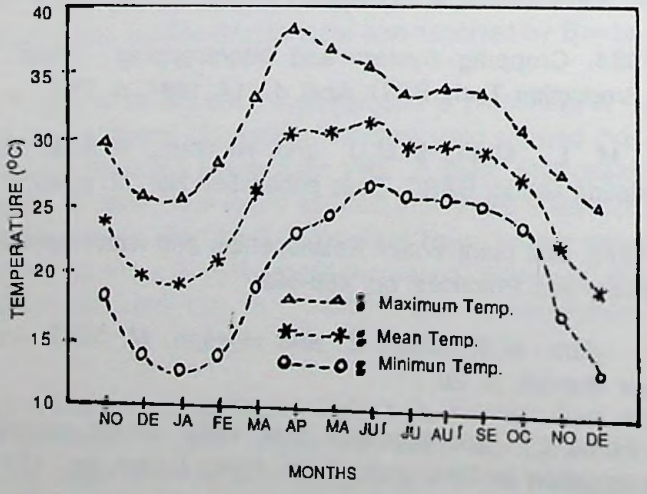
APPENDIX-1



a) **Monthly Rainfall & Evapotranspiration Pattern at Darsana, Chuadanga (Average of crop seasons 1988-89 to 1990-91).**



b) **Monthly Maximum, Minimum & Mean Temperature at Darsana, Chuadanga. (Average of crop seasons 1988-89 to 1990-91).**