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Effects of different Irrigation methods and Interplant Spacings on Sugarcane Production

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ABSTRACT

Three field experiments were conducted at the Sugar Mills farm of Carew's & Co., Darshana, Chuadanga, to study the integrated effect of three water application methods, namely, rainfed, spot irrigation and flood irrigation and four interplant spacing viz., 30, 45, 60 and 75 cm on the yield of sugarcane during the crop seasons 1993-94 to 1995-96. The experiments were laid out in split-plot design and the data were analyzed by Bartlet test. Significant differences in yield was observed among the irrigation methods, interplant spacing and also among their interactions. Among the four interplant spacings, the highest cane yield (80.80 t/ha) was obtained from 45 cm interplant spacing taken as the main plot treatment. Similarly, for the sub-plot treatments of three irrigation methods, flood irrigation resulted the highest yield (96.27 t/ha). In case of interactions, the highest yield (106.63 t/ha) and the highest benefit-cost ratio (7.47) were obtained when flood irrigtation was applied with 45 cm interplant spacing.

INTRODUCTION

Sugarcane is one of the most important cash crops in Bangladesh. The average yield of this crop is very low due to various reasons including the management problems. Among these, fertilization, irrigation and plant spacings are the most important agronomic practices which have 12 to 49% contribution in sugarcane production (Ali *et al.* 1989). Although the technologies to produce 162 tonnes of cane per hectare (TCH) of sugarcane is available in the country, the present average production of sugarcane is 42 t/ha (Ali *et. al.* 1989). In Hawaii and Australia the sugarcane productions are 222 TCH and 74 TCH, respectively (Hossain *et al.* 1990) To increase sugarcane yield, spaced-transplanting technique (STP) has gained popularity among the farmers. Having no irrigation facilities, many farmers are cultivating sugarcane following STP under rainfed and spot irrigated conditions in the low rainfall areas of Banlgadesh. Some farmers are practising flood irrigation in an unplanned way to spaced-transplanting sugarcane. The STP requires proper interplant spacing and available soil moisture for better yield of the crop.

For optimum growth of sugarcane 1500 to 1800 mm rainfall is necessary (Rashid *et al.* 1987). The annual rainfall in Bangladesh ranges from 1000-5500 mm, which is

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unevenly distributed throughout the year. Around 70% of the total rainfall occurs during the monsoon period of July to September, whereas, a very little railfall occurs in the months of November to May which is the establishment and tillering phases of sugarcane. Adequate soil moisture plays a vital role during the germination/ establishment and tillering phases for maximising sugarcane yield. Imam *et al.* (1988) reported that irrigation always played a vital role for increasing cane yield at tillering stage.

High yield of sugarcane was reported at 90 to 100 cm inter-row and 60 cm interplant spacing with high doses of nitrogen application (Matherne, 1974; Majid *et al.* 1992). However, in a developing country, like Bangladesh, the uncertainty in availability and high prices of nitrogen fertilizer are the limiting factors for its large-scale usage. By adopting proper irrigation techniques and adjusting interplant spacing of sugarcane settings, it is possible to get high yield of sugarcane. Interplant spacings govern stalk population of sugarcane (Metherne, 1974; Oworu, 1986). Significant effect of interplant spacing on the yield of transplanted sugarcane was reported by Uddin *et al.* (1989).

Several investgators have studied the effect of interplant spacing and nitrogen application of sugarcane production (Uddin *et al.* 1989; Hossain *et al.* 1994; Saha *et al.* 1994). They observed that high dose of nitrogen application increased sugarcane production but was found to be uneconomic. On the other hand, information on the response of transplanted sugarcane to the method of irrigation under different interplant spacings is rather inadequate. Therefore, an attempt was undertaken to find out the effect of irrigtation methods under different interplant spacings on the yield of transplanted sugarcane.

MATERIALS AND METHODS

Three experiments were conducted in the farm of Sugar Mill (Carew & Co. Ltd.), Darshana, Chuadanga, Bangladesh during the crop seasons of 1993-94 to 1995-96. The sugarcane variety Isd 16 was used as a test crop. The soil of the experimental plots belonged to the High Ganges River Calcareous Brown Flood Plain of AEZ-11. Texturally, the soil was sandy loam having field capacity (F.C.) of 27%. The experiments were laid out in the month of November each year. The Experimental desing was a split-plot with three replications and the net plot size was 8m x 10 m. Four interplant spacings were used as the main plot and three irrigation methods as sub-plot thus having 12 treatment combinations. The treatments were as follows:

A. Interplant spacings (main-plot treatments):

S_1 = 30 cm
S_2 = 45 cm
S_3 = 60 cm
S_4 = 75 cm

B. Irrigation methods (sub-plot treatments):

I_0 = Rainfed/control

I_1 = Spot irrigation by strainer/pitcher

I_2 = Flood irrigation

Line to line or inter-row distance was 100 cm. The planting of sugarcane was done on 15 November each year by Spaced Transplanting Technique and 45 to 50 days old two-eyed soil-bed settlings were transplanted in the field.

Spot irrigation of 2 litres per day per plot was applied with strainer or pitcher at three consecutive days after transplanting the settlings for establishment. Follwing the previous study of Prasad and Yadav (1988), flood irrigation was applied to the experimental plots at an irrigation schedule of IW/CPE ratio of 0.8 to raise the soil moisture up to field capacity (27%) level. All the plots were isolated by inserting polyethylene sheets to a depth of 75 to 80 cm to prevent scepage of water between the adjacent plots. Each plot was equally fertilized with a recommended rate of 370 kg urea, 276 kg MP, 276 kg TSP, 185 kg gypsum and 30 kg zinc sulphate ($ZnSO_4$) per hectare. One-third of urea and MP was applied as basal dose and one-half of the rest as 1st and the remaining one-half as 2nd top dressing. The whole quantity of TSP, gypsum and ZnSo4 was applied during plantation. The amount of irrigation water applied to the experimental plots and its distribution over the growing season are presented in the Table 1. All the intercultural operations were performed as and when required.

Table 1. Amount of irrigation water applied to the experimental plots.

Irrigation at growth stages of sugarcane	Establishment stage (one live irrigation)	Tillering stage (supplemental irrigation)					
Date of Irrigatioon	3rd week of November (20th Nov.)	Last week of December	1st week of February	1st week of March	Last week of March	3rd week of April	2nd week of May
Irrigation applied at DAP*	Flood Just after planting	40	40,32	40,32, 32	40,32, 32,20	40,32, 32,20, 20	40,32, 32,20, 20,17
	Spot Just after planting	-	-	-	-	-	-
Number of irrigation	Flood 1	2	3	4	5	6	7
	Spot 3	1	-	-	-	-	-
Irrigation depth (cm)	Flood 10	10	10	10	10	10	10
	Spot 2 litre	-	-	-	-	-	-
Cumulative amount of irrigation	Flood 10	20	30	40	50	60	70
	Spot 6 litre	-	-	-	-	-	-

* DAP=Days after planting.

The important meteorological data viz. rainfall, pan evaporation and temperature of the study area during the experimental period were collected and have been shown in the Figure 1. Data on the yield and sucrose content of sugarcane were collected during harvesting in the month of December of each year. Data on yield were statistically analysed using the Bartlet test (1937). Cost-benefit analyses were also performed to evaluate the economic feasibility of various treatments.

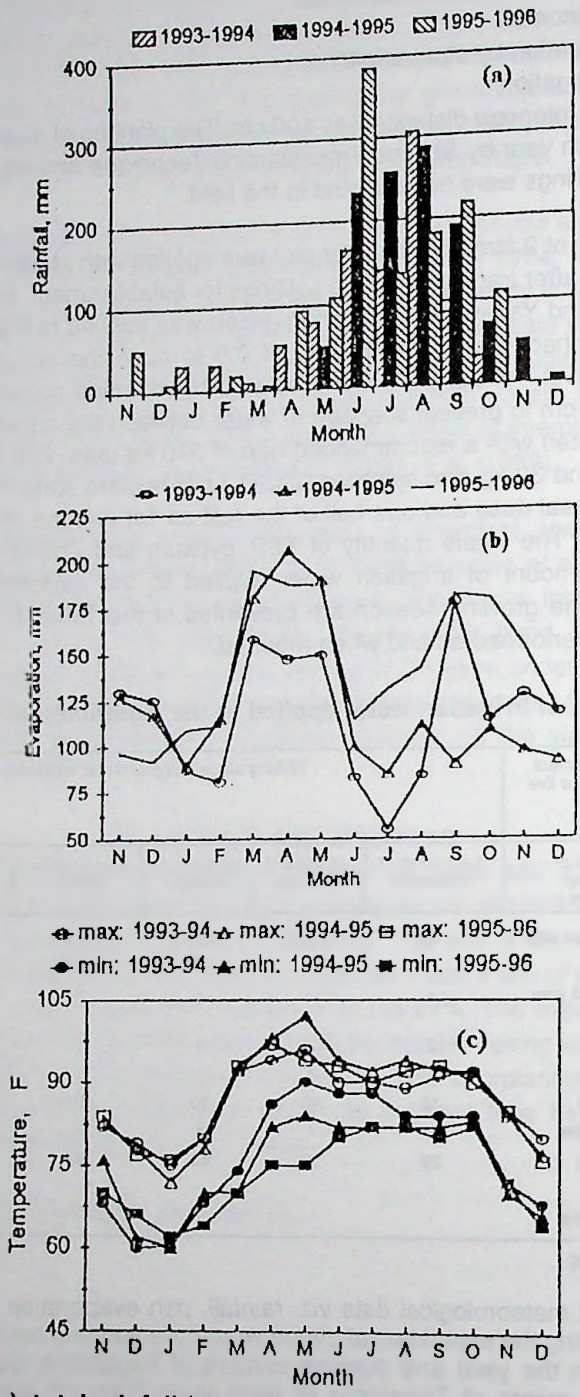

Figure 1. Monthly (a) total rainfall (mm), (b) evaporation (mm) and (c) maximum and minimum terperatures (°F) for the three cropping seasons in Darshana, Chuadanga.

RESULTS AND DISCUSSON

The yield of sugarcane and sucrose content obtained under different treatment the combinations are presented in the Table 2. The critical difference (CD) at 5% level of significance (p=0.05) for the main-plot treatment, sub-plot treatment and their interactions calculated by Bartlet test are also listed in Table 2. The results revealed that the different interplant spacings such as 30, 45, 60 and 75 cm and the methods of irrigation significantly (p=0.05) influenced the cane yield. The interactions between main-plot (interplant spacings) and sub-plot treatments (irrigation methods) were significant (p=0.05). Among the interplant spacings, the highest mean yield (80.80 t/ha) was obtained from 45 cm interplant spacing which was significantly (p= 0.05) superior to that from other spacings. This might be due to the maximum number of planis accommodated per unit area. Lower number of millable cane was obtained for 30 cm interplant spacing because of higher tiller moratality than for other spacings. In addition, due to high density of tillers and millable cane for this spacing, minimum unit stalk weight was obtained which resulted in reduced cane yield. It can be seen that the cane yield decreased in all the spacings except for 40 cm interplant spacing. Saha *et al.* (1994) reported similar results earlier.

Table 2. Yield of sugarcane and sugar recovery in percent under different levels of irrigation and interplant spacing (mean data of 3 years, 1993-96).

Main-plot treatment (plant spacing, cm)	Sub-plot treatment (method of irrigation)			Mean
	I_0 = 0	I_1 = 3.0**	I_2 = 70.00	
S_1 = 30	62.10	76.96	99.10	79.38
	(7.72)*	(7.92)	(8.30)	(7.98)
S_2 = 45	62.83	72.96	106.63	80.80
	(7.79)	(7.94)	(8.42)	(8.11)
S_3 = 60	60.00	73.76	101.20	78.32
	(7.97)	(8.06)	(8.77)	(8.26)
S_4 = 75	59.50	60.90	78.16	66.19
	(8.49)	(8.20)	(8.67)	(8.45)
Mean	61.10	71.15	96.27	
	(7.72)	(8.02)	(8.54)	

* Figures within parentheses indicate sucrose content of sugarcane

** 6 litre spot Irritgated water is equivalent to a depth of 3 cm.

CD (P = 0.05) for spacing (S) = 8.73
CD (P = 0.05) for Irrigation (I) = 4.73
I at same level of S = 9.46
S at same or different level of I = 11.63

Among the sub-plot treatments, the highest mean yield (96.27 t/ha) was obtained from flood irrigation. Similar performance of irrigation method was also reported elsewhere (Anon., 1987). Significantly highest yield (106.63 t/ha) was obtained among the interaction

of flood irrigation and 45 cm interplant spacing. This result is in agreement with the findings of Hossain *et al.*(1994) and Saha *et al.*(1994) published earlier.

Recoverable sucrose contents from the millable cane of flood irrigated plots were higher in the wider interplant spacings than in the closer interplant spacings with only one exception (Table 2). These findings are also in agreement with that of Majid *et al.* (1992) and Hossain *et. al.* (1994). The higher sucrose content under the wider spacing might be due to uniform interception of sun light by the leaves of the plants. However, the highest sugar yield was recorded under closer spacings due to higher cane yield.

The benefit-cost ratios (BCR) for different interplant spacings and irrigagion methods are depicted in the Figure 2. Higher BCR is always obtained under flood irrigation, whereas, lower value is always obtained in the control treatment (no irrigation). The highest benefit-cost ratio (7.47) was observed with interplant spacing of 45 cm along with flood irrigation receiving a total of 70 cm irrigation water.

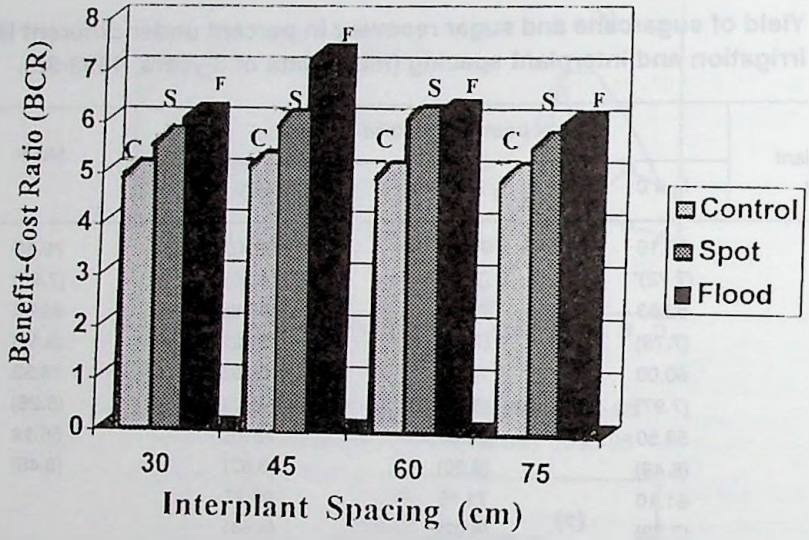

Figure 2. Benefit-cost ratio (BCR) for different treatment combinations (Control-no irrigation; Spot-irrigation; Flood-irrigation).

The findings of this study lead to conclude that for profitable production of sugarcane, the crop should be cultivated with flood irrigation at 45 cm interplant spacing in the High Ganges River Calcareous Brown Flood Plain of AEZ 11.

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