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Effect of Row and Plant Spacing on Growth, Yield and Quality of Sugarcane and Intercrops

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ABSTRACT

An experiment was carried out at the Bangladesh Sugarcane Research Institute (BSRI) farm during 2004-2005 cropping season under irrigated condition to study the effect of row and plant spacing suitable for higher growth, yield and quality of sugarcane and accommodate intercrops properly. Sugarcane variety Isd 34 were transplanted during November following 75 cm ´ 30 cm, 75 cm ´ 45 cm, 100 cm ´ 30 cm, 100 cm ´ 45 cm, (105 cm + 45 cm) ´ 30 cm, (105 cm + 45 cm) ´ 45 cm, (140 cm + 60 cm) ´ 30 cm and (140 cm + 60 cm) ´ 45 cm row and plant spacing with first intercrop potato (*Solanum tuberosum* L.) and second intercrop mungbean (*Vigna radiata* L.). Mortality of tiller was higher (31%) under closer row spacing of 75 cm ´ 30 cm and 75 cm ´ 45 cm while minimum (20.98%) under wider spacing of (140 cm + 60 cm) ´ 45 cm. The maximum benefit-cost ratio (BCR) of 2.85 and cane yield of 96.68 t ha^{-1} were obtained with spacing of 100 cm ´ 30 cm while the lowest BCR and cane yield were with closer spacing. The maximum total adjusted cane yield of 137.75 t ha^{-1} was obtained with spacing (140 cm + 60 cm) ´ 30 cm followed by 136.57 t ha^{-1} with spacing 100 cm ´ 30 cm and the lowest one was obtained with spacing (105 cm + 45 cm) ´ 30 cm. Producing one intercrop in single row and two intercrops sequentially in paired row planting system with row spacing 140 cm found to be profitable practice with sugarcane. In treatment T_5 and T_6 where row spacing was 105 cm and two lines of potato was planted in that space but yield was not satisfactory might be due to closer spacing and interplant competition. Therefore, spacing (140 cm + 60 cm) ´ 30 cm and 100 cm ´ 30 cm exhibited the best performance and may be recommended for higher yield and accommodation of intercrops properly.

Key words : Sugarcane, intercrop, spacing, yield, quality

INTRODUCTION

Sugarcane (*Saccharum officinarum* L) is the major cash cum food crop in Bangladesh but its yield is very low compared to other sugarcane growing countries. Plant population as well as row and plant spacing among several factors play a vital role in determining yield and quality of agro-products, which is equally true in case of sugarcane. In out country, row spacing for sugarcane plantation varies from 60 cm to 140 cm irrespective of variety, location and planting time. The stalk population is essentially governed by the variety grown, inter-row as well as interplant spacing (Matherne, 1974). Bull (1975) reported that yield of sugarcane is positively correlated with the final stalk population and the latter is governed by inter-row spacing. Stalk population increase per unit area as the inter-row

spacing decreases (Matherne, 1974 and Matherne and Irvine, 1978). In sugarcane, stalk population and cane yield are correlated especially in sub-tropical cane growing area (Kanwar and Sharma, 1974; Bull, 1975; Miah and Rahman, 1981). In North India, a row spacing of 90 cm and particularly in Punjab state a row spacing of 60 cm is used (Kanwar and Sharma, 1974). In South Africa conventional row spacing is 140 cm and yield may be increased by about 5% for every 30 cm reduction in inter-row spacing down to 60 cm (Thompson, 1962). Intense narrow rows caused lesser increase in yield because of severe competition among plants which reduced the yield per plant. With increasingly wider rows, yield decreased as competition (and compensation) ceased and non-productive voids occurred in the stand (Benda *et al.*, 1987).

In our country, traditionally sugarcane is transplanted in narrow spaced rows, which is believed to produce higher yield. But in recent days sole cane growing is not economic. It is demanded to grow one or more than one intercrop sequentially in between cane row spaces. Intercropping one or more crops with sugarcane is an appropriate approach for getting additional farm income besides the principal sugarcane crop. Short duration winter crops may be grown as intercrop that increase total yield, higher monitory return and greater resource utilization and fulfils the diversified need of the farmers (Singh *et al.*, 1986). Therefore, this experiment was undertaken to accommodate cane rows in different distances as well as regulate interplant distance such as the row space and plant population suitable for higher growth, yield and quality of sugarcane and accommodate intercrops properly.

MATERIALS AND METHODS

An experiment was conducted at the Bangladesh Sugarcane Research Institute (BSRI) farm, Ishurdi, Pabna during 2004-2005 cropping season under irrigated condition. The site represents High Ganges River Floodplain under Agro-ecological Zone-11 with medium high land of typical sandy loam soil having pH 7.6. In this experiment sugarcane variety Isd 34 was grown in eight different spacings viz. 75 cm ´ 30 cm, 75 cm ´ 45 cm, 100 cm ´ 30 cm, 100 cm ´ 45 cm, (105 cm + 45 cm) ´ 30 cm, (105 cm + 45 cm) ´ 45 cm, (140 cm + 60 cm) ´ 30 cm and (140 cm + 60 cm) ´ 45 cm with first intercrop potato (*Solanum tuberosum* L.) variety cardinal and second intercrop mungbean (*Vigna radiata* L.) variety BINA mung-5 to find out the most suitable row and plant spacing for higher growth, yield and quality of sugarcane and sequential intercropping. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 8.0 m ´ 6.0 m.

Single budded settlings of sugarcane previously raised in soil bed were transplanted in each plot during mid November, 2004 as per treatment. Number of settlings required per hectare has been presented in Table 1. Along with sugarcane one line potato and mungbean in 75-100 cm row space, two lines in 105 cm row and three lines in 140 cm row space as intercrop were grown. Fertilizer for sugarcane were @ 347, 244, 184 and 222 kg ha^{-1} as Urea, TSP, MP and Gypsum, respectively (BARC, 1997). All TSP, Gypsum and one third of MP were applied in trench and thoroughly mixed with soil prior to transplanting of settlings. The first dose of Urea was applied as side dressing at 21 days after transplanting

(DAT) of settlings. The second of Urea (1/3rd) and MP (1/3rd) were applied as first top dressing at 90 DAT. Final top dressing of rest Urea and MP were applied at 150 DAT. In case of first intercrop potato, Urea, TSP, MP and Gypsum were applied @ 150, 75, 120 and 55 kg ha^{-1} and for second intercrop mungbean Urea, TSP and MP were applied @ 20, 40 and 25 kg ha^{-1}. To control insect pests, furadan 5G was applied @ 40 kg ha^{-1} as per recommendation. Other intercultural operations like irrigation, gap filling, weeding, mulching, earthing-up, tying and cross tying were done intime. Collection of data on yield and yield contributing parameters of cane and intercrops were done. The yields of first and second intercrops were recorded at harvest. Tiller population of sugarcane was recorded at 90, 120, 150 and 180 DAT. Millable cane and yield were recorded at harvest. The total adjusted cane yield was calculated by adding the cane yield with the equivalent cane yield obtained from the intercrops on the basis of prevailing market price. Economic and statistical analysis on different parameters for sugarcane and intercrops were done following the standard procedures.

Table 1. Number of required settlings under different treatment combinations.

Treatments	Number of required settlings (ha^{-1})
T_1 : 75 cm x 30 cm	44,444
T_2 : 75 cm x 45 cm	29,630
T_3 : 100 cm x 30 cm	33,333
T_4 : 100 cm x 45 cm	22,222
T_5 : (105 cm + 45 cm) x 30 cm	44,444
T_6 : (105 cm + 45 cm) x 45 cm	29,630
T_7 : (140 cm + 60 cm) x 30 cm	33,333
T_8 : (140 cm + 60 cm) x 45 cm	22,222

RESULTS AND DISCUSSION

Tiller and millable cane population

Data on tiller and millable cane production under different treatments are presented in Table 2. There was significant effect on tiller and millable cane production among the different treatments. The highest tiller population of 197.01 x 10^3 ha^{-1} was found from T_1 (75 cm x 30 cm) followed by 180.95 x 10^3 ha^{-1} from T_2 (75 cm x 45 cm) and the lowest tiller was found from T_8 (140 cm + 60 cm x 45 cm). This result revealed that closer spacing produced higher number of tillers compared to wider spacing (Rahman *et al.*, 1987 and Imam *et al.*, 1988). In case of millable cane production the maximum number of cane stalks of 135.83 x 10^3 ha^{-1} was recorded from T_1 followed by 124.65 x 10^3 ha^{-1} from T_2 and the minimum 109.30 x 10^3 ha^{-1} was from T_4 (100 cm x 45 cm). Tiller mortality was higher (31%) under closer row spacing of 75 cm x 30 cm and 75 cm ´ 45 cm while minimum (20.98%) under wider spacing of 140 cm + 60 cm x 45 cm.

Table 2. Tiller, millable cane, % tiller mortality, cane yield, intercrop yield, total adjusted cane yield as affected by different row and plant spacing (BSRI, 2004-2005).

Treatments	Tiller ($x 10^3$ ha^{-1})	Millable cane ($x 10^3$ ha^{-1})	% tiller mortality (ha^{-1})	Cane yield (t ha^{-1})	Intercrop yield (t ha^{-1})		Equivalent cane yield (t ha^{-1})	Total adjusted cane yield (t ha^{-1})
					1st	2nd		
T_1 : 75 cmx30 cm	197.01	135.83	31.05	83.40	9.24	0.14	40.28	123.68
T_2 : 75 cmx45 cm	180.95	124.65	31.11	91.34	9.27	0.19	41.95	133.29
T_3 : 100 cmx30 cm	169.75	123.96	27.00	96.68	8.02	0.28	39.89	136.57
T_4 : 100 cmx45 cm	154.00	109.30	29.03	89.67	8.30	0.30	41.60	131.27
T_5 : (105 cm+45 cm)x30 cm	164.25	120.42	26.68	83.86	6.24	0.25	32.04	115.90
T_6 : (105 cm+45 cm)x45 cm	151.62	118.98	21.53	85.10	6.83	0.27	34.96	120.06
T_7 : (140 cm+60 cm)x30 cm	156.60	121.33	22.52	91.67	8.17	0.46	46.08	137.75
T_8: (140 cm+60 cm)x45 cm	148.60	116.94	20.98	86.97	8.25	0.47	46.70	133.67
LSD (5%)	8.14	11.86	-	6.30	1.35	0.04	4.59	7.96

Cane yield

Row and plant spacing make significant differences in the yield of cane. Among different treatments, the highest cane yield of 96.68 t ha^{-1} was obtained from T_3 (100 cm x 30 cm) followed by 91.67 and 91.34 t ha^{-1} from T_7 (140 cm + 60 cm x 30 cm) and T_2 (75 cm x 45 cm) while the lowest cane yield of 83.40 t ha^{-1} was recorded from T_1 (75 cm x 30 cm) (Table 2). In closer spacing maximum number of settlings were planted and maximum number of tillers and millable canes were produced but yield was lower than other treatment due to less per stalk weight of cane.

Intercrop yield

The yield of first intercrop (potato) was found satisfactory in all plots except T_5 and T_6 (Table 2). The maximum yield of potato of 9.24 and 9.27 t ha^{-1} were found from T_1 and T_2 where row spacing was 75 cm followed by 8.02 and 8.30 t ha^{-1} from T_3 and T_4 where row spacing was 100 cm and the lowest yield was recorded from the treatment T_5. Yield of second intercrop mungbean varied with different row spacing. The highest mungbean yield of 0.47 t ha^{-1} was obtained from T_8 treatment followed by T_7 (0.46 t ha^{-1}) while the lowest yield of 0.14 t ha^{-1} was recorded from T_1. From the single row planting systems, satisfactory yield of first intercrop was obtained but yield of second intercrop was not satisfactory due to canopy coverage of sugarcane in the vacant spaces. In paired row planting system higher yield of first and second intercrops were obtained in the plots where 140 cm distance was maintained between two paired rows. In treatment T_5 and T_6 where row spacing was 105 cm and two lines of potato was planted in that space but yield was

not satisfactory might be due to closer spacing and interplant competition. This result indicated that inter-row and inter-plant distance of cane and intercrops influenced the yield of intercrops.

Adjusted cane yield

Adjusted cane yield is an important parameter for determining the total yield of the intercropped plot (Table 1). The highest adjusted cane yield of 137.75 t ha^{-1} was recorded from T_7 (140 cm + 60 cm ´ 30 cm) followed by 136.57 t ha^{-1} from T_3 (100 cm x 30 cm) and the lowest adjusted cane yield of 115.90 t ha^{-1} was from the T_5 (105 cm + 45 cm x 30 cm). The result indicated that T_7 and T_3 were superior to other treatments.

Pol % cane

There was significant effect on pol % cane among the different treatments (Fig. 1). The highest pol % cane of 14.54 was obtained from treatment T_7 (140 cm + 60 cm x 30 cm) followed by treatment T_8 (140 cm + 60 cm x 45 cm) and the lowest pol % cane of 12.28 was recorded from treatment T_1 (75 cm x 30 cm). This result was in agreement with the findings of Imam *et al.* (1988).

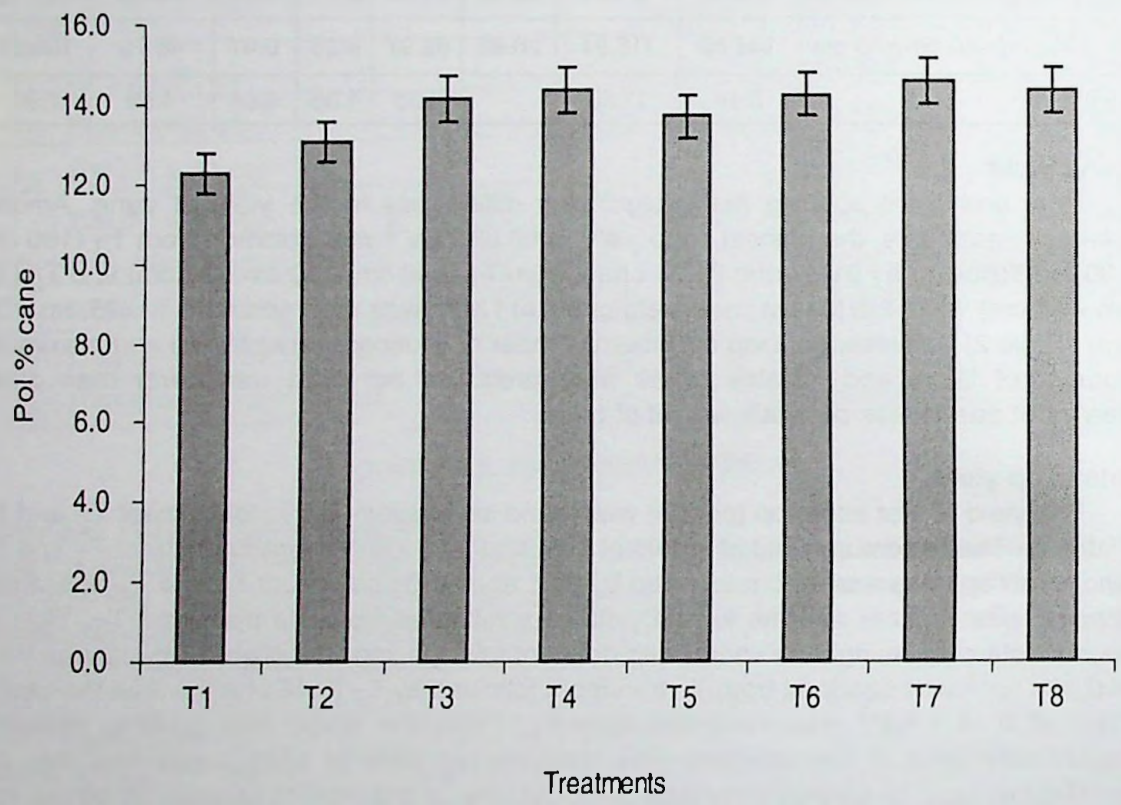

Figure 1. Pol % cane as affected by different treatment combinations

Economics

Table 3 shows the economic analysis of the experiment under different treatments. The variable cost for seed cane, potato and mungbean varied in different treatment. The highest total production cost of Tk. 67,500 was for treatment T_5 (105 cm + 45 cm x 30 cm) followed by Tk. 66,000 for T_1 and T_6 while the lowest of Tk. 60,000 for treatment T_4 (100 cm x 45 cm).

Table 3. Economics and benefit cost ratio (BCR) of different treatment combinations (BSRI, 2004-2005).

Treatments	Total production cost (Tk. ha^{-1})	Gross return (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
T_1 : 75 cm x 30 cm	66,000	1,59,052.48	93,052.00	2.40
T_2 : 75 cm x 45 cm	64,500	1,71,410.94	1,06,910.00	2.65
T_3 : 100 cm x 30 cm	61,500	1,75,629.02	1,14,129.02	2.85
T_4 : 100 cm x 45 cm	60,000	1,68,813.22	1,08,813.22	2.81
T_5 : (105 cm + 45 cm) x 30 cm	67,500	1,49,047.40	81,547.40	2.20
T_6 : (105 cm + 45 cm) x 45 cm	66,000	1,55,091.60	89,091.60	2.34
T_7 : (140 cm + 60 cm) x 30 cm	64,500	1,77,146.50	1,12,646.50	2.74
T_8: (140 cm + 60 cm) x 45 cm	63,000	1,71,889.84	1,08,889.84	2.72

Price of crops : Sugarcane: 1286 $Tk.t^{-1}$, Potato : 5.00 $Tk.kg^{-1}$ and Mungbean : 40.00 $Tk.kg^{-1}$

The maximum gross return of Tk. 1,77,146.50 was recorded from T_7 followed by Tk. 1,77,146.50 from T_3 and the lowest was from T_5 of Tk. 1,49,047.40. In case of gross margin, the highest of Tk. 1,14,129.02 was obtained from T_3 followed by T_7 (Tk. 1,08,889.84) while the lowest of Tk. 81,547.40 was recorded from T_5. The highest benefit cost ratio (BCR) of 2.85 was recorded from the T_3 followed by T_4 and the lowest BCR was from T_5. The over all result suggested that producing one intercrop in single row and two intercrops sequentially in paired row planting system with row spacing 140 cm was found to be profitable practice with sugarcane. Therefore, spacing 100 cm ´ 30 cm and 140 cm + 60 cm ´ 30 cm exhibited the best performance and may be recommended for higher yield and accommodate intercrops properly.

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