Impact of Paired Row Sugarcane with Double Intercrops

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ABSTRACT

The study was conducted during 1997 to 1998 cropping season under irrigated condition to find out the impact of paired row cane (PRC) with double intercrops. Ten different treatment combinations assigned for four various first intercrops viz. potato, onion, mustard and lentil followed by mungbean as second intercrop. The maximum millable cane stalks (108.10 x 103 ha^{-1}) and cane yield (92.12 t ha^{-1}) were obtained from the treatment T_2 (PRC + potato - mungbean) while the minimum millable cane stalks (92.29 x 103 ha^{-1}) and cane yield (66.56 t ha^{-1}) were from the treatment T_4 (PRC + mustard - mungbean). Potato gave the most satisfactory yield (12.76 t ha-1) followed by onion (6.58 t ha^{-1}) compared to their sole crops. Mungbean as second intercrop after lentil showed better performance. Highest adjusted cane yield (154.12 t ha^{-1}), additional income (Tk. 33,840 ha^{-1}), higher benefit cost ratio (2.68) and land equivalent ratio (2.67) were recorded from the T_2 plot while the lowest were from the T_4 plot (except additional income) compared to the control. Overall results suggested that PRC + potato - mungbean (T_2) combination was found the most productive and remunerative package technology for sustainable sugarcane farming.

Key words : Paired row cane, double intercropping, potato, mungbean.

INTRODUCTION

Intercropping is one of the ways for increasing productivity and economic return per unit area of land. It is reported that 50 to 80 percent of the rainfed crops are planted as intercrops with sugarcane (Saccharum officinarum, L.) in many developing countries (Norman, 1974 and Jodha, 1977).

In recent days intercropping has become the most important practice for sustainable sugarcane production to the marginal farmers. Only 15 to 20 percent areas are intercropped in Bangladesh while in Mauritius, about 70-77 percent cane areas are intercropped mainly with potato and tomato (Imam, 1990 and Anon.,1986). But the yield of intercrops and sugarcane under traditional practices are not satisfactory and remains almost static position for the last two to three decades. This situation led farmers to grow crops other than sugarcane. Because, in the present single row planting system, cane

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yield as well as intercrop yield can not be improved further. To overcome this problem, recently "paired row system" of cane planting has been developed which allows additional space to accommodate more rows of intercrops without any adverse effect on cane yield. In this method, there is also a scope to grow another second intercrop after harvesting first. Growing double intercrop under paired row system increases the productivity by 31.20 percent compared to the single intercrop under single row system (Alam, 1999). A limited research has been done on the performance of paired row planting of sugarcane, no detail study has so far been made to examine the impact of paired row sugarcane compared to the single row sugarcane with double crops. Therefore, the present study was undertaken to analyze the productivity and impact of paired row sugarcane with double intercrops.

MATERIALS AND METHODS

An experiment was conducted at the Bangladesh Sugarcane Research Institute (BSRI) farm, Ishurdi, Pabna during 1997 to 1998 cropping season. The site represents High Ganges River Floodplain under Agro-Ecological Zone-11, with medium high land of typical sandy loam soil with pH 7.6. Four different first intercrops viz. potato (*Solanum tuberosum*, L.), onion (*Allium cepa*, L), mustard (*Brassica campestris*, L.) and lentil (*Lens culinaris*, L.) followed by a second intercrop mungbean (*Vigna radiata*, L.) were grown with sugarcane (variety Isd 28) to find out the most suitable intercrop combination for sustainable sugarcane farming. The experiment was laid out in a randomized complete block design with three replications. The plot size was 8m x 7m. Following treatments were included in this experiment.

T_1 = Paired row cane (PRC), control
T_2 = PRC + (potato - mungbean)
T_3 = PRC + (onion - mungbean)
T_4 = PRC + (mustard - mungbean)
T_5 = PRC + (lentil - mungbean)
T_6 = Sole potato - mungbean
T_7 = Sole onion - mungbean
T_8 = Sole mustard - mungbean
T_9 = Sole lentil - mungbean
T_{10} = Sole mungbean

Sugarcane settlings previously raised in polybag were transplanted in each plot during mid-November, 1997 with 45 cm interplant spacing in paired rows of 60 cm spacing. Spacing between two paired rows was 140 cm. For sugarcane, urea, TSP, MP and gypsum were applied @ of 347, 244, 184 and 222 kg ha^{-1}, respectively (BARC, 1989). All TSP, gypsum and one third (1/3rd) of MP were applied in trench and mixed with soil prior to transplanting of settlings. The basal dose of urea (1/3rd) was applied as side dressing at 21st days after transplanting (DAT). The second dose of $^1/_3$rd urea and $^1/_3$rd MP were applied as first top dressing (TD) at 90 DAT. Final TD of urea and MP were done at 150 DAT. Urea, TSP, MP and gypsum for potato were applied at the rate of 156, 107, 120 and 67 kg ha^{-1}, for onion @ 52, 71, 100 and 40 kg ha-1, for mustard @ 104, 80, 40 and 67 kg ha^{-1}, for lentil @ 16, 52, 12 and 20 kg ha^{-1} and for mungbean only TSP and MP were applied @ 47 and 30 kg ha^{-1} (BARC, 1989). To control insect-pests, Furadan 5G was

applied @ of 40 kg^{-1} ha in three splits during December, 1997, March and May, 1998. Other intercultural operations like irrigation, gapfilling, weeding, mulching, earthing-up, tying etc were done in time. Collection of data on yield and various yield contributing characteristics for cane and intercrop were done. The yield of first and second intercrops were recorded at harvest. Plant population of cane were recorded in each month with thirty days interval from transplanting of settlings till harvest. The number of millable canes were counted at harvest. Plant population and millable canes were expressed as 1000 ha^{-1}. The yield of sugarcane stalk was recorded at final harvest. The adjusted cane yield for the intercropped plot was calculated by adding the cane yield and the equivalent cane yield obtained from the intercrops on the basis of sale proceeds. Chemical analyses of sugarcane juice for brix (%), pol (%), purity (%) and recovery (%) at harvest were done. Net return, benefit cost ratio (BCR) and land equivalent ratio (LER) were also calculated. Economic and statistical analyses on different treatments for sugarcane and intercrops were done following the standard procedures.

RESULTS AND DISCUSSION

Tiller and millable cane production

Tiller production has been influenced significantly by different intercrop combinations under paired row system of planting (Fig. 1). The highest tiller population of 317.30 x 103 ha^{-1} was produced from the T_2 plot (PRC + potato - mungbean) followed by the T_5 plot (PRC + lentil - mungbean) while the lowest of 248.9 x 103 ha^{-1} was from the T_4 plot (PRC + mustard - mungbean). This result further indicated that potato showed beneficial effect on tiller production but mustard excerted adverse effect on it.

The number of millable cane stalks were statistically identical under different treatment combinations except for the T_4 plot (Fig. 1). The maximum millable cane stalks (108.10 x 103 ha^{-1}) was recorded from the T_2 plot and the minimum (92. 29 x 103 ha-1) was from the T_4 plot. Intercropping mustard reduced millable cane stalks production by 11.4 % to 14.6% while intercropping potato and lentil increased it by 3.7% and 2.9%, respectively. Adverse effects of intercropping mustard on tiller and millable cane stalks production have also been observed by many workers (Kanwar, 1975; Rathi and Tripathi, 1975 and Imam *et al.*, 1982). On the other hand, the beneficial effects of intercropping potato and lentil on tiller and millable cane stalks production have been reported by Rathi and Singh (1979) and Nankar (1990). Decrease in population density under mustard intercropping is attributed to the higher branching habit, shading effect and higher water requirement by the mustard.

Significantly, the maximum cane yield of 92.12 t ha^{-1} was obtained from the treatment T_2 followed by the treatment T_5 while the minimum of 66.56 t ha^{-1} was from theT_4 treatment (Fig. 2). The yield of T_3 treatment was statistically identical to that of T_5 treat ment. Also the yield of T_1 and T_3 treatment was statistically at par. In this study, potato intercropping increased cane yield by 25% while mustard intercropping reduced it by 11%. The higher yield of sugarcane under the T_2 treatment may be attributed to the higher number of millable stalks production accompanied with higher dry matter production and favourable micro-environment resulting from a number of causes viz. improved soil physical condition under potato intercropping, residual effect of potato biomass incorporated into the soil, minimum weed infestation due to potato intercropping and residual soil

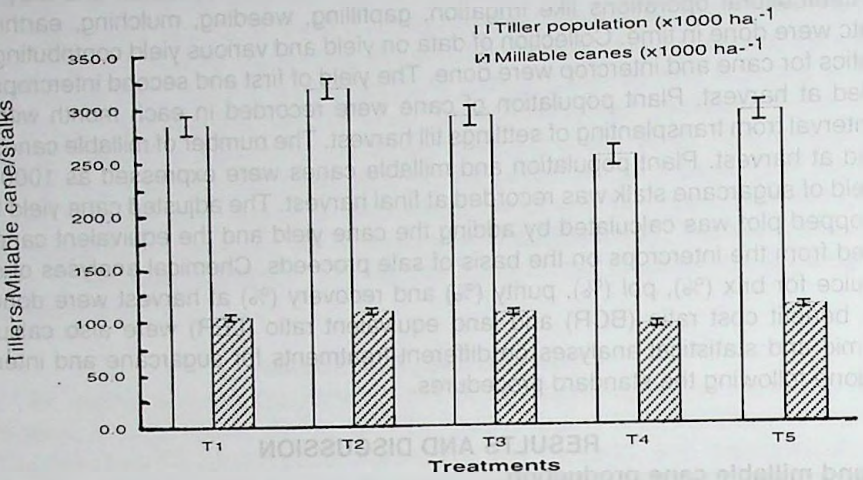

Figure 1. Tiller population and millable cane stalks as affected by different intercrop combinations. Vertical bar indicates LSD at 5% level.

moisture. Thus, among all intercrops, potato was proven to be the most ideal intercrop for sugarcane. Increased cane yield with potato intercropping has also been reported by Rathi and Singh (1980) and Imam *et al.* (1982) while the decreased cane yield by mustard (2-64%) intercropping has been observed by Kanwar (1975) and Shaheen (1990). However, lentil could be an alternative to potato as first intercrop preferably under paired row system with an appreciable yield increase in sugarcane. Lentil intercropping with sugarcane also improves soil fertility by fixing atmospheric N in the soil (Yadav, 1987).

The highest sugar yield of 8.92 t ha^{-1} was obtained from the T_2 treatment followed by T_5 treatment while the lowest of 4.48 t ha-1 was from the T_4 treatment (Fig. 2). Potato and lentil intercrops showed beneficial effect on sugar yield but onion and mustard exerted an adverse effect on it. These results are in good agreement with the findings of Imam et al. (1982) and Shaheen (1990). Higher sugar yield in the T_2 treatment was mainly due to higher cane yield accompanied by higher pol (%), purity (%) and sucrose (%) in cane juice while the lowest sugar yield in the T_4 treatment was due to the lower cane yield accompanied by less pol (%) and purity (%) of cane juice.

Yield of intercrop

The overall yield performance of the first intercrops (potato, onion, mustard and lentil) under paired row system was found satisfactory compared to the yield of each intercrop as sole crop. Kinds of intercrops also showed large effect on the yield of first intercrops. Among all intercrops, potato gave the most satisfactory yield (12.76 tha^{-1}) compared to the sole crop of it (Table 1). The yield difference between intercropping potato and sole crop potato was found lower (10.9%). Usually the yield of any intercrop is considered to be at least 50 % of its sole crop when grown with sugarcane. Therefore, in the present experiment, potato showed the best performance as intercrop with sugarcane. Although,

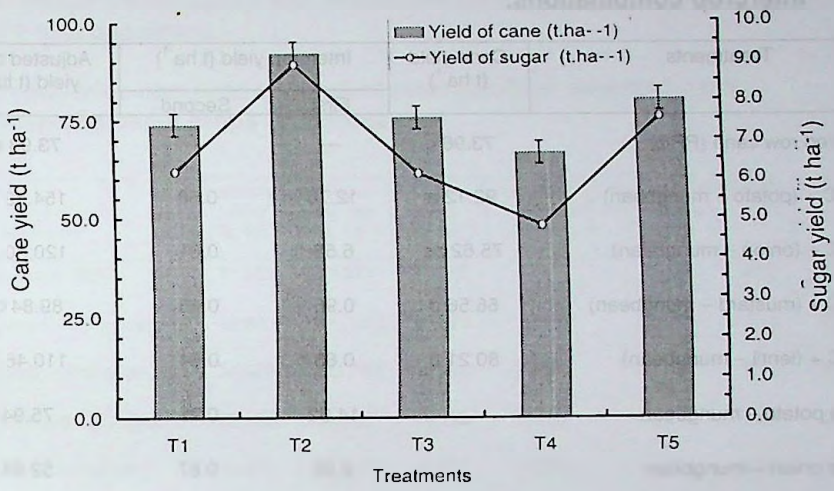

Figure 2 Yield of cane and sugar as affected by different intercrop combinations.

mustard was discouraged as intercrop with sugarcane, but the yield of intercrop mustard with paired row sugarcane was very near to that of the sole crop mustard. Lentil intercropping was as good as potato intercropping. Higher yield difference (26.56%) between intercrop onion and sole crop onion has been observed compared to that of other intercrops.

The yield of mungbean as second intercrop ranged from 0.45 to 0.64 t ha^{-1} with the highest value on the T_5 plot and the lowest on the T_4 plot. On the contrary, yield of mungbean as sole crop ranged from 0.79 to 1.10 t ha^{-1} with the highest value on the T_{10} plot and the lowest on the T_8 plot. The data again showed that under intercropping condition, the kind of first intercrop affects the yield of second intercrop.

Adjusted cane yield

Adjusted cane yield is an important parameter for determining the total yield potentials of the intercropped plot (cane + intercrop) over the sole cane plot. In the present experiment (Table 1), significantly the highest adjusted cane yield of 154.12 t ha^{-1} was obtained from the T_2 plot (PRC + potato - mungbean) followed by T_3 plot (PRC + onion - mungbean) while the lowest of 73.93 t ha^{-1} was from the T_1 plot (sole cane). Khan et al. (1995) obtained the highest adjusted cane yield of 140.8 t ha^{-1} from paired row cane + potato - kangkong combination. Maximum increase of adjusted yield over control (108%) was obtained from the T_2 plot and the minimum (21%) was from the T_4 plot. This result indicated that PRC + potato - mungbean combination (T_2) was superior to other.

Table 1. Yield of cane, intercrops and adjusted cane yield under different intercrop combinations.

Treatments	Cane yield (t ha^{-1})	Intercrop yield (t ha^{-1})		Adjusted cane yield (t ha^{-1})
		First	Second	
T_1 = Paired row cane (PRC)	73.96 c	---	---	73.93 e
T_2 = PRC + (potato – mungbean)	92.12 a	12.76	0.58	154.12 a
T_3 = PRC + (onion – mungbean)	75.62 bc	6.58	0.61	120.50 b
T_4 = PRC + (mustard – mungbean)	66.56 d	0.96	0.45	89.84 d
T_5 = PRC + (lentil – mungbean)	80.21 b	0.88	0.64	110.46 c
T_6 = Sole potato – mungbean	_	14.32	0.95	75.94
T_7 = Sole onion – mungbean	_	8.96	0.87	52.98
T_8 = Sole mustard – mungbean	_	0.99	0.79	30.50
T_9 = Sole lentil – mungbean	_	0.98	0.83	36.02
T_{10} = Sole mungbean	_	0.00	1.10	21.89

Figures in a column accompanied by similar letters do not differ significantly at 5% level.

Economic analyses

a. Cost of cultivation

Table 2 shows the economic analysis of the experiment under various treatments. It is seen from the table that T2 treatment (PRC + potato - mungbean) incurred the maximum cost of cultivation (Tk.57,800 ha^{-1}) followed by T3 treatment (PRC + onion - mungbean) while the minimum (Tk.31,000 ha^{-1}) was from paired row sole cane. However, Miah et al. (1994) reported that sugarcane + onion intercropping required the maximum cost of cultivation than that of the sugarcane + mustard, sugarcane + lentil and sugarcane + potato combinations.

In case of single crop culture, sole potato - mungbean (T_6) needed the highest amount of monetary investment (Tk. 36,450 ha^{-1}) followed by the sole onion - mungbean (T_7). Mungbean sole cropping (T_{10}) showed the lowest cost of cultivation (Tk. 9,000 ha^{-1}) compared to other combinations.

b. Gross income and net return

Under intercrop condition, the highest gross income of Tk. 1,54,890 ha^{-1} was obtained from the T_2 plot followed by the T_3 plot while the lowest gross income was from the T_4 plot. Under sole crop condition, potato - mungbean (T_6) gave the highest gross income (Tk. 76,320 ha^{-1}) and the lowest gross income (Tk. 22,000) was from the sole mungbean T_{10} (Table 2). Similar result has also been obtained in case of net return for

both the intercrop and sole crop conditions. These results indicated that among all the first intercrops, potato intercropping with sugarcane gave the highest gross and net return when grown with sugarcane.

Table 2. Economics and land equivalent ratio (LER) of different cane intercrops/sole crops combinations.

Treatments	Production cost (Tk. ha^{-1})	Gross income (Tk. ha^{-1})	Net return (Tk. ha^{-1})	Addl. cost for intercrop (Tk. ha^{-1})	Addl. income from intercrop (Tk. ha^{-1})	BCR	LER
T_1 = Paired row cane (PRC)	31,000	74,329	43,329	---	---	2.40	1.00
T_2 = PRC + (potato – mungbean	57,800	1,54,890	97,090	26,800	33,840	2.68	2.67
T_3 = PRC + (onion – mungbean)	54,600	1,21,102	66,502	23,600	10,100	2.22	2.30
T_4 = PRC + (mustard – mungbean)	41,000	90,289	49,289	10,000	12,400	2.20	2.28
T_5 = PRC + (lentil - mungbean)	44,405	1,11,012	66,607	10,000	18,400	2.50	2.50
T_6 = Sole potato – mungbean	36,450	76,320	39,870	---	---	2.09	2.00
T_7 = Sole onion – mungbean	33,450	53,245	19,794	---	---	1.59	2.00
T_8 = Sole mustard – mungbean	12,350	28,652	16,302	---	---	2.32	2.00
T_9 = Sole lentil – mungbean	13,250	32,200	18,250	---	---	2.43	2.00
T_{10} = Sole mungbean	9,000	22,000	13,000	---	---	2.44	1.00

Prices of crops:
Sugarcane: Tk. 1005 t^{-1} Mustard : Tk. 15 kg^{-1}
Potato : Tk. 4 kg^{-1} Lentil : Tk. 20 kg^{-1}
Onion : Tk. 5 kg^{-1} Mungbean: Tk. 20 kg^{-1}

c. Additional cost and income due to intercropping

These two economic parameters are considered to be the most influencing factors for adoption of any intercrops to be grown with sugarcane by the farmers. In the present study, PRC + potato - mungbean combination (T_2) incurred the maximum additional cost of Tk.26,800 ha^{-1} followed by the PRC + onion - mungbean (T_3) combination. On the contrary the maximum additional cost of Tk.10,000 ha^{-1} was needed for the PRC + mustard - mungbean and PRC + lentil - mungbean combinations.

The highest additional income of Tk. 33840 ha^{-1} was from the T_2 plot while the lowest additional income of Tk. 10,100 ha^{-1} was from the T_3 plot. In terms of additional income, lentil was found more remunerative than onion. This might be due to higher cost of onion (bulb) seed than that of lentil seed.

d. Benefit-cost ratio and land equivalent ratio

Under intercrop conditions, the benefit cost ratio was found to be maximum (2.68) in the T_2 treatment followed by the T_5 treatment (2.50) while the minimum benefit cost ratio (2.20) was from the T_4 treatment. It is reported that potato and onion gave the highest benefit cost ratio when grown as intercrop with sugarcane compared to other intercrop combinations (Imam *et al.*, 1982).

In case of sole culture of the first intercrop followed by mungbean, lentil showed the highest benefit cost ratio of 2.43 followed by mustard 2.32 and onion showed the lowest benefit cost ratio of 1.59. The single crop culture of mungbean (T_{10}) showed almost similar benefit cost ratio (2.44) compared to lentil - mungbean combination (T_9). Land equivalent ratio (LER) is an important parameter for determining the adoption or rejection of any intercrop compared to their respective sole crop. Data on the LER value of different sugarcane + intercrop combination indicated that the treatment T_2 (PRC + potato-mungbean) showed the highest LER of 2.67 while the lowest LER of 2.28 was from the T_4 (PRC + mustard - mungbean) treatment. The LER value greater than 1.0 indicates the advantage of the component crops in intercropping system compared to their sole cropping. Therefore, in the present experiment, sugarcane + potato - mungbean combination under paired row system was proven to be highly profitable over other intercrop combinations. It is imperative that LER value less than 1.0 indicated that the bad performance of the component crops in intercropping system. In the present experiment all the intercrop combinations showed LER value higher than 1.0. The overall results suggest that PRC + (potato - mungbean) intercrpping systems can produce the best performance compared to all other intercropping systems.

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