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SYSTEM PRODUCTIVITY AND ECONOMICS OF INTERCROPPING MAIZE WITH SUGARCANE

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Abstract

To investigate the effects of intercropping of maize with sugarcane on cane development, outturn, and overall economic return, field experiments were carried out during the cropping year 2021–22 in two different locations: Bangladesh Sugarcrop Research Institute (BSRI), Ishwardi, Pabna and the Regional Sugarcrop Research Station (RSRS), Thakurgaon, Bangladesh. There were nine treatments namely T_1: Single row sugarcane only (SS), T_2: SS+ Maize (During sett placement), T_3: SS+ Maize (7 days after sett placement), T_4: SS+ Maize (14 days after sett placement), T_5: SS+ Maize (21 days after sett placement), T_6: SS+ Maize (28 days after sett placement), T_7: SS+ Maize (35 days after sett placement), T_8: SS+ Maize (42 days after sett placement), T_9: Maize (M) only. Sugarcane variety "Isd 39" and maize variety "Super 92" were used in this experiment as experimental materials. Results indicated that T_7 treatment was superior in terms of germination (56.56% at BSRI and 57.33% at Thakurgaon). The treatments T_1 (174.33×10^3 ha^{-1} and 184.00×10^3 ha^{-1}) and T_7 (162.67×10^3 ha^{-1} and 168.00×10^3 ha^{-1}) consistently exhibited superior tiller production and millable cane yield at both the locations. However, T_1 generally resulted in higher cane yield, while T_7 demonstrated higher SEY (108.25 t ha^{-1} at BSRI and 114.79 t ha^{-1} at Thakurgaon), LER (1.56 at BSRI and 1.52 at Thakurgaon), ATER (1.20 at BSRI and 1.16 at Thakurgaon), gross monetary value (487133 BDT ha^{-1} at BSRI and 516533 BDTha^{-1}at Thakurgaon), and monetary advantage index (175178 at BSRI and 177542 at Thakurgaon) compared to other treatments. Treatment T_2 also showed competitive SEY (105.52 t ha^{-1} at BSRI and 108.69 t ha^{-1} at Thakurgaon), LER (1.64 at BSRI and 1.54 at Thakurgaon), ATER (1.13 at BSRI and 1.07 at Thakurgaon), gross monetary value (474867 BDT ha^{-1}at BSRI and 489100 BDT ha^{-1}at Thakurgaon), and monetary advantage index (184942 at BSRI and 173134 at Thakurgaon), indicating its effectiveness in enhancing sugarcane production. Therefore, it maize planted 35 days after sugarcane sett placement (T_7) or during sugarcane sett placement (T_2), profitable intercropping system.

Keywords: Multiple cropping, maize, sugarcane, yield, monetary benefit

Introduction

Sugarcane (*Saccharum officinarum*)., is a significant industrial crop that belongs to the Poaceae family and the Andropogoneae tribe and grows in every tropical and subtropical region of the globe (Li *et al.* 2018). The cultivation of this crop has been shown to have major global applications in the extraction of sugar and the manufacture of biofuels (Surendran *et al.* 2016). It is expected that sugarcane will continue to maintain its dominant position, accounting for roughly 87% of the overall sugar crop output along with 86% of the worldwide sugar produced (Luo *et al.* 2016). Worldwide 26.34 million hectares of land were devoted to sugarcane cultivation in 2021 and the yield was 1859 million metric tons (FAOSTAT 2021).

Typically, sugarcane is grown in rows, with a recommended spacing ranging from 80 to 150 centimeters, and exhibits a juvenile state that lasts around 100-110 days, which has led to the wide acceptance of intercropping practices (Li *et al.* 2013, Yang *et al.* 2013). Intercropping is a method of farming where various crops are grown side by side and cohabit on the same land for

a certain period. The utilization of wide row spacing, combined with the observed slow growth rate during the initial phase of sugarcane cultivation, presents a favorable prospect for implementing intercropping practices within sugarcane fields. This structure also permits a productive use of available space and resources, including nutrients, moisture, and light, and thus presents a potential for the implementation of intercropping as a viable option to increase the productivity of short-duration crops like vegetables, oilseeds, legumes, maize and spices (Singh *et al.* 2021). Intercropping sugarcane with other crops such as watermelons, peas, onions, and so forth, would substantially increase economic income while decreasing sugarcane yield. However, it may also lead to a significant gain in economic revenue (Al Azad and Alam 2004). Intercropping typically exhibits an upward trend toward high yield and overall production is higher even in regions where the companion crop's output is much lower (Aggarwal *et al.* 1992)

The net cropped area of Bangladesh is estimated to be 8.12 million hectares with a cropping intensity of 198% (BBS 2022). As there isn't much room for horizontal land expansion to enhance productivity, utilizing land intensively is the only option for farmers to maximize their revenue from their farms (Kamruzzaman and Hasanuzzaman, 2007). From planting to harvesting, sugarcane takes 10 to 14 months to grow. Small and medium farmers, predominantly sharecroppers in Bangladesh, are unable to endure for such a long time due to financial strain and greater everyday food and vegetable needs. Consequently, there is a tendency among individuals to decrease the cultivation of cane while simultaneously increasing the cultivation of other crops. During the cropping year of 2020-21, a total of 72 thousand hectares of land were allocated for the cultivation of sugarcane, resulting in a yield of 3.08 million metric tons. In contrast, maize was planted on 0.478 million hectares of land, yielding 4.26 million metric tons. (BBS 2022). Maize is gaining prominence in Bangladesh and now ranks second in terms of cultivation area, behind rice (BBS 2022). Maize is steadily expanding in areas under cultivation due to its short growing season, and a variety of uses including food, fuel and the production of starch, alcohol, soup, varnish, paint, and other products, as well as its overall higher profitability when compared to other crops.

Intercropping has been acknowledged as a prospective approach for enhancing production in subsistence farming scenarios, both spatially and temporally. There is usually a pull toward increased productivity when employing intercropping techniques. Numerous intercrop combinations have been extensively investigated in sugarcane fields throughout the entire world. Maize and autumn-planted sugarcane were tested as intercrops in Banswar, Haryana (Panwar *et al*. 1990). However, there is lack of any notable study investigating the effects of intercropping maize with sugarcane. Therefore, the present study aims to examine the impact of maize as an intercrop with sugarcane's in relation to growth, yield, yield-contributing parameters, and economy to assess the profitability of this particular crop combination.

Materials and Methods

Experimental materials and locations: Conventional two-budded setts from 10 months old sugarcane (*Saccharum officinarum* L.) variety "Isd 39" used as sugarcane planting material and maize variety "Super 92" used as maize sowing material. The experiment was conducted in two locations namely the research field of Agronomy and Farming Systems Division of BSRI, Block-C_4 (24.1156° N, 89.0817° E), Ishwardi-6620, Pabna, Bangladesh, and the research field of RSRS (26.0274° N, 88.4646° E), Thakurgaon-5100, Bangladesh; during the cropping year 2021-22. Soil samples were collected from both locations and analyzed in soils & nutrition division, Bangladesh Sugarcrop Research Institute, Ishwardi, Pabna.

The experiment was designed following a randomized complete block design (RCBD) with three replications having nine treatments namely T_1: Single row sugarcane only (SS), T_2: SS+ Maize (During sett placement), T_3: SS+ Maize (7 days after sett placement), T_4: SS+ Maize (14 days after sett placement), T_5: SS+ Maize (21 days after sett placement), T_6: SS+ Maize (28 days after sett placement), T_7: SS+ Maize (35 days after sett placement), T_8: SS+ Maize (42 days after sett placement), T_9: Maize (M) only. The size of each plot was 6m×6m. Two budded setts were planted end to end with the conventional method where 100cm row-to-row distance was maintained. In between the space of two sugarcane rows maize was sown in a single line where continuous sowing was done. Before

Soil parameters of the two locations are given below:

Soil properties	Analytical values	
	BSRI, Ishwardi	**RSRS, Thakurgaon**
Texture class	Silt loam	Sandy loam
Sand (%)	67	67.33
Silt (%)	22	17.27
Clay(%)	11	15.40
pH	7.62	5.15
Organic matter (%)	1.0	1.05
Total nitrogen (%)	0.07	0.09
Calcium (meq 100 g^{-1})	11.51	3.0
Magnesium (meq 100 g^{-1})	0.83	1.25
Potassium (meq 100 g^{-1})	0.15	0.17
Phosphorus (µg g^{-1})	12.00	14.00
Sulphur (µg g^{-1})	20.00	12.00
Boron (µg g^{-1})	0.20	0.20
Iron (µg g^{-1})	3.40	3.40
Zinc (µg g^{-1})	0.56	0.90

sowing, the maize seeds were soaked in water overnight. After successful establishment, a 15cm plant-to-plant distance was maintained.

Sett germination: The germination parameter on final germination (%) of sugarcane was recorded 45 days after sett planting with the following formula:

([Number of germinated setts/total number of setts] ×100) (Hernández-Herrera *et al.* 2014).

Yield contributing parameters: The tiller number (×10^3 ha^{-1}) of sugarcane was counted at 150 days after sett sowing. Millable cane (×10^3 ha^{-1}), sugarcane yield (t ha^{-1}), and maize yield (t ha^{-1}) were recorded during harvest. Pol % cane was determined with the aid of an automatic polarimeter (P850 Pro, Hanon, China) and recorded after the sugarcane harvest.

Productivity and economic indices: Sugarcane equivalent yield (SEY): Sugarcane was the main crop; therefore, the yield of maize in the intercropping system was converted to sugarcane equivalent yield as stated by Choudhary et al. (2014):

$$SEY = [Y_1 + \{(Y_2 \times P_M)/P_S\}]$$

Where, Y_1= Yield of sugarcane in intercropping (t ha^{-1}); Y_2= Yield of maize in intercropping (t ha^{-1}); P_M= Price of maize grain t^{-1}; and P_S= Price of sugarcane t^{-1}.

Land equivalent ratio (LER): The intercropping system productivity was evaluated based on the land equivalent ratio (LER). LER was calculated as stated by Willey (1979):

$$LER = [(Y_1/M_1) + (Y_2/M_2)]$$

Where, Y_1= Yield of sugarcane in intercropping; Y_2= Yield of maize in intercropping; M_1= Yield of sugarcane in pure stand; and M_2= Yield of maize in pure stand.

Area time equivalent ratio (ATER): ATER provides a more realistic comparison of the yield advantage of intercropping over monocropping in terms of time taken by component crops in the intercropping systems (Hiebsch and McCollum 1987, Aasim *et al.* 2008, Yahuza 2011). ATER was calculated using the following formula:

$$ATER = LER \times D_c/D_t$$

Where, LER= Land equivalent ratio; D_c= Time taken by crop; and D_t= Time taken by the whole system.

Gross monetary value (GMV): Gross monetary value (GMV) was calculated as the product of yields of the component crops (t ha^{-1}) multiplied by their respective unit prices during harvesting time. An average of 2021–22 market price of Bangladeshi Taka (BDT) 4500 t^{-1} for sugarcane and BDT 35000 t^{-1} for maize grains were taken for the economic analysis.

Monetary advantage index (MAI): The higher the MAI value the more profitable is the cropping system). The monetary advantage index (MAI) can be calculated as stated by Ghosh (2004):

MAI = (Value of combined intercrops) × (LER – 1) / LER

Where, LER= Land equivalent ratio

Data analysis: Data obtained from two locations and were subjected to analysis of variance (ANOVA) using the software program Statistix 10 (Analytical Software, Tallahassee, FL, USA) and the mean differences were compared least significant difference (LSD) at $P \leq 0.05$.

Results and Discussions

The performance of different treatments on germination percentage (%), tiller number ($\times 10^3$ ha^{-1}), millable cane ($\times 10^3$ ha^{-1}), cane yield (t ha^{-1}), and pol% cane in two locations are presented in Table 1.

Proper germination is a pre-requisite for better plant growth and development at later stages (Apon *et al.* 2023). At BSRI, T_7 had the highest germination rate (56.56%), which was statistically similar to T_1 (54.50%) and T_3 (53.00%) that also highly effective in promoting germination. T_3 (53.00%), T_5 (52.16%), and T_8 (51.66%) fall into a moderate germination range. These treatments are effective but not as superior as T_7 and T_1. Their relatively close germination percentages suggest similar efficacy in enhancing germination. T_2 (49.16%) and T_4 (48.00%) exhibit lower germination rates. Their performance is significantly less effective compared to T_7, T_1, T_3, T_5 and T_8. T_6 has the lowest germination rate at 47.00%. This suggests that T_6 is the least effective among all treatments tested.

At Thakurgaon, T_7 (57.33%) shows the highest germination rate, significantly outperforming all other treatments. T_5 (54.20%) also exhibits a high germination rate, following closely behind T_7. T_1 (53.2%) and T_8 (52.50%) also fall into the high germination category. These treatments are effective in promoting seed germination, although not as superior as T_7. Treatments T_2 (50.3%), T_3 (50.50%), and T_4 (50.16%) show moderate germination rates. T_6 (47.94%) has the lowest germination rate, indicating it is the least effective treatment (Table 1). In both of the locations T_7 showed the highest germination percentage might be due to late sowing of maize seeds which ensured better resource use efficiency as a result of comparative late inter-specific competition with maize. There might be involvement of some unknown reasons also. A similar result was reported by Singh *et al.* (2019).

At BSRI, T_1 exhibited the highest (174.33×10^3 ha^{-1}) tiller number, whereas T_7 had a slightly inferior tiller number of 162.67×10^3 ha^{-1} which was statistically similar to T_1. The T_3 treatment had the lowest (105.33×10^3 ha^{-1}) tiller number, which was statistically indistinguishable from T_4 (108.33×10^3 ha^{-1}). In the Thakurgaon instance, T_1 had the highest (184.00×10^3 ha^{-1}) tiller number among all the treatments, followed by T_7 (168.00×10^3 ha^{-1}), T_2 (165.00×10^3 ha^{-1}) and T_8 (155.33×10^3 ha^{-1}), which don't have any statistical difference and also similar to the BSRI locations. The T_3 treatment had the lowest (114.00×10^3 ha^{-1}) tiller number. It was statistically similar to the T_4 scenario, which had a tiller number of 122.67×10^3 ha^{-1} and the T_6 treatment, which had a tiller number of 141.33×10^3 ha^{-1}, in that respective order. In both locations, the tiller population of sugarcane was significantly higher in T_1 (sole) treatment followed by T_7. On the contrary, T_3 treatment showed the lowest tiller population (Table 1). This might be due to the exhaustive nature of maize which depleted more nutrients and moisture for its growth led to a comparatively lower tiller population of sugarcane in T_3. A similar finding was reported by Singh *et al.* (2022). Despite having maize as an intercrop in T_7, it produced the highest number of tillers. Kumar *et al.* (2016) also did not observe a significant effect on the tiller population of sugarcane under the sugarcane + garlic intercropping system.

At BSRI, T_1 exhibited the highest (97.23×10^3 ha^{-1}) number of millable cane, followed by T_7 (93.06×10^3 ha^{-1}) which was statistically similar to T_1. The T_3 treatment had the

lowest number of millable cane, measuring 62.36×10^3 ha^{-1}, which was statistically equivalent to T_4 (68.43×10^3 ha^{-1}) and T_6 (71.10×10^3 ha^{-1}). In the Thakurgaon instance, T_1 had the highest (104.63×10^3 ha^{-1}) number of millable cane among all the treatments, similar to the BSRI. The T_3 treatment had the lowest number of millable cane, measuring 64.60×10^3 ha^{-1}. In both locations, the millable cane was significantly higher in T_1 (sole) treatment followed by T_7. On the contrary, T_3 treatment showed the lowest number of millable cane (Table 1). This might be due to the absence of inter-specific competition which ensured better resource use efficiency such as nutrients, water, and solar radiation throughout the growing period in T_1 treatment. Kumar *et al.* (2015) also reported the superiority of sole cropping over intercropping system in respect to the number of millable canes. Again, in case of T_7 treatment, it showed the highest number of millable cane might be due to the late sowing of maize seeds, which ensured better resource use efficiency such as nutrients, water, and solar radiation during the early growth phase of sugarcane. Consequently, this led to vigorous growth of sugarcane over maize plants in T_7 treatment. On the contrary, T_3 treatment showed the lowest mill able cane population. This might be due to the rapid depletion of nutrients and moisture for the growth of maize as in T_3 treatment it was sown much earlier as compared to T_7 treatment.

Significant variation in cane yield was recorded due to different treatments. At BSRI, T_1 exhibited the highest (84.00 t ha^{-1}) cane yield, followed by T_7 (79.73 t ha^{-1}) which was statistically similar to T_1. The T_3 treatment had the lowest cane yield (59.53 t ha^{-1}), which was statistically similar to T_4 (60.43 t ha^{-1}), T_5 (63.63 t ha^{-1}), and T_6 (62.43 t ha^{-1}). In the case of Thakurgaon, T_1 had the

Table 1. Effect of different intercropping treatments on growth and yield components of sugarcane

Treatments	BSRI					Thakurgaon				
	Germination (%)	Tiller ($\times10^3$ ha^{-1})	Millable Cane ($\times10^3$ ha^{-1})	Cane Yield (tha^{-1})	Pol %	Germination (%)	Tiller ($\times10^3$ ha^{-1})	Millable Cane ($\times10^3$ ha^{-1}	Cane Yield (tha^{-1})	Pol %
T^1	54.50ab	174.33a	97.23a	84.00a	12.90a	53.20b	184.00a	104.63a	91.60a	12.83
T_2	49.16c-e	140.33c	79.33bc	65.60c	12.70ab	50.33bc	165.00ab	83.77c	67.46d	13.03
T_3	53.00a-c	105.33e	62.36e	59.53d	12.98a	50.50bc	114.00d	64.60e	60.03e	13.06
T_4	48.00de	108.3de	68.43de	60.43d	12.83ab	50.16bc	122.67cd	72.77d	62.40de	12.46
T_5	52.16bc	143.0bc	73.76b-d	63.63cd	12.80ab	54.20ab	144.33bc	80.47cd	67.43d	12.70
T_6	47.00e	128.33cd	71.10c-e	62.43cd	11.96c	47.94c	141.33bcd	74.87d	65.00de	12.53
T_7	56.56a	162.67ab	93.06a	79.73a	12.76ab	57.33a	168.00ab	95.50b	83.93b	12.93
T_8	51.66b-d	144.33bc	81.66b	70.66b	12.20bc	52.50b	155.33ab	88.30bc	76.40c	13.03
T_9	-	-	-	-	-	-	-	-	-	-
CV (%)	3.95	21.47	8.78	4.98	0.64	4.08	28.86	7.93	6.70	NS

Data are means of three replications. Means within a column followed by different letters are significantly different and followed by NS are not significantly (NS) different based on the least significant difference (LSD) at $P \leq 0.05$. Treatments are- T_1: Single row sugarcane only (SS), T_2: SS+ Maize (During sett placement), T_3: SS+ Maize (7 days after sett placement), T_4: SS+ Maize (14 days after sett placement), T_5: SS+ Maize (21 days after sett placement), T_6: SS+ Maize (28 days after sett placement), T_7: SS+ Maize (35 days after sett placement), T_8: SS+ Maize (42 days after sett placement), T_9: Maize (M) only. NS= Non-Significant.

highest (91.60 t ha^{-1}) cane yield among all the treatments, similar to the BSRI. The T_3 treatment had the lowest (60.03 t ha^{-1}) cane yield. Treatment T_4 (62.40 t ha^{-1}), and T_6 (65.00 t ha^{-1}) were also found statistically similar to T_3 treatment. In both locations, the cane yield was significantly higher in T_1 (sole) treatment followed by T_7. On the contrary, the T_3 treatment showed the lowest yield of sugarcane (Table 1). This might be due to the maximum nutrients, water, and solar radiation exploitation throughout the growing period in T_1 treatment as there were no other crop species except sugarcane. Kumar *et al.* (2015) also reported the superiority of sole cropping over intercropping system concerning the number of millable canes. Again, in case of T_7 treatment, it showed the highest cane yield similar to sole cane yield might be due to the early establishment of sugarcane than maize, which gave sugarcane an advantage over maize for rapid canopy development and harvesting of the resources nutrients, water, and solar radiation resulted in higher yield. On the contrary, T_3 treatment showed the lowest cane yield might be due to the aggressive uptaking of nutrients and moisture for the growth of maize as in T_3 treatment maize was sown much earlier as compared to T_7 treatment. These findings are supported by Shamsi *et al.* (2003).

At BSRI, T_3 showed the highest pol % (12.98), followed by T_1 (12.90), T_4 (12.83), T_5 (12.80), T_7 (12.76), and T_2 (12.70) which was statistically similar to T_1. The T_6 treatment had the lowest pol % (11.96), which was statistically similar to T_8 (12.20). In the case of Thakurgaon pol % values are non-significant for all of the treatments (Table 1). Singh et al. (2022) also reported that pol % cane did not differ significantly with different treatments.

The outcomes of different treatments on sugarcane equivalent yield (t ha^{-1}), land equivalent ratio (LER), area time equivalent ratio (ATER), gross monetary value (GMV), and monetary advantage index (MAI) in two locations are presented in Table 2.

At BSRI, T_7 had the highest (108.25 t ha^{-1}) sugarcane equivalent yield, which was statistically similar to T_2 (105.52 t ha^{-1}). The T_9 treatment revealed the lowest (46.67 t ha^{-1}) sugarcane equivalent yield A yield advantage of 131.9% was obtained from T_7 followed by 126.0% in T_2 as compared to T_9 treatment. Treatment T_7 in the Thakurgaon instance had the highest (114.79 t ha^{-1}) sugarcane equivalent yield followed by T_2 (108.69 t ha^{-1}). The scenario with the lowest (50.81 t ha^{-1}) sugarcane equivalent yield was observed in the T_9 treatment. A yield advantage of 125.9% was obtained from T_7 followed by 113.9% in T_2 as compared to T_9 treatment. It was also observed that, T_7 and T_2 treatments shows a high sugarcane equivalent yield (t/ha) in both locations (Figure 1). It is also notable that in every treatment where maize was a component crop, sugarcane equivalent yield was much higher than the sole plot of sugarcane or maize (Figure 1). Geetha *et al.* (2015) also reported similar findings.

When LER > 1 the intercropping favors the growth and yield of the species. In contrast, when LER < 1 there is no intercropping advantage and the interspecific competition is stronger than the interspecific interaction within the intercropping system (Zhang *et al.* 2011). At BSRI, T_2 had the highest (1.64) land equivalent ratio. The T_9 treatment revealed the lowest (1.00) land equivalent ratio followed by T_1 treatment (1.00) which was statistically similar to T_9 treatment. T_2 in the Thakurgaon instance had the highest (1.54) land equivalent ratio followed by T_3 (1.46) and T_4 (1.44). Just like the findings of BSRI, the T_9 treatment revealed the lowest land equivalent ratio (1.00) followed by T_1 treatment (1.00) which was statistically similar to T_9 treatment. LER was greater than 1.0 in all intercropping treatments (Table 2), indicating that intercropping of sugarcane with maize was more productive than sole cropping of each crop. Nurgi *et al.* (2023) supported these findings.

At BSRI, T_7 had the highest (1.20) area time equivalent ratio. The T_9 treatment revealed the lowest (0.49) area time equivalent ratio. Treatment T_7 in the Thakurgaon instance had the highest (1.16) area time equivalent ratio. Just like the findings of BSRI, the T_9 treatment revealed the lowest (0.41) area time equivalent ratio. In both locations, T_7 gave the maximum yield advantage of intercropping over monocropping of the component crops in the intercropping systems (Table 2). Doubi *et al.* (2016) also reported similar findings.

Evaluating the economic benefit of the intercropping system helps identify the most rewarding treatments. At BSRI, T_7 had the highest (487133 BDT h^{-1}) gross monetary value followed by T_2 (474867 BDT h^{-1}) and T_3

Table 2. Yield advantage and economics of various treatments

Treatment	BSRI				Thakurgaon			
	LER	ATER	GMV (BDT h^{-1})	MAI	LER	ATER	GMV (BDT h^{-1})	MAI
T_1	1.00e	1.00d	378000	0	1.00c	1.00b-d	412200	0
T_2	1.64a	1.13b	474867	184942	1.54a	1.07b	489100	173134
T_3	1.52b	1.04cd	439400	151587	1.46ab	0.98cd	454483	143608
T_4	1.49bc	1.03cd	433533	142643	1.44ab	0.99b-d	455800	140699
T_5	1.42cd	1.03cd	426350	127232	1.39b	1.00b-d	453950	128450
T_6	1.41d	1.01cd	420950	122602	1.40b	0.97d	439500	125954
T_7	1.56b	1.20a	487133	175178	1.52a	1.16a	516533	177542
T_8	1.38d	1.06c	395000	112012	1.38b	1.05bc	468633	129431
T_9	1.00e	0.41e	210000	0	1.00c	0.41e	228667	0
CV	0.07	0.05	-	-	0.11	0.07	-	-

Data are means of three replications. Means within a column followed by different letters are significantly different and followed by NS are not significantly (NS) different based on the least significant difference (LSD) at $P \leq 0.05$. Treatments are- T_1: Single row sugarcane only (SS), T_2: SS+ Maize (During sett placement), T_3: SS+ Maize (7 days after sett placement), T_4: SS+ Maize (14 days after sett placement), T_5: SS+ Maize (21 days after sett placement), T_6: SS+ Maize (28 days after sett placement), T_7: SS+ Maize (35 days after sett placement), T_8: SS+ Maize (42 days after sett placement), T_9: Maize (M) only. LER: Land equivalent ratio, ATER: Area time equivalent ratio, GMV: Gross monetary value, MAI: Monetary advantage index.

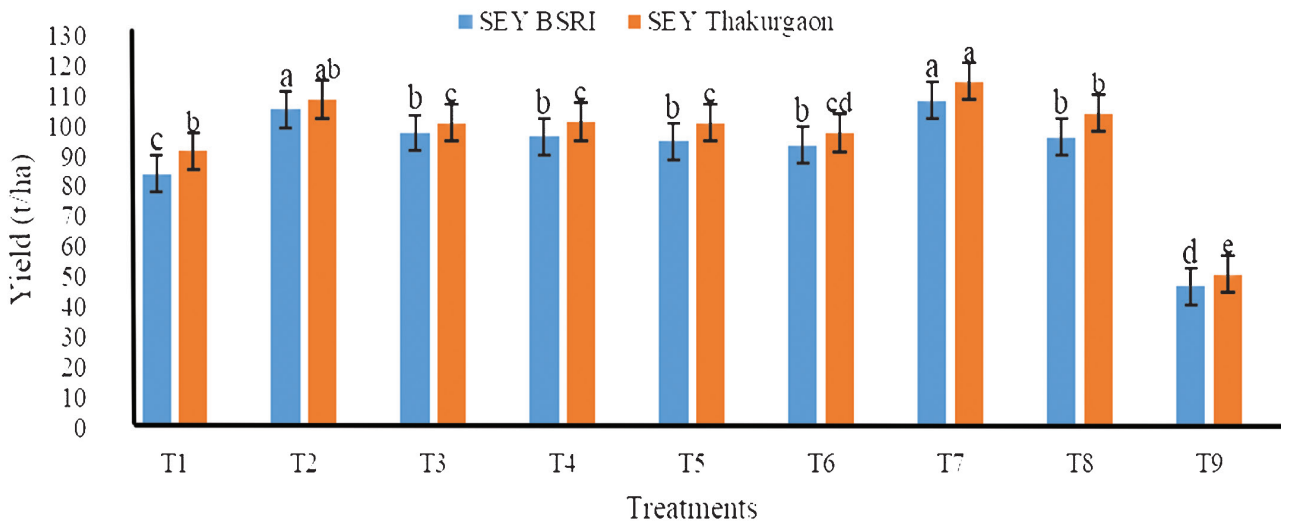


Figure 1. Effect of different treatments on sugarcane equivalent yield (SEY) in two different locations. Data are means of three replications, where error bar implies standard deviation of the values of three replications. Means within a location followed by different letters are significantly different based on the least significant difference (LSD) at $P \leq 0.05$. Treatments are- T_1: Single row sugarcane only (SS), T_2: SS+ Maize (During sett placement), T_3: SS+ Maize (7 days after sett placement), T_4: SS+ Maize (14 days after sett placement), T_5: SS+ Maize (21 days after sett placement), T_6: SS+ Maize (28 days after sett placement), T_7: SS+ Maize (35 days after sett placement), T_8: SS+ Maize (42 days after sett placement), T_9: Maize (M) only.

(439400 BDT h^{-1}), in that order. The T_9 treatment revealed the lowest (210000 BDT h^{-1}) gross monetary value. At Thakurgaon, T_7 had the highest (516533 BDT h^{-1}) gross monetary value followed by T_2 (489100 BDT h^{-1}). Just like the findings of BSRI, the T_9 treatment revealed the lowest gross monetary value (228667 BDT h^{-1}) (Table 2). In agreement with this result, Agegnehu *et al.* (2008) reported a significant difference in GMV for the maize-common bean intercropping system.

At BSRI, T_2 exhibited the highest (184942) monetary advantage index, followed by T_7 (175178) which was statistically similar to T_2. The T_9 treatment had the lowest (0) monetary advantage index, which was also found in the treatment T_1. In the case of Thakurgaon, T_7 had the highest (177542) monetary advantage index among all the treatments, followed by T_2 (173134) and T_3 (143608). The T_9 treatment had the lowest (0 monetary advantage index), which was also found in T_1 treatment. The monetary advantage index (MAI), which is an indicator of the economic feasibility of an intercropping system, was positive for all of the treatments where maize was a component crop (Table 2). A similar result was reported by Ghosh (2004) that when the land equivalent ratio is higher there is also significant economic benefit expressed with a higher effective monetary advantage index.

Conclusions

The current investigation showed that T_7 treatment was superior in terms of germination. T_1 and T_7 showed superiority in case of tiller production at both locations. However, for millable cane and cane yield, both T_1 and T_7 treatments displayed the highest performance. In contrast, T_2 and T_7 treatments resulted in more SEY, LER, ATER, GMV, and MAI. Therefore, based on agronomic performance and economics, it is concluded that growing sugarcane intercropped with maize may be a beneficial practice if the maize is sown 35 days after sugarcane sett placement (T_7) or during sugarcane sett placement (T_2).

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