Productivity and profitability of chilli as intercrop with sugarcane in different planting system

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ABSTRACT

A field experiment was conducted to evaluate the productivity and profitability of intercropped chilli with sugarcane during 2016-17 cropping season in farmers' field of Thakurgaon sugar mills area under Old Himalayan Piedmont Plain Soils (AEZ-1). The treatments were T_1: Single row cane (SRC) sole, T_2: Paired row cane (PRC) sole, T_3: SRC (75 cm)+1 line chilli, T_4: SRC (75 cm)+2 lines chilli, T_5: SRC (100 cm)+1 line chilli, T_6: SRC (100 cm)+2 lines chilli, T_7: PRC+2 lines chilli and T_8: PRC + 3 lines chilli. The sugarcane variety was Isd 37 and chilli variety was BARI morich -1. Results revealed that the highest number of tiller (166.00×10^3 ha^{-1}), millable cane (110.00×10^3 ha^{-1}), stalk height (3.35 m) and stalk diameter (2.31cm) were obtained in T_1 treatment. No significant effect was found in Brix and the highest cane yield (99.44 t ha^{-1}) was also obtained in T_1. The highest chilli yield (5.95 t ha^{-1}) was obtained from T_8 treatment and the highest equivalent cane yield of intercrop (59.09 t ha^{-1}) was found in T_6 treatment. The highest benefit cost ratio (BCR) of 2.75 was found in T_5 treatment and the lowest of 2.07 was found in T_2 treatment. Therefore, growing single row cane with chilli might be profitable for sugarcane farming in Old Himalayan Piedmont Plain Soil in Northern Region of Bangladesh.

Keywords: Benefit cost ratio,chilli, intercropping, sugarcane, yield

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is one of the most important food-cum-cash-cum-industrial crop in Bangladesh. It is the principal cash crop especially in north-western and south-western low rainfall belt of Bangladesh. Sugarcane is the raw material of sugar industry and the main source of white sugar and jaggary (locally called gur). Sugarcane is a long duration crop takes about 12-14 months from planting to harvesting which decreases economic return to the farmers compared to other crops from the same duration. To get higher economic return from sugarcane field, appropriate intercropping practices with short duration crops might be the alternative way to increase total yield, interim and higher monetary return. Intercropping is the practice of cultivating two or more crops simultaneously on the same piece of land per year (Guleria and Kumar 2016) and have many advantages over sole cropping such as enhancement of efficient use of environmental factors (e.g., light, nutrient and soil moisture) and labors, reduces the adverse effect of various biotic and abiotic stress, provides the diversity of food, generates more income, offers insurance against crop failure, higher return and total productivity per unit area (Farhad et al. 2014). The growth rate of sugarcane during its initial stages (first 90-120 days) is rather slow, with the leaf canopy providing sufficient uncovered area for growing of other crops (Shahana et al. 2019). In early stage of growth, some short duration crops viz., vegetables, pulses, oil seeds and spices can be grown as intercrop in the vacant spaces between two rows of sugarcane. In paired rows system of sugarcane planting, two rows of cane are planted at 60 cm apart in a trench leaving 120-140 cm vacant space between two paired rows of cane (Alam et al. 2008). Chilli is one of the major spices

and an important cash crop in Bangladesh. About 103381.49 ha of land of Bangladesh is under chillicultivation both Rabi (winter) and Kharif (summer) seasons. The production is about 136,872 metric tons (BBS 2017). The review of research work done so far indicated that growth of chilli as intercrops is more beneficial than growing chilli in many situations (Sadashiv 2004). Intercropping results in an increased farm income and better utilization of resources. The farming community can get inspiration and higher net returns from this system (Akhtar et al. 2010). Therefore, the present study was undertaken to examine the productivity of chilli as intercrop with sugarcane in Old Himalayan Piedmont Plain Soil.

MATERIALS AND METHODS

An experiment was conducted at farmers' field of Thakurgaon sugar mills area, Thakurgaon, Bangladesh during 2016-2017 cropping season under irrigated condition. The site represents the Old Himalayan Piedmont Plain Soils (Agro Ecological Zone 1) with medium high land of typical sandy loam soil having pH 5.5. Chilli as intercrop was grown with single and paired row sugarcane. The sugarcane variety was Isd 37. The experiment was laid out in a randomized complete block design with three replications where the unit plot size was 8m × 6m. The treatments were T_1: Single row cane (SRC) sole, T_2: Paired row cane (PRC) sole, T_3: SRC (75 cm) + 1 line chilli, T_4: SRC (75 cm) + 2 lines chilli, T_5: SRC (100 cm) + 1 line chilli, T_6: SRC (100 cm) + 2 lines chilli, T_7: PRC + 2 lines chilli and T_8: PRC + 3 lines chilli. Two budded sugarcane setts were planted in each plot on 15th November 2016. For the fertilizer requirements of sugarcane, Urea, TSP, MoP, Gypsum and $ZnSo_4$ were applied @ 358, 275, 240, 188 and 7kg ha^{-1}, respectively. Full quantity of TSP, Gypsum, $ZnSO_4$, 1/3rd of urea and 1/3rd of MoP were applied in trench. The second dose of Urea (1/3rd) and MoP (1/3rd) were applied as first top dressing at 90 DAT and final top dressing was done with the rest amount of Urea and MoP at 150 DAT. Fertilizers were applied for chilli as intercrop separately. For chilli, management practices, like thinning for once at 4-5 leaf stage, hoeing, weeding, irrigation and other intercultural operations were done timely as needed. Nitro 505 EC (0.1%) was sprayed twice at15 days interval starting from 120 days after planting (DAP). To control hairy caterpillar, soon after infestation, the larvae were destructed by hand. Ten plants were randomly harvested from each plot at 150 DAS to determine yield and yield attributes. Chilli yield (t ha^{-1}) was recorded at the time of harvest. For sugarcane, to control termite, Regent 3 GR (chlorpyrifos) was applied @ 33 kg ha^{-1} during planting and Furadan

5G (carbofuran) was applied @ 40 kg ha^{-1} in two times in the month of March and May 2016. Intercultural operations like irrigation, gap filling, weeding, mulching, earthing-up, tying and cross tying were done in time and as needed. Cultural operations for chilli were also done as and when required. Yield data of chilli were collected at harvest i.e. after five months of planting. Tiller population of sugarcane was recorded at 150 DAT. Stalk height, stalk diameter, millable cane, brix(%) and cane yield were recorded at harvest.

Statistical analysis: Fisher's analysis of variance (ANOVA) was used for statistical analysis of collected data and for comparison of differences among treatment means. Least significant difference (LSD) test was done at 5% level of probability (Steel et al. 1996). Statistix 10 (Tallahassee FL 32317) was used for the determination of statistical differences.

Equivalent cane yield of intercrops: Yield of intercrop was converted into equivalent cane yield (ECY) on the basis of prevailing market price and calculated by the following formula (Laland Ray 1976, Verma and Modgal 1983, Bandyopadhyay 1984).

$$\text{Equivalent cane yield of intercrops (ECY)} = \frac{\text{Yis x Ps}}{\text{PS}}$$

where,

$\quad$ Yis $\quad$ = Yield of chilli intercrop (t ha^{-1})
$\quad$ Ps $\quad$ = Selling price of chilli
$\quad$ PS $\quad$ = Selling price of sugarcane

Adjusted cane yield (ACY): Adjusted cane yield was calculated by adding equivalent cane yield of intercrops with the yield of sugarcane.

Adjusted cane yield (ACY) = ECY + SY

where,

$\quad$ ECY = Equivalent cane yield of intercrop
$\quad$ SY $\quad$ = Sugarcane yield

Benefit cost ratio (BCR): Benefit cost ratio was calculated by the following formula (CIMMYT 1988).

$$\text{BCR} = \frac{\text{Gross return (Tk.)}}{\text{Total production cost (Tk.)}}$$

RESULTS AND DISCUSSION

Tiller and millable cane production: Tiller is an important factor of sugarcane production. Chilli intercropping with single row and paired row sugarcane affected significantly the tiller production of sugarcane. The highest number of tillers of 166.00×10^3

ha^{-1} was obtained in T_1 treatment which was statistically similar (156.67 × 10^3 ha^{-1}) with treatment T_3 and the lowest of 120.33 × 10^3 ha^{-1} was found in T_7 (Table 1). The results are in agreement with the findings of (Islam et al. 2016) when sugarbeet was intercropped with sugarcane. Millable cane production was affected significantly by chilli intercropping with sugarcane. The highest number of millable cane of 110.00×10^3 ha^{-1} was produced in T_1 treatment and the lowest of 69.67×10^{3}ha^{-1} was in T_8 treatment (Table 1). Similar result was found by Islamet al. (2017). They found that millable cane higher in sole sugarcane than sugarbeet intercropping.

Stalk height, diameter and Brix (%): Significant effect was observed in stalk height of sugarcane with chilli intercropping (Table 2). The highest stalk height (3.35 m) was obtained in T_1 treatment and the lowest stalk height (3.18 m) was obtained in T_8 treatment.A significant variation was found on stalk diameter of sugarcane also. The highest stalk diameter (2.31cm) was recorded in T_7 treatment and the lowest of 2.16 cm

recorded in T_3 treatment (Table 2). Brix readings have been shown in Table 2. Brix (%) was not differed significantly among the treatments. Range of the brix (%) 21.33-20.26). The highest brix % (21.23) was obtained in the treatments T_1. The lowest brix (%) (20.26) and (18.95) were obtained from the treatment T_6. Similar result was found by Karim et al. (2014).

Yield of sugarcane and chilli as intercrop: It was observed that significantly the highest cane yield of 99.44 t ha^{-1} was obtained in T_1 treatment followed by T_2 (88.34 t ha^{-1}) and T_5 (85.54 t ha^{-1}) treatments. The lowest cane yield (67.75 t ha^{-1}) was obtained from treatment T_8 (Table 1). The results were reported by Karim et al. (2014). They reported that sole sugarcane gave the higher yield than chilli intercropping. Significant effect on chilli yield was observed when it was grown with sugarcane under different treatment combinations. The highest chilli yield of 5.94 t ha^{-1} was obtained in T_7 treatment and the lowest yield of 3.85 t ha^{-1} was obtained in T_5 treatment (Table 2). The similar findings were agreements with Karim et al. (2014).

Table 1. Number of tiller, number of millable cane and cane yield as affected by chilli intercropping with sugarcane

Treatments	Tiller(×10^{3}ha^{-1})	Millable cane(×10^{3}ha^{-1})	Cane yield(t ha^{-1})
T_1	166.00 a	110.00 a	99.44 a
T_2	150.00 bc	85.67 c	88.34 b
T_3	156.67 ab	73.33 ef	77.00 c
T_4	135.33 de	70.67 f	70.66 d
T_5	146.00 bcd	92.00 b	85.54 b
T_6	136.33 cd	79.33 d	69.96 e
T_7	120.33 f	77.00 de	75.94 cd
T_8	122.00 ef	69.67 f	67.75 e
LSD (0.05)	14.08	5.88	5.38

Within column values followed by different letter (s) are significantly different by DMRT at 5% level of probability.

Table 2. Brix (%), stalk height, stalk diameter and intercrop yield as affected by chilli intercropping with sugarcane

Treatments	Brix (%)	Stalk height (m)	Stalk diameter (cm)	Intercrop yield(t ha^{-1})
T_1	21.23	3.35 a	2.24 ab	-
T_2	20.83	3.33 ab	2.19 bcd	-
T_3	21.13	3.28 abc	2.16 d	4.10 c
T_4	20.83	3.25 abc	2.17 cd	4.81 b
T_5	21.00	3.23 abc	2.31 a	3.85 c
T_6	21.00	3.22 abc	2.27 a	4.87 b
T_7	20.66	3.20 bc	2.20 bcd	5.94 a
T_8	20.26	3.18 c	2.23 bc	5.15 b
LSD (0.05)	NS	0.14	0.06	0.56

Within column values followed by different letter (s) are significantly different by DMRT at 5% level of probability.

(Table 3). The similar findings were agreement with

Equivalent cane yield of intercrop and Total adjusted cane yield: The highest equivalent cane yield of intercrop (59.09 t ha^{-1}) was found in T_6 treatment and the lowest equivalent cane yield of 44.18 t ha^{-1} found in T_5

Islam et al. (2016). Total adjusted cane yields have been shown in table 3. The highest total adjusted cane yield was recorded from the treatment T_4 (132.74 t ha^{-1}) and

the lowest (88.33 t ha^{-1}) from the treatment T$_2$.

Economics of intercropping: The economic analysis of the experiment under different treatments is shown in Table 4. Among the different treatments total production cost of 1,61,000.00 Tk. ha^{-1} was the highest in T$_8$ (PRC +

chilli (3 lines) treatment and the lowest of 1,20,000.00 Tk. ha^{-1} in T$_1$ (SRC only) treatment. The highest gross return of 4,02,067.00 Tk. ha^{-1} was achieved in T$_7$: PRC + chilli (2 lines) treatment and the lowest of 2,69,437.00 Tk. ha^{-1} in T$_2$ (PRC sole) treatment. The highest gross

Table 3. Cane yield, intercrop yield, equivalent cane yield of intercrop and total adjusted cane yield as affected by chilli intercropping with sugarcane

Treatments	Cane yield(t ha^{-1})	Intercrop yield(t ha^{-1})	Eq. cane yield of intercrop (t ha^{-1})	Total ad. cane yield (t ha^{-1})
T$_1$	99.44	-	-	99.44
T$_2$	88.34	-	-	88.33
T$_3$	77.00	4.10	47.05	124.05
T$_4$	70.66	4.81	55.08	132.74
T$_5$	85.54	3.85	44.18	129.72
T$_6$	69.96	4.87	48.43	118.19
T$_7$	75.94	5.94	55.89	131.83
T$_8$	67.75	5.15	59.09	126.85

Sugarcane price : 3,050.00 Tk. t^{-1} , Chilli price: 35 Tk. kg^{-1}

Table 4. Production cost, gross return, net return and benefit cost ratio (BCR) of chilli intercropping with sugarcane

Treatments	Cost of production (Tk.ha^{-1})	Gross return (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})	BCR
T$_1$	1,20,000.00	3,03,292.00	1,83,292.00	2.53
T$_2$	1,30,000.00	2,69,437.00	1,39,376.00	2.07
T$_3$	1,45,000.00	3,78,350.00	2,33,350.00	2.61
T$_4$	1,48,000.00	3,83,513.00	2,35,513.00	2.59
T$_5$	1,44,000.00	3,95,647.00	2,51,647.00	2.75
T$_6$	1,47,000.00	3,61,078.00	2,14,078.00	2.44
T$_7$	1,58,000.00	4,02,067.00	2,44,067.00	2.54
T$_8$	1,61,000.00	3,86,918.00	2,25,918.00	2.40

Sugarcane price: 3,050.00 Tk. t^{-1}, Chilli price: 35 Tk. kg^{-1}

margin of 2,51,647.00 Tk. ha^{-1} was obtained in T$_5$: SRC (100 cm) + chilli (1 line) treatment and the lowest gross margin of 1,39,376.00Tk.ha^{-1} in T$_2$ (PRC cane sole) treatment. The highest benefit cost ratio (BCR) of 2.75 was found in T$_5$: SRC (100 cm) + chilli (1 line) treatment and the lowest of 2.07 was found in T$_2$ (PRC sole) treatment. The cost and return are in agreement with the economic analysis Islam et al. (2017) when sugarcane was intercropped with sugarbeet.

CONCLUSION

It is concluded that growing single row cane with one-line chilli would be profitable, and it could be remunerative package technologies for the sugarcane farmers in Old Himalayan Piedmont Plain Soil especially in Northern region of Bangladesh.

REFERENCES

Akhtar M, Yaqub M, Iqbal Z, Ashraf MY, Akhter J and Hussain F. 2010. Improvement in yield and nutrient uptake by co-cropping of wheat and chickpea. Pakistan Journal of Botany. 42: 4043–4049.

Alam MJ, Hossain MS, Islam AKMR, Rahman MK and Kabir ML. 2008. Performance of jute varieties for seed production as first and mungbean as second intercrop under transplanted cane in paired row. Bangladesh Journal of Sugarcane. 30: 116-121.

Bandyopadhyay SN. 1984. Nitrogen and water relations in grain sorghum-legume intercropping systems. Ph.D. Dissertation, Indian Agricultural Research Institute, New Delhi.

BBS (Bangladesh Bureau of Statistics). 2017.

Agricultural Statistical Yearbook of Bangladesh. Statistics Division, Bangladesh Bureau of Statistics. Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.

CIMMYT. 1988. From Agronomic Data to Farmers Recommendations: An Economics Training Manual. Completely revised edition. Mexico.D.F. pp. 31-45.

Farhad, ISM, Chowdhury MMU, Bhowal SK, Choudhury AK and Khan ASMMR. 2014. Chilli - Garlic intercropping system in coastal saline area. Applied Science Report. 6(2): 47-50.

Guleria G and Kumar N. 2016. Sowing methods and varying seed rates of cowpea on production potential of sorghum, sudan grass hybrid and cowpea: A review. Agricultural Reviews. 37: 290-299.

Islam AKMR, Razzak MA, Sohel MAT, Roy HP and Islam N. 2016. Intercropping Tropical Sugarbeet Varieties with Sugarcane in Different Planting Geometry. Bangladesh Journal of Sugarcane. 37: 1-9.

Islam MS, Hossain MS, Alam MJ, Rashid MM and Habib MA. 2017. Productivity of Tropical sugarbeet as intercrop with sugarcane in old Himalayan piedmont plain soil. Bangladesh Journal of Sugarcane. 38: 109-118.

Karim SMR, Razzak MA, Kashem MN, Islam S and Rahman MH. 2014. Paired row system of sugarcane cultivation with chilli as intercrop under Tista Meander Flood Plain soils. Bangladesh Journal of Sugarcane. 35: 102-1107.

Lal RB and Ray S. 1976. Economics of crop production of different intensities. Indian Journal of Agricultural Sciences. 46: 93-96.

Sadashiv B. 2004. Production potential of hybrid cotton (*Gossypiumhirsutum*) based vegetable intercropping systems under irrigation. M.S. thesis, University of Agricultural Sciences.Dharwad, India.

Shahana F, Bharati Y and Joseph B. 2019. Identification of profitable intercrops in summer sugarcane in NTZ. Journal of Pharmacognosy and Phytochemistry.8(5): 1602-1604.

Steel RGD, Torrie JH and Dicky DA. 1996. Principles and Procedures of Statistics, A Biometrical Approach, 3rd ed.; McGraw Hill, Inc. Book Co.: New York, NY, USA.

Verma SP. and Modgal SC. 1983. Production potential and economics of fertilizer application as resource constraint in maize-wheat crop sequence. Himachal Pradesh Journal of Agricultural Research. 9: 89-92.