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Intercropping Tropical Sugarbeet Varieties with Sugarcane in Different Planting Geometry

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ABSTRACT

A field trials were carried out at the Bangladesh Sugarcrop Research Institute (BSRI) farm, Ishurdi, Pabna to study the impact of intercropping sugarbeet with sugarcane in different planting geometry. For this purpose two tropical sugarbeet varieties viz. CS 0328 and Cauvery and with two planting geometry i.e single row cane (SRC) and paired row cane (PRC) planting systems were included in the trial. Sugarbeet seeds were sown in one line in SRC and three lines in PRC respectively in between two paired rows of cane. Among the treatment combinations the highest root yield and Brix % were found in paired row cane (PRC) planting systems 61.42 t ha^{-1} and 19.80 respectively. In case of cane yield sole crop of sugarcane exhibited the highest average cane yield i.e 100.07 with 14.05 pol % cane. All the treatments showed higher benefit cost ratio (BCR) than the sole cane crop. Sugarbeet intercropping with paired rows cane could be considered as a technology for sustainable sugarcane farming maintaining soil health and also maximum achievable production potential of both crops on the same unit area.

Key words: Intercropping, sugarbeet, sugarcane, planting system

INTRODUCTION

Sugarbeet (*Beta vulgaris* L.) belongs to the family *Chenopodiaceae*, is considered as the second important sugarcrop all over the world after sugarcane (*Saccharum officinarum* L.) It is grown in about 57 countries. Sugarbeet is mainly produced in Europe and to a lesser extent, in Asia and North America (Kumar and Pathak, 2013) and generally considered as a crop of temperate region, is spreading to subtropical countries where it can be grown successfully during winter season. It is having growth period of near about half of sugarcane but productivity per unit area is higher and requires less water than sugarcane. Many environmental and agronomic factors influence sugarbeet yield and quality. For successful production of sugarbeet under subtropical environmental conditions there is need to evaluate the performance of different varieties as intercropping with sugarcane. It contributes about 21.8 % of world sugar (Anonymous 2013). It is a biennial halophytic as well as Na- salts scavenger C3 plant containing up to 20 % sugar on fresh weight basis. The storage organ of this plant is usually called the root, of which 90% is actually root derived and the remaining 10% (the crown) is derived from the hypocotyls (Shrivastava *et al*, 2013). Composition wise, a freshly harvested sugarbeet root contains 75-76% water, 15-20 % sugars, 2.6% non-sugars and 4-6 % pulp. Processing one ton of fresh sugarbeet roots yields 121 kg sugar,

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38 kg molasses (containing 18.2 kg sugar, 12.1 kg impurities and 7.8 kg water) and 50 kg of pulp.

Sugarcane (*Saccharum officinarum* L.) is one of the major food-cum-industrial cash crops in Bangladesh and cultivated in about more than 90 countries of the tropical and sub-tropical regions of the world (FAO, 2011). Sugarcane occupies an area of 23.82 million hectares with a total production of 1685.44 million metric tons (FAO, 2012). In Bangladesh, on an average 4.5 million metric tons of sugarcane is produced annually from 0.12 million hectares of land (FAOSTAT, 2012). Sugarcane is mainly grown in high and medium high land under rainfed conditions in the north-west and south-west regions of the country. The world average yield of sugarcane is 70.76 t ha^{-1} while in Bangladesh it is about 44 t ha^{-1} (BBS, 2010). Sugarcane cultivation fetches less benefit compared to other short duration fruit and vegetable crops like papaya, banana, tomato, cabbage and cauliflower. Because of this, sugarcane is being replaced by different profitable short duration crops. Conventionally sugarcane setts are planted in trenches made at 90-100 cm distances. In many cases, plant population establishment is hampered in this system. To overcome this problem and to ensure plant establishment the system of settling planting at specified distances in the trenches has been developed. The transplanting of cane ensures optimum plant establishment. The initial crop growth of the crop is slow and thus inter row spaces is not covered by sugarcane leaf canopy for the first 120-150 days. The vacant space can be used for intercrop cultivation. 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. The intercropping offers an opportunity of increasing land utilization. The traditional intercropping with single row sugarcane is less remunerative as the growth and yield of both the component crops are not satisfactory. Successful intercropping of various crops with sugarcane has been reported by many researchers (Alam *et al.*, 2007 and Alam *et al.*, 2008). It has been reported that potato, onion, garlic and cabbage could be cultivated profitably as first intercrops with sugarcane (Matin *et al.*, 2001).

Intercropping also increases nutritional quality of diet for the farm family (Khan *et al.*, 2005), allows better control of weeds, increases land equivalent ratio (Imran *et al.*, 2011). In an intercrop community, the individual plant of one crop exposed to both intra and inter-specific competition although causing a reduction in individual yield but total productivity per unit area increases (Gani and Paul, 2005). Sugarbeet is relatively a new sugarcrop and seems promising for its short duration. The intercropping of sugarbeet with sugarcane can be a good option for raising total yield and productivity of the system through optimum land utilization. The information of varietal performance regarding growth, yield and quality of sugarbeet under intercropping with sugarcane is limited. Therefore, the present study was undertaken to find out growth, yield, quality and economics of sugarbeet intercropping in single and paired rows sugarcane.

MATERIALS AND METHODS

The experiment was conducted at the Bangladesh Sugarcane Research Institute (BSRI) farm, Ishurdi, Pabna during 2012-2013 and 2013-2014 cropping seasons. The experimental plot represents High Ganges River Floodplain under Agro-Ecological Zone 11 with medium high land of typical sandy loam soil. The experiment was set up in randomized complete block design with three replications. The unit plot size was 8m × 8m. The treatments were as follows:

T_1 – Single rows cane (SRC) only
T_2 – Paired rows cane (PRC) only
T_3 - SRC + Beet 1 (CS 0328) -1 line
T_4 - SRC + Beet 6 (Cauvery) -1 line
T_5 - PRC + Beet 1 (CS 0328) - 3 lines
T_6 - PRC + Beet 6 (Cauvery) - 3 lines

Two budded setts of sugarcane (Isd 39) were planted on 1st November 2012 and 04 November 2013 following end to end method in single row system that is 100 cm distance between two rows and 60 cm apart paired rows maintaining 45 cm interplant spacing. For sugarcane fertilizers were applied following the recommended rates (BARC, 2012) of Urea, TSP, MOP Gypsum and $ZnSO_4$ @ 206, 127, 160, 90 and 4 kg ha^{-1}, respectively. All amounts of TSP, Gypsum, $ZnSO_4$ and one-third MOP were applied in trench and mixed with soil prior to planting of setts. One-third urea was applied at 21 days after planting (DAT) of setts. The remaining in two equal split at 90 and 150 days after planting. Recommended fertilizers also were applied for the sugarbeet as intercrop. After land preparation in the experiments, Mustard Oil Cake, Urea, TSP, MOP, Gypsum, ZnSO4, Boric acid were applied at the rate of 450 kg, 120 kg, 105 kg, 150 kg, 35 kg, 2.5 kg and 1.2 kg ha^{-1} (Anonymous. 2005). Total MOC was applied at the time of final land preparation. All TSP, 1/ 3 MOP and 1/3 Urea, Gypsum, Zinc sulphate, Boric acid were applied in the line before ridge preparation. Rest amount of Urea and MOP was applied in two installments at 30 and 60 days after sowing. Then the plots were prepared and layout was made. Then manual sowing of seed of sugarbeet varieties was carried out and seeds were sown on light ridge soil at 3-4 cm depth. The distance between two ridges was 50 cm and seed to seed distance was 20 cm. Management practices, like thinning for once at 4-5 leaf stage, hoeing five times, weeding, irrigation and other intercultural operations were done timely. Pheromone trap (*Spodoptera pheromone*) was placed in the field to trap male insect. Parasitoid insect (*Bracon hebetor*) was also released in the field to control *Spodoptera litura*. To control *Spodoptera litura* (a Lepidopterous insect), an integrated approach was rendered. Nitro 505 EC (0.1%) was sprayed twice at 7 days interval. To control hairy caterpillar, soon after infestation, the larvae were destructed by hand. Ten plants were randomly harvested from each at 165 (five and half months) days after sowing to determine yield and yield attributes. Data regarding germination percentage, beet weight (gm), beet yield (t ha^{-1}) and beet brix % were counted. Germination (%) was recorded thirty days after planting, while, beet yield (t ha^{-1}) and beet brix % were recorded at the time of harvest. The total soluble solids in the extract (brix%) were measured with the help of refractometer. Generated data were compiled and analyzed properly using statistica 10 software. Treatment means were judged with LSD at 5% level of probability.

RESULTS AND DISCUSSION

Effects on Germination (%)

Tested two tropical sugarbeet genotypes showed a good germination percentage (Table 1). There is no any sign of abnormal growth was observed. The highest germination (93.14%) was found in variety Cauvery in three lines with PRC which is similar with variety CS 0328 -1 line with SRC (92.85%). The lowest germination was found in variety (CS 0328) - 3 lines with PRC (86.53 %).

Table 1. Performance of sugarbeet as intercrop with Sugarcane

Treatments	Germination (%)	Sugarbeet yield (t ha^{-1})	Brix %
T_1 : Single row cane (SRC) only	-	-	-
T_2 : Paired row cane (PRC) only	-	-	-
T_3 : SRC + Beet 1 (CS 0328) -1 line	92.85 a	54.19 b	19.83 ab
T_4 : SRC + Beet 6 (Cauvery) -1 line	89.98 ab	54.51 b	19.70 ab
T_5 : PRC + Beet 1 (CS 0328) - 3 lines	86.53 c	55.74 b	19.73 ab
T_6 : PRC + Beet 6 (Cauvery) - 3 lines	93.14 a	61.42 a	19.80 a
LSD (0.05)	4.00	4.28	0.97

Sugarbeet yield (intercrop) with sugarcane

It is evident from table 1 that the sugarbeet yield was significantly different in different planting systems. In paired row system sugarbeet yield was relatively higher compare to single row system. The highest sugarbeet yield of 61.42 t ha^{-1} was recorded Cauvery when three lines of sugarbeet was planted in 140 cm vacant spaced of paired row sugarcane. In case of single row system both sugarbeet varieties showed statistically similar beet yield.

Brix % of sugarbeet

Regarding sugar contents (Brix %), a significant difference was found among varieties/genotype (Table 1). Cauvery contains more sugar than CS 0328. The highest Brix % was observed in Cauvery (19.80 %) in paired row system followed by SRC and variety Cauvery planted in single row sugarcane.

Number of tiller ('000 ha^{-1})

The results shown in Table 2 revealed that the highest (144.73 × 10^3 ha^{-1}) number of tillers was found in treatment T_1 (single row cane only) followed by T_2 (136.85 × 10^3 ha^{-1}) and T_4 (134.92 × 10^3 ha^{-1}). The lowest (110 × 10^3 ha^{-1}) number of tillers was found in T_3 where one line of sugarbeet (line CS 0328) was intercropped with single row sugarcane.

Single rows cane (SRC) only

Paired rows cane (PRC) only

SRC + Beet 1 (CS 0328) -1 line

SRC + Beet 6 (Cauvery) -1 line

PRC + Beet 1 (CS 0328) - 3 lines

PRC + Beet 6 (Cauvery) - 3 lines

Figure 1. Field view of sugarbeet intercrop

Number of Millable cane ('000 ha^{-1})

The millable cane was significantly higher in both control treatments (single and paired row cane only) and the treatment T_4 (SRC + Cauvery). The lowest number of millable cane (80.08 × 10^3 ha^{-1}) was found in the treatment T_5 where CS 0328 was intercropped with paired row sugarcane (Table 2).

Table 2. Number of tillers and millable cane, cane yield, pol% and adjusted cane yield of sugarcane as sugarbeet intercropping under different planting geometry

Treatments	Tiller ($\times 10^3$ ha^{-1})	Millable cane ($\times 10^3$ ha^{-1})	Yield (tha^{-1})	Pol %	Cane equivalent yield (tha^{-1})
T_1 : Single row cane (SRC) only	144.73 a	102.50 a	100.07 a	14.05	100.07
T_2 : Paired row cane (PRC) only	136.85 ab	100.64 a	95.07 a	13.35	95.07
T_3 : SRC + Beet 1 (CS 0328) -1 line	110.0 c	85.33 b	84.03 b	13.50	149.06
T_4 : SRC + Beet 6 (Cauvery) -1 line	134.92 ab	96.33 a	92.52 a	13.45	157.93
T_5 : PRC + Beet 1 (CS 0328) - 3 lines	112.55 b	80.08 c	76.25 b	13.83	143.14
T_6 : PRC + Beet 6 (Cauvery) - 3 lines	112.27 bc	82.61 bc	75.63 b	13.47	149.34
LSD (0.05)	32.17	10.77	12.51	NS	-

Price: Sugarcane: 2500 Tk. t^{-1} and Sugarbeet 3000 Tk. t^{-1} (Assume).

Pol % cane

The pol % of cane among different intercrops combinations was found non-significant (Table 2). Intercropping has no adverse effect on sugar content of cane. The highest pol % (14.05) was found in T_1 (single row cane only) followed by T_5 (PRC + 3 lines CS 0328) treatment (13.83 %). Islam *et al.* (2013) also noted that there is no significant effect of intercropping on sugar content of sugarcane.

Sugarcane and Cane equivalent yield (tha^{-1})

Results shown in table 2 revealed that the highest cane yield (100.07 tha^{-1}) was found in T_1 (Single row cane only) which was statistically similar with T_2 i.e. paired row cane only (95.07 tha^{-1}) and T_4 (92.52 tha^{-1}) where one line of sugarbeet (Cauvery) was intercropped with single row cane. The lowest cane yield was found in T_6 (75.63 tha^{-1}) where three lines of sugarbeet (Cauvery) was intercropped with paired row sugarcane

which was statistically similar with T_3 and T_5. By adjusting intercrop yield with sugarcane the highest (157.93 tha^{-1}) adjusted cane yield was found in T_4 where one line of sugarbeet (Cauvery) was intercropped with single row sugarcane followed by T_6 (PRC + 3 lines Cauvery).

Table 3. Economic analysis of sugarbeet intercropping with single and paired row sugarcane

Treatments	Total cost (Tk. ha^{-1})	Gross return (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	Benefit cost ratio (BCR)
T_1 : Single row cane (SRC) only	90,000	2,50,175	1,60,175	2.78
T_2 : Paired row cane (PRC) only	93,000	2,37,675	1,44,675	2.56
T_3 : SRC + Beet 1 (CS 0328) -1 line	1,10,000	3,72,650	2,62,650	3.38
T_4 : SRC + Beet 6 (Cauvery) -1 line	1,10,000	3,93,825	2,83,825	3.58
T_5 : PRC + Beet 1 (CS 0328) - 3 lines	1,15,000	3,57,850	2,42,850	3.11
T_6 : PRC + Beet 6 (Cauvery) - 3 lines	1,15,000	3,73,350	2,58,350	3.25

Economic performance of sugarbeet intercropping following different planting geometry is presented in table 3. Results revealed that the highest gross return (3,93,825 Tk. ha^{-1}), gross margin (2,83,825 Tk. ha^{-1}) and BCR (3.58) was recorded from T_4 (SRC + 1 line Cauvery) followed by the treatment T_3 (SRC + 1 line CS 0328). The lowest economic return (BCR 2.56) was recorded from T_2 (Paired row cane only). So, one line sugarbeet of the tested variety/line intercropped with single row sugarcane were found economically superior to other treatments.

From the above results it is concluded that sugarcane – sugarbeet intercropping system is feasible and acceptable to the growers due to higher production and economic return.

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