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Productivity of Soybean-Mungbean Sequential Intercropping with Paired Rows Transplanted Sugarcane

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ABSTRACT

An experiment was conducted at the Bangladesh Sugarcrop Research Institute (BSRI) farm, Ishurdi, Pabna during the cropping year 2008-2009 and 2009-2010 to find out the best soybean variety in soybean-mungbean sequential intercropping in paired rows transplanted sugarcane. Soybean varieties such as Sohag, BARI Soybean 5 and Bangladesh Soybean 4 were used as intercrop. Paired rows cane+onion-mungbean treatment was used as standard check. Results revealed that sequential intercropping practices did not affect sugarcane yield and juice quality. All the sequential intercropping treatments showed higher benefit cost ratio than the sole cane crop. Soybean variety Sohag and mungbean variety BINA mung 5 performed better in respect of yield, yield contributing characters and economic return. Practicing sequential intercropping improved soil organic matter, total N content, available P, available S and Zn content in soil compared to sole cane crop. Mungbean can be grown for green manuring but not for grain as second intercrop after soybean. Mungbean based sequential intercropping with paired rows transplanted sugarcane could be considered as a profitable combination for sustaining sugarcane production and maintaining soil fertility.

Key words: Productivity, sugarcane, paired rows cane, intercropping, soybean

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is one of the major food-cum-industrial cash crops in Bangladesh. On an average 4.5 million metric tons of sugarcane is produced annually from 0.12 million hectares of land in Bangladesh (FAOSTAT, 2012). It is mostly grown in the north-west and south-west regions of the country especially in the greater districts of Jessore, Kushtia, Pabna, Rajshahi, Bogra, Rangpur, Dinajpur and Faridpur and in some pockets of greater districts of Mymensingh, Dhaka, Noakhali, Sylhet, Comilla, Chittagong, Khulna and Barisal. The world average yield of sugarcane is 70.76 tha^{-1} while in Bangladesh it is around 44 tha^{-1} (BBS, 2010).

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Conventionally sugarcane setts are planted in trench made at 90-100 cm distances. In many cases, plant population establishment is hampered in this system. To overcome this situation and ensure plant establishment the system of settling planting at specified distance in the trench has been developed. The transplanting of cane ensures optimum plant establishment. The initial growth of this crop is slow and thus inter-row spaces are 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. Under this situation, paired rows system of cane cultivation has been developed that unveils the potential of practicing intercropping with sugarcane with high profit. In paired rows system of sugarcane planting, two rows of cane are planted at 60 cm apart rows in a trench leaving 120-140 cm vacant space between two paired rows of cane (Alam *et al.*, 2008). The paired rows planting patterns are very easy to adopt and no modifications are necessary in the existing implements (Umrani, 1981). More than one intercrops in sequence can be easily cultivated with paired rows system to make sugarcane cultivation more profitable (Alam *et al.*, 2007). Successful intercropping of various crops with sugarcane has been reported by many researchers (Islam *et al.*, 2009; Alam *et al.*, 2007; 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). Besides, after harvesting of first intercrop, the possibility of growing some short duration crops such as leafy vegetables, mungbean and dhaincha successfully as second intercrop with sugarcane has been explored. Many reports suggest that mungbean can be used as second intercrop (Hossain *et al.*, 1995). The possibility of growing a second intercrop under single row system of cane plantation is restricted due to canopy development of cane after the harvest of first intercrop. On the other hand, sequential intercropping in paired rows sugarcane is feasible (De and Singh, 1979).

Hossain *et al.* (1995) stated that soybean has been emerged as a potential intercrop among the leguminous crops. It contains 40-45% protein and 20-22% oil and produces about 3.5 to 4.5 tha^{-1} biomass which may be incorporated in the soil to partially replenish the depleted soil organic matter. The crop is also capable of fixing atmospheric nitrogen through nitrogen fixing bacteria available in their nodules. They also added that under paired rows planting system of sugarcane, the highest sugarcane yield (86.2 tha^{-1}) was obtained where soybean was first intercrop followed by *Sesbania rostrata* as second intercrop. The highest net return of Tk. 10,400 was obtained from soybean intercropping while the lowest of Tk. 1,000 only was from peanut in paired rows system. It is further observed that the level of intercrop yield (soybean) was increased in paired rows system compared to the single row system.

Bangladesh is an over populated country with a limited land area where land holding size is very small. Farmers with small land holding size are not in a position to grow long duration crops like sugarcane because of its less economic return. Due to

higher demand of cereals and other short duration high value crops farmers are switching over to grow other crops instead of sugarcane and thus acreage of sugarcane is being decreased at the face of huge demand of sugar and *goor*. So, there is a need to develop such agronomic options that could help sugarcane cultivation remunerative and beneficial to improve soil health. Intercropping with sugarcane can be such an agronomic tool to achieve these goals. But the research on sequential intercropping with sugarcane is highly inadequate and inconclusive. Therefore, the present study was undertaken to find out the best soybean variety on growth, yield and quality in soybean-mungbean sequential intercropping with paired rows transplanted sugarcane for sustainable cane cultivation.

MATERIALS AND METHODS

The experiment was conducted at the Bangladesh Sugarcrop Research Institute (BSRI) farm, Ishurdi, Pabna during 2008-2009 and 2009-2010 cropping seasons. The site represents High Ganges River Floodplain under Agro-Ecological Zone 11 with medium high land of typical sandy loam soil. Sohag, BARI Soybean 5 and Bangladesh Soybean 4 were used as soybean (*Glycine max* L.) varieties. The experiment was set up in randomized complete block design with four replications. The unit plot size was 8m × 8m. The treatments were as follows:

T_1 - Paired rows cane (PRC) only
T_2 - PRC + onion - BINA Mung 5 (standard)
T_3 - PRC + Sohag - BINA Mung 5
T_4 - PRC + BARI Soybean 5 - BINA Mung 5
T_5 - PRC + Bangladesh Soybean 4 - BINA Mung 5

Forty five days old sugarcane settlings of variety Isd 38 were transplanted at 45 cm inter-plant spaces on well prepared trenches in paired rows on 25 November 2008 and 08 November 2009 in 2008-2009 and 2009-2010 cropping seasons, respectively. The trenches were made by paired rows trencher at 140cm distance. Soybean seeds were sown in 3 rows (30 cm apart) continuously in the space between two paired rows of cane. The first intercrops (onion and soybean) were sown on 26 November 2008 and 24 November 2009 for 2008-2009 and 2009-2010 cropping seasons, respectively. The second intercrop BINA Mung 5 was sown on 10 March 2008 and 08 March 2010 in 2008-2009 and 2009-2010 cropping seasons, respectively. Sole crop of all first and second intercrops were sown in one side of the main field with three replications in the same day. The seed rates of soybean were 15.0 kg and 22.0 kg ha^{-1} for intercrop and sole crop, respectively.

For sugarcane and intercrops, fertilizers were applied following the recommended rates (BARC, 2005). N, P, K, S and Zn were applied in sugarcane @ 150, 50, 90, 34 and 3.5 kg ha^{-1}, respectively while N, P, K, S, Zn and B were applied @ 75, 30, 75, 30, 3 and 0.6 kg ha^{-1} for onion and @ 12, 15, 21, 6, 0.6 and 0.3 kg ha^{-1} for soybean. Only N, P and K were applied in mungbean @ 15, 18 and 14 kg ha^{-1}, respectively. Sole crops received 100% of the recommended doses of fertilizers while 60 % of the recommended rate was applied in intercrops. N, P, K, S, Zn and B were applied in the form of Urea, triple super phosphate (TSP), muriate of potash (MoP), Gypsum, Zinc sulphate ($ZnSO_4$) and Boric acid, respectively. Pest management and necessary intercultural operations like weeding (3 times), mulching (3 times), gap filling (1 time), irrigation (4 times), earthing up (2 times), tying (1 time) etc. were done according to the recommendation. Data on number of tiller,

millable cane, plant height, cane diameter, number of internodes stalk^{-1}, unit stalk weight, cane dry matter m^{-2}, and cane yield (tha^{-1}) were recorded for sugarcane. The plant height, weight of 1000 grains, grain yield, straw yield and days to maturity were recorded for soybean and mungbean. The plant height and bulb yield were recorded for onion. Brix (%), pol (%) cane, purity (%), recoverable sucrose (%) and sugar yield (tha^{-1}) were also recorded for sugarcane. Organic matter content, pH, total nitrogen, available phosphorus, exchangeable potassium, available sulphur and available zinc content of post-harvest soil were estimated. Cane equivalent yield of intercrops and the adjusted cane yield were also calculated. Total production cost, gross income, net return, benefit cost ratio and land equivalent ratio (LER) were calculated for economic analysis of different sequential intercropping with sugarcane.

RESULTS AND DISCUSSION

Growth parameters of sugarcane

Cane height, cane diameter and number of internodes of sugarcane did not differ significantly in different soybean- mungbean sequential intercropping treatments under paired rows system of planting in 2008-2009 and 2009-2010 cropping seasons but the dry matter yield of sugarcane differed significantly both the seasons. The highest cane dry matter yields in 2008-2009 and 2009-2010 cropping seasons were 3709 g m^{-2} and 3350 g m^{-2}, respectively while the lowest value of 3188 g m^{-2} and 3110 g m^{-2} were found with and T_1 (Paired rows cane only) treatments, respectively in 2008-09 and 2009-10 (Table 1).

Table 1. Effect of soybean-mungbean sequential intercropping in paired rows transplanted sugarcane on growth parameters of sugarcane in 2008-2009 and 2009-2010

Treatments	Cane height (m)		Cane diameter (cm)		No. of internodes stalk^{-1}		Dry matter yield (gm^{-2})	
	08-09	09-10	08-09	09-10	08-09	09-10	08-09	09-10
T_1	2.98	2.40	2.18	2.05	28	25	3188 b	3110 c
T_2	2.95	2.66	2.20	2.10	29	26	3608 a	3350 a
T_3	2.85	2.91	2.06	2.25	27	28	3650 a	3306 a
T_4	2.55	2.87	2.03	2.17	26	27	3617 a	3240 b
T_5	2.49	2.84	1.99	2.15	24	26	3709 a	3200 b
$S\bar{x}$	0.08	0.05	0.04	0.03	0.08	0.89	50.51	14.93
CV (%)	8.47	5.03	5.16	3.91	8.39	9.53	4.02	1.30
Level of significance	NS	NS	NS	NS	NS	NS	**	**

In a column, figures with similar letters do not differ significantly at 5% level

T_1 - Paired rows cane (PRC) only
T_2 - PRC + onion - BINA Mung 5 (standard)
T_3 - PRC + Sohag - BINA Mung 5
T_4 - PRC + BARI Soybean 5 - BINA Mung 5
T_5 - PRC + Bangladesh Soybean 4 - BINA Mung 5

Yield and yield attributes of sugarcane

Number of millable cane, unit cane weight and cane yield did not differ significantly in case of different soybean - mungbean sequential intercropping treatments with paired rows transplanted sugarcane. The tiller population differed significantly among these treatments. The highest number of tiller 227 × 10^3 ha^{-1} and 220 × 10^3 ha^{-1} were obtained from T_4 (PRC + BARI Soybean 5 - BINA Mung 5) treatment in both the years, while the lowest tiller population 171 × 10^3 ha^{-1} and 203 × 10^3 ha^{-1} were found in T_1 (PRC cane only) treatment in both the years (Table 2).

Table 2. **Effect of soybean - mungbean sequential intercropping with paired rows transplanted sugarcane on yield and yield attributes of sugarcane in 2008-2009 and 2009-2010**

Treatments	No. of tiller (×10^3 ha^{-1})		No. of millable cane (×10^3 ha^{-1})		Unit cane weight (kg)		Cane yield (tha^{-1})	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
T_1	171 b	203 b	99	100	0.86	0.82	80.60	82.00
T_2	217 a	217 a	114	114	0.82	0.74	93.70	84.48
T_3	216 a	216 a	116	117	0.79	0.78	91.41	91.45
T_4	227 a	220 a	122	115	0.72	0.77	87.70	89.00
T_5	222 a	213 a	119	111	0.74	0.79	88.14	87.33
$S\bar{x}$	6.05	2.23	2.33	2.86	0.04	0.01	3.25	1.95
CV (%)	8.13	2.94	5.82	7.26	13.44	3.59	10.39	6.36
Level of significance	**	**	NS	NS	NS	NS	NS	NS

In a column, figures with similar letters do not differ significantly at 5% level

Growth attributes of intercrops

Plant height, biomass yield, straw yield, 1000-grain weight and crop duration of first intercrop differed significantly among the different treatment combinations. The highest plant height of 64.33 cm and 61.40 cm were found from the treatment T_5 (PRC + Bangladesh Soybean 4 - BINA Mung 5) in both the years while the lowest plant height were 39.30 cm and 36.50 cm with T_4 (PRC + BARI Soybean 5 - BINA Mung 5) and T_3 (PRC + soybean (Sohag) - BINA Mung 5) treatments in 2008-2009 and 2009-2010 seasons, respectively. In case of biomass yield 1.91 tha^{-1} and 1.84 tha^{-1} were observed from the treatment T_5 (PRC + Bangladesh Soybean 4 - BINA Mung 5) in both the years while the lowest biomass yield 0.66 tha^{-1} and 0.88 tha^{-1} were produced in T_2 (PRC + onion - BINA Mung 5) (Table 3). The similar trend was observed in straw yield in both the years. The highest 1000-grain weight of 80.00 g and 85.00 g were recorded at treatment T_3 for both the year while the lowest 1000-grain weight 51.00 g and 53.00 g were observed in T_5 (PRC + Bangladesh Soybean 4 - BINA Mung 5) treatment in both the years. The crop duration was lowest of 100 days and 102 days with treatment T_2 (PRC + onion - BINA Mung 5) and the highest duration of 123 days (2008-2009) and 131 days (2009-2010) were found in T_5 (PRC + Bangladesh Soybean 4 - BINA Mung 5) treatment (Table 3).

Table 3. Effect of soybean - mungbean sequential intercropping with paired rows transplanted sugarcane on growth yield attributes of first intercrops in 2008-2009 and 2009-2010

Treatments	Plant height (cm)		Biomass yield (tha^{-1})		Straw yield (tha^{-1})		1000-grain wt. (g)		Crop duration (days)	
	08-09	09-10	08-09	09-10	08-09	09-10	08-09	09-10	08-09	09-10
T_1	-	-	-	-	-	-	-	-	-	-
T_2	50.00 b	53.00 b	0.66 d	0.88 c	0.83 c	1.10 d	-	-	100 c	102 d
T_3	39.88 c	36.50 d	1.38 c	1.32 b	1.73 b	1.65 c	80.00	85.00	117 b	129 c
T_4	39.30 c	38.25 c	1.42 b	1.37 b	1.77 b	1.71 b	75.00	80.00	117 b	129 c
T_5	64.33 a	61.40 a	1.91 a	1.84 a	2.39 a	2.30 a	51.00	53.00	123 a	131 a
$S\bar{x}$	0.38	0.37	0.04	0.04	0.01	0.01	0.01	0.01	0.59	0.45
CV (%)	2.74	2.70	1.96	1.92	2.86	1.89	0.02	0.01	1.80	1.29
Level of significance	**	**	**	**	**	**	**	**	**	**

In a column, figures with similar letters do not differ significantly at 5% level

Biomass yield of second intercrops was not affected significantly due to soybean-mungbean sequential intercropping with paired rows transplanted sugarcane system but crop duration was not affected significantly. The crop duration was 81 days in 2008-2009 and 77 days in 2009-2010 season from sowing to harvesting.

Intercrop yield and adjusted cane yield

The yield of the first intercrops (onion, sohag, BARI Soybean 5 and Bangladesh Soybean 4) under paired rows system was found satisfactory. Adjusted cane yield was significantly affected for the different intercrop combinations. The yield of mungbean as second intercrop was significantly differed among the different treatment combinations. The seed yield of 0.42 tha^{-1} (2008-2009) and 0.64 tha^{-1} (2009-2010) were obtained from T_2 treatment. The highest adjusted cane yield of 223.81 tha^{-1} and 160.54 tha^{-1} were obtained from the T_2 treatment (PRC + onion - BINA Mung 5) in 2008-2009 and 2009-2010 seasons, respectively, while the lowest of 80.6 tha^{-1} and 82.0 tha^{-1} were from the T_1 treatment (sole cane) in both the seasons (Table 4).

Table 4. Effect of soybean - mungbean sequential intercropping on intercrops yield, cane equivalent yield of intercrops and total adjusted cane yield in 2008-2009 and 2009-2010

Treatments	Intercrop yield (tha^{-1})				Cane equivalent yield of intercrop (tha^{-1})		Adjusted cane yield (tha^{-1})	
	First intercrop		Second intercrop					
	08-09	09-10	08-09	09-10	08-09	09-10	08-09	09-10
T_1	-	-	-	-	80.60	82.00	80.60 c	82.00 c
T_2	6.50	8.82	0.42	0.64	130.11	76.06	223.81 a	160.54 a
T_3	0.86	0.79	-	-	19.74	16.71	111.15 b	108.16 b
T_4	0.88	0.74	-	-	20.31	15.97	108.01 b	104.97 b
T_5	0.91	0.87	-	-	20.99	18.48	109.13 b	105.81 b
$S\bar{x}$	-	-	-	-	-	-	3.25	2.09
CV (%)	-	-	-	-	-	-	7.25	5.29
Level of significance	-	-	-	-	-	-	**	**

Cane juice quality and sugar yield

Sugarcane juice quality parameters like brix (%), pol (%) cane, purity (%), recoverable sucrose (%) and sugar yield (tha^{-1}) did not differ significantly by different soybean-mungbean sequential intercropping in 2008-2009 and 2009-2010 (Table 5). The brix (%) ranged from 21.30 to 22.08 and 17.50 to 18.75 in 2008-2009 and 2009-2010 seasons, respectively. The pol (%) cane ranged from 14.93 to 15.55 and 12.31 to 13.45 in 2008-2009 and 2009-2010 seasons. The range was 89.86 to 91.58 and 88.96 to 90.73 in 2008-2009 and 2009-2010 seasons in case of purity (%). The recoverable sucrose (%) ranged from 12.56 to 13.05 and 9.82 to 10.95 in 2008-2009 and 2009-2010 seasons. Sugar yield (t ha^{-1}) ranged from 10.31 to 12.03 and 8.42 to 9.54 in 2008-2009 and 2009-2010 seasons.

Table 5. Effect of soybean - mungbean sequential intercropping on juice quality and sugar yield (t ha^{-1}) in 2008-2009 and 2009-2010

Treatments	Brix (%)		Pol (%) cane		Purity (%)		Recoverable sucrose (%)		Sugar yield (t ha^{-1})	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
T_1	21.85	18.57	15.39	13.15	90.29	89.11	12.89	10.65	12.03	8.42
T_2	21.48	18.75	15.27	13.45	91.18	90.73	12.77	10.95	11.98	9.23
T_3	21.40	18.10	15.28	12.90	91.58	90.09	12.78	10.40	11.69	9.54
T_4	22.08	17.50	15.55	12.31	90.37	88.96	13.05	9.82	11.00	8.79
T_5	21.30	18.33	14.93	12.90	89.86	89.10	12.56	10.40	10.31	9.06
$S\bar{x}$	0.22	0.37	0.13	0.37	0.42	1.08	0.11	0.37	0.46	0.44
CV (%)	2.89	5.74	2.42	8.22	1.34	3.01	2.45	10.19	11.39	13.83
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

In a column, figures with similar letters do not differ significantly at 5% level

Economic analyses

Cost of cultivation

The cost of cultivation was estimated for different sequential intercropping treatment. The maximum costs of cultivation were 1,62,000 $Tk.ha^{-1}$ and 1,45,000 $Tk.ha^{-1}$ in 2008-2009 and 2009-2010 seasons, respectively which were required for the treatment T_2 (PRC + onion - BINA Mung 5). The minimum cost of 80,000 $Tk.ha^{-1}$ required for the sole cane in both the years while other treatments required 1,04,000 $Tk.ha^{-1}$ and 1,06,000 $Tk.ha^{-1}$, respectively (Table 6).

Gross income and net return

The highest gross income Tk. 3,93,912 ha^{-1} and Tk. 3,46,777 ha^{-1} was obtained from the T_2 treatment in 2008-2009 and 2009-2010, respectively. The lowest gross income of Tk. 1,41,856 ha^{-1} and Tk. 1,77,120 ha^{-1} was obtained from T_1 (sole cane only) treatment in 2008-2009 and 2009-2010. The highest net return of Tk. 2,31,912 ha^{-1} and Tk. 2,01,776 ha^{-1} were obtained with T_2 (PRC + onion – BINA Mung 5) in 2008-2009 and 2009-2010 seasons, respectively. The lowest net return of Tk. 61,856 ha^{-1} and Tk. 97,120 ha^{-1} were found with T_1 (sole cane only) in 2008-2009 and 2009-2010 seasons (Table 6).

Benefit cost ratio (BCR) and land equivalent ratio (LER)

The benefit cost ratio (BCR) was maximum in T_2 (PRC + onion - BINA Mung 5) treatment which were 2.43 in 2008-2009 and 2.39 in 2009-2010. The next highest BCR were 1.88 and 2.20 with T_3 (PRC + sohag - BINA Mung 5) treatment in 2008-2009 and 2009-2010 seasons, respectively. The minimum benefit cost ratio were 1.77 in 2008-2009 and 2.21 in 2009-2010 in treatment T_1 (sole cane only). Data on the LER value of different sugarcane + intercrop combination showed that the treatment T_3 (PRC + sohag - BINA Mung 5) exhibited the highest LER of 2.17 in 2008-2009 and 2.35 in 2009-2010 while the lowest LER of 1.89 was obtained in 2008-2009 and 2.07 was in 2009-2010 with T_5 (PRC + Bangladesh Soybean 4 - BINA Mung 5) treatment (Table 6).

Table 6. Effect of soybean - mungbean sequential intercropping on cost of production, benefit cost ratio and land equivalent ratio in 2008-2009 and 2009-2010

Treatments	Total production cost (Tk. ha^{-1})		Gross income (Tk. ha^{-1})		Net return (Tk. ha^{-1})		BCR		LER	
	08-09	09-10	08-09	09-10	08-09	09-10	08-09	09-10	08-09	09-10
T_1	80000	80000	141856	177120	61856	97120	1.77	2.21	1.00	1.00
T_2	162000	145000	393912	346777	231912	201776	2.43	2.39	2.14	2.34
T_3	104000	106000	195632	233632	91631	127632	1.88	2.20	2.17	2.35
T_4	104000	106000	190102	226730	86102	120730	1.83	2.14	2.13	2.29
T_5	104000	106000	192076	228557	88076	122556	1.85	2.16	1.89	2.07

Price of crops (2008-09) Sugarcane : 1760 Tk.t^{-1}, Onion : 32 Tk.kg^{-1}, Soybean : 35 Tk.kg^{-1}, Mungbean (grain) : 50 Tk.kg^{-1}, Mungbean (GM): 600 TK. t^{-1}
Price of crops (2009-10) Sugarcane : 2160 Tk.t^{-1}, Onion : 15 Tk.kg^{-1}, Soybean : 40 Tk.kg^{-1}, Mungbean (grain) : 50 Tk.kg^{-1}, Mungbean (GM): 600 TK. t^{-1}

Soil characteristics

Effect of soybean-mungbean sequential intercropping with paired rows transplanted sugarcane on pH value, organic matter (%), total N content (%), available P (mg kg^{-1}) and exchangeable K (cmol kg^{-1}) of post harvest soil were not significant while available S (mg kg^{-1}) and Zn (mg kg^{-1}) were significant in both the years. The available S was highest from treatment T_2 (31.20 mg kg^{-1}) in 2008-2009 and from T_5 (21.50 mg kg^{-1}) in 2009-2010 seasons while the lowest was in T_1 (21.30 & 16.30 mg kg^{-1}) in both the years. The highest available Zn was found from T_4 (0.81 and 0.83 mg kg^{-1}) while the lowest value from T_5 (0. 60 & 0. 64 mg kg^{-1}) in 2008-2009 and 2009-2010 seasons (Table 7 and 8). Before experimentation the pH value, organic matter content, total nitrogen, available status of calcium, magnesium, potassium, phosphorus, sulphur, boron, iron and zinc in the soil were 7.62, 1%, 0.05%, 11.51cmol kg^{-1}, 0.83 cmol kg^{-1}, 0.15 cmol kg^{-1},12.0 mg kg^{-1}, 20 mg kg^{-1}, 0.20 mg kg^{-1}, 3.40 mg kg^{-1} and 0.56 mg kg^{-1} soil, respectively.

Table 7. Effect of soybean - mungbean sequential intercropping on pH, organic matter (%), total N content (%) and available P (mg kg^{-1}) content of post harvest soil in 2008-2009 and 2009-2010.

Treatments	pH		Organic matter (%)		Total N content (%)		Available P (mg kg^{-1})	
	08-09	09-10	08-09	09-10	08-09	09-10	08-09	09-10
Post harvest soil								
T_1	7.6	7.7	1.00	0.98	0.05	0.04	13.20	12.50
T_2	7.6	7.7	1.02	1.02	0.05	0.05	25.10	18.20
T_3	7.6	7.7	1.04	1.05	0.06	0.05	25.50	16.70
T_4	7.5	7.6	1.05	1.07	0.05	0.05	26.00	16.60
T_5	7.6	7.6	1.04	1.00	0.05	0.05	25.00	12.40
$S\bar{x}$	0.01	0.04	0.01	0.02	0.01	0.01	0.01	0.69
CV (%)	0.64	1.57	0.79	5.57	1.74	19.83	0.08	12.15
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS

In a column, figures with similar letters do not differ significantly at 5% level

Table 8. Effect of soybean-mungbean sequential intercropping on exchangeable K (cmol kg^{-1}), available S (mg kg^{-1}) and available Zn (mg kg^{-1}) content of post harvest soil in 2008-2009 and 2009-2010

Treatments	Exchangeable K (cmol kg^{-1})		Available S (mg kg^{-1})		Available Zn (mg kg^{-1})	
	08-09	09-10	08-09	09-10	2008-09	2009-10
Post harvest soil						
T_1	0.16	0.18	21.30	16.30	0.65	0.71
T_2	0.14	0.19	31.20	20.30	0.66	0.62
T_3	0.17	0.22	22.90	17.30	0.61	0.65
T_4	0.16	0.21	25.00	17.30	0.71	0.73
T_5	0.15	0.20	27.30	21.50	0.60	0.64
$S\bar{x}$	0.01	0.01	0.04	0.46	0.01	0.04
CV (%)	1.23	12.80	0.40	7.02	0.24	13.85
Level of significance	NS	NS	**	**	**	**

In a column, figures with similar letters do not differ significantly at 5% level

The overall results suggested that intercropping of soybean with sugarcane does not have any adverse effect on growth, yield and juice quality of sugarcane rather it is economically profitable than sole cane. Among the tested three soybean varieties, Sohag (PB1) showed better performance in different soybean–mungbean combinations for higher economic return. Thus, this variety can be selected for soybean-mungbean sequential intercropping in paired rows transplanted sugarcane for sustainable sugarcane farming and maintaining soil fertility.

REFERENCES

Alam, G.M.M.; Alam, M.M.; Alam, M.J.; Zahan, W.A. and Alam, M.S. 2007. Profitability of intercropping with sugarcane in some selected mills zones. *Bangladesh J. Sugarcane*, **29**: 64-67.

Alam, M.J.; Hossain, M.S.; Islam, A.K.M.R.; Rahman, M.K. and Kabir, M.L. 2008. Performance of jute varieties for seed production as first and mungbean as second intercrop under transplanted cane in paired row. *Bangladesh J. Sugarcane*, **30**: 116-121.

BARC (Bangladesh Agricultural Research Council), 2005. Fertilizer Recommendation Guide. Bangladesh Agri. Res. Coun., New Airport Road, Farm gate, Dhaka-1215. pp. 97-136.

BBS, 2010. Statistical Year Book of Agricultural Statistics of Bangladesh. Planning Division, Ministry of Planning. Government of the Peoples' Republic of Bangladesh. p. 122.

De, R. and Singh, S.P. 1979. Management practices for intercropping system. In Proceedings of international workshop on intercropping. Hyderabad, India 10-13 June 1979. International Crops Research Institute for the Semi-Arid Tropics, India pp.17-21.

FAOSTAT. 2012. Food and Agricultural Organization of the United Nations: Economic and Social Department: The Statistical Division. p. 567.

Hossain, A.H.M.D.; Rahman, M.K.; Kabir, M.L.; Matin, M.A. and Alam, M.J. 1995. Performance of soybean and some other crops as intercrops with paired row transplanted sugarcane. *Bangladesh J. Sugarcane*, **17**: 119-122.

Islam, A.K.M.R.; Hossain, M.S.; Alam, M.J.; Rahman, M.K.; Haque, M.A. and Kabir, M.L. 2009. Yield of different winter crops with cane as first and mungbean as second intercrop in rainfed condition under paired row planting system. *Bangladesh J. Sugarcane*, **31**: 38-44.

Matin, M.A.; Kabir, M.L.; Alam, M.J. and Zaman, A.K.M.M. 2001. Performance of winter vegetable and summer mung as intercrops with paired row transplanted sugarcane. *Bangladesh J. Sugarcane*, **23**: 7-14.

Umrani, N.K. 1981. Intercropping for higher production of pulses. *Indian Farming,* **31**(9): 25-30.