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Successive Intercropping of Potato and Mungbean with Sugarcane

Md. Shariful Islam[1] and M. Obaidul Islam[2]*

[1]Physiology and Sugar Chemistry Division, Bangladesh Sugar Crop Research Institute, Ishurdi, Pabna, Bangladesh; [2]Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, Bangladesh

**Corresponding author and Email: obaidul7_mo@yahoo.com*

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Abstract

The experiment was carried out at the Bangladesh Sugarcane Research Institute (BSRI) farm at Ishurdi, Pabna, Bangladesh during2008-2009 and 2009-2010to investigate the growth and yield of main crop sugarcane, and companion crops potato and mungbean as successive intercrops. Row to row spacing (RRS) of sugarcane were 80 (S_1), 100 (S_2) and 120 cm (S_3) and sugarcane was intercropped with 1, 2 and 3 rows of potato as 1st intercrop and followed by mungbean with same row ratio as 2nd intercrop. Sugarcane and companion crops potato and mungbean were cultivated following the cultivation methods of BSRI and Bangladesh Agricultural Research Institute (BARI), respectively. To provide more light to intercrops bended leaves of sugarcane on both sides of rows were cut at middle and compared with non-cutting of leaves in respect of growth and yield of main crop and intercrops as well. The total dry matter production, cane yield and sugar yield were the highest at 120 cm RRS of sugarcane (non-leaf cutting=C_0) intercropped with 3 rows of potato followed by 3 rows of mungbean (S_3C_0). The number of tiller and millable canes, and leaf area index (LAI) were the highest at 80 cm RRS of sugarcane (C_0) with one row of potato and one row of mungbean (S_1C_0). The effect of light interception on growth and yield of first intercrop (potato) was insignificant whereas it was significant for second intercrop. Yield of mungbean (2nd intercrop) and light interception ratio (%) was the lowest in S_3C_1 where sugarcane RRS was 120 cm + 3 R potato followed by 3 R mungbean with leaf cutting (LC). The results of the experiment indicated that sugarcane transplanted at RRS of 120 cm with 3 rows of potato followed by 3 rows of mungbean can be grown as intercrops for increased yield of sugarcane as well as for increased cropping intensity and might be recommended for farmers practice in High Ganges River Flood Plain soils under AEZ 11 of Bangladesh.

Keywords: Successive intercropping, yield, intensity.

1. Introduction

Sugarcane is an important cash-cum-industrial crop of Bangladesh. It has great value to provide sugar for 160 million people of the country. More than half of the global population also depends on sugar produce from sugarcane. Sugarcane is a long duration crop. It needs about 12-13 months from sett transplanting to harvest and therefore faces more environmental stresses and gives less economic return compare to other cash crops. Stress tolerant and short duration cultivar development, better management practices and adopting high valued intercrops in sugarcane are possible steps to get higher economic return from sugarcane cultivation. Intercropping in sugarcane has long been practiced to get interim monetary return. Intercropping helps in diversification of crop production and fulfils the need of farmers (Singh *et al*., 1986). It is reported that about 80% farmers are practicing intercropping in sugarcane in Panjab (The Indian express, 2014). Recent report indicates that intercropped soybean not only increases yield but also enhances soil quality through nitrogenise and urease activity in soil which finally enhances nitrogen and phosphorus contents of rhizospheric soil (Li *et al*., 2013). Sugarcane is usually planted at 80 to 120 cm row to row spacing (RRS). It needs 3-5 months for full canopy development and therefore, allows selective short duration intercrop. Thus, sugarcane provides ample opportunity for spatial and temporal intercropping to enhance intensification as well as economic return.

However, RRS affects light intensity, intercrop competition and other growth supporting factors which finally affect growth and yield of both sugarcane and companion crop. Higher light intensity and long duration promote the number of tillers in sugarcane while cloudy and short days affect it adversely. Narrow vacant space in between two sugarcane rows affects light interception resulting in higher level of shading on intercrops especially on second intercrop and consequently affects photosynthesis. Wide row spacing is required to receive enough solar radiation for proper photosynthesis, growth and yield of second intercrop (Miah *et al*., 2002).

Therefore, selection of successive intercrop under RRS of sugarcane is an important factor for sustainable intensification and economic return from sugarcane cultivation. In present study two high valued crops potato and mungbean were cultivated as successive intercrops with sugarcane to estimate growth performance and yield attributes under different spacings. Govinden (1990) claimed intercropping in sugarcane cultivation as a successful system and showed that 22% more potato was produced over sole crop when cultivated as an intercrop without any loss of sugarcane yield as a main crop. The bulk of the potato in Mauritius is produced on sugarcane lands (Govinden, 1990). However, almost all reports are on single intercrop or pair intercrops in sugarcane. Report on successive intercrop in sugarcane is scarcely available. To fill the gap, present research is planned to estimate row to row spacing of sugarcane transplanting when intercropped with potato and mungbean successively for increased growth and yield.

2. Materials and Methods

2.1 Location and soil properties

The experiment was conducted at Bangladesh Sugarcane Research Institute (BSRI) farm, Ishurdi, Pabna, Bangladesh in 2008-2009 and repeated in 2009-2010 cropping seasons. The main crop sugarcane (cv. Isd 37) was cultivated with potato (cv. Cardinal) and mungbean (BINA moog 5) as successive intercrop. The site is located at $24^0 8'$ North latitude and $89^0 04'$ East longitude and situated about 15.5 m above from the mean sea level. The experimental site represents the High Ganges River Flood Plain soils under the Agro ecological zone-11 (AEZ 11). The experiments were laid out in farm field soil having good internal drainage. The land category was medium high land. The soil belongs to 'Sara series' of calcareous soil. The soil was sandy loam in texture having pH 7.58, contained organic carbon 0.88%, total N (0.05%), available phosphorus 17.00 µg g^{-1}, available sulphur 21.0 µg g^{-1}, exchangeable potassium 0.20 meq 100 g^{-1}, available zinc 0.77 µg g^{-1} and having cation exchange capacity (CEC) 12.25 meq 100 g^{-1} of soil.

2.2 Treatments and experimental design

The experiment with two factors (A and B) was laid out in a Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 8 m × 6 m and separated by 1.0 m border.

Factor A (Row to row spacing of sugarcane and number of row of intercrops)

S_1= Sugarcane RRS 80 cm + 1R of 1st intercrop followed by 1R of 2nd intercrop.

S_2= Sugarcane RRS 100 cm + 2 rows of 1st intercrop followed by 2 rows of 2nd intercrop.

S_3= Sugarcane RRS 120 cm + 3 rows of 1st intercrop followed by 3 rows of 2nd intercrop.

S_4= Sole sugarcane, RRS 100 cm (farmers practice).

Factor B (Leaf cutting of sugarcane)

C_0= Non leaf cutting (NLC)

C_1= Leaf cutting (LC)

Only bended leaves at bending position of sugarcane were cut (about 20 %) 3 times with 21 days interval up to sowing of 2nd intercrop.

2.3 Land preparation and fertilizer application

The land was ploughed and trenches were made by tractor drawn plough and harrow. Fertilizer (kg per hectare) applied in crops is presented in Table 1.

For sugarcane full dose of TSP, Gypsum, $ZnSo_4$ and one-third of MoP were mixed with soil in trench during land preparation. Urea was topdressed at 21, 90 and 150 DAT @ of 1/3rd of total dose. Similarly second and 3rddose(1/3rd) of MoP was also top dressed at 90 and 150 DAT (FRG, 2005).For potato total amount of TSP, Gypsum and 50% of urea and 50% of MoP were mixed with furrow soil as basal dose. The remaining 50% of urea and MoP were side dressed in two equal splits at 25 and 45 DAT during first and second earthing-up (Rahman *et al.* 2005). For mungbean all fertilizers were applied at basal dose at sowing (Rahman *et al.* 2008).

2.4 Settlings transplantation and management

Previously raised 45 days old sugarcane settlings in polybag were transplanted in trenches at 45 cm plant to plant spacing (PPS) in 2nd week of November for both the years. First intercrop potato tubers (1st intercrop) were also sown on same day and mungbean seeds (2nd intercrop) were sown in 1st week of March in ridge just after harvesting of potato. The average seed rate of potato tuber and mungbean were 0.75 t ha^{-1} and 10 kg ha^{-1}, respectively as intercrop, while these were 1.5 t ha^{-1} and 25 kg ha^{-1} as sole crop. After transplanting of the settlings irrigation (about 10 cm) was given in trenches. Further irrigation was done at 30, 60, 90 and 120 DAT. Dead settling were replaced by healthy settlings within 15 days after transplanting. After each irrigation surface soil of trenches was mulched manually with a *khupri*. The plots were kept weed free up to 135 DAT. Earthing-up and tying of sugarcane were done after 140 days of plantation. During trench preparation Chlorpyrifos (Regent 3 GR) was applied in the trenches @ 33 kg ha^{-1} to control termite and Carbofuran (Furadan5G) was applied as a preventive measure against borers at 90 and 150 days (two times) after planting @ 40 kg ha^{-1} for each time (Alam *et al.*, 1990). No disease infestation was observed in sugarcane and intercrop during cultivation.

Table 1. Fertilizer applied in crops (kg per hectare)

Crops	Urea	TSP	MoP	Gypsum	$ZnSO_4$
Sugarcane (main crop)	325	250	180	190	09
Potato (1st intercrop)	120	60	100	45	00
Mungbean (2nd intercrop)	20	40	25	00	00
Sugarcane (sole crop)	325	250	180	190	09
Potato sole (sole crop)	220	120	220	100	08
Mungbean (sole crop)	30	80	50	50	03

2.5 Data collection and analysis

For sugarcane, data on plant height, number of tillers, leaf area index, total dry matter, millable cane, cane height, cane diameter and cane yield were collected. Similarly data on % light interception (measured by a 660/730. Red: Far red measuring system; SKR 110/100 Skys Instruments Ltd. Powys, U.K.) was also collected. Light interception was calculated according to the following formula:

% light interception =

$$(1.0 - \frac{I}{I_0}) \times 100$$ .... (Szeicz *et al.*, 1964).

Where,

I = Light intensity received at the ground level

I_0=Light intensity received above the crop canopy

The analysis of variance for different parameters was done and means differences were compared by Duncan's Multiple Range Test (DMRT) using program MSTAT-C (Russel, 1986).

3. Results and Discussion

3.1 Plant height

Growth parameters of sugarcane varied differently under different RRS with successive intercrops. The highest plant height of sugarcane was 4.25 m in S_3 (sugarcane RRS 120 cm + 3 R potato-3 R mungbean) in 2008-2009 season followed by S_2 (sugarcane RRS 100 cm + 2 R potato-2 R mungbean) and the lowest height was 4.08 m in S_1 (sugarcane RRS 80 cm + 1 R potato-1 R mungbean) under successive intercropping of potato-mungbean (Table 2). Similar trend of plant height was observed in 2009-2010 cropping year. The effect of leaf cutting of sugarcane on plant height was insignificant (Table 3). The interaction of RRS and LC or NLC of sugarcane on plant height shows that plant height was the highest (4.29 m) in S_3C_0 (sugarcane RRS 120 cm + 3 R potato followd by 3 R mungbean with NLC) followed by S_3C_1 and the lowest in S_1C_1 (sugarcane RRS 80 cm + 1 R potato-1 R mungbean with LC) in both the years (Table 4).

3.2 Tiller production and leaf area index (LAI)

The number of tiller per hill, an important yield contributing character was the highest at the lowest spacing. In S_1 the number of tiller was 246.00×10^3 ha^{-1}, which decreased to 152.90×10^3 ha^{-1} in S_3 during 2008-2009 (Table 2). Similar trend of number of tiller was observed in 2009-2010 cropping year. The interaction effects (Table 4) also support that lower spacing enhanced tiller number. Higher LAI was found in lower spacing. Table 4 shows the highest LAI was in S_1C_0 followed by S_2 and the lowest one was in S_3C_1.

Table 2. Effects of RRS on growth of sugarcane with potato-mungbean as successive intercrop

Treatment (S)	Plant height (m)	Number of tiller (10^3ha^{-1})	LAI	Total dry matter (kg m^{-2})	Plant height (m)	Number of tiller (10^3ha^{-1})	LAI	Total dry matter (kg m^{-2})
	2008-2009				2009-2010			
S_1	4.08b	246.00a	7.87a	4.20 c	4.04b	226.80a	7.75a	4.17c
S_2	4.15b	181.10b	7.72ab	5.15a	4.09b	184.10b	7.63ab	4.99a
S_3	4.25a	152.90c	7.55b	4.87b	4.19a	155.70c	7.45b	4.68b
S_4	4.14 b	181.10b	7.81a	5.08a	4.09b	183.00b	7.70a	4.89a
LSD 0.05)	0.067	12.67	0.210	0.193	0.055	18.32	0.217	0.164

S_1= Sugarcane RRS 80 cm + 1 R potato - 1 R mungbean

S_2= Sugarcane RRS 100 cm + 2 R potato - 2 R mungbean

S_3= Sugarcane RRS 120 cm + 3 R potato - 3 R mungbean

S_4= Sole sugarcane RRS 100 cm

C_0= Non leaf cutting (NLC)

C_1= Leaf cutting (LC)

*Figures with similar letter (s) of a column don't differ significantly at 5.0% probability by DMRT

Table 3. Effects of LC or NLC on growth of sugarcane with potato-mungbean as successive intercrop

Leaf cutting (C)	Plant height (m)	Number of tiller ($10^3 ha^{-1}$)	LAI	Total dry matter (kg m^{-2})	Plant height (m)	Number of tiller ($10^3 ha^{-1}$)	LAI	Total dry matter (kg m^{-2})
	2008-2009				2009-2010			
No leaf cut (C_0)	4.18	191.64	7.75	4.87	4.12	188.93	7.65	4.73
Leaf cut (C_1)	4.13	188.92	7.73	4.78	4.08	185.82	7.61	4.62
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 4. Interaction effects of RRS and LC or NLC on growth of sugarcane with potato-mungbean as successive intercrop

Interaction (S×C)	Plant height (m)	Number of tiller ($10^3 ha^{-1}$)	LAI	Total dry matter (kg m^{-2})	Plant height (m)	Number of tiller ($10^3 ha^{-1}$)	LAI	Total dry matter (kg m^{-2})
	2008-2009				2009-2010			
S_1C_0	4.11bc	247.75a	7.88a	4. 28d	4.06cd	228.75a	7.76a	4.23d
S_1C_1	4.06c	244.23a	7.86a	4.13d	4.02d	224.79a	7.74a	4.11d
S_2C_0	4.18b	181.74b	7.73ab	5.19a	4.11 bc	185.83b	7.65ab	5.07a
S_2C_1	4.13bc	180.48b	7.71ab	5.12ab	4.07cd	82.29b-d	7.61ab	4.91ab
S_3C_0	4.29a	154.49c	7.56 b	4.91bc	4.22a	56.87cd	7.49ab	4.73bc
S_3C_1	4.21ab	151.36c	7.55b	4.84c	4.17ab	154.58d	7.42b	4.63c
S_4C_0	4.16bc	182.59b	7.84ab	5.11a-c	4.12bc	84.29bc	7.73a	4.94ab
S_4C_1	4.12bc	179.63b	7.78ab	5.05a-c	4.06cd	81.65b-d	7.68ab	4.85a-c
LSD (0.05)	0.095	17.92	0.296	0.273	0.078	25.90	0.308	0.232

3.3 Total dry matter

The highest total dry matter production (5.15 kg m^{-2}) was in $S_2$and the lowest one was in S_1 (Table 2). The effect of leaf cutting and non-cutting was ineffective on dry matter production (Table 3). The interaction also shows that the highest total dry matter was produced in S_2C_0 and the lowest total dry matter was observed in S_1C_1 in both the years (Table 4).

3.4 Number of millable cane production

The number of millable cane is an important yield contributing factor. The number of millable cane was the highest (105.90×10^3 ha^{-1}) in $S_{1,}$ followed by S_2 (97.71×10^3 ha^{-1}) and the lowest one was in S_3(91.58×10^3 ha^{-1}). Similar number was also obtained in the next year (Table 5). The effect of leaf cutting of sugarcane had no significant effect on number of millable cane (Table 6). The interaction effects of RRS and LC or NLC show that the number of millable cane was similar in S_1C_0 and $S_2C_{o,}$ and decreased significantly in S_3C_0. The highest number of millable cane was 106.30×10^3 ha^{-1}, produced in S_1C_0 and the lowest number (92.32×10^3 ha^{-1}) was in S_3C_1 (Table 7).

3.5 Stalk height and diameter

Stalk height, an important yield contributing character of sugarcane was the highest (2.73 m) in S_3 followed by S_2 and the lowest one was (2.50 m) in S_1 (Table 5). The interaction effects of RRS and LC or NLC of sugarcane on stalk height shows that the highest stalk height was obtained in S_3C_0 in both the years (Table 7). Similar result was obtained for stalk diameter of sugarcane. The highest stalk diameter was observed under higher spacing (S_3) and the lowest (2.54 cm) was in S_1. The effect of leaf cutting of sugarcane on stalk diameter was statistically insignificant (Table 6). The interaction effects of RRS and LC or NLC of sugarcane on stalk diameter indicate the highest stalk diameter (2.56 cm) was found in S_3C_0 and the lowest (2.37 cm) was in S_1C_1.

Table 5. Effects of RRS on cane yield component and cane yield of sugarcane with potato-Mungbean as intercrop

Treatment (S)	Number of millable cane (10^3ha^{-1})	Stalk height (m)	Stalk diameter (cm)	Cane yield (t ha^{-1})	Number of millable cane (10^3ha^{-1})	Stalk height (m)	Stalk diameter (cm)	Cane yield (t ha^{-1})
	2008-2009				2009-2010			
S_1	105.9a	2.50c	2.39c	87.20b	103.90a	2.47c	2.36c	84.01c
S_2	97.71b	2.60b	2.46b	96.89a	94.99b	2.57b	2.43b	93.76a
S_3	91.58b	2.73a	2.54a	91.06ab	89.04b	2.71a	2.52a	87.69bc
S_4	97.04b	2.59b	2.45b	95.20a	94.73b	2.55b	2.43b	91.87ab
LSD(0.05)	8.087	0.055	0.039	6.303	8.767	0.039	0.039	5.272

Table 6. Effects of LC or NLC on cane yield component and cane yield of sugarcane with potato-mungbean as intercrop

Cutting (C)	Number of millable cane (10^3ha^{-1})	Stalk height (m)	Stalk diameter (cm)	Cane yield (t ha^{-1})	Number of millable cane (10^3ha^{-1})	Stalk height (m)	Stalk diameter (cm)	Cane yield (t ha^{-1})
	2008-2009				2009-2010			
C_0	98.52	2.62	2.48	93.02	96.09	2.60	2.45	89.78
C_1	97.58	2.58	2.44	91.96	95.26	2.55	2.42	88.89
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 7. Interaction effects of RRS and LC or NLC on cane yield component and cane yield of sugarcane with potato-mungbean as intercrop

Interaction (S×C)	Number of millable cane (10^3ha^{-1})	Stalk height (m)	Stalk diameter (cm)	Cane yield (t ha^{-1})	Number of millable cane (10^3ha^{-1})	Stalk height (m)	Stalk diameter (cm)	Cane yield (t ha^{-1})
	2008-2009*				2009-2010*			
S_1C_0	106.30a	2.52d	2.42cd	87.93ab	104.20 a	2.49de	2.38cd	84.05b
S_1C_1	105.50a	2.48d	2.37d	86.47b	103.70a	2.45e	2.35d	83.98b
S_2C_0	98.23ab	2.63b	2.48bc	97.62a	95.20ab	2.61b	2.45b	94.39a
S_2C_1	97.18ab	2.57bc	2.45c	96.15ab	94.78ab	2.54cd	2.41bc	93.13a
S_3C_0	92.32b	2.75a	2.56a	91.14ab	89.16b	2.72a	2.54a	88.23ab
S_3C_1	90.84b	2.71a	2.52ab	90.98ab	88.93b	2.69a	2.51a	87.15ab
S_4C_0	97.25ab	2.61b	2.46c	96.13ab	95.82ab	2.58bc	2.44b	92.45a
S_4C_1	96.84ab	2.58bc	2.44c	94.27ab	93.64ab	2.52d	2.42bc	91.29ab
LSD (0.05)	11.44	0.078	0.055	8.914	12.40	0.055	0.055	7.456

3.6 Cane yield

The highest cane yield was in $S_2$and the lowest was in S_1in both the years (Table 5). The interaction effects of RRS and LC or NLC show that the highest cane yield (97.62 t ha^{-1}) was obtained in S_2C_0. Similar cane yield was observed in S_3C_0 and the lowest one was (86.47 t ha^{-1}) in S_1C_1 (Table 8). Cane yield in sole sugarcane was similar to that in S_3C_0 indicated that intercropping did not reduce can yield severely.

3.7 Yield of first intercrop potato

Yield of potato (first intercrop) varied significantly with different RRS of sugarcane compared to sole potato. The highest potato tuber yield was 15.28 t ha^{-1} in S_5 (sole potato) and the lowest was 7.79 t ha^{-1} in S_1C_1 (Table 9). The second highest potato yield was in S_3C_1 which was significantly lower than that of sole potato. About 28% yield reduction was observed in potato under intercropping with sugarcane. Light interception (%) by potato was insignificant in all spacing treatments in both the years. Light interception by potato under successive intercropping was also insignificant (Table 9). At 75 days the light interception was 1.65 at S_3C_0 compared to that in S_5 (1.29). This indicates that sugarcane leaf did not affect growth and yield of potato.

Table 8. Interaction effects of RRS and LC or NLC on yield of Sugarcane and Potato (1st intercrop), Mungbean (2nd intercrop) as successive intercrop

Treatments	Cane yield (t ha^{-1})	Yield of intercrops (t ha^{-1})		Cane yield (t ha^{-1})	Yield of intercrops (t ha^{-1})	
		Potato (1^{st})	Mungbean (2^{nd})		Potato (1^{st})	Mungbean (2^{nd})
	2008-2009*			2009-2010*		
S_1C_0	87.93ab	7.84c	0.23e	84.05b	6.92c	0.19d
S_1C_1	86.47b	7.79c	0.26e	83.98b	6.81c	0.23d
S_2C_0	97.62a	9.67b	0.32de	94.39a	9.37b	0.24d
S_2C_1	96.15ab	9.94b	0.38cd	93.13a	9.54b	0.43c
S_3C_0	91.14ab	10.62b	0.47c	88.23ab	10.16b	0.36c
S_3C_1	90.98ab	10.85b	0.72b	87.15ab	10.25b	0.74b
S_4C_0	96.13ab	-	-	92.45a	-	-
S_4C_1	94.27ab	-	-	91.29ab	-	-
S_5	-	15.28a	-	-	14.75a	-
S_6	-	-	1.14a	-	-	1.16a
LSD(0.05)	8.914	1.776	0.112	7.456	1.973	0.097

*Figures with similar letter (s) of a column don't differ significantly at 5.0% probability by DMRT

S_1= Sugarcane RRS 80 cm + 1 R potato - 1 R mungbean
S_2= Sugarcane RRS 100 cm + 2 R potato - 2 R mungbean
S_3= Sugarcane RRS 120 cm + 3 R potato - 3 R mungbean
S_4= Sole sugarcane RRS 100 cm
S_5 = Sole potato (var. BARI potato 7: Diamant)
S_6= Sole summer mungbean (var. Binamoog-5)

C_0= Non leaf cutting (NLC)
C_1= Leaf cutting (LC)

Table 9. Effects of interaction between RRS on light interception of potato under successive intercropping of potato-mungbean

Treatment (S)	Light interception (%) of potato at different days after sowing									
	15	30	45	60	75	15	30	45	60	75
	2008-2009					2009-2010				
S_1C_0	0.86	0.89	0.94	1.76	1.87	0.75	0.84	0.91	1.54	1.76
S_1C_1	0.79	0.85	0.92	1.74	1.85	0.68	0.79	0.88	1.47	1.71
S_2C_0	0.73	0.79	0.88	1.65	1.79	0.65	0.74	0.83	1.42	1.68
S_2C_1	0.59	0.65	0.82	1.59	1.76	0.55	0.68	0.79	1.37	1.55
S_3C_0	0.44	0.52	0.8	1.42	1.65	0.41	0.54	0.7	1.3	1.51
S_3C_1	0.41	0.51	0.76	1.37	1.62	0.39	0.42	0.63	1.24	1.47
S_5	0.26	0.31	0.62	1.06	1.29	0.19	0.22	0.58	1.14	1.43
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

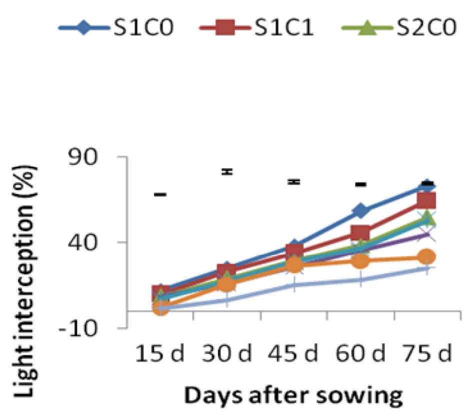

Figure 1. Light interception (%) of mungbean in 2008-2009. Narrow vertical bars indicate LSD values.

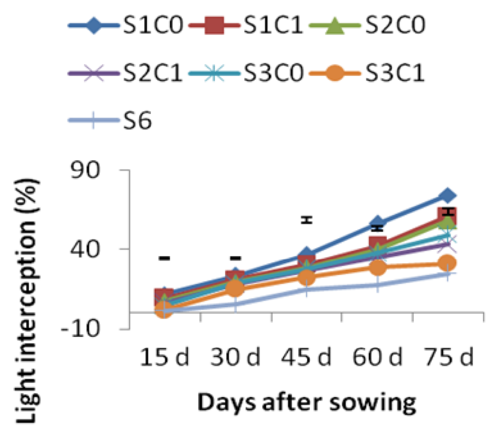

Figure 2. Light interception (%) of mungbean in 2009-2010. Narrow vertical bars indicate LSD values.

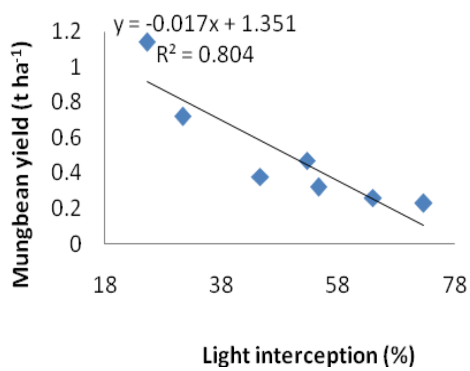

Figure 3. Relationship between light interception (%) and yield of mungbean at 75 DAS in 2008-2009.

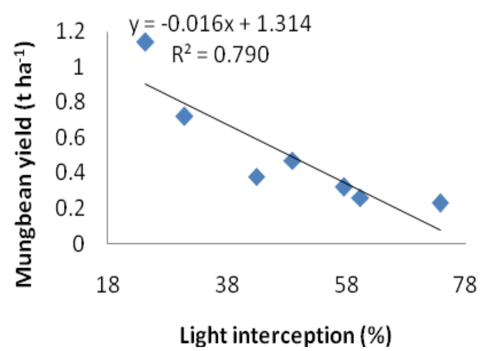

Figure 4. Relationship between light interception (%) and yield of mungbean at 75 DAS in 2009-2010.

3.8 Yield of second intercrop mungbean

Yield of mungbean as second intercrop with sugarcane varied significantly due to RRS and LC or NLC of main crop of sugarcane. The highest yield of mungbean was in S_3C_1 (0.72 t ha^{-1}) where 3 rows of mungbean was cultivated as second intercrop in 120 cm row spacing of sugarcane during 2008-2009. Similar result was obtained in 2009-2010. However, the yield of mungbean was significantly lower than that of sole mungbean crop (Table 8). About 36.8 % yield reduction was observed in mungbean due to intercropping in S_3C_1 with sugarcane. The lowest yield of mungbean was observed in S_1C_0. The highest light interception (%) was found in S_1C_0 and the lowest in S_3C_1in both the years (Figure 2, 3).

A negative correlation between light interception (%) and grain yield of mungbean at 75 DAS was observed. Mungbean yield and light interception (%) can be determined by the equation, $Y= -0.017x + 1.351$ (R^2 =0.80; Figure 3). The equation indicates that mungbean yield can be increased at the rate of 0.80 (t ha^{-1}) with the decreased in light interception (%) from 75DAS (Figure 3). Similar relationship was observed in 2009-2010 (Figure 4).

3.9 Cropping intensification

Due to intercropping with sugarcane there were 3 crops produced per year without loss of main crop sugarcane. Although yield of both the intercrops decreased under intercropping, the intensity of crop production enhanced to 300% compared to 100% at sole sugarcane.

Sugarcane is an important cash cum industrial crop. In early stage it grows slowly and can accommodate a number of short duration crops. Intercropping has been recognized an excellent practice to increase total yield, interim return as well as total high monetary returns, resource utilization, enhance cropping intensification and fulfil the diversified need of farms. There are number of short duration crops like potato, tomato, chilies, onion, garlic, carrot, turnips, cabbage, knoll kohl, lettuce, coriander, peas, lady's finger, linseed, fennel, arson, ray, sunflower, lentil and wheat which can be intercropped with sugarcane. Farmers have also long been practicing intercrop with sugarcane for interim income. However, most of growers practice single crop intercropping in sugarcane. Major intercrop combinations in sugarcane identified are: sugarcane + potato, sugarcane + onion, sugarcane + wheat, sugarcane + coriander, sugarcane + mustard, sugarcane + tomato and sugarcane + cabbage, sugarcane + garlic, sugarcane + sunflower etc. From intercropping practices, pest management benefit has been realized due to increased crop diversity, and intercropping reduced smut disease of sugarcane by interrupting the smut spores (Dawn, 2006). Planting of intercropping should be done in inter-row spaces and plant to row spaces should be critically maintained to avoid undue competition. Very little research effort has been made pertaining to input use, seasonal pattern of production and other practices followed by farmers. The present result documented that growth and yield of sugarcane and two successive intercrops was satisfactory at 120 cm RRS of sugarcane. Ultimately it will enhance cropping intensification and interim return as well as total income of farmers.

The economics of sugarcane is questioned when farmers earn more profit from other crops. If farmers follow various intercropping practices to increase interim income from sugarcane cultivation it will enhance total farm income from sugarcane cultivation. The present experiment strongly supported that sugarcane row to row spacing 120 cm under leaf cutting was the best for the highest growth and yield of sugarcane with 3 rows of potato followed by 3 rows of mungbean. Similar double and successive intercropping in sugarcane was supported by Hossain *et al*. (2003). Present result fully agreed to that report where potato was first intercrop and sesame was the second intercrop in sugarcane. Yield reduction of first intercrop was due to space limitation but in second intercrop due to light as well as space limitation underS_3C_1. This result might support increased cropping intensity and income generation from sugarcane cultivation in AEZ 11 of Bangladesh.

4. Conclusions

From the research result it may be concluded that sugarcane is to be cultivated at row to row spacing of 120 cm under leaf cutting with 3 rows of potato followed by 3 rows of mungbean for higher growth and yield of sugarcane with higher cropping intensity and interim income generation.

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