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FEASIBILITY OF INTERCROPPING LEAFY VEGETABLES AND LEGUMES WITH BRINJAL

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Abstract

An experiment was conducted during 2010 and 2011 to find out the suitable crop combination for increasing total productivity, return and maximize land utilization through intercropping system. Six treatments viz. Brinjal 100% + Red amaranth 100%, Brinjal 100% + Leaf amaranth 100%, Brinjal 100% + Jute as patshak 100%, Brinjal 100% + Mungbean 60%, Brinjal 100% + Blackgram 60% and sole of base crops (brinjal) were used in the study. Results showed that different intercropping combination did not influenced yield and yield contributing characters of brinjal. The yield of brinjal comparatively lower in intercropping but total productivity increased due to additional yield of leafy vegetables and legumes. The increases in total productivity in terms of brinjal equivalent yield (BEY) was 8.80 to 26.67 t/ha in intercrop combination compared to base crop. All the intercropping combinations were higher in terms of brinjal equivalent yield, gross return and benefit cost ratio (BCR) over sole crops. Among the intercropping combinations, Brinjal 100% (100 cm × 75 cm) + Mungbean 60% (three rows mungbean in between brinjal rows maintained 30 cm apart rows with continuous seeding) was the most feasible and profitable intercropping system in respect of brinjal equivalent yield (20.85 t/ha), gross return (Tk.312750/ha), gross margin (Tk.212693/ha) and benefit cost ratio (3.13).

Keywords: Intercropping, leafy vegetables, legumes, brinjal.

Introduction

Brinjal (*Solanum melongena* L.) as a vegetable crop is cultivated round the year throughout the country. It is a long durated (240-280 days) and wide spaced (100 cm × 75 cm) crop. So, there is a great scope to cultivate short durated (30-40 days) leafy vegetable and legumes (65-75 days) in the inter row space of brinjal. Leafy vegetable like red amaranth, leaf amaranth, jute and legumes viz., mungbean and blackgram being short structure quick growing crops can be easily intercropped between two rows of brinjal at early growth stage. The practice of intercropping of leafy vegetable and legumes with brinjal is provided high yield and income. In the contrary, legumes crop can be added additional nitrogen in the

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soil and it improved the soil fertility. Mian (2008) reported that mungbean supply 56.20, 60.62 and 66.93 kg N under low, moderate and high nutrient level, respectively. In Bangladesh small farmers constitute 79.4% of our farming community and their cultivated lands are shrinking day by day (MOA, 2014). In those context, intercropping is one of the viable technology to ensure efficient utilization of their resources for increased production and family income. Intercropping offers the possibility of yield advantage relative to sole cropping through yield stability and improved yield in tropical and sub tropical areas (Nazir *et al*., 2002; Malik *et al*., 2002; Bhatti *et al*., 2005). Besides, multiple cropping may ensure proper utilization of resources towards increased production per unit area and time on a sustainable basis (Ahmad *et al*., 2007). However, very few studies have been conducted in the past about vegetables/legumes intercropping system. Considering the above facts, this trial was undertaken to find out the suitable crop combination for increasing total productivity, return and maximize land utilization.

Materials and Method

The experiment was conducted during 2010 and 2011 at the farm of Regional Agricultural Research Station (RARS), Ishurdi, Pabna. The soil of experimental site was clay loam in texture having P^H 7.26, organic matter 1.05%, total nitrogen 0.059%, available phosphorus 11µg/ml, available potassium 0.12 meq/100g soil, sulphur 13 µg/ml, boron 0.20 µg/ml and zinc 1.8 µg/ml. Six treatments viz., T_1= Brinjal 100% + Red amaranth 100%, T_2= Brinjal 100% + Leaf amaranth 100%, T_3= Brinjal 100% + Jute 100%, T_4= Brinjal 100% + Mungbean 60%, T_5= Brinjal 100% + Blackgram 60% and T_6 = Sole crop of brinjal were evaluated. The trial was set up in a randomized complete block design (RCBD) with three replications. The sole crop of brinjal and intercropped treatments were fertilized with cowdung 10 t/ha and 140-50-100-15-2-0.5 kg/ha N-P-K-S-Zn-B in the form of urea, triple super phosphate, muriat of potash, gypsum, zinc sulphate and boric acid, respectively. One third of N, half of K and full amount of cowdung, P, S, B, Zn were applied during final land preparation. Remaining N and K were applied in three equal installments at 20, 40 and 60 days after transplants (DAT) as ring method around the brinjal plant. Brinjal (Var. BARI Brinjal-8) as base crop and red amaranth (var. BARI Red Amaranth -1), leaf amaranth (var. BARI Leaf Amaranth -2), Jute (Binapatshak-1), mungbean (var. BARI Mungbean-6) and blackgram (var. BARI Blackgram -3) were used as intercrops in this study. The unit plot size was 4 m × 3 m. The sole crop of brinjal was planted at a spacing of 100 cm × 75 cm. In intercropping system three rows of mungbean (60%) and blackgram (60%) were intercropped in between brinjal rows @ 40 kg seed/ha maintaining 30 cm apart rows with continuous seeding. After 20 days after sowing (DAS) mungbean and blackgram plants were thinned out keeping 6-7cm plant to plant distance. Red amaranth, leaf amaranth and jute seed were broadcast

(100%) in between brinjal rows at the rate of 2, 1.5 and 15 kg seed/ha. Brinjal (thirty days old seedling), seed of red amaranth, leaf amaranth (danta shak), jute (patshak), mungbean and blackgram were planted/sown on 20 and 25 March 2010 and 2011, respectively. Harvesting of brinjal was started on 20-25 July and continuous to 24-27 November in 2010 and 2011, respectively. Red amaranth, leaf amaranth and jute (patshak) were harvested on 15, 21; 21, 25 and 27, 30 April 2010 and 2011, respectively. Blackgram was harvested on 21 and 25 May, 2010 and 2011, respectively. Two pickings of mungbean were done at 60-65 and 70-75 DAS, respectively in both the years. After pickings, the mungbean plants were incorporated (5.36 ton biomass/ha) in soil. Three irrigations were done in the experimental field. First was applied at just after transplanting (brinjal) and sowing (component crop) of the crop. Second and third irrigation were applied at 80 and 160 days after transplanting (DAT) of brinjal. Weeding was done as per requirement. Spinosad (Tracer 45 SC) at the rate of 0.4ml/litre water was sprayed on brinjal for control of brinjal shoot and fruit borer at active vegetative, fruit setting and fruit developing stage. Data on yield and yield contributing characters were taken and analyzed statistically. Data on yield and yield attributes of brinjal for two consecutive years showed similar trend. So, these data were pooled and means were adjudged by Least Significant Difference (LSD) test at 5% level of significance. Brinjal equivalent yield (BEY) was converted by converting yield of intercrops on the basis of presenting market price of individual crop following the formula:

$$\text{BEY} = \text{Yield of intercrop Brinjal} + \frac{\text{Yi} \times \text{Pi}}{\text{Price of brinjal}}$$

Where, Yi = yield of intercrops (leafy vegetables/legumes) and Pi = Price of intercrop (leafy vegetables/legumes). Land equivalent ratio (LER) values were determined from the yield data of the crops according to Mian (2008).

$$\text{LER} = \text{RY}_b + \text{RY}_i = \frac{\text{B}_{IY}}{\text{B}_{SY}} + \frac{\text{B}_{EYCC}}{\text{B}_{SY}}$$

Where,

RY_b= Relative yield of brinjal (main crop)

RY_i= Relative yield of intercrops (vegetables and legumes)

B_{IY} = Intercrop yield of brinjal

B_{SY} = Sole crop yield of brinjal

B_{EYCC} = Brinjal equivalent yield of component crops {(component crop yield in intercrop × price of component crop)/price of brinjal}.

Benefit cost analysis was also done. The total mean rainfall 974.72, 38.59, 50.54, 191.79 and 179.86 mm was recorded in brinjal, red amaranth/leaf amaranth, jute, mungbean and blackgram, respectively during the growing season (Table 4). The distribution of rainfall was higher in 2011 than 2010 and the crop as well as yield performance was also comparatively better in 2011 than 2010. It indicates that rainfall had positive effect on crop growth and development.

Results and Discussion

Yield and yield contributing characters of brinjal

There was no significant difference in yield and yield attributes of brinjal due to intercropping of leafy vegetables/legumes i.e. growing of intercrops in interspaces between brinjal rows did not affect the base crop (Table 1). The number of fruit/plant ranged from 21.26 to 23.33 cm where maximum number of fruit/plant was obtained in sole brinjal (23.33). The lower number of fruit/plant was recorded in Brinjal 100% + Jute 100% intercropping combination. Similar trend was found in case fruit length.

Table1. Number of fruit/plant, fruit length and fruit yield/ha of brinjal in brinjal- leafy vegetables-legumes intercropping system (pooled data of 2010 and 2011).

Treatments	Number of fruit/plant	Fruit length (cm)	Fruit yield/plant (kg)	Fruit yield (t/ha)
T_1	21.79	15.81	1.20	15.03
T_2	22.20	16.16	1.11	15.11
T_3	21.26	16.22	1.10	15.01
T_4	22.87	16.65	1.10	16.33
T_5	22.59	16.47	1.14	16.19
T_6	23.33	16.61	1.12	16.46
$LSD_{(0.05)}$	NS	NS	NS	NS
CV (%)	6.36	3.94	7.52	7.19

NS= Not significant

The maximum fruit yield (16.46 t/ha) was obtained from brinjal sole crop but statistically identical to intercropped combinations. Among the intercropped combinations the maximum brinjal yield was recorded when it was intercropped with mungbean (16.33 t/ha) and blackgram (16.19 t/ha). After harvest of mungbean the plants were incorporated with the soil that's may add additional organic matter (OM), nitrogen and other nutrients elements resulting higher fruit yield of brinjal. On the other hand, brinjal 100% + red amaranth 100%, brinjal

100% + leaf amaranth 100% and brinjal 100% + jute 100% intercropped combination, the fixed amount of applied fertilizer were uptake both the base (brinjal) and component (leafy vegetables/legumes) crops. Additional nutrients were not added in these combinations. So, brinjal yields were comparatively lower than brinjal 100% + mungbean 60% and brinjal 100% + blackgram 60% intercropping system.

Companion crop yield

On an average, the yield of red amaranth, leaf amaranth, jute, mungbean and blackgram under intercrops were 7.52, 8.39, 7.05, 1.13 and 0.99 t/ha, respectively (Table 2). Results showed that, among the leafy vegetables, leaf amaranth showed higher yield (8.39 t/ha) in intercropping followed by red amaranth (7.52 t/ha) and jute as vegetable (7.05 t/ha). Similarly, between the legumes crops mungbean yield (1.13 t/ha) and blackgram (0.99 t/ha) was almost similar.

Table 2. Yield of companion crops and Brinjal equivalent yield (BEY) under brinjal-leafy vegetables-legumes intercropping system (pooled data of 2010 and 2011).

Treatments	Yield of leafy vegetables/legumes (t/ha)	BEY (t/ha)	% increase of BEY over sole brinjal	LER
T_1	7.52	19.04	15.67	1.16
T_2	8.39	17.91	8.80	1.09
T_3	7.05	18.30	11.18	1.11
T_4	1.13	20.85	26.67	1.27
T_5	0.99	19.49	18.40	1.18
T_6	-	16.46	-	1.00

T_1= Brinjal 100% + Red amaranth 100%, T_2= Brinjal 100% + Leaf amaranth 100%, T_3= Brinjal 100% + Jute 100%, T_4= Brinjal 100% + Mungbean 60%, T_5= Brinjal 100% + Blackgram 60% and T_6 = Sole crop of brinjal

Brinjal equivalent yield (BEY)

Brinjal equivalent yield was expressed in total productivity. Brinjal equivalent yields were higher in all the intercrops (17.91-20.85 t/ha) than the sole crop of brinjal (16.46 t/ha). The highest brinjal equivalent yield (20.85 t/ha) was recorded in brinjal 100% + mungbean 60% intercropped combination which was followed by brinjal 100% + blackgram 60% (19.49 t/ha), brinjal 100% + red amaranth 100% (19.04 t/ha) and brinjal 100% + jute 100% (18.30 t/ha) (Table 2) and the total productivity also increase of 15.67, 8.80, 11.17, 26.67 and 18.40 percent

over sole brinjal. The result revealed that brinjal 100% + mungbean 60% led to higher total productivity than sole crops. Ahmed *et al.* (2013) also reported 28 to 45% yield advantages in okra-vegetables intercropping system.

Land equivalent ratio (LER)

Highest land equivalent ratio (1.27) was recorded under brinjal 100% + mungbean 60% intercropping system followed by brinjal 100% + blackgram 60% (Table 2). The lowest LER (1.09) was in brinjal 100% + leaf amaranth 100% intercropped combination. LER of different crop combinations ranged from 1.09 to 1.27 indicating 9-27% yield increase by intercropping. The mean values of LER (more than one) in all intercropping treatments revealed that land was more efficiently utilized under intercropping than under sole cropping of brinjal.

Table 3. Cost benefit analysis of brinjal-leafy vegetables-legumes intercropping system (pooled data of 2010 and 2011).

Treatments	Gross return (Tk/ha)	Total cost (Tk/ha)	Gross margin (Tk/ha)	BCR
T_1	285610	96257	189353	2.97
T_2	268600	96557	172043	2.78
T_3	274500	97157	177343	2.83
T_4	312750	100057	212693	3.13
T_5	292350	97577	194773	3.00
T_6	246900	91057	155843	2.71

Price: Brinjal: Tk 15/kg, Red amaranth: Tk 8/kg, Leaf amaranth: Tk 5/kg, Jute (as patshak): Tk 7/kg, Mungbean: Tk 60/kg, Blackgram: Tk 50/kg

Cost benefit analysis

Intercropping combination of brinjal with leafy vegetables and legumes showed higher monetary return than sole crop (Table 3). The highest gross return (Tk.312750/ha) was recorded from brinjal 100% + mungbean 60% intercrop combination which was 21.06 percent higher than sole brinjal (Table 3). This intercropping combination also gave the higher gross margin (Tk 212693/ha) and benefit cost ratio (3.13) followed by brinjal 100% + blackgram 60% with BCR (3.00). Among the intercrops, the lowest gross return (Tk 268600/ha), gross margin (Tk 172043/ha) and BCR (2.78) were obtained from the combination of brinjal 100% + leaf amaranth 100% followed by jute as intercrop. The results of increased productivity and returns were consistent with the earlier reports of yield advantage of crop mixture compared to monoculture (Akhteruzzaman and Quayyum, 1991; Islam *et al*., 2012; Ahmed *et al*., 2013).

Table 4. Monthly total rainfalls (mm) occurred during the growth period.

Month	Brinjal		RA/LA		Jute		Mungbean		Blackgram	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
March	0.20 (1)*	12.09 (3)*	0.20 (1)*	2.09 (2)*	0.20 (1)*	12.09 (2)*	0.20 (1)*	12.09 (2)*	0.20 (1)*	12.09 (2)*
April	30.22 (3)	58.53 (5)	6.36 (1)	58.53 (5)	30.22 (3)	58.53 (5)	30.22 (3)	58.53 (5)	30.22 (3)	58.53 (5)
May	135.24 (8)	164.81 (8)	-	-	-	-	117.74 (7)	164.81 (8)	93.87 (5)	164.81 (8)
June	115.88 (8)	202.05 (9)	-	-	-	-	-	-	-	-
July	83.84 (6)	227.48 (10)	-	-	-	-	-	-	-	-
August	61.09 (5)	451.81 (12)	-	-	-	-	-	-	-	-
September	91.35 (8)	245.64 (10)	-	-	-	-	-	-	-	-
October	69.21 (4)	0.0	-	-	-	-	-	-	-	-
November	0.0	0.0	-	-	-	-	-	-	-	-
Total	587.03 (43)	1362.41 (57)	6.56 (2)	70.62 (7)	30.42 (4)	70.67 (7)	148.16 (11)	235.43 (15)	124.29 (9)	235.43 (15)
Average	974.72 (50)		38.59 (5)		50.54 (6)		191.79 (13)		179.86 (12)	

Source: Bangladesh Sugarcane Research Institute (BSRI), Ishurdi, Pabna

RA= Red amaranth, LA= Leaf amaranth, *The figures in the parentheses indicate the number of rainy days.

Conclusion

The results revealed that all intercropping treatments were suitable as compared to sole treatments but brinjal 100% + mungbean 60% intercropped combination i.e., brinjal spacing (100 cm × 75 cm) and three rows of mungbean, 30 cm apart with continuous seeding was more productive and profitable in respect of brinjal equivalent yield and monetary return. Besides, mungbean biomass could help in soil fertility point of view.

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