

## PERFORMANCE OF LEAFY VEGETABLES INTERCROPPED WITH BRINJAL

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### Abstract

An experiment was conducted during rabi and kharif season of 2018 - 2019 and 2019-2020, respectively at Regional Agricultural Research Station (RARS), Cumilla to find out the suitable crop combination of leafy vegetables with brinjal for increasing productivity and economic return through intercropping system. Five treatments viz. Brinjal + Red amaranth (T<sub>1</sub>), Brinjal + Leaf amaranth (T<sub>2</sub>), Brinjal + Patshak (T<sub>3</sub>), Brinjal + Spinach (T<sub>4</sub>) and Sole crop of brinjal (T<sub>5</sub>) were used in rabi season. In kharif season all the treatments were same except T<sub>4</sub> where Indian spinach was used with brinjal instead of spinach. Results showed that yield and yield contributing characters of brinjal did not differ significantly due to different intercropping systems. Yield of brinjal was comparatively low in intercropping but total productivity increased due to additional yield of leafy vegetables. Increase of total productivity in terms of brinjal equivalent yield (BEY) was 2.03 to 25.68% (Rabi) and 2.36 to 22.29% (Kharif) and in intercrop combination compared to sole crop. All the intercropping combinations showed higher brinjal equivalent yield (BEY), gross return and benefit cost ratio (BCR) over sole crop. Among the intercropping combinations, Brinjal + Spinach (rabi) and Brinjal + Indian spinach (kharif-1) was the most feasible and profitable in respect of BEY (48.94 and 27.62 t/ha, respectively), gross return (Tk. 1223400 and 1105000/ha, respectively), gross margin (Tk.908823 and 782487/ha, respectively) and benefit cost ratio (3.88 and 3.42, respectively).

Keywords: Intercropping, leafy vegetables, brinjal, B:C ratio.

### Introduction

Brinjal (*Solanum melongena* L.) is one of the most popular and widely cultivated vegetable crops in Bangladesh. It is a wide spaced (100 cm × 75 cm) crop and life span ranges 240-280 days. Being relatively a long duration crop in first growth stage brinjal grows slowly and establishment of full canopy takes several weeks. This privilege can be taken for growing various short duration (30-40 days) crops (mostly leafy vegetable) in between the rows as intercrops. Most of the green leafy vegetables like red amaranth, leaf amaranth, patshak, spinach and Indian spinach are rich source of minerals including iron, calcium, potassium, magnesium and also provide important vitamins, including vitamins K, C, E, and many of the vitamins B (Natesh *et al.*, 2017). Those crops can easily be

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intercropped with brinjal at early growth stage for their short stature and quick growing habit. Intercropping has been considered advantageous in terms of economy of space, saving on tillage, as well as utilization of available nutrients and moisture in unused space. It could result in an increase in the productivity of vegetables per unit area, and could increase gross return. The practice of intercropping leafy vegetables with brinjal may provide higher yield and income (Islam *et al.*, 2014). Intercropping is one of the increased production systems and it offers the possibility of yield advantage compare to sole cropping through yield stability and improved yield in tropical and sub-tropical areas (Nazir *et al.*, 2002; Malik *et al.*, 2002; Bhatti, 2005). In Bangladesh small farmers constitute 79.4% of our farming community and their cultivated lands are decreasing day by day (MoA, 2014). 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, various studies have been conducted in the past about vegetables intercropping system but results on brinjal-leafy vegetables intercropping are very scanty. Considering the scope of intercropping with brinjal, this trial was undertaken to find out the suitable crop combination for increasing total productivity, net return and maximization of land utilization.

### Materials and Methods

This experiment was conducted at the experimental field of Regional Agriculture Research Station (RARS), Cumilla during the rabi and kharif season of 2018-2019 and 2019-2020, respectively. The study was set in RCB design with three replications. There were five treatments in kharif season viz. T<sub>1</sub>: Brinjal + Red amaranth, T<sub>2</sub>: Brinjal + Leaf amaranth, T<sub>3</sub>: Brinjal + Jute as patshak, T<sub>4</sub>: Brinjal + Indian spinach and T<sub>5</sub>: sole crop of brinjal and for rabi season treatments were T<sub>1</sub>: Brinjal + Red amaranth, T<sub>2</sub>: Brinjal + Leaf amaranth, T<sub>3</sub>: Brinjal + Jute as patshak, T<sub>4</sub>: Brinjal + Spinach and T<sub>5</sub>: sole crop of brinjal. Seeds of red amaranth, leaf amaranth, patshak, Indian spinach and spinach were sown in between brinjal rows at the rate of 2, 1.5, 15, 35 and 35 kg seed/ha, respectively. Brinjal (thirty days old seedling), seeds of red amaranth, leaf amaranth, patshak and spinach were planted/sown on 5 and 9 November 2018 and 2019 in rabi season, respectively and in kharif season thirty days old seedling of brinjal and seeds of red amaranth, leaf amaranth, patshak and Indian spinach were planted/sown on 8 and 15 March 2019 and 2020, respectively. Unit plot size, spacing, fertilizer doses and intercultural operations were same for both the season. The unit plot size was 5.0 m × 2.25 m and the sole crop of brinjal was transplanted at 1.0 m × 0.75 m spacing. The sole crop of brinjal and intercropped treatments were fertilized with cowdung 10 t/ha and 170-50-125-18-4.3-1.70 kg/ha NPKSZnB ha<sup>-1</sup> in the form of urea, triple super phosphate, muriate 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. Brinjal (Var. BARI Begun-10) as base crop and red amaranth (var. BARI Lalshak-1), leaf amaranth (var. BARI Datashak-2), Jute (Binapatshak-1),

Indian spinach (var. BARI Puishak-2) and spinach (var. BARI Palongshak-1) were used as intercrops in this study. Three irrigations were done in the experimental field. First irrigation was applied when transplanting brinjal/sowing the component 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 0.4 ml/litre water was sprayed on brinjal for controlling brinjal shoot and fruit borer at vegetative, fruit setting and fruit developing stage. Harvesting of crops for rabi season was started on 22 and 27 March and continued to 15 and 21 June in 2019 and 2020, respectively and for kharif season harvesting was started on 5 and 8 July and continued to 19 and 25 October in 2019 and 2020, respectively. Data on yield and yield contributing characters were recorded and analyzed using Statistics 10 software and the means were separated by LSD test at 5% level of significance. Brinjal equivalent yield (BEY) was converted by converting yield of intercrops on the basis of present market price of individual crop following the formula:

$$\text{BEY} = \text{Yield of intercrop brinjal} + \frac{Y_i \times P_i}{\text{Price of brinjal}}$$

Where,  $Y_i$  = yield of intercrop (leafy vegetables) and  $P_i$  = Price of intercrop (leafy vegetables). Land equivalent ratio (LER) values were determined from the yield data of the crops according to Mian (2008).

$$\text{LER} = \text{RY}_b + \text{RY}_i = \frac{E_{IY}}{E_{SY}} + \frac{\text{BEY}_{CC}}{E_{SY}}$$

Where,

$\text{RY}_b$  = Relative yield of brinjal (main crop)

$\text{RY}_i$  = Relative yield of intercrops (leafy vegetables)

$E_{IY}$  = Intercrop yield of brinjal

$E_{SY}$  = Sole crop yield of brinjal

$\text{BEY}_{CC}$  = Brinjal equivalent yield of component crops {(component crop yield in intercrop  $\times$  price of component crop)/price of brinjal}

Benefit cost analysis was also done

## Results and Discussion

### Rabi

#### Yield and Yield Contributing Characters of Brinjal

Growing of intercrops in interspaces between brinjal rows did not affect much the base crop (Table 1). The number of fruits/plant ranged from 26.91 to 34.24 where maximum number of fruits/plant was obtained in sole crop of brinjal (34.24) followed by Brinjal + Leaf amaranth (31.76) intercropping combination. The lowest number of fruits/plant (26.91) was recorded in Brinjal + Spinach

intercropping combination. In case of fruit length, the longest fruit (32.07 cm) was found in Brinjal + Patshak and the smallest one (28.90 cm) was found from the combination of Brinjal + Red amaranth (Table 1).

**Table 1. Yield and yield attributes of brinjal in brinjal- leafy vegetables intercropping system in rabi (pooled data of 2018-2019 and 2019-2020).**

Treatments	Number of fruit/plant (no.)	Fruit length (cm)	Individual fruit weight (g)	Fruit yield/plant (kg)	Fruit yield (t/ha)
T <sub>1</sub> (Brinjal + Red amaranth)	28.40	28.90	94.18	2.67	35.89
T <sub>2</sub> (Brinjal + Leaf amaranth)	31.76	30.00	95.32	3.02	36.74
T <sub>3</sub> (Brinjal + Patshak)	30.16	32.07	99.90	3.01	37.68
T <sub>4</sub> (Brinjal + Spinach)	26.91	31.80	102.75	2.77	34.00
T <sub>5</sub> (sole crop of brinjal)	34.24	31.87	110.85	3.76	38.94
CV (%)	12.36	2.94	9.13	9.52	11.60
LSD <sub>(0.05)</sub>	2.13	1.11	8.34	3.11	8.99

Individual fruit weight and fruit yield/plant was recorded maximum in sole crop of brinjal. The maximum fruit yield (38.94 t/ha) obtained from sole crop of brinjal. Islam *et al.* (2014) also reported that the maximum fruit yield (16.46 t/ha) was obtained from sole crop of brinjal crop than intercropping system. In intercropped combination, the fixed amounts of applied fertilizer were uptake both the base (brinjal) and component (leafy vegetables) crops. Additional nutrients were not added in these combinations. So, brinjal yields were comparatively higher in sole crop of brinjal than intercropping system. Among the intercropped combinations the maximum fruit yield was recorded (37.68 t/ha) when it was intercropped with patshak followed by Brinjal + Leaf amaranth (36.74 t/ha) and Brinjal + Red amaranth (35.89 t/ha) and minimum yield was recorded in Brinjal + Spinach intercropping combination (34.00 t/ha).

On an average, the yield of red amaranth, leaf amaranth, patshak and spinach under intercropping were 10.56, 16.20, 3.41 and 18.67 t/ha, respectively (Table 2). Results showed that, among the leafy vegetables, spinach showed higher yield (18.67 t/ha) in intercropping followed by leaf amaranth (16.20 t/ha).

**Table 2. Yield of companion crops and brinjal equivalent yield (BEY) under brinjal-leafy vegetables intercropping system in rabi (pooled data of 2018-2019 and 2019-2020).**

Treatment	Yield of leafy Vegetables (t/ha)	BEY (t/ha)	% increase of BEY over sole crop of brinjal	LER
T <sub>1</sub> (Brinjal + Red amaranth)	10.56	40.11	3.00	1.03
T <sub>2</sub> (Brinjal + Leaf amaranth)	16.20	43.22	10.99	1.10
T <sub>3</sub> (Brinjal + Patshak)	3.41	39.73	2.03	1.02
T <sub>4</sub> (Brinjal + Spinach)	18.67	48.94	25.68	1.26
T <sub>5</sub> (sole crop of brinjal)	-	38.94	-	1

### Brinjal Equivalent Yield (BEY)

Brinjal equivalent yields were higher in all the intercropping combination (39.73 to 48.94 t/ha) than the sole crop of brinjal (38.94 t/ha). The highest brinjal equivalent yield (48.94 t/ha) was recorded in Brinjal + Spinach intercropped combination which was followed by Brinjal + Leaf amaranth (43.22 t/ha) and Brinjal + Red amaranth (40.11 t/ha) (Table 2). Total productivity was also increased of 3.0, 10.99, 2.03 and 25.68 percent over sole crop of brinjal. The result revealed that Brinjal + Spinach led to higher total productivity than other intercropping combinations as well as sole crop. Islam *et al.* (2014) also reported the increases in total productivity in terms of brinjal equivalent yield (BEY) 8.80 to 26.67 t/ha in intercrop combination compared to base crop.

### Land Equivalent Ratio (LER)

LER of different crop combinations ranged from 1.02 to 1.26. The highest land equivalent ratio (1.26) was recorded under Brinjal + Spinach intercropping system followed by Brinjal + Leaf amaranth (1.10) (Table 2). The lowest LER (1.02) was in Brinjal + Patshak intercropped combination. The mean values of LER (more than one) in all intercropping treatments revealed that land was more efficiently utilized under intercropping than sole crop of brinjal. The results are in agreement with the findings of Juskiw *et al.* (2000), Islam *et al.* (2012).

**Table 3. Cost benefit analysis of brinjal-leafy vegetables intercropping system in rabi (pooled data of 2018-2019 and 2019-2020).**

Treatments	Gross return (Tk/ha)	Total cost (Tk/ha)	Gross margin (Tk/ha)	BCR
T1 (Brinjal + Red amaranth)	1002850	280257	722593	3.57
T2 (Brinjal + Leaf amaranth)	1080500	294956	785544	3.66
T3 (Brinjal + Patshak)	993250	288070	705180	3.45
T4 (Brinjal + Spinach)	1223400	314577	908823	3.88
T5 (sole crop of brinjal )	973500	285150	688350	3.41

Price: Brinjal: Tk 25/kg, Red amaranth: Tk 10/kg, Leaf amaranth: Tk 10/kg, Patshak :Tk 15/kg, Spinach: Tk 20/kg

### Cost benefit analysis

Intercropping combination of brinjal with leafy vegetables showed higher monetary return than sole crop (Table 3). The highest gross return (Tk.1223400/ha) was recorded from Brinjal + Spinach intercropping. This intercropping combination also gave the higher gross margin (Tk. 908823/ha) and benefit cost ratio (3.88) followed by Brinjal + Leaf amaranth as intercrop with BCR (3.66). Among the intercropping, the lowest gross return

(Tk.993250/ha), gross margin (Tk. 705180/ha) and BCR (3.45) were obtained from the combination of Brinjal + Patshak. The results of increased productivity and returns were consistent with the earlier reports of yield advantage of crop mixture compared to monoculture (Islam *et al.*, 2012; Ahmed *et al.*, 2013; Islam *et al.*, 2014).

### Kharif-1

#### Yield and Yield Contributing Characters of Brinjal

The number of fruits/plant ranged from 19.52 to 22.02 where maximum number of fruits/plant was obtained in sole crop of brinjal (22.02) followed by Brinjal + Red amaranth (21.14) intercropping combination and the minimum number of fruits/plant (19.52) was recorded in Brinjal + Patshak intercropping combination (Table 4). In case of fruit length, the longest fruit was found in sole crop of brinjal (16.56 cm) followed by Brinjal + Indian spinach (16.03 cm) and the shortest was found in Brinjal + Red amaranth (15.44 cm) intercropping combination. Individual fruit weight and fruit yield/plant was recorded maximum in sole crop of brinjal. The highest fruit yield (22.43 t/ha) was also obtained from sole crop of brinjal. Islam *et al.* (2014) also reported that the maximum fruit yield (16.46 t/ha) was obtained from sole crop of brinjal than intercropping system. In intercropped combination, the fixed amount of applied fertilizer was uptake both the base (Brinjal) and component (leafy vegetables) crops. Additional nutrients were not added in these combinations. So, brinjal yields were comparatively higher in sole crop of brinjal then intercropping system. Among the intercropped combinations the highest brinjal yield was recorded when it was intercropped with Patshak (19.89 t/ha) followed by Brinjal + Indian spinach (18.00 t/ha) and the lowest yield was recorded in Brinjal + Leaf amaranth (15.87 t/ha) intercropping combination.

**Table 4. Yield and yield attributes of brinjal in brinjal-leafy vegetables intercropping system in kharif-1 (pooled data of 2018-2019 and 2019-2020).**

Treatment	Fruits/plant (no.)	Fruit length (cm)	Individual fruit weight (g)	Fruit yield /plant (kg)	Fruit yield (t/ha)
T <sub>1</sub> (Brinjal + Red amaranth)	21.14	15.44	65.87	1.40	17.30
T <sub>2</sub> (Brinjal + Leaf amaranth)	20.36	15.87	65.61	1.33	15.87
T <sub>3</sub> (Brinjal + Patshak)	19.52	15.87	61.93	1.17	19.89
T <sub>4</sub> (Brinjal + Indian spinach)	20.74	16.03	67.00	1.33	18.00
T <sub>5</sub> (sole crop of brinjal)	22.02	16.56	77.5	1.69	22.43
CV (%)	10.03	1.11	8.62	8.51	5.39
LSD (0.05)	1.67	0.33	10.97	0.22	1.79

On an average, the yield of red amaranth, leaf amaranth, patshak and Indian spinach under intercropping were 13.83, 18.90, 6.99 and 15.40 t/ha, respectively (Table 5). Results showed that, among the leafy vegetables, leaf amaranth showed the highest yield (18.90 t/ha) in intercropping followed by Indian spinach (15.40 t/ha) where patshak was showed the lowest yield (6.99 t/ha).

**Table 5. Yield of companion crops and brinjal equivalent yield (BEY) under brinjal-leaf vegetables intercropping system in kharif-1 (pooled data of 2018-2019 and 2019-2020).**

Treatments	Yield of leafy vegetables (t/ha)	BEY (t/ha)	% increase of BEY over sole crop of brinjal	LER
T <sub>1</sub> (Brinjal + Red amaranth)	13.83	24.22	7.98	1.07
T <sub>2</sub> (Brinjal + Leaf amaranth)	18.90	22.96	2.36	1.02
T <sub>3</sub> (Brinjal + Patshak)	6.99	23.38	4.23	1.04
T <sub>4</sub> (Brinjal + Indian spinach)	15.40	27.62	22.29	1.23
T <sub>5</sub> (sole crop of brinjal )	-	22.43	-	1.00

#### **Brinjal Equivalent Yield (BEY)**

Brinjal equivalent yield was expressed in total productivity. Brinjal equivalent yield were higher in all the intercropping brinjal (22.96 to 27.62 t/ha) than the sole crop of brinjal (22.43 t/ha) (Table-5). The highest brinjal equivalent yield (27.62 t/ha) was recorded in Brinjal + Indian spinach intercropped combination which was followed by Brinjal + Red amaranth (24.22 t/ha) and Brinjal + Patshak (23.38 t/ha) (Table 5). The total BEY also increased 7.98, 2.36, 4.23 and 22.29 percent in red amaranth, leaf amaranth, patshak and Indian spinach intercropping, respectively over sole crop of brinjal. Islam *et al.* (2014) also reported the increases in total productivity in terms of brinjal equivalent yield (BEY) 8.80 to 26.67 t/ha in intercrop combination compared to base crop.

#### **Land Equivalent Ratio (LER)**

LER of different crop combinations ranged from 1.02 to 1.23 (Table 5). The highest land equivalent ratio (1.23) was recorded under Brinjal + Indian spinach intercropping system followed by Brinjal + Red amaranth (1.07) (Table 5). The lowest LER (1.02) was in Brinjal + Leaf amaranth intercropped combination. 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. The results are in agreement with the findings of Juskiw *et al.* (2000), Islam *et al.* (2012).

**Table 6. Cost benefit analysis of Brinjal-leafy vegetables intercropping system in kharif-1 (pooled data of 2018-2019 and 2019-2020).**

Treatments	Gross return (Tk/ha)	Total cost (Tk/ha)	Gross margin (Tk/ha)	BCR
T <sub>1</sub> (Brinjal + Red amaranth)	968600	317481	651119	3.05
T <sub>2</sub> (Brinjal + Leaf amaranth)	931700	319167	612533	2.92
T <sub>3</sub> (Brinjal + Patshak)	935400	313570	621830	2.98
T <sub>4</sub> (Brinjal + Indian spinach)	1105000	322513	782487	3.42
T <sub>5</sub> (sole crop of brinjal )	897200	308928	588272	2.90

Price: Brinjal: Tk 40/kg, Red amaranth: Tk 20/kg, Leaf amaranth: Tk 15/kg, Patshak: Tk 20/kg, Indian spinach: Tk 25/kg.

### Cost Benefit Analysis

Intercropping combination of Brinjal with leafy vegetables showed higher monetary return than sole crop (Table 6). The highest gross return (Tk. 1105000/ha) was recorded from Brinjal + Indian spinach intercrop combination than sole crop of brinjal (Tk. 897200/ha) (Table 6). This intercropping combination also gave the higher gross margin (Tk.782487/ha) and benefit cost ratio (3.42) followed by Brinjal + Red amaranth with BCR (3.05). Among the intercropping, the lowest gross return (Tk. 897200/ha), gross margin (Tk. 588272/ha) and BCR (2.90) were obtained from the sole crop of brinjal followed by Brinjal + Leaf amaranth (2.92). The results of increased productivity and returns were consistent with the earlier reports of yield advantage of crop mixture compared to monoculture (Islam *et al.*, 2012; Ahmed *et al.*, 2013; Islam *et al.*, 2014).

### Conclusion

The results of two years study during *rabi* and *kharif* season showed that intercropping of leafy vegetables with Brinjal increased total productivity as well as economic return over sole crop of brinjal. Among the intercropped combinations, Brinjal + Indian Spinach in summer and Brinjal + Spinach in winter were more productive and profitable than all other combinations.

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