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ECONOMIC FEASIBILITY OF INTERCROPPING OF CHILI WITH SWEET GOURD

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Abstract

A field experiment was conducted at Regional Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI), Ishurdi, Pabna during two consecutive years of 2012-2013 and 2013-2014 to find out the suitable combination of intercropping of chili with sweet gourd for increasing the productivity and economic return. The treatments were T_1=100% sweet gourd (2m x 2m) + 40% chili (50cm x 100cm) + 100% recommended fertilizer (RF) of chili, T_2=100% sweet gourd (2m x 2m) + 40% chili (50cm x 100cm) + 75% RF of chili, T_3=100% sweet gourd (2m x 2m) + 40% chili (50cm x 100cm) + 50% RF of chili, T_4=100% sweet gourd (2m x 2m) + 50% chili (50cm x 80cm) + 100% RF of chili, T_5=100% sweet gourd (2m x 2m) + 50% chili (50cm x 80cm) + 75% RF of chili, T_6=100% sweet gourd (2m x 2m) + 50% chili (50cm x 80cm) + 50% RF of chili, T_7=Sole sweet gourd, T_8= Sole chili. The experiment was laid out in a randomized complete block design with three replications. Fruit yield was calculated for sweet gourd and chili in ton per hectare considering the whole plot as harvested area. Results revealed that the yield of both sweet gourd and chili significantly affected by plant population and fertilizer dose in the intercropping systems. The highest equivalent yield of sweet gourd (21.21 t ha-^{1}), land equivalent ratio (1.59), gross return (Tk. 318150.00 ha^{-1}), gross margin (Tk. 237935.00 ha^{-1}) and benefit cost ratio (3.97) were obtained from 100% sweet gourd (2m x 2m) + 50% chili (50cm x 80cm) + 100% RF of chili (T_4). Sole crop of chili (T_8) gave the lowest equivalent yield of sweet gourd (7.38 t ha-^{1}), gross return (Tk. 110700.00 ha^{-1}), gross margin (Tk. 37455.00 ha^{-1}) and benefit cost ratio (1.51). Therefore, sweet gourd (100%) and chili (50%) with recommended fertilizer (100%) of chili might be economically profitable for chili with sweet gourd intercropping system.

Keywords: Economics, Fertilizer, Intercropping and Yield

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Introduction

Bangladesh is an agricultural country and contributes 16.33% to the gross domestic product (GDP) of the country (BBS, 2014). Sweet gourd (*Cucurbita moschata*: Cucurbitaceae) and chili (*Capsicum annuum* L.) is very important edible crop which are usually grown as sole and in some cases as intercrop in farmers field in various parts of Bangladesh. The total production of chili is about 1,26,000 metric tons under 2,40,000 acres of land and 3,41,000 metric tons of sweet gourd in Bangladesh (BBS, 2012). Chili is a very popular and essential spice in our country. Green chili is rich in vitamin A and vitamin C (Datta and Jana, 2010) and in 'rutin' which is of immense pharmaceutical need (Purseglove, 1977). Sweet gourd is another important vegetable crop grown extensively throughout the tropical and subtropical countries. Due to its high nutritional content and lucrative market price, sweet gourd may be considered as a high value crop. In our country, both immature and mature fruits are used as a vital ingredient for several culinary preparations. Sweet gourd are rich in carbohydrate and minerals and cheaper source of vitamins, especially carotenoid pigments, which have a major role in nutrition in the form of pro-vitamin A, antioxidants, when used at ripening stage (Dutta *et al*., 2006). Thus, this vegetable can contribute to improve nutritional status of the people of Bangladesh, particularly the vulnerable group in respect of vitamin A requirement.

Intercropping is a traditional practice in Bangladesh. It increases total productivity per unit area through maximum utilization of land, labour and growth resources (Willey, 1979). Intercropping of chili with different crops offers greater scope to utilize the land and other resources to maximum extent for small farmers. Farmers use fertilizers in intercropping situation like sole crop. Fertilizer could not be same to produce higher yield in intercropping system like sole crop. Moreover, literature relating to fertilizer dose of intercropping chili with sweet gourd is not in available. Hence, this experiment was undertaken to find out the suitable combination of intercropping of chili with sweet gourd for increasing the productivity and economic return.

Materials and Methods

A field experiment was conducted at Regional Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI), Ishurdi, Pabna during rabi season of 2012-2013 and 2013-2014 for the suitable combination of intercropping of chili with sweet gourd for increasing the productivity and economic return.

The climate of the experimental site was subtropical in nature and belongs to the Agro-ecological Zone-11 (AEZ-11) in Bangladesh. The latitude and longitude of the experimental site is 24.030S and 89.050 E, respectively. The land was medium high and the soil was clay loam in texture having 8.10 pH, 1.43% organic matter, 0.076% total nitrogen, 13.1 µg ml^{-1} available phosphorus, 0.30 meq 100 g^{-1} soil available potassium, 10 µg ml^{-1} sulphur, 0.16 µg ml^{-1} boron and 1.91 µg ml^{-1} zinc. Field capacity and bulk density of the soil were 27% and 1.40 g cc^{-1}, respectively; permanent wilting point was near about 14%. The crops received total rainfall of 412.37 mm and 206.81 mm during crop growing period in 2012-2013 and 2013-2014, respectively. The experiment was laid out in a RCBD with three replications. Eight treatments *viz*; T_1=100% sweet gourd (2m x 2m) + 40% chili (50cm x 100cm) + 100% recommended fertilizer dose (RF) of chili, T_2=100% sweet gourd (2m x 2m) + 40% chili (50cm x 100cm) + 75% RF of chili, T_3=100% sweet gourd (2m x 2m) + 40% chili (50cm x 100cm) + 50% RF of chili, T_4=100% sweet gourd (2m x 2m) + 50% chili (50cm x 80cm) + 100% RF of chili, T_5=100% sweet gourd (2m x 2m) + 50% chili (50cm x 80cm) + 75% RF of chili, T_6=100% sweet gourd (2m x 2m) + 50% chili (50cm x 80cm) + 50% RF of chili, T_7= Sole sweet gourd and T_8=Sole chili were included in this experiment. The unit plot size was 4m × 4m. Fertilizer was applied at the rate of 120-80-120-20-4 kg ha^{-1} of N, P, K, S and Zn for sole chili through urea, triples super phosphate, muriate of potash, gypsum and zinc sulphate, respectively. In sole sweet gourd and intercrop, fertilizers were applied at the rate of 80-36-100-24-2-2 kg ha^{-1} N, P, K, S, Zn and B through urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. Cow dung @ 10 t ha^{-1} was applied as a blanket dose during final land preparation. Fifty per cent of nitrogen and all other fertilizers for sole chili were applied at the time of final land preparation and rest amount of nitrogen was applied at three installments of 25, 50 and 70 days after planting (DAP). On the other hand, full amount of all fertilizers except nitrogen were applied in each pit 7 days prior to seed sowing for sole sweet gourd and intercrop. Nitrogen was applied as ring method at 30 and 50 days after planting followed by irrigation. Fifteen days old seedling of sweet gourd (var: BARI Mistikumra-2) and one month old seedling of chili (var: Ishurdi local) were transplanted at 05 December in both year. Intercultural operation like irrigation (five times), weeding (two times) and spraying of insecticides and fungicides (three times) were done. Sweet gourd was harvested on 18 April 2013 and 23 April 2014. Chili was harvested at two times as green chili dated on 09 May and 29 May 2013 and on 23 April and 20 May 2014. Fruit yield was calculated for sweet gourd and chili in ton per hectare considering the whole plot as harvested area. Five plants of chili and five fruits of sweet gourd from each plot were selected randomly to collect data on yield components.

Sweet gourd equivalent yield (SEY) was computed by converting yield of intercrops on the basis of prevailing market price of individual crop following the formula of Anjaneyulu *et al.* (1982) as given below:

$$\text{SEY} = \text{Yield of intercrop sweet gourd} + \frac{\text{yield of intercrop chili} \times \text{price of chili}}{\text{price of sweet gourd}}$$

Land equivalent ratio (LER) was computed according to Shaner *et al*. (1982) as follows:

$$\text{LER} = \frac{\text{yield of intercrop sweet gourd}}{\text{yield of sole sweet gourd}} + \frac{\text{yield of intercrop chili}}{\text{yield of sole chili}}$$

Relative crowding coefficient (RCC) was calculated using the following formulae (De Wit, 1960):

$$\text{RCC} = \frac{\text{Yab}}{(\text{Yaa} - \text{Yab})} - \frac{\text{Zc}}{\text{Zs}}$$

The competitive ratio (CR) among different combinations was calculated using the following formulae (Chatterjee and Maiti, 1984):

$$CRs = (RYs/RYc)/(Zs/Zc)$$
$$CRc = (RYc/RYs)/(Zc/Zs)$$

Benefit cost analysis was performed considering the prevailing price of sweet gourd and green chili at harvesting period in the local market. Benefit cost ratio (BCR) was calculated by following the formula:

$$BCR = \frac{\text{Gross return (Tk.)}}{\text{Variable cost (Tk.)}}$$

Where,

Yaa= yield of sole sweet gourd, Yab= yield of intercrop sweet gourd, CRs= competitive ratio of Sweet gourd, CRc = competitive ratio of chili (intercrop), RYs= relative yield of Sweet gourd, RYc= relative yield of chili, Zs and Zc are the sown/planting proportion of sweet gourd and chili, respectively, in mixture.

Collected data were analyzed (combined analysis) statistically with the help of 'R' software (version: R-3.2.1) and mean separation was done as per LSD at 5% level of significance.

Results and Discussion

Yield and yield component of sweet gourd

The vine length at harvest, vine length at 1st fruiting, fruits plant^{-1}, fruit length and diameter, single fruit weight and fruit yield of sweet gourd had significant difference among the treatments (Table 1). The length of vine was recorded from T_7 (640.00 cm and 340.00 cm) followed by T_1 (636.66 cm) and the shortest vine was calculated from T_6 (480.00 cm and 220.00 cm) at harvesting and at 1st fruiting, respectively. This is in agreement with the findings of Bello *et al.* (1995). Vine length and leaf number were not affected by all treatment factors. These results are consistent with the findings of Johnston and Onwueme (1998) who reported that assimilate does not build new leaves but are used to make more chlorophyll in existing leaves to increase light vesting. The highest number of fruits plant^{-1} (4.18) was obtained from T_7 which was followed by T_1 (3.45) and the lowest number of fruits plant^{-1} (2.59) was found in the treatment T_6. Sole sweet gourd (T_7) gave the highest fruit length (26.20 cm) and diameter (18.44 cm) which was followed by T_1 treatment (26.01cm length and 18.14 cm diameter) and the lowest fruit length (24.64 cm) and diameter (16.94 cm) were measured in T_6. Flesh thickness was no significant difference among the treatments. The highest fruit weight (2.06 kg) was observed from T_7 which was followed by T_1 (1.99 kg). Datta and Jana (2010) stated that the fruit length and diameter was positively and significantly correlated with individual fruit weight. The yield of sweet gourd in different treatments varied from 12.16 to 17.12 t ha^{-1} where 1.34 to 28.93 % yield reduction was recorded in intercropping systems than sole sweet gourd (T_7). Islam *et al.* (2013) stated that 15.51% yield was reduced in intercropping systems than sole potato. This was due to less competition of chili population with sweet gourd and apply optimum recommended fertilizer dose. The results are in agreement with the findings of Alom *et al.* (2014).

Table 1. Yield and yield component of sweet gourd of intercropping chili with sweet gourd under different fertilizer dose (pooled data of two years)

Treatment	Vine length (cm)	Vine length at 1st fruiting (cm)	Fruits plant^{-1} (no.)	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (cm)	Single fruit weight (kg)	Fruit yield (t ha^{-1})
T_1	636.66	296.66	3.45	26.01	18.14	4.11	1.99	16.88
T_2	573.33	243.33	3.16	25.96	17.72	3.89	1.77	15.22
T_3	573.33	226.66	2.92	25.11	17.33	3.44	1.70	13.50
T_4	636.66	246.66	3.40	25.96	17.97	4.05	1.87	16.09
T_5	553.33	220.00	3.15	24.84	17.30	3.77	1.88	14.71
T_6	480.00	220.00	2.59	24.64	16.94	3.75	1.77	12.16
T_7	640.00	340.00	4.18	26.50	18.44	4.19	2.06	17.12
T_8	-	-	-	-	-	-	-	-
LSD (0.05)	19.058	24.76	0.64	0.60	0.54	NS	0.19	0.702
CV (%)	2.74	8.14	16.56	1.98	2.60	8.202	8.63	3.88

T_1=100% sweet gourd (2m x 2m) + 40% chili (50cm x 100cm) + 1 00% RF of chili, T_2=100% sweet gourd (2m x 2m) + 40% chili (50cm x 100cm) + 75% RF of chili, T_3=100% sweet gourd (2m x 2m) + 40% chili (50cm x 100cm) + 50% RF of chili, T_4=100% sweet gourd (2m x 2m) + 50% chili (50cm x 80cm) + 100% RF of chili, T_5=100% sweet gourd (2m x 2m) + 50% chili (50cm x 80cm) + 75% RF of chili, T_6=100% sweet gourd (2m x 2m) + 50% chili (50cm x 80cm) + 50% RF of chili, T_7=Sole sweet gourd, T_8= Sole chili

Yield and yield component of chili

The results showed that there were significant differences of plant height, branches plant^{-1}, fruits plant^{-1} and fruit yield between sole crop and inter crops of chili in different fertilizer dose (Table 2). The tallest plant was recorded from T_8 (83.72 cm) and the shortest plant was calculated from T_6 (71.84 cm) at final harvest. Similar results were also obtained by Kadalli *et al.* (1989). The maximum number of branches plant^{-1} (6.38) was found from T_8 and the minimum number of branches was observed from T_6 (4.09). The highest number of fruits $plant^{-1}$ (95.66) was obtained from T_8 which was followed by T_1 (84.03) and the lowest number of fruits $plant^{-1}$ was found in T_6 (49.88) treatment. The maximum fruit weight $plant^{-1}$ was recorded from T_8 (193.33 g) and the minimum fruit weight $plant^{-1}$ was calculated from T_6 (77.50 g). Length of fruit did not differ significantly. The treatment T_8 (3.69 t ha^{-1}) produced the highest fruit yield and treatment T_3 (1.63 t ha^{-1}) gave lowest fruit yield. Alom *et al.* (2014) reported that green chili yield was higher in sole chili as compared to their corresponding intercrop yield. The chili yield was less due to mite infestation and heavy rainfall. Variation in fruit yield ha^{-1} of green chili might be influenced by the plant population and fertilizer dose in the intercropping systems.

Table 2. Yield and yield component of chili of intercropping chili with sweet gourd under different fertilizer dose (pooled data of two years)

Treatment	Plant height (cm)	Branches $plant^{-1}$ (no.)	Fruits $plant^{-1}$ (no.)	Fruit weight $Plant^{-1}$ (g)	Fruit length (cm)	Fruit yield (t ha^{-1})
T_1	81.41	6.16	84.03	143.33	5.19	1.99
T_2	77.56	4.89	58.83	100.00	5.04	1.67
T_3	75.68	4.56	52.19	82.50	5.12	1.63
T_4	83.28	5.32	70.27	136.67	5.13	2.56
T_5	79.50	5.08	59.11	111.66	4.79	2.09
T_6	71.84	4.09	49.88	77.50	4.64	1.72
T_7	-	-	-	-	-	-
T_8	83.72	6.38	95.66	193.33	5.21	3.69
$LSD_{(0.05)}$	1.57	0.367	1.18	9.27	NS	0.37
CV (%)	1.68	5.93	1.48	6.47	6.78	14.23

Relative crowding coefficient (RCC) and competitive ratio (CR)

Relative crowding coefficient plays a vital role in determining the competition effects and advantages of intercropping (Willey, 1979). Sweet gourd was highly dominant in T_1 treatment as it had higher value for relative crowding coefficient (69.93) than other intercrop (Table 3). It was inferred that the intercropped sweet gourd utilized the resources more competitively from T_1 treatment than other one and the lowest relative crowding coefficient (1.95) was measured in T_6.

Competitive ratio (CR) is an important way to know the variation among the intercrop combinations indicating their differential competitive ability of component crops as influenced by varying population and fertilizer dose. In case of sweet gourd, 100% sweet gourd (2m x 2m) + 40% chili (50 cm x 100cm) + 100% RF of chili (T_1) is more competitive than all other inter crops. Chili showed better competitiveness over sweet gourd indicating higher CR values (1.27-1.85). The highest CR value of chili was recorded in 100% sweet gourd (2m x 2m) + 50% chili (50 cm x 80cm) +100% RF of chili (T_4) due to higher population of chili and recommended fertilizer. Similarly, the highest CR value of sweet gourd (0.79) was found in 100% sweet gourd (2m x 2m) + 40% chili (50 cm x 100cm) + 75% RF of chili (T_2). Lower difference of CR values indicated better utilization of growth resources. However, T4 treatment produced higher productivity in terms of sweet gourd equivalent yield (21.21 t ha^{-1}) with CR difference (1.30). Treatment T_2 failed to produce higher productivity although CR difference was minimum (0.49). This was probably occurred due to poorer yield of sweet gourd. The CR over 1 (unity) indicates the species as good competitor while less than 1 (unity) indicates the species as poor competitor when grown in association (Jedel *et al*., 1998).

Table 3. Relative crowding coefficient (RCC) and Competitive ratio of intercropping chili with sweet gourd under different fertilizer dose

Treatment	Relative crowding coefficient (RCC)	Competitive ratio (CR)		
		Sweet gourd	chili	Difference
T_1	69.93	0.73	1.37	0.64
T_2	7.61	0.79	1.27	0.49
T_3	3.33	0.71	1.40	0.69
T_4	15.12	0.54	1.85	1.30
T_5	5.60	0.61	1.65	1.04
T_6	1.95	0.61	1.64	1.03
T_7	-	-	-	-
T_8	-	-	-	-

Sweet gourd equivalent yield (SGEY)

The sweet gourd equivalent yield was influenced in response to their different plant population and fertilizer dose (Table 4). The maximum sweet gourd equivalent yield (21.21 t ha^{-1}) was obtained from T4 treatment followed by T_1 treatment (20.86 t ha^{-1}). Sole crop of chili (T_8) gave the lowest sweet gourd equivalent yield of 7.38 t ha^{-1}. In some cases, sweet gourd equivalent yield was lower than sole crop due to poor yield of chili.

Table 4. Economic evaluation of intercropping chili with sweet gourd under different fertilizer dose

Treatment	SGEY (t ha^{-1})	LER	Gross return (Tk. ha^{-1})	Cost of production (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	Benefit cost ratio (BCR)
T_1	20.86	1.48	312900	80125	232775	3.91
T_2	18.56	1.30	278400	75218	203182	3.70
T_3	16.76	1.19	251400	70310	181090	3.58
T_4	21.21	1.59	318150	80215	237935	3.97
T_5	18.89	1.39	283350	75312	208038	3.76
T_6	16.6	1.14	249000	70418	178582	3.54
T_7	17.11	1.00	256650	70112	186538	3.66
T_8	7.38	1.00	110700	73245	37455	1.51

Price: *sweet gourd = Tk. 15 kg^{-1}, green chili = Tk. 30 kg^{-1}, Urea=TK. 16.00 kg^{-1}, TSP= TK. 22 kg^{-1}, MOP =TK. 15 kg^{-1}, Labour= TK. 300.00 per 8 hour head^{-1}*

Land equivalent ratio (LER)

The land equivalent ratio (LER) value is more than one (1.00) indicates yield advantage of intercropping. Land equivalent ratio (LER) of different intercropping combinations ranged from 1.14 to 1.59 which indicated the productivity increased 14-59% by intercropping. The highest land equivalent ratio (1.59) was obtained from 100% sweet gourd (2m x 2m) + 50% chili (50 cm x 80cm) + 100% RF of chili (T_4). LER value of 1.59 indicating productivity of intercropping 59% more land by growing sweet gourd and chili as intercropped. The lowest LER (1.14) was observed from 100% sweet gourd (2m x 2m) + 50% chili (50 cm x 80cm) + 50% RF of chili (T_6). The results are in agreement with the findings of Karim *et al.* (1990).

Economic evaluation

The highest gross return (Tk. 318150.00 ha^{-1}) and gross margin (Tk. 237935.00 ha$^{-1)}$ was obtained from T_4 which was followed by T_1. Gross return was increased with the increase of SGEY and the cost of production mainly increased with the increase of fertilizer cost. The lowest gross return (Tk. 110700.00 ha^{-1}) and gross margin (Tk. 37455.00 ha^{-1}) was obtained from T_8. Gross return and gross margin reflected the benefit cost ratio (BCR) among the treatments. As a result, higher BCR was recorded in T_4 (3.97) which was followed by T_1 (3.91) and lowest BCR (1.51) was calculated in treatment T_8 (Table 4). Akhteruzzaman *et al.* (2008) also obtained more benefit from intercropping due to judicious application of fertilizers.

Conclusions

Sweat gourd (100%) and chili (50%) with recommended fertilizer (100%) of chili might be economically profitable for chili with sweet gourd intercropping system.

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