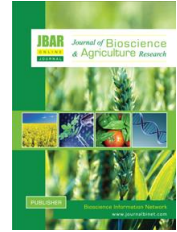


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Vol. 21, Issue 01: 1755-1761

Journal of Bioscience and Agriculture ResearchJournal Home: www.journalbinet.com/jbar-journal.html

Intercropping of pointed gourd with leafy vegetable and spices

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Article received: 01.04.19; Revised: 18.05.19; First published online: 30 May 2019.

ABSTRACT

*Intercropping, a method of crop intensification practiced produces more food per unit area and also used the maximum land of a country. In this study, to find out the performance of pointed gourd (*Trichosanthes dioica*) intercropped with two leafy vegetables (*Red amaranth*, *Amaranthus cruentus* & *Spinach*, *Beta vulgaris*) and one spices (*Coriander*, *Coriandrum sativum*). An intercropping experiment was conducted at the farmer's field of Multi location Testing (MLT) site (medium highland under AEZ-03), Goneshpur of Shibganj upazilla under Bogura district during two consecutive rabi season of 2012-13 to 2013-14. The experiment was laid out in randomized complete block design (RCBD) with six replications. There were four treatments viz. T_1 = Sole pointed gourd (100%), T_2 = 100% pointed gourd + 50% red amaranth, T_3 = 100% pointed gourd + 50% spinach and T_4 = 100% pointed gourd + 50% coriander. The highest pointed gourd equivalent yield (29.36 t ha^{-1}) and higher gross return (TK. 446288 t ha^{-1}) were found from T_4 (100% pointed gourd + 50% coriander) which was statistically similar to T_3 (100% pointed gourd + 50% spinach) & T_2 (100% pointed gourd + 50% red amaranth. The lowest equivalent yield (24.11 t ha^{-1}) and lowest BCR (3.46) were obtained from respective sole pointed gourd in the experiment. The result revealed that all the intercrops produced higher in terms of pointed gourd equivalent yield, gross return, gross margin and benefit cost ratio (BCR) over the sole pointed gourd in both the years. Therefore, the suitable intercropping system pointed gourd with spices crop is more profitable than that of other intercropping system in Bogura region.*

Key Words: Intercrop, Pointed gourd, Equivalent yield, Spinach, Red amaranth and Coriander

Cite Article: Akther, M. A., Parvin, S., Mollah, M. R. A. and Akther, S. (2019). Intercropping of pointed gourd with leafy vegetable and spices. Journal of Bioscience and Agriculture Research, 21(01), 1755-1761. **Crossref:** <https://doi.org/10.18801/jbar.210119.214>



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I. Introduction

Intercropping, a method of crop intensification practiced in densely populated countries produces more food per unit area. Crop intensification is thought to be a method for maximum utilization of land. Pointed gourd, *Trichosanthes dioica*, Family: cucurbitaceous; spinach, *Beta vulgaris*; Family: Chenopodiaceae; red amaranth, *Amaranthus cruentus*; Family: Amaranthaceae; Bushbean, Phaseolus

Vulgaris; Fabaceae etc. are good intercropping crop in our country same as maize with red amaranth (Alam *et al.*, 2018). The use of early maturing crop varieties, row arrangement, spacing and plant population are some of the imported methods that helps to increase the yield of intercrop (Craufard 2000). It increase the total productivity per unit area though maximum utilization of land, labour, and growth resources (Anonymous 1979). Intercrop is the practice of growing two or more crops simultaneously in same land area, particularly in the tropics (Faruque *et al.*, 2006). Intercropping offers more stability, less risk, better utilization of limited resources and wide diversity in the production of food (Hirota *et al.*, 1995; Islam *et al.*, 2006).

Intercropping is a system that might be increase total production profitability per unit area per time per inputs without affecting the production of the sole crops (Islam *et al.*, 2013). People of Bangladesh not only suffer from food deficit, but also suffer from different nutritional deficiency like protein and calories as well as vitamins and minerals. Pointed gourd (*Trichosanthes dioica*) can supply these types of vitamins & minerals because it is one of the most nutritive cucurbitaceous vegetables in our country. In Bangladesh, it is cultivated during summer season in about 4651 ha of land with total production of 25,295 tons. It is cultivated round the year in about 10020 hectares of land throughout the country (BBS 2011). It also has a good medicinal value. It is easily digestible, diuretic and laxative invigorates the heart & brain, and is useful in disorder of the circulatory system (Malek 2009). The scarcity of vegetables is also serious problems of Bangladesh in rainy season. In such situation, pointed gourd is one of the important vegetable to meet the food demand. Because, it is relatively long durable (8-10 months) and wide spaced crop with slow growth in early stage. So there is a scope to grow high value vegetables (red amaranth, spinach, bush bean) as intercrop at early growth stage without hampering pointed gourd production. The optimum planting time of pointed gourd is last week of October to second week of November. The growth of pointed gourd remains stunted during winter and at that time it could not cover the whole plot. Short duration leafy vegetable and spices can be cultivated in the uncovered area without hampering the yield of pointed gourd. The study was under taken to observe the performance of pointed gourd intercropped with leafy vegetables and spices.

II. Materials and Methods

The experiment was carried out at the Multi location Testing (MLT) site (medium highland under AEZ-03), Goneshpur of Shibganj upazilla under Bogura district during two consecutive rabi season of 2012-13 to 2013-14. In the study, to elucidate the suitable and profitable vegetables or spices crop for intercropping with pointed gourd. The experiment was laid out in randomized complete block design (RCBD) with six replications. The unit plot size was 2.5 m × 4 m and plant to plant distance was 1 m × 1.25 m. The climatic condition was cold and humid at the vegetative stage and moderately hot & high humid with frequent rain during fruiting and harvesting phase (Table 01). Pointed gourd var. BARI potol-2, red amaranth var. BARI Lalshak-1, Local var. of spinach and Local var. of coriander were used in the experiment. There were four treatments *viz.* T₁ = Sole pointed gourd (100%), T₂ = 100% pointed gourd + 50% red amaranths, T₃ = 100% pointed gourd + 50% spinach and T₄ = 100% pointed gourd + 50% coriander. The vines of pointed gourd were used as planting materials. The intercrops (red amaranth var. BARI Lalshak-1, Local var. of spinach and Local var. of coriander) were sown in broadcast on raised pointed gourd bed in line. Weeding, irrigation and crop protection measure were taken as and when necessary. No additional fertilizer was applied for intercrops. The vines were planted on 5-11 November 2012 and the seeds of vegetables & coriander were sown on 5- 25 November 2012. Manure and fertilizer were applied @ 277, 96, 300, 5, 3, 1.5 kg ha⁻¹, N, P, K, S, Zn, respectively and Cow dung @ 15 t ha⁻¹. Nitrogen (N) applied in three equal splits at 20, 60, 90 days after planting (DAP) of vine. Total amount of P, K, S, Zn and Cowdung were applied in pit during pit preparation. Before 5 days of planting of pointed gourd, pits were prepared. The pointed gourd plants were trailed over one meter high bamboo pandal. Pointed gourd was harvested from May 5 and continued up to October 21, 2013. After final harvest of pointed gourd fruit, the vines were pruned on late October, 2013. After vine pruning, the opened pointed gourd cultivated land were again cultivated for leafy vegetables and spices. The yield of intercrop was recorded in plot wise. Pruned pointed gourd again started fruiting on May 2014 and data was recorded on base of treatments. The yield and yield related data of all intercrops were recorded, and data were analyzed statistically using MSTAT-C and The significance of the differences among pairs of treatment means was calculated by DMRT (Gomez and Gomez, 1984). Pointed gourd equivalent yield, land equivalent ratio (LER) and benefit cost ratio (BCR)

were calculated to ascertain the efficiency of intercropping. Economic analysis was done on the basis of existing market prices of input and output (Reddy and Reddi, 1992).

Table 01. Meteorological data recorded at the experimental site during the study period

Months	During 2012-13			During 2013-14		
	Average Temperature (°C)		Average Relative Humidity (%)	Average Temperature (°C)		Average Relative Humidity (%)
	Maxi.	Min.		Maxi.	Min.	
January	-	-	-	23.43	10.14	93.87
February	-	-	-	28.74	15.22	89.03
March	-	-	-	32.78	19.85	86.5
April	-	-	-	33.69	22.92	84.97
May	-	-	-	-	-	-
June	-	-	-	-	-	-
July	32.88	26.54	93.09	-	-	-
August	33.23	26.8	87.13	-	-	-
September	33.02	26.3	93.06	-	-	-
October	32.54	22.94	93.41	-	-	-
November	29.27	17.22	91.9	-	-	-
December	23.09	13.09	94.31	-	-	-

System productivity: Total system productivity was calculated as summation of individual crop yield of each cropping cycle. The productivity of different crop sequences was compared by calculating their economic pointed gourd equivalent yield (PEY). The PEY was calculated using the following formula employed by (Ahlawat and Sharma, 1993).

$$\text{PEY} = \frac{\text{Yield of each intercrop (t ha}^{-1}\text{)} \times \text{Economic value of respective crop (Tk. t}^{-1}\text{)}}{\text{Price of Pointed gourd (Tk. t}^{-1}\text{)}}$$

On the other hand, Land equivalent ratio (LER) values were determined from the yield data of the crops according to Main (2008).

$$\text{LER} = \text{RYp} + \text{RYi} = \frac{\text{PiY}}{\text{PsY}} + \frac{\text{PEYcc}}{\text{PsY}}$$

Where, RYp=Relative yield of pointed gourd (main crop), RYi= Relative yield of intercrops (vegetables and spices), PiY= Intercrop yield of pointed gourd, PsY= Sole crop yield of pointed gourd, PEYcc= Pointed gourd equivalent yield of component crops {(component crop yield in intercrop price of component crop)/price of pointed gourd}.

III. Results and Discussion

Yield and yield contributing characters of pointed gourd: The yield and yield attributes of pointed gourd was presented in (Table 02). There was no significant different among the treatments in both the years. But numerically difference among the treatments in both the years. The highest average mean value of fruit length (9.66 cm) was observed in treatment T₁ (sole pointed gourd) and the lowest (5.25 cm) in treatment T₄ (100% pointed gourd + 50% coriander). The highest average mean value of fruit breath (3.49 cm) was recorded in treatment T₁ and the lowest (3.38. cm) in treatment T₂ (100% pointed gourd + 50% red amaranth). Similarly, the highest average mean value of fruits plant⁻¹ (2.94 kg) was recorded in treatment T₁ and the lowest (2.88 kg) in treatment T₂ (100% pointed gourd + 50% red amaranth).

Yield and yield contributing characters of pointed gourd and component crop: As the main crop pointed gourd was present in all the treatments. Result of intercropping on the yield of pointed gourd, red amaranth spinach and coriander are presented in Table 03. Slightly higher yield was observed from the sole pointed gourd cultivation in both the years. Due to the introduction of red amaranth, spinach, and coriander, the yield of pointed gourd was decreased. Both two year, the average highest value of fruit yield of pointed gourd (24.25 t ha⁻¹) was observed in treatments T₁ (sole pointed gourd), and the lowest (23.23 t ha⁻¹) from treatment T₄ (100% pointed gourd + 50% Coriander). The average mean value of yield of red amaranth (9.64 t ha⁻¹) of two years was recorded in treatment T₂ (100% pointed gourd + 50% red amaranth) whereas the average mean value of yield of spinach (10.50 t ha⁻¹) was observed in

treatment T₃ (100% pointed gourd + 50% spinach). On the other hand, the average mean value of yield of coriander (4.43 t ha⁻¹) in both year was obtained from treatment T₄ (100% pointed gourd + 50% Coriander). However, coriander yield was observed far below. But, it contributed on the productivity system of pointed gourd by increasing the production with the same management practices. It was observed that pointed gourd grown after red amaranth spinach, and coriander produced slightly lower yield than that of pointed gourd grown only. In case of total productivity and benefit cost ratio, the result indicated that intercropping system is better than sole crop.

Table 02. Yield contributing characters of pointed gourd with leafy vegetables and spices under intercropping situation at the MLT site of Shibganj upazilla under, Bogura district during Rabi 2012-13 to 2013-14

Treatments	Fruits length (cm)			Fruit breadth (cm)			Wt. of fruits plant ⁻¹ (kg)		
	2012-13	2013-14	Mean	2012-13	2013-14	Mean	2012-13	2013-14	Mean
	T ₁ =100% pointed gourd	10.16	9.16a	9.66	3.65	3.33a	3.49	2.98a	2.90a
T ₂ =100% pointed gourd + 50% red amaranth	9.83	9.00a	9.41	3.56	3.20a	3.38	2.93a	2.83a	2.88
T ₃ =100% pointed gourd + 50% spinach	9.66	8.66a	9.16	3.63	3.25a	3.44	3.18a	3.06a	3.12
T ₄ =100% pointed gourd + 50% Coriander	10.00	8.50a	5.25	3.60	3.25a	3.42	3.09a	3.01a	3.05
CV(%)	8.71	7.36	8.03	8.01	8.86	8.43	9.25	10.91	10.08

Means in a column having same letter did not differ significantly.

Table 03. Yield and equivalent yield of pointed gourd and intercropped at MLT site of Shibganj upazilla under Bogura district during the rabi season of 2012-13 to 2013-14

Treatments	Fruit yield of pointed gourd (t ha ⁻¹)			Yield of intercrop (t ha ⁻¹)									Pointed gourd equivalent yield (t ha ⁻¹)		
	2012-13	2013-14	Mean	Red amaranth			Spinach			Coriander			2012-13	2013-14	Mean
				2012-13	2013-14	Mean	2012-13	2013-14	Mean	2012-13	2013-14	Mean			
T ₁	24.40	24.10	24.25	-	-	-	-	-	-	-	-	-	24.40b	24.11b	24.30
T ₂	23.75	23.35	24.00	7.15	12.13	9.64	-	-	-	-	-	-	25.88ab	26.99ab	26.43
T ₃	23.60	23.65	23.63	-	-	-	7.63	13.3	10.5	-	-	-	26.70a	28.31a	27.50
T ₄	23.31	23.16	23.23	-	-	-	-	-	-	3.91	4.96	4.43	27.23a	29.36a	28.30
CV(%)	-	-	-	-	9.17	-	-	-	-	-	-	-	8.08	-	-

Means in a column having same letter did not differ significantly. T₁ = Sole pointed gourd (100%), T₂ = 100% pointed gourd + 50% red amaranth, T₃ = 100% pointed gourd + 50% spinach and T₄ = 100% pointed gourd + 50% coriander

Pointed gourd equivalent yield (PEY) and economics: The results presented in Table 02 indicated that yield contributing characters of pointed gourd were not varied significantly among the treatments but pointed gourd equivalent yield in all the intercropping treatments showed better performance than sole (Table 04). The maximum pointed gourd equivalent yield (29.36 t ha⁻¹) was obtained from the treatment T₄ (100% pointed gourd +50% Coriander) and it was statistically similar to T₃ (100% pointed gourd + 50% spinach) and T₂ (100% pointed gourd +50% red amaranth) but differed from T₁ (100% pointed gourd). Higher pointed gourd equivalent yield was recorded from all the treatments. As high as Tk. 566000 ha⁻¹ in terms of gross return was achieved by intercropping of pointed gourd with coriander followed by pointed gourd + spinach (Tk. 550000 ha⁻¹), pointed gourd + red amaranth (Tk. 528600 ha⁻¹) and sole pointed gourd (Tk. 486000 ha⁻¹) (Table 05). Regarding net return, the maximum of Tk. 425088 ha⁻¹ was gained while pointed gourd was intercropped with coriander. Intercropping pointed gourd with spinach (Tk. 408588 ha⁻¹) ranked next to pointed gourd + coriander followed by pointed gourd + red amaranth (Tk. 387288 ha⁻¹) and the least with pointed gourd sole (Tk. 366500 ha⁻¹) (Table 05). While benefit cost ratio (BCR) was calculated, the intercropping pointed gourd with coriander incurred the highest value of 4.01 followed by pointed gourd with spinach (3.88), pointed gourd with red amaranth (3.76) and sole pointed gourd (3.48). In the present investigation, it was observed that intercropping pointed gourd with red amaranth spinach and coriander gave higher economic return than sole pointed gourd. Among the intercrops coriander

intercropped with pointed gourd was most profitable in terms of yield and economic return. The total productivity increase of 11.94-21.77 percent over sole pointed gourd where the combined treatment of 100% pointed gourd + 50% coriander was the highest total productivity (21.77%) than other treatments (Table 04). Anonymous (1979) said that intercropping system increase total productivity per unit area though maximum utilization of land, labour and growth resources. Mondol et al. (2004) reported that monoculture produced the highest yields of individual crop. Maitra et al. (2001) reported that all intercropping systems generated higher returns than sole crop. Islam et al. (2015) also reported that intercropping system pointed gourd with vegetables and spices was better than that of sole pointed gourd. A similar result was also reported by Rao and Willey (1980). Ahmed et al. (2010) and Mahfuza et al. (2012) found that the higher equivalent yield of pointed gourd in intercropping systems compared to sole crop.

Land equivalent ratio (LER): The land equivalent ratio (LER) in all the intercropping system was efficient having LER values more than 1.0 (Table 04). LER of different crop combination ranged from (1.07-2.17) indicating 12-22% yield advantage by intercropping. The maximum LER value (2.17) was found from treatment T₄ (100% pointed gourd + 50% Coriander. The total productivity increase of percent over sole pointed gourd where 100% pointed gourd+ 50% coriander increased the highest total productivity (21.77).

Table 04. Pointed gourd equivalent yield (PEY) and land equivalent ratio (LER) under intercropping pointed gourd with vegetables and spices

Treatments	PEY	LER	% increase of total productivity
T ₁ = 100% pointed gourd	24.11	1.00	-
T ₂ = 100% pointed gourd + 50% red amaranth	26.99	1.25	11.94
T ₃ = 100% pointed gourd + 50% spinach	28.31	1.07	17.42
T ₄ = 100% pointed gourd + 50% Coriander	29.36	2.17	21.77

Table 05. Economic performance of pointed gourd and leafy vegetables & spices in intercropping system at MLT site of Shibgonj upazilla under, Bogura district during 2013 to 2014 (Average of 2 Years)

Treatments	Gross return (Tk. ha ⁻¹)	Total cost (Tk. ha ⁻¹)	Gross margin (Tk. ha ⁻¹)	BCR
T ₁ = 100% pointed gourd	486000	139412	366500	3.48
T ₂ = 100% pointed gourd + 50% red amaranth	528600	141312	387288	3.74
T ₃ = 100% pointed gourd + 50% spinach	550000	141412	408588	3.88
T ₄ = 100% pointed gourd + 50% coriander	566000	140912	425088	4.01

Market price: Red amaranth @Tk. 6/kg, Spinach @ Tk. 7/kg, Coriander @ Tk. 25/kg and Pointed gourd @ Tk. 20/kg.

IV. Conclusion

Considering two years result, it was observed that intercropping of pointed gourd with red amaranth, spinach and coriander gave higher economic return than the sole pointed gourd. Among the intercrops, coriander was the most profitable intercrop and ensuring higher yield and economic return to the farmers in both the years.

Acknowledgement

We gratefully acknowledge the financial support of integrated crop Management (ICM) project, BARI Gazipur to conduct the research. We also want to thank for nice co-operation of farmers and Md. Shifur Rahman, scientific Assistant of Multiplications Testing Site (MLTS), Shibganj, Bogura.

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