

EFFECT OF VARIETY AND PLANT SPACING ON LEAF YIELD OF BOTTLE GOURD IN BANGLADESH

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Abstract

An experiment was conducted in the farmers' field at the Farming System Research and Development site of On-Farm Research Division, Bangladesh Agricultural Research Institute, Elenga, Tangail, during the two consecutive years of *Rabi* (winter) season of 2014-15 and 2015-16 under young Brahmaputra and Jamuna floodplain to find out the suitable variety and planting spacing of bottle gourd for leaf production purpose through increasing twig production and ultimately increasing farmers' income in this region of Bangladesh. The experiment was conducted in Randomized Complete Block Design with six dispersed replications. Three varieties viz., BARI Lau-3, BARI Lau-4, and one local variety were tested with four planting spacing viz., 30 cm × 20 cm, 35 cm × 10 cm, 40 cm × 10 cm, and 40 cm × 20 cm. Among the varieties, the highest average twig yield (37.76 t ha⁻¹) and gross margin (Tk. 468170 ha⁻¹) along with BCR (3.69) were obtained from var. BARI Lau-4 along with 30 cm × 20 cm plant spacing. After the completion of a two-years trial, BARI Lau-4 may be recommended for large scale production following 30 cm x 20 cm spacing for better twig yield and economic benefit.

Keywords: Bottle gourd, spacing, variety leaf yield, gross margin and BCR.

Introduction

Bottle gourd [*Lagenaria siceraria* (Molina) Standl.] is one of the popular vegetables generally grown in the homestead areas of Bangladesh. But now a days it is commercially grown in the crop fields. Bottle gourd cultivation is increasing due to its high yield potential and steady market price. The fruits contain 0.2% protein, 2.9% carbohydrates, 0.5% fat, and 11 mg of vitamin C per 100g fresh weight (Aykroyd, 1963). A 100 g bottle gourd leaves contain 109 Kcal energy, 90.2 g water, 2.5 g protein, 0.6 g fat, 0.6 g carbohydrate, 4.4 g total dietary fibre, 1.7 g ash, 94 mg Ca, 3.1 mg Fe, 69 mg Mg, 28 mg P, 276 mg K, 41 mg Na, 0.49 mg Zn, 0.15 mg Cu, 198 micro gram Vitamin A, 0.07 mg Thiamin, 0.17 mg Riboflavin, 1.4 mg Niacin, 0.19 mg Vitamin B6, 73 micro gram folate, 47.7 mg Vitamin C (Shaheen *et al.*, 2013). According to Rahman (2003), among all the cucurbits, the bottle gourd is the only plant that contains the highest choline level

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along with required metabolic precursors for brain function. At present land under vegetable production in Bangladesh is 4,49,742 ha, yielding 45,76,225 ton. Among the total vegetable production, bottle gourd leaf contributes 31126 t from 6816 ha of land (BBS, 2021). Recently the leaves and twigs of bottle gourd have become a very popular vegetable all over the country. Its demand is increasing day by day. It has a strong possibility of becoming the most popular leafy vegetable. Farmers' can easily produce and sell this leafy vegetable at a high price and get a higher benefit within a short period of time. There is no recommended variety of bottle gourd available for leaf production. Farmers can grow the following BARI released bottle gourd varieties for leaf production: BARI Lau-2, BARI Lau-3, and BARI Lau-4. The leaf of the bottle gourd can reduce the nutritional deficiency and the farmers will be economically benefitted (Rahman *et al.*, 2008). Spacing is one of the most important factors for crop production. Baloch *et al.* (2002) observed that wider plant spacing or lowered densities increased the nutrient area per plant which results in developed morphological characters. El-Badaway and Mehasen, 2012, revealed that the closest spacing gave the tallest plant due to greater competition for space and light and thereby forcing the plants to grow taller. On the other hand, wider spacing ensures the basic requirements but decrease the total number of plants as well as total yield. Yield may be increased up to 25% by using optimum spacing (Bansal, *et al.*, 1995). Along with the mentioned benefits there are also other benefits of proper plant spacing like seedling age, soil quality, nutrient intake, disease management, weeding, irrigation, ease of harvest, increased yield, and so on. Therefore, the present study was undertaken to find out the best suitable variety and planting spacing of bottle gourd for leaf purposes in the young Brahmaputra and Jamuna floodplain regions of Bangladesh.

Materials and Methods

The experiment was conducted at the FSRD (Farming System Research and Development) site, of On-Farm Research Division, Bangladesh Agricultural Research Institute, Elenga, Tangail, during rabi 2014-15 and 2015-16 under AEZ# 8 (Young Brahmaputra and Jamuna Floodplain). The study site is located at latitude 24°20'9.2904" North and longitude 89°54'30.6972" East at a height of 15 m above sea level. The maximum, minimum temperature (°C), and total rainfall (mm) are presented in figure 1 (BMD, 2016). The experimental location was prepared one month before transplanting. The land was fertilized with 5 t ha⁻¹ cow dung and 81, 35, 75, 18, 5, and 2 kg ha⁻¹ of N, P, K, S, Zn, and B, respectively. All cow dung, 1/5 N, P, 1/2 K, S, Zn, and B were applied during final land preparation. The remaining K and N were applied in four splits after each harvest of twigs. After that, the soil of the site was cleared, ploughed, leveled, and divided into plots. The experiment was laid out in Randomized Complete Block Design with six dispersed replications. The unit plot size was 4 m × 2 m. Three varieties viz., V₁: BARI Lau-3, V₂: BARI Lau-4, and V₃: Local variety with four planting spacing viz., S₁: 30 cm × 20 cm, S₂: 35 cm × 10 cm, S₃: 40 cm × 10 cm and S₄: 40 cm × 20

cm were selected as treatments. The seeds were sown on 27 to 28 October 2014 and 13 to 14 October 2015 in 2014 and 2015, respectively. Weeding and all other intercultural operations were done as and when necessary. Insecticides, fungicides, and other pesticides were applied when required. Data collection started from 35 DAS and continued to 95 DAS. The twigs were harvested five times (at 12-15 days intervals). Data on length of twigs, bundle/plot, and twig yield/plot were recorded during harvesting. After collecting the data from different parameters were statistically analyzed using the R Project for Statistical Computing Software version (4.1.1) (R Core Team, 2021). The cost and return analysis was conducted according to the market value of inputs and produce.

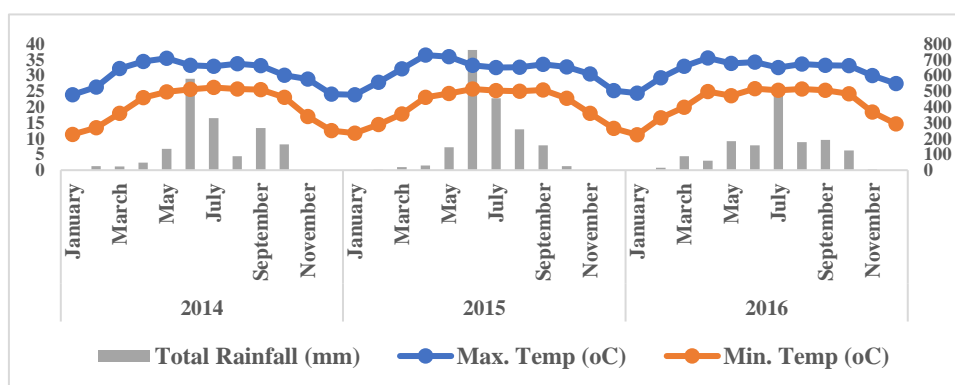


Fig. 1. Maximum, minimum temperature (°C), and total rainfall (mm) during 2014-15 and 2015-16 at FSRD site, Elenga, Tangail.

Results and Discussion

Effect of variety on yield and yield attributes of bottle gourd

The effect of bottle gourd varieties on yield and yield attributes was analyzed and summarized in table 1. The analysis was found that in season 2014-15, the length of twigs of BARI Lau-3 (V_1), BARI Lau-4 (V_2), and local variety (V_3) was statistically non-significant. But in the 2015-16 seasons it was found that BARI Lau-4 had the highest length of twigs, which is significantly different from other varieties. In the case of the number of bundles per plot, it was found that in season 2014-15, the highest number of bundles per plot was observed in BARI Lau-4 followed by local variety and BARI Lau-3. However, in season 2015-16, it was observed that the maximum number of bundles of twigs per plot was found in BARI Lau-4, followed by BARI Lau-3 and local variety. In season 2014-15, individual bundle weights of twigs of three varieties were not significantly different but in season 2015-16 performances of varieties were significantly different. The maximum individual bundle weight of twigs was found in BARI Lau-4 followed by BARI Lau-3 and local variety. Twig weight per plot was significantly affected by varieties. In the season 2014-15, analysis of twig weight per plot showed that the higher weight of twig per plot in BARI Lau-4 followed

by local variety and BARI Lau-3. In season 2015-16 it was found that higher weight of twig per plot in BARI Lau-4 was similar to the result of the previous season but the performance of BARI Lau-3 was comparatively better than local variety.. Yield analysis revealed that in season 2014-15, yield of twigs was not significantly affected by the variety but season (2015-16) it was observed that the twig yields were significantly affected by the variety. The highest twig yield was found in BARI Lau-4 which was significantly different from the other two varieties. The lowest twig yield was found in the local variety and the moderate twig yield in BARI Lau-3. By analyzing the two season's data it was showed that the highest twig yield was obtained from BARI Lau-4.

Table 1. Twig yield and yield contributing attributes of bottle gourd as influenced by variety at FSRD site, Elenga, Tangail during 2014-15 and 2015-16

Variety	Length of the twig (cm)		Bundle plot ⁻¹ (no.)		Individual bundle weight (kg)		Twig weight plot ⁻¹ (kg)		Yield (t ha ⁻¹)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
V ₁	50.75 a	52.50b	44.90b	63.75b	0.518a	0.516ab	22.27b	32.11b	25.89a	37.10b
V ₂	51.75a	54.62a	48.07a	67.75a	0.529a	0.522a	24.43a	34.92a	28.40a	40.60a
V ₃	52.25a	52.62b	46.75ab	55.87c	0.524a	0.506b	23.44ab	27.73c	27.25ab	31.66c
LSD _{0.05}	2.20	1.62	2.33	3.96	0.01	0.01	1.49	2.48	1.73	3.07
CV (%)	5.88	4.70	4.54	5.76	2.43	2.80	5.80	7.14	6.85	7.64

Note: V= Variety, V₁= BARI Lau-3; V₂= BARI Lau-4 and V₃= Local variety.

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

Effect of planting spacing on yield and yield attributes of bottle gourd

The effect of planting spacing on yield and yield attributes of bottle gourd was analyzed(table 2). The length of twigs was not significantly affected by the planting spacing during 2014-15, but in season 2015-16 it was found that the highest length of twigs was found in 35 cm x 10 cm spacing and the lowest twig length in 40 cm x 20 cm spacing, but in the case of spacing 30 cm x 20 cm and spacing 40 cm x 10 cm was found statistically similar. The number of bundles per plot was also statistically different depending on planting spacing. In 2014-15, the maximum number of bundles per plot was obtained with a 30 cm x 20 cm (S₁) followed by 35 cm x 10 cm (S₂) and 40 cm x 10 cm (S₃) planting spacing. But the minimum number of bundles per plot was obtained using 40 cm x 20 cm (S₄) planting spacing. On the other hand, in season 2015-16, planting spacing of 30 cm x 20 cm, 35 cm x 10 cm, and 40 cm x 10 cm showed a statistically similar but the lowest number of bundles per plot with 40 cm x 20 cm plant spacing. Planting spacing had a significant effect on individual bundle weight. In season 2014-15 the maximum weight of an individual bundle was obtained from 40 cm x 20 cm followed by 40 cm x 10 cm and 35 cm x 10 cm planting spacing and the minimum

weight of an individual bundle from 30 cm x 20 cm planting spacing. In season (2015-16) revealed that 40 cm x 20 cm planting spacing provided the maximum performance, followed by 30 cm x 20 cm and 40 cm x 10 cm planting spacing and the lowest from 35 cm x 10 cm planting spacing. Twig yield per plot and twig yield per hectare were also significantly affected by planting spacing. In season 2014-15 was found that the maximum twig yield per plot and per hectare was obtained from a 30 cm x 20 cm followed by 35 cm x 10 cm and 40 cm x 10 cm spacing treatments. But the lowest twig yield per plot and per hectare was obtained from the 40 cm x 20 cm spacing treatment. Whereas, in season 2015-16 was found that the spacing effect was statistically non-significant. In the case of spacing effect on yield and yield attributes of bottle gourd, it can be concluded that the spacing effect S₁ (30 cm x 20 cm) performed better than any other planting spacing treatments. The results of the spacing effect are in conformity with the findings of Kabir *et al.* (2013) and Naher (2015).

Table 2. Yield and yield attributes of bottle gourd as influenced by planting spacing at FSRD site, Elenga, Tangail during 2014-15 and 2015-16

Spacing	Length of the twig (cm)		Bundle plot ⁻¹ (no.)		Individual bundle weight (kg)		Twig weight plot ⁻¹ (kg)		Yield (t ha ⁻¹)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
S ₁	52.50a	53.50ab	51.93a	64.33a	0.510c	0.512ab	25.54a	32.36a	29.69a	37.42a
S ₂	51.17a	54.00a	48.47b	65.00a	0.517bc	0.507b	24.09ab	32.35a	28.01ab	37.43a
S ₃	50.83a	53.50ab	45.30c	61.83ab	0.529ab	0.512ab	22.98b	31.10a	26.71b	35.82a
S ₄	51.83a	52.00b	40.60d	58.67b	0.538a	0.529a	20.91c	30.54a	24.31c	35.14a
LSD _{0.05}	2.54	1.87	2.69	4.57	0.016	0.02	1.72	2.87	2.00	3.54
CV (%)	5.88	4.70	4.54	5.76	2.43	2.80	5.80	7.14	6.85	7.64

Note: S= Spacing, S₁= 30 cm x 20 cm; S₂= 35 cm x 10 cm; S₃= 40 cm x 10 cm and S₄= 40 cm x 20 cm. In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

Interaction effect of variety and spacing on yield and yield attributes of bottle gourd

Interaction effects between variety and spacing of planting were significant for yield and yield attributes, which were analyzed and summarized in Table 3. In the first season (2014-15) analysis was found that the maximum length of the twig was observed in local variety planted at a spacing of 30 cm x 20 cm which was statistically identical to all of the interaction effects except for BARI Lau-3 planted at a spacing of 40 cm x 10 cm. The lowest length of the twig was observed in BARI Lau-3 planted at a spacing of 40 cm x 10 cm. In season (2015-16) maximum twig length was observed in var. BARI Lau-4, planted at a spacing of 30 cm x 20 cm which was at par to same variety planted at 35 cm x 10 cm, 40 cm x 10 cm spacing and with BARI Lau-3 planted at 35 cm x 10 cm, 40 cm x 10 cm, 40 cm x 20 cm and also similar to local variety planted at 30 cm x 20 cm, 35 cm x 10 cm,

40 cm x 10 cm spacing. The lowest length of the twig was observed in bottle gourd local variety planted at a spacing of 40 cm x 20 cm. In season 2014-15, BARI Lau-4 planted at a spacing of 30 cm x 20 cm provided the maximum number of bundles per plot which was statistically identical to the same variety planted at 35 cm x 10 cm spacing and local variety planted at a spacing of 30 cm x 20 cm. The lowest number of bundles per plot was obtained from BARI Lau-3 planted at a spacing of 40 cm x 20 cm. Similarly, in the following season (2015-16), the number of bundles per plot was maximum BARI Lau-4 planted at a spacing of 30 cm x 20 cm while local variety planted at 40 cm x 20 cm provided the lowest number of bundles per plot. In the case of individual bundle weight of twigs, in the first season (2014-15), the highest individual bundle weight of twigs was observed in BARI Lau-4. The lowest individual bundle weight of a twig was obtained from BARI Lau-3 planted at a spacing of 30 cm x 20 cm. In the season 2015-16, the maximum individual bundle weight of twigs was found in BARI Lau-3 followed by BARI Lau-4 planted at a spacing of 40 cm x 20 cm and BARI Lau-3 along with planting spacing of 30 cm x 20 cm, 35 cm x 10 cm, 40 cm x 10 cm, BARI Lau-4 planted at 30 cm x 20 cm, 35 cm x 10 cm, 40 cm x 10 cm and local variety planted at 40 cm x 10 cm, 40 cm x 20 cm spacing. The lowest weight of an individual bundle of the twig was found in local variety planted at a spacing of 30 cm x 20 cm and 35 cm x 10 cm. BARI Lau-4 planted at a spacing of 30 cm x 20 cm gave the highest twig yield per plot and per hectare in both seasons (2014-15 and 2015-16), which was statistically identical to BARI Lau-4 planted at a spacing of 35 cm x 10 cm and local variety planted at a spacing of 30 cm x 20 cm in season 2014-15. In case of season 2015-16, BARI Lau-3 planted at a spacing of 35 cm x 10 cm and BARI Lau-4 planted at a spacing of 35 cm x 10 cm, 40 cm x 10 cm were also statistically identical. But in 2014-15, BARI Lau-3 planted at a spacing of 40 cm x 20 cm gave the lowest twig yield in both cases, and in the case of season 2015-16, local variety planted at 40 cm x 10 cm and 40 cm x 20 cm gave the lowest twig yield per plot and per hectare. Finally, revealed that the maximum average twig yield per hectare was found in BARI Lau-4 planted at a spacing of 30 cm x 20 cm. In the case of the spacing effect similar results were also reported by Samih (2008), Kabir *et al.* (2013), and Shivani *et al.* (2019).

Cost and return analysis for different varietal and planting spacing effects

The fundamental aim of the research was to find out the cost effective and profitable cultivation technique to the farmers. In table 4, showed the comparison of average twig yield, gross margin, and BCR among different treatments. In table 4, the highest average twig yield (37.76 t ha⁻¹) was obtained from the interaction effect of BARI Lau-4 along with planting spacing of 30 cm x 20 cm and the lowest average twig yield (28.28 t ha⁻¹) from the local bottle gourd variety along with planting spacing of 40 cm x 20 cm. In the case of gross margin, it was found that the maximum gross margin (Tk. 468170 ha⁻¹) along with the highest BCR (3.69) was obtained from V₂S₁ treatment (BARI Lau-4 along with planting spacing of 30 cm x 20 cm). The minimum gross margin (Tk. 307095 ha⁻¹) was obtained from the V₃S₄ treatment (Table 4), along with the lowest BCR (2.77).

Table 3. Interaction effects of varieties and spacing on the yield and yield attributes of bottle gourd during 2014-15 and 2015-16

Variety and spacing	Length of the twig (cm)		Bundle plot ⁻¹ (no.)		Individual bundle weight (kg)		Twig weight plot ⁻¹ (kg)		Yield (t ha ⁻¹)		
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	Average
V ₁ S ₁	52.00	51.00	49.40	64.50	0.497	0.505	23.59	31.52	27.43	36.45	31.94
	ab	bc	bcd	abcd	c	ab	bc	bcd	bc	bcd	
V ₁ S ₂	50.50	53.50	47.90	70.00	0.520	0.505	23.92	34.40	27.81	40.30	34.05
	ab	ab	bcde	ab	abc	ab	bc	ab	bc	ab	
V ₁ S ₃	49.50	52.50	43.70	61.00	0.530	0.520	22.18	31.16	25.79	35.82	30.80
	b	abc	ef	cdef	ab	ab	cd	bcd	cd	bcd	
V ₁ S ₄	51.00	53.00	38.60	59.50	0.525	0.535	19.37	31.37	22.52	36.12	29.32
	ab	abc	g	def	abc	a	d	bcd	d	bcd	
V ₂ S ₁	51.00	55.50	54.70	71.00	0.520	0.530	27.53	37.31	32.00	43.52	37.76
	ab	a	a	a	abc	ab	a	a	a	a	
V ₂ S ₂	52.00	55.00	51.00	68.00	0.520	0.515	25.52	34.64	29.67	40.30	34.98
	ab	a	abc	abc	abc	ab	ab	ab	ab	ab	
V ₂ S ₃	52.00	55.00	45.20	69.50	0.532	0.510	23.08	34.83	26.83	40.52	33.67
	ab	a	def	ab	ab	ab	bc	ab	bc	ab	
V ₂ S ₄	52.00	53.00	41.40f	62.50	0.545	0.535	21.58	32.88	25.09	38.03	31.56
	ab	abc	g	bcde	a	a	cd	abc	cd	abc	
V ₃ S ₁	54.50	54.00	51.70	57.50	0.512	0.500	25.50	28.25	29.65	32.27	30.96
	a	ab	ab	def	bc	b	ab	cd	ab	cd	
V ₃ S ₂	51.00	53.50	46.50	57.00	0.513	0.500	22.83	28.00	26.55	31.98	29.26
	ab	ab	cde	def	bc	b	bc	cd	bc	cd	
V ₃ S ₃	51.00	53.00	47.00	55.00	0.525	0.505	23.67	27.30	27.51	31.12	29.31
	ab	abc	cde	ef	abc	ab	bc	d	bc	d	
V ₃ S ₄	52.50	50.00	41.80	54.00	0.545	0.517	21.77	27.37	25.31	31.26	28.28
	ab	c	fg	f	a	ab	cd	d	cd	d	
LSD _{0.05}	4.40	3.24	4.66	7.92	0.03	0.03	2.98	4.96	3.47	6.13	-
CV(%)	5.88	2.76	4.54	5.76	2.43	2.80	5.80	7.14	5.80	7.64	-

Note: VS= Variety and spacing. In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

Table 4. Cost and return analysis of bottle gourd varieties and spacing interaction during 2014-15 & 2015-16

Treatments	Average Twig yield (t ha ⁻¹)	Gross return (Tk. ha ⁻¹)	Total cost (Tk. ha ⁻¹)	Gross margin (Tk. ha ⁻¹)	BCR
V ₁ S ₁	31.94	542980	173750	369230	3.13
V ₁ S ₂	34.05	578935	173750	405185	3.33
V ₁ S ₃	30.80	523685	173750	349935	3.01
V ₁ S ₄	29.32	498440	173750	324690	2.87
V ₂ S ₁	37.76	641920	173750	468170	3.69
V ₂ S ₂	34.98	594745	173750	420995	3.42
V ₂ S ₃	33.67	572475	173750	398725	3.29
V ₂ S ₄	31.56	536520	173750	362770	3.09
V ₃ S ₁	30.96	526320	173750	352570	3.03
V ₃ S ₂	29.26	497505	173750	323755	2.86
V ₃ S ₃	29.31	498355	173750	324605	2.86
V ₃ S ₄	28.28	480845	173750	307095	2.77

Note: The market price of different inputs (Tk kg⁻¹): Urea- 16, TSP (Triple Super Phosphate)- 22, Muriate of Potash (MoP)- 15, Gypsum-13, Zinc Sulphate-200, Boric acid-400, Cowdung- 2, Labour wage- 300 day⁻¹ person⁻¹, land leasing cost Tk.75,000 . ha⁻¹year⁻¹. The market price of twig (Tk. kg⁻¹):17.

Conclusion

The highest average bottle gourd twig yield (37.76 t ha⁻¹) was obtained from bottle gourd var. BARI Lau-4 along with planting spacing of 30 cm x 20 cm and the lowest average twig yield (28.28 t ha⁻¹) from the local bottle gourd variety along with planting spacing of 40 cm x 20 cm.

In the case of gross margin, the maximum gross margin (Tk. 468170 ha⁻¹) along with the highest BCR (3.69) was obtained from V₂S₁ treatment (BARI Lau-4 along with planting spacing of 30 cm x 20 cm). After the completion of a two year trial, var. BARI Lau-4 could be recommended for large scale production following 30 cm x 20 cm spacing in the Tangail region of Bangladesh for better twig yield and economic benefit.

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