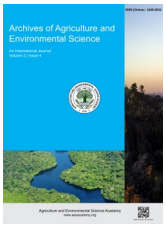
Archives of Agriculture and Environmental Science 5(3): 313-319 (2020)
https://doi.org/10.26832/24566632.2020.0503012

e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes



ORIGINAL RESEARCH ARTICLE

Effect of variety and nutrient sources on growth and yield of broccoli in southern belt of Bangladesh

Mohammad Imran Hossain[1], Mohammad Ali[1], Md. Nazmul Hasan Mehedi[2*], Mahmudul Hasan[1], Mohammad Joyel Sarkar[2] and Nowrin Islam Toma[3]

[1]Department of Horticulture, Patuakhali Science and Technology University, [2]Horticulture Division, Bangladesh Institute of Nuclear Agriculture, [3]Department of Agricultural Economics, EXIM Bank Agricultural University BANGLADESH
[*]Corresponding author's E-mail: nazmul02348@gmail.com

ARTICLE HISTORY

Received: 09 July 2020
Revised received: 31 August 2020
Accepted: 18 September 2020

Keywords

Broccoli
Fermented plant juice
Nutrient
Variety
Yield

ABSTRACT

Ongoing use of synthetic fertilizers affects soil structure. Organic manures can serve as an alternative to synthetic fertilizers. The study evaluated performance of five different types of nutrient sources (T_0 =control, T_1 = Urea @ 250 kg/ha, TSP @ 150 kg/ha, MoP @ 200 kg/ha, T_2 = Cowdung @ 25 t/ha, T_3 = Vermi compost @ 5 t/ha, T_4 = fermented plant juice @ 500 ml/ha and T_5 =Liquid fertilizer (Flora: consists of 20% nitrobenzene) @ 200 ml/ha) on growth and yield of broccoli, cvs. "V_1=Known You" and "V_2=Early Green". Yield and yield contributing parameters such as plant height, number of leaves per plant, leaves fresh weight, length of stem, stem diameter, stem fresh weight, days taken for primary curd initiation, curd diameter, fresh weight of primary curd, no. of secondary curd per plant, fresh weight of secondary curd and yield per plot as well as hectare were measured in this experiment. In case of variety, the highest yield/plot 5.83kg and yield/ha 20.23 tons were recorded from "Early green". Considering the nutrient factor, the highest curd weight (290.4g) per plant and yield/plot (5.01kg) were found in fermented plant juice nutrient sources. The highest benefit cost ratio BCR (3.21:1) was found in V_2T_4, among all other treatment combinations in respect of net return (Tk. 228934.97/ha) through the use of fermented plant juice. Therefore, it can be concluded that fermented plant juice @ 500 ml/hacan be used to improve vegetative growth, and yield quality and quantity, and the broccoli cv. "Early Green" appears to be the best of the cultivars tested.

Citation of this article: Hossain, M.I., Ali, M., Mehedi, M.N.H., Hasan, M., Sarkar, M.J. and Toma, N.I. (2020). Effect of variety and nutrient sources on growth and yield of broccoli in southern belt of Bangladesh. *Archives of Agriculture and Environmental Science*, 5(3): 313-319, https://dx.doi.org/10.26832/24566632.2020.0503012

INTRODUCTION

The name broccoli comes from Italian word, and is derived from the Latin word 'brachium', which means arm/branch (Gómez-Campo, 1999). Broccoli (*Brassica oleracea* var. *italica*) is one of the non-traditional crop and several other cruciferous vegetables i.e. cabbage, cauliflower, kohlrabi, and brussels sprouts all originate from the wild type of *Brassica oleracea*, which grew along the Mediterranean coasts several hundred years BC. Although originated from temperate region, its distribution has been extended to the subtropical and tropical countries including Bangladesh. Broccoli is fairly rich in vitamin A, ascorbic acid and contains appreciable amounts of calcium, phosphorus, thiamin, riboflavin, niacin and iron (Thompson and Kelly, 1988, Lincoln, 1987). Watt (1963) reported that broccoli is more nutritious than any other cole crop such as cabbage, cauliflower and kohlrabi. The cancer- fighting properties of broccoli are not new and previous studies have related these benefits to the high levels of active phytochemicals called glucosinolates (Zhao *et al*., 2007). Eating more than one serving of broccoli a week reduces the risk of prostate cancer by up to 45 percent. Thus broccoli can play a vital role in improving the nutritional status of the people

of Bangladesh. Broccoli is environmentally better adapted than cauliflower and reported to withstand comparatively higher temperature than cauliflower (Rashid, 1976). Its preference to the consumers is increasing day by day.

In recent times, consumers are demanding higher quality and safer food and highly interested in organic products. In respect to food safety, organic products have been verified with no or fewer pesticide residues, compared to conventional products (Baker *et al*., 2002). The difference in nutritional value between organic and conventional vegetables varied. The cultivation of broccoli requires an ample supply of plant nutrient. The requirement of these plants nutrients can be provided by applying inorganic fertilizer or organic manure or both. Broccoli responds greatly to major essential elements like N, P, and K in respect of its growth and yield (Mital *et al*., 1975; Singh *et al*., 1976; Thompson and Kelly, 1988) and storage life. Organic manures such as cattle manure and poultry manure improve the soil structure, aeration, slow release nutrient which support root development leading to higher yield and better quality of broccoli plant. Organic manure plays a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization, improving the physical and physiological properties of soils.

However, farmers are now showing interest in organic farming because of, they are more aware about the residual effect of chemical substances used in the crops field and environmental degradation. Organic manure can serve as alternative practice to mineral fertilizers for improving soil structure and microbial biomass (Gupta *et al*., 2015). Organic manures like cowdung, poultry litter, mustard oil cake (MOC), Vermicompost, fermented plant juice (FPJ) and compost when applied, help to improve the soil texture, structure, color, aeration, water holding capacity and microbial activity of soil (Dauda *et al*., 2008). The application of both organic and inorganic fertilizer combined, can increase the yield as well as keep the environmental sound (Hsieh *et al*., 1996). Therefore, utilization of locally produced manures for vegetable production operations may increase crop yields with less use of chemical fertilizers. Considering the above mentioned facts, the present research was aimed to assess the effect of different sources of plant nutrients on the growth and yield of broccoli as well as relative cost and return in broccoli production with different sources of plant nutrients.

MATERIALS AND METHODS

The study was conducted under field conditions during the winter season of 2017 taking broccoli cv. Early green (V_1) and Known you (V_2) collected from Advanced Chemical Industry Seed Company Limited with five types of nutrients sources *viz*., T_0= Control (No or zero fertilizer applied), T_2= N: P: K- 250:150:200 kg/ha, T_3 = Vermi compost – 5 t/ha, T_4= Fermented Plant Juice (FPJ)-500 ml/ha and T_5 = Liquid fertilizer – 200 ml/ha (Flora: consists of 20% nitrobenzene). Hence, Gypsum =120 kg/ha, Zinc oxide =10 kg/ha, Boric acid= 4 kg/ha were applied in the experiment filed for all treatments. The experiment was laid out in randomized complete block design (RCBD) with three replications. One-month seedlings were transplanted in the field at a spacing of 60 cm (row) by 40 cm (plant) on raised beds. The unit plot size was 3m × 3m. Seedlings were watered after transplanting. The transplanted seedlings were kept shade with pieces of banana leaf sheaths during the day time to protect those from the scorching sunshine. At night those were kept open to receive dew. Shading and watering were continued for 3 days until the seedlings were established. A number of seedlings were planted at the same time in the border of the experimental plot for gap filling. Weeding, irrigation, crop management and harvesting were done manually. The fermented plant juice were applied when the seedling age became of 25 days were DAT. It was applied 3 times keeping 7 days interval and sprayed the evening. Thus the application of FPJ was completed before the harvesting of curd from the plot. The curds were harvested in compact condition before the flower buds opened (Thompson and Kelly, 1988). Five plants were selected randomly for data collection in each plot and labeled. All broccoli heads of each plot were harvested at marketable stage. The collected data for various growth and yield contributing characters were statistically analyzed using the MSTAT-C program. The mean for all the calculated and the analysis of variances (ANOVA) for each of the characters under study was done by F (variance ratio) test. The treatment means were separated by Least Significant Difference (LSD) at 5% level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Plant height

The results reveled that variance in different nutrient doses had significant influence on plant height in different growth stages. Results indicated that variety “Known You” showed the highest plant height (36.41, 51.41 and 64.17 cm at 45, 60 DAT and at harvest respectively) and “Early Green” gave the lowest plant height (34.75, 44.80 and 62.06 cm at 45, 60 DAT and at harvest respectively) at all the growth stages (Figure 1). Highest plant height (15.35, 50.98 and 65.46 cm at 45, 60 DAT and at harvest respectively) was found from T_4 (Fermented plant juice) which was statistically similar, to that of T_1 (Recommended fertilizer dose). On the other hand, the lowest plant height (13.01, 42.12 and 57.67 cm at 45, 60 DAT and at harvest, respectively) was observed from T_0 (Control) which was significantly different from all other treatments (Figure 2). In combined effect, the highest plant height (15.46, 54.15 and 67.22 cm at 45, 60 DAT and at harvest, respectively) which was statistically similar to V_1T_1 at the time of harvest while the lowest plant height (13.03, 43.29 and 56.65 cm at 45, 60 DAT and at harvest respectively) was achieved by V_1T_0. Similar results also found by Singh *et al.* (2000).

Number of leaves per plant

A good foliage status indicates vigor condition of plants. Vigor plant provides higher growth, development and productivity of plants. The variety “Known You” showed the highest number of

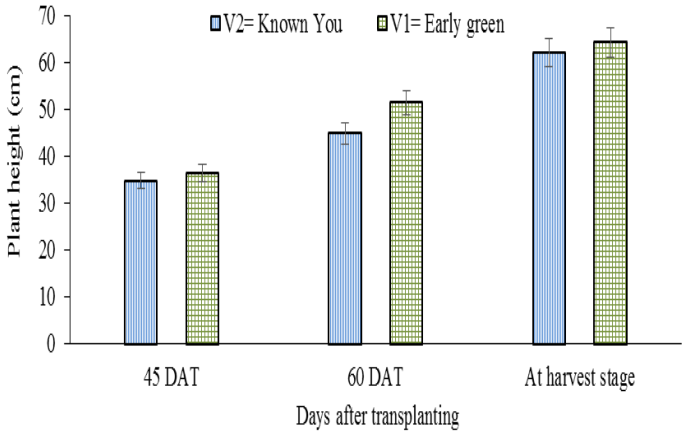


Figure 1. *Effect of variety on plant height (cm) of broccoli at different days after transplanting. LSD represents at 5% level of probability.*

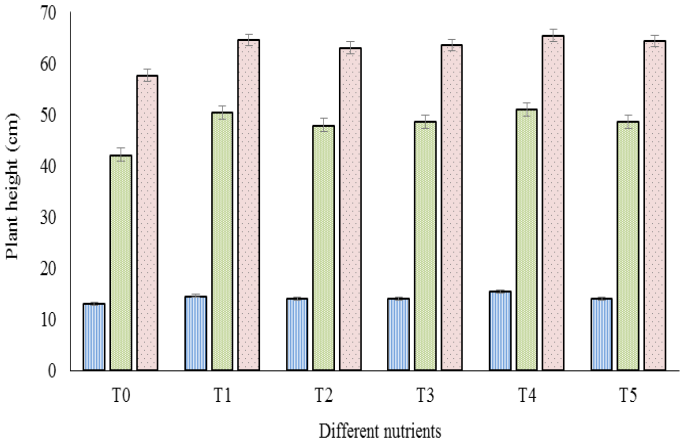


Figure 2. *Effect of different sources of nutrients on plant height (cm) of broccoli. (LSD represents at 5% level of probability, T_0= No fertilizer, T_1=Recommended fertilizer dose, T_2= Cow dung,T_3= Vermicompost, T_4= Fermented plant juice, T_5= Liquid fertilizer).*

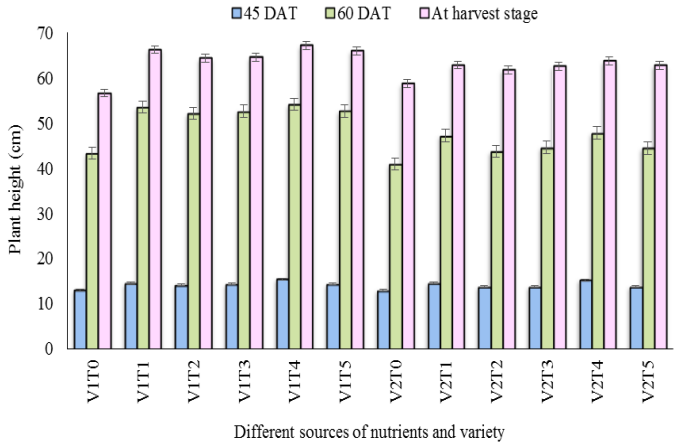


Figure 3. *Combined effect of different sources of nutrients and variety on plant height of broccoli. LSD represents at 5% level of probability.*

V_1T_0= Known You with no fertilizerV_1T_1= Known You with recommended fertilizer dose; V_1T_2= Known You with cow dung V_1T_3= Known You with vermicompost; V_1T_4= Known You with FPJV_1T_5= Known You with liquid fertilizer; V_2T_0=Early Green with no fertilizerV_2T_1= Early Green with recommended fertilizer dose; V_2T_2= Early Green with cow dungV_2T_3= Early Green with vermicompost; V_2T_4=Early Green with FPJV_2T_5= Early Green with liquid fertilizer.

leaves (14.29) which was statically similar to the "Early Green" and number of leaves (14.02). The highest number of leaves (15.35) was found from fermented plant juice while the lowest number of leaves was found in the control. It was observed that the highest number of leaves (15.46) was found in V_1T_4which was statistically similar to that of V_2T_4. On the other hand the lowest number of leaves (12.98) was achieved by V_2T_0 which was statistically different from all other treatments at the time of growth (Table 3).

Fresh weight of leaf

The variety "Known You" showed highest leaf weight (625.92 g) at all growth stages and "Early Green" gave lowest leaf weight (505.72 g) at their growth stages. Momentous variation was also found among the nutrients in respect of fresh weight of leaf at their growth stages. The results exposed that the highest fresh leaf weight was found from T_4 (580.0 g) treatment which was identical to T_1 (579.5 g) and followed by T_5 and T_3. On the other hand, the lowest leaf weight was observed from T_0 (515.2 g) which was significantly poles apart from all other treatments combinations. In combined effect, the highest fresh leaf weight was achieved from the treatment combination of V_1T_4(656.90 g) which was statistically poles apart from all other treatments followed by V_1T_1 (653.8 g) and V_1T_5 (647.0 g). Simultaneously significantly different results performed by V_1T_0 (524.3 g) which was apart from others combinations (Table 3). Nonnecke *et al.* (2002) found that using mineral fertilizer (N, P, K) increasing broccoli vegetative growth, yield and quality.

Length of stem

A statistically significant difference was found on varieties in respect of length of stem presentation. Results indicated that the variety V_1 (9.32 cm) showed the highest stem height at harvest stage and V_2 (8.48 cm) gave the lowest plant height at harvest stage. The highest stem height was found from fermented plant juice nutrient source while the lowest stem height (8.15 cm) was observed from control. The highest stem length was achieved from the treatment combination of V_1T_4 (9.61cm) which was statistically similar to V_1T_1, V_1T_5 and V_1T_3 at the time of harvest. The lowest stem length was achieved by V_2T_0 (8.05 cm). Similar results were also found by Singh *et al.* (2000) reported a linear increased in plant height was observed with increasing N and K rates. K improved the development of roots and the utilization of N.

Diameter of stem

Variety Known You showed the highest stem diameter (3.75 cm) at the harvest stage and Early Green shown the lowest (3.66 cm) at harvest stage. Fermented plant juice treated plant gave the highest stem diameter (3.98 cm) and control plant resulted the lowest stem diameter (3.28 cm). Combined Known You variety and Fermented plant juice nutrient source gave the highest stem diameter (4.14 cm) which was statistically similar to V_1T_1, V_1T_5, V_2T_4 and V_2T_1 at the time of harvest. The lowest stem diameter was achieved by V_2T_0 (3.26 cm) (Table 3).

Table 1. Effect of variety on number of leaves per plant, fresh weight of leaves, stem length, stem diameter and stem weight of broccoli.

Variety	Number of leaves/ plant	Fresh weight leaves (g)	Stem length (cm)	Stem diameter (cm)	Stem weight (g)
Known You (V1)	14.30	625.92 a	9.32 a	3.75	63.00 a
Early Green (V2)	14.02	505.73 b	8.48 b	3.66	60.06 b
$LSD_{0.05}$	0.21	3.472	0.52	0.12	1.26
Level of significance	NS	**	**	NS	**
CV (%)	10.51	9.53	8.42	6.29	7.63

In a column figures having similar and no letter(s) do not differed significantly at 5% level whereas figures with dissimilar letter(s) differed significantly as per DMRT at same level; **= 1% level of probability, NS= Non-significant, CV=Coefficient of variation

Table 2. Effect of nutrient sources on number of leaves, fresh weight of leaves, stem length, stem diameter and stem weight of broccoli.

Treatment	Number of leaves/ plant	Fresh weight leaves(g)/Plant	Stem length (cm)	Stem diameter (cm)	Fresh stem weight (g)
T_0	13.01 c	515.2 c	8.15 c	3.28 c	48.05 e
T_1	14.51 ab	579.5 a	9.17 a	3.82 ab	65.12 b
T_2	13.99 bc	568.6 b	8.89 b	3.69 b	61.19 d
T_3	14.04 bc	573.4 ab	8.99 b	3.70 b	62.97 c
T_4	15.35 a	580.0 a	9.19 a	3.98 a	66.89 a
T_5	14.06 bc	578.2 ab	9.02 b	3.78 ab	64.96 b
$LSD_{0.05}$	1.00	9.52	0.13	0.23	1.20
Level of significance	*	**	**	**	**
CV (%)	10.51	9.53	8.42	6.29	7.63

In a column figures having similar and no letter(s) do not differed significantly at 5% level whereas figures with dissimilar letter(s) differed significantly as per LSD at same level; *= 5% level of probability, ** = 1% level of probability, CV= Coefficient of variation; T_0= No fertilizer; T_1=Recommended fertilizer dose; T_2= Cow dung; T_3= Vermicompost; T_4= Fermented plant juice; T_5= Liquid fertilizer.

Table 3. Combined effects of nutrient sources and varieties on number of leaves, fresh weight of leaves, stem length, stem diameter and stem weight of broccoli.

Combined effect of different sources of nutrients X Varieties	Number of leaves/plant	Fresh weight leaves (g)	Stem length (cm)	Stem diameter (cm)	Fresh stem weight (g)
V_1T_0	13.03 c	524.3 d	8.25	3.31	48.49 f
V_1T_1	14.47 a-c	653.8 ab	9.59	3.85	66.43 b
V_1T_2	14.20 a-c	633.0 c	9.35	3.69	61.51 e
V_1T_3	14.30 a-c	640.5 bc	9.55	3.70	64.46 c
V_1T_4	15.46 a	656.9 a	9.61	4.14	69.60 a
V_1T_5	14.33 a-c	647.0 ab	9.58	3.83	67.53 b
V_2T_0	12.98 c	506.1 e	8.05	3.26	47.62 f
V_2T_1	14.55 a-c	505.2 e	8.75	3.78	63.81 cd
V_2T_2	13.79 bc	504.1 e	8.44	3.69	60.88 e
V_2T_3	13.78 bc	506.3 e	8.43	3.71	61.49 e
V_2T_4	15.24 ab	509.5 e	8.77	3.81	64.19 c
V_2T_5	13.79 bc	503.2 e	8.47	3.74	62.38 de
$LSD_{0.05}$	1.42	13.23	0.18	0.33	1.69
Level of significance	**	**	NS	NS	**
CV (%)	10.51	9.53	8.42	6.29	7.63

In a column figures having similar and no letter(s) do not differed significantly at 5% level whereas figures with dissimilar letter(s) differed significantly as per LSD at same level; **= 1% level of probability, NS= Non-significant, CV= Coefficient of variation.

Table 4. Effect of variety on days taken to primary curd initiation, head height, head diameter, primary curd weight /plant of broccoli.

Varieties	Days taken to Primary curd initiation	Head diameter (cm)	Primary curd wt. (g) /plant	Number of secondary curd/plant	Fresh wt. of secondary curd /plant (g)	Total yield/ plot (kg)
V_1	70.27 a	16.52	281.24 a	0.000 b	0.000 b	3.38 b
V_2	55.13 b	15.32	258.30 b	20.908 a	227.137 a	5.83 a
$LSD_{0.05}$	1.85	2.37	6.35	11.98	11.59	1.24
Level of significance	**	NS	**	**	**	**
CV (%)	7.76	11.63	7.39	11.16	9.57	9.57

In a column figures having similar and no letter(s) do not differed significantly at 5% level whereas figures with dissimilar letter(s) differed significantly as per DMRT at same level; **= 1% level of probability and NS= Non-significant, CV= Coefficient of variation.

Table 5. Effect of nutrient sources on days taken to primary curd initiation, head height, head diameter, primary curd weight /plant of broccoli.

Varieties	Days taken to Primary curd initiation	Head diameter (cm)	Primary curd wt. (g) /plant	Number of secondary curd/plant	Fresh wt. of secondary curd /plant (g)	Total yield/ plot (kg)
T_0	66.80 a	13.57 d	179.6 d	8.27 c	79.00 c	947.6 c
T_1	60.53 d	17.07 a	288.8 b	11.88 a	123.9 ab	1487 ab
T_2	64.04 b	15.54 c	285.9 c	10.41 a-c	110.7 b	1329 b
T_3	63.45 bc	15.85 bc	286.9 c	9.22 bc	119.2 ab	1431 ab
T_4	60.29 d	17.19 a	290.4 a	12.09 a	127.5 a	1530 a
T_5	61.06 cd	16.28 b	287.1 c	10.86 ab	121.0 ab	1453 ab
$LSD_{0.05}$	2.73	0.49	1.27	2.15	13.01	156.1
Level of significance	**	**	**	**	**	**
CV (%)	7.76	11.63	7.39	11.16	9.57	9.57

In a column figures having similar and no letter(s) do not differed significantly at 5% level whereas figures with dissimilar letter(s) differed significantly as per LSD at same level; ** = 1% level of probability, CV= Coefficient of variation; T_0= No fertilizer; T_1=Recommended fertilizer dose; T_2= Cow dung; T_3= Vermicompost; T_4= Fermented plant juice; T_5= Liquid fertilizer.

Fresh weight of stem

The results indicated that variety V_1 (63.00 g) showed highest stem weight at harvest stage and V_2 (60.06 g) shown the lowest stem weight at the harvest stage. It was observed that the highest fresh stem weight was achieved from the treatment combination of V_1T_4 (69.60 g) which was statistically poles apart from all other treatments followed by V_1T_5 (67.53 g) and V_1T_1 (66.43 g). On the other hand the lowest results achieved from V_2T_0 (47.62 g), followed by V_1T_0 (Table 3). A similar experiment was conducted Farooque and Islam (1989) showed in an experiment that application of cowdung, oil cake, urea, triple superphosphate and muriate of potash combined gave better growth and maximum yield of cabbage.

Days taken to primary curd initiation

The results indicated that variety V_1 (70.265) were taken maximum days for primary curd initiation and minimum days were taken by V_2 (55.126) for their primary curd initiation. Due to the nutritional effect, maximum days were taken by T_0 (66.80) and then T_2 (64.04) treatments for their primary curd initiation. On the other hand the lowest days were taken by T_4 (60.29) closely followed by T_1 (60.53) for their primary curd initiation. It was pragmatic that the maximum days taken for primary curd initiation V_1T_0 (74.45) closely followed by V_1T_2 (73.01). The lowest days were taken by V_2T_4 (53.57) closely followed by treatments V_2T_1, V_2T_5, and V_2T_3 for their primary curd initiation (Table 6).

Head diameter of primary curd

A significant variation was also found in terms of varietal performance. The variety V_1 (16.51 cm) showed the highest head diameter at the harvest stage and V_2 (15.318 cm) shown the lowest head diameter at the harvest stage. Fermented plant juice treated plant gave the highest head diameter (17.19 cm) but the lowest head diameter (13.57 cm) was observed in T_0 which was significantly different from all other treatments (Table 6). From the similar experiment of Roy (1981) reported an increased curd diameter from 15.1-20.2 cm and yields from 1083-2614 kg/ha by increasing the levels of N from 60-200 kg/ha in a period of 3 years with cv. Dania.

Primary curd weight per plant

Results indicated that variety V_1 (281.24 g) showed highest curd weight at the time of harvest stage and V_2 (258.30 g) gave the lowest curd weight at their harvest stage. The weight of curd was the maximum in T_4 (290.4 g/plant) treatment while T_1 (288.8 g/plant) was better than those of other treatments. But due to the nutrient effects T_0 (179.6 g/plant) shown the lowest in relation to others. It was matter-of-fact that the maximum primary curd exposed V_1T_4 (303.1 g/plant) followed by V_1T_1 (300.3 g/plant). moderate result was shown by the treatment combination of V_2T_4 (277.7 g/plant) which were statistically similar to V_2T_1 (277.3 g/plant). But the lowest results were found from the treatment combination of V_2T_0 (166.5 g/plant) at the harvest stage (Table 6).

Number of secondary curds per plant

Combined effect of varieties and nutrients on secondary curd formation per plant was found significant. It was practical that the highest number of secondary curd was found V_2T_4 (24.17) at the production to final harvest stage followed by V_2T_1 (23.75) and V_2T_5 (21.73). On the other hand results also indicated that the lowest number of secondary curd produced by V_2T_0(16.54) which were poles apart from other treatments. Simultaneously there was no secondary curd achieved of their any stage of life from the treatments of V_1T_0, V_1T_1, V_1T_2, V_1T_3, V_1T_4 and V_1T_5 due to their varietal effect which were also influenced by nutrients' (Table 6).

Fresh weight of secondary curd per plant

The result indicates that variety V_1 (0.00) showing no secondary curd from beginning to its harvest stage. But due to varietal effect V_2 (227.14 g/plant) exposed the fresh weight of secondary curd found in its total harvest stage. The maximum fresh weight of secondary curd was found from T_4(127.5 g/plant) which was followed by treatment T_1 (123.9 g/plant), T_5(121.0g/plant), andT_3 (119.2 g/plant). The lowest secondary curd production was shown by T_0 (79.0 g/plant). The highest weight of secondary curd was found V_2T_4 (255.0 g/plant) at the production to harvest final harvest stage followed by V_2T_1 (247.8 g/plant) and V_2T_5 (242.1 g/plant). Simultaneously there was no secondary curd weight achieved of their any stage of life from the treatments of V_1T_0, V_1T_1 and V_1T_2.

Total yield per plot

A significant variation was found on total yield/plot is respect of variety, nutrient sources and their combined effect. Known You showed the minimum curd weight (3.38 kg/plot) at harvest stages and Early Green gave utmost curd weight through primary and secondary (5.83 kg/plot) at their harvest stages. Fermented plant juice gave the uppermost fresh curd weight (5.01 kg/plot) and the minimum curd weight was observed from the treatment combination of T_0 (3.10 kg/plot) which were significantly poles apart from all other treatments combinations. In the experiment it was observed that the uppermost fresh curd weight was achieved from the treatment combination of V_2T_4(6.39 kg/plot). The lower most total curd weight produced by the treatment combination of V_1T_0 (2.31 kg/plot) in presence of combined effect of variety and nutrient (Table 6). Sharma *et al.* (2000) a field experiment was conducted to evaluate the effects of N (60, 120, 180 and 240 kg/ha) and P (60, 120 and 18 kg/ha) on the growth and seed yield of Broccoli cv. Green Curd and observed. In general, all parameters significantly improved with increasing concentrations of N and P.

Cost and return analysis

Materials, non-materials and overhead cost were recorded for all the treatments of unit plot and calculated on per hectare basis. The price of broccoli at the local market rate was considered. The total cost of production ranged between Tk. 103580 to Tk. 133580per hectare among the different treatment combinations. The variation was due to different cost of broccoli cultivar and different sources of nutrients. The highest cost of production Tk. 96530 per hectare was recorded in the treatment combinations of vermicompost with "Known You" or "Early Green" cultivar; while the lowest cost of production TK. 66530 per hectare was recorded in the combination of no fertilizer with "Known You" or "Early Green" cultivar. The sale of harvested broccoli was @ Tk. 15,000 per ton. Among the different combinations, fermented plant juice with "Early Green" cultivar gave the highest net return (Tk. 228930 per hectare) while the lowest net return Tk. (16860 per hectare) was obtained from the treatment combination of no fertilizer with "Known You" cultivar. The benefit cost ratio (BCR) was found the highest (3.21) in the treatment combination V_1T_4 (Fermented plant juice with "Early Green" cultivar). On the other hand, the lowest BCR (1.16) was recorded from V_1T_0 (no fertilizer with "Known You") cultivar.

Table 6. Combined effects of nutrient sources and varieties on days taken to primary curd initiation, head height, head diameter, primary curd weight /plant of broccoli.

Combined effect of nutrients×Varieties	Days taken to Primary curd initiation	Head diameter (cm)	Primary curd wt. (g) /plant	Number of secondary curd/plant	Fresh wt. of secondary curd /plant (g)	Total yield/ plot (kg)
V_1T_0	12.28 f	74.45	192.7 f	0.00 e	0.00 e	0.00 f
V_1T_1	14.85 ab	67.44	300.3 b	0.00 e	0.00 e	0.00 f
V_1T_2	13.58 de	73.01	296.8 c	0.00 e	0.00 e	0.00 f
V_1T_3	13.97 cd	72.09	297.1 c	0.00 e	0.00 e	0.00 f
V_1T_4	15.11 a	67.02	303.1 a	0.00 e	0.00 e	0.00 f
V_1T_5	14.18 b-d	67.59	297.4 c	0.00 e	0.00 e	0.00 f
V_2T_0	11.45 g	59.14	166.5 g	16.54 d	158.00 d	1496.00 e
V_2T_1	13.89 cd	53.62	277.3 d	23.75 ab	247.80 ab	2974.00 b
V_2T_2	12.94 ef	55.07	274.9 e	20.82 bc	221.50 c	2658.00 d
V_2T_3	13.42 de	54.82	276.6 de	18.44 cd	238.50 b	2862.00 c
V_2T_4	14.40 a-c	53.57	277.7 d	24.17 a	255.00 a	3059.00 a
V_2T_5	13.42 de	54.54	276.8 de	21.73 ab	242.10 ab	2905.00 c
$LSD_{0.05}$	0.69	1.85	1.79	3.04	14.59	62.52
Level of significance	**	NS	**	**	**	**
CV (%)	7.76	11.63	7.39	11.16	9.57	9.57

In a column figures having similar and no letter(s) do not differed significantly at 5% level whereas figures with dissimilar letter(s) differed significantly as per LSD at same level; **= 1% level of probability, NS= Non-significant, CV= Coefficient of variation.

Table 7. Cost and return of broccoli due to use of different sources of nutrients and varieties of broccoli.

Treatment	Yield ton/ha	Gross return (000 Tk./ha)	Total cost of production (000 Tk./ha)	Net return (000 Tk./ha)	Benefit cost ratio (BCR)
V_1T_0	8.03	120.45 (1420 $)	103.58 (1218 $)	168.66 (199 $)	1.16
V_1T_1	12.49	187.35 (2204 $)	115.78 (1362 $)	715.66 (842 $)	1.62
V_1T_2	12.42	186.3 (2191 $)	128.58 (1512 $)	577.16 (680 $)	1.45
V_1T_3	12.39	185.85 (2186 $)	133.58 (1571 $)	522.66 (615 $)	1.39
V_1T_4	12.63	189.45 (2228 $)	103.61 (1254 $)	858.35 (1010 $)	1.83
V_1T_5	12.4	186 (2188 $)	104.23 (1226 $)	817.67 (962 $)	1.78
V_2T_0	13.52	202.8 (2385 $)	103.58 (1218 $)	992.16 (1168 $)	1.96
V_2T_1	21.88	328.2 (3861 $)	115.78 (1362 $)	2124.16 (2499 $)	2.83
V_2T_2	20.69	310.35 (3651 $)	128.58 (1512 $)	1817.66 (2139 $)	2.41
V_2T_3	21.46	321.9 (3787 $)	133.58 (1571 $)	1883.16(2215 $)	2.41
V_2T_4	22.17	332.55 (3912 $)	103.61 (1219 $)	2289.35 (2693 $)	3.21
V_2T_5	21.01	315.15 (3707 $)	108.23 (1273 $)	2069.17 (2435 $)	2.91

Conclusion

The result of the experiment revealed that almost all the parameters studied were significantly influenced by different sources of nutrients. More or less, all the characters attained highest values when fermented plant juice had applied. The control gave the lowest value in all the characters studied. Maximum yield (22.83 ton/ha) were obtained by fermented plant juice and the minimum yield (8.03 ton/ha) were found in the control plot. The maximum yield (20.23 ton/ha) were obtained from "Early green" variety. In combined effect of different sources of organic nutrients and cultivars exhibited that, highest yield (20.83 ton/ha) was recorded from the treatment combination of fermented plant juice with "Early green" cultivar (V_1T_4) where the minimum yield (8.03 ton/ha) was found from control with "Known you" (V_1T_0) treatment combination. The application of Fermented plant juice with "Early Green" cultivar was found to be conducive to higher economic return from broccoli and from soil under the field belongs to the Agro–ecological zone of AEZ –13, Ganges Tidal Floodplains.

REFERENCES

Baker, B.P., Benbrook, C.M., Iii, E.G. and Benbrook, K.L. (2002). Pesticide residues in conventional, integrated pest management (IPM)-grown and organic foods: insights from three US data sets. *Food Additives & Contaminants*, 19: 427-446.

Dauda, S.N., Ajayi, F.A. and Ndor, E. (2008). Growth and yield of water melon (*Citrullusla natus*) as affected by poultry manure application. *Journal Agricultural Society of Science*, 4: 121–124.

Farooque, A.M. and Islam, A.F.M.S. (1989). Effect of spacing and different management practices on the growth and yield of cabbage. *Bangladesh Horticulture*, 17(1): 45- 47.

Gomez, K.A. and Gomez, A.A. (1984). Statistical procedures for agricultural research (2 ed.). John Wiley and sons, New York, pp. 680.

Gómez-Campo (1999). Biology of Brassica coenospecies, 490 pp. Elsevier, Amsterdam.https://www.elsevier.com/books/biology-of-brassica-coenospecies/gomez-campo/978-0-444-50278-0

Gupta, G., Parihar, S.S., Ahirwar, N.K., Snehi, S.K. and Singh, V. (2015). Plant Growth Promoting Rhizobacteria (PGPR): Current and Future Prospects for Development of Sustainable Agriculture. *Journal of Microbiology and Biochemical Technology*, **7**: 096-102, http://doi.org10.4172/1948-5948.1000188.

Hsieh, C., Hsu, K.N. and Hsieh, C.F. (1996). An experiment on the organic farming of broccoli. *Bulletin of Taichung District Agriculture Improvement Station* No. 53 (35-40): 18.

Lincoln, C.P. (1987). Vegetable Characteristics, Production and Marketing. John Wiley and Sons. Inc. New York. pp. 217.

Mital, R.K., Singh, T., Bhugat, M. and Maheshwari, K.P. (1975). Response of broccoli to nitrogen and row spacing. *Indian Journal of Agronomy*, 20(3): 278-279.

Nonnecke, I.L. (2002). Vegetable Production. Van Nostrand Reinhold, New York. pp. 394-399.

Rashid, M.M. (1976). Bangladesh Shabji. 1st Edition. Bangla Academy, Dhaka, Bangladesh. pp. 244-248.

Roy, H.K. (1981). Vegetables Science. India. (8): 75-78.

Sharma, K.C. (2000). Influence of integrated nutrient management on yield and economics in broccoli (*Brassica oleracea* L. var. *italica*) plant under cold temperate conditions. *Vegetable Science*, 27 (1): 62-63.

Singh, A.K., Akhilesh, S. and Singh, A. (2000). Influence of nitrogen and potassium on growth and head yield of broccoli (*Brassica oleracea* L. var. *italica*) under low hills subtropical condition of H.P. Regional Research Station, Dhaulakua, Sinnour- 173 001 Himachal Pradesh, India. *Vegetable Science*, 27(1): 99-100.

Singh, R.D., Tiwari, S.N., Singh, B.B. and Seth, J.N. (1976). Effect nitrogen and potash on growth and curd yield of cauliflower variety Snowball-16. *Progressive Horticulture*, 7(4): 31-34.

Thompson, H.C. and Kelly, W.C. (1988). Vegetables Crops. Fifth edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, India, pp. 611.

Watt, B.K. (1963). Nutritive Value of Fruits and vegetables. USDA, Hand book No 8.https://naldclegacy.nal.usda.gov/naldc/download.xhtml?id=CAT79710594&content=PDF

Zhao, H.J., Lin, H., Hernandez, I.M., Dinney, C.P. and Wu, X. (2007). Dietary isothiocyanates, GSTMI, GSTTI, NAT2 polymorphisms and bladder cancer risk, *International Journal of Cancer*, 120 (10): 2208- 2213.