

## EFFECT OF PLANTING DATES ON PERFORMANCE OF BROCCOLI IN COSTAL AREA OF BANGLADESH

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### Abstract

The field experiment on broccoli (*Brassica oleracea var. italica* L.) taking three planting dates *viz.*, 21 November, 01 December and 11 December, 2019 and four genotypes, namely BARI Broccoli-1, Thiland-1, Thailand-2 and Japan-1 was conducted during *rabi* season of 2019-20 in the experimental field of Bangladesh Agricultural Research Institute, On-Farm Research Division, Dawlatpur, Khulna to investigate the effect of planting dates on the growth and yield of broccoli genotypes on saline soil having salinity level 2.6-4.8 dS/m. The experiment was laid out in 4 x 3 factorial randomized complete block design with three replications. The genotype Japan-1 gave maximum number of leaves/plant (25.44), fresh weight of leaves/plant (830.77 g), fresh weight of stem/plant (311.69 g), fresh weight of root/plant (53.47 g), which were not reflected into yield and yield attributes. The genotype Thailand-2 produced significantly lower all growth characters than those of Japan-1 but gave the highest curd diameter (18.11 cm, curd weight (360.19 g) and curd yield (16.01 t/ha) of all genotypes. Broccoli planted on 21 November initiated early flower head, recorded maximum number of leaves/plant (27.84), fresh weight of leaves/plant (800.87 g), fresh weight of stem/plant (313.73 g), fresh weight of root/plant (60.79 g), curd diameter (17.01 cm), curd weight (285.65 g) and curd yield (12.69 t/ha). The genotype Thiland-2 coupled with 21 November showed the best performance in respect of curd weight (419.74 g/plant) and curd yield (18.66 t/ha).

Keywords: Broccoli, genotype, planting date, curd yield. Coastal area, Bangladesh.

### Introduction

Broccoli (*Brassica oleracea var. italica* L.), an important member of “Cole” crops, belongs to the family *Brassicaceae*. Broccoli originated from west Europe (Prasad and Kumer, 1999). The word “Cole” means a group of highly differentiated plants originated from a single wild *Brassica oleracea var. oleracea* (Sylvestris L.) commonly known as wild cabbage (Bose and Som, 1986). Broccoli is grown in winter season in Bangladesh as an annual crop. It is environmentally better adapted and can resist comparatively high temperature

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than cauliflower (Rashid *et al.*, 1976). Its wider environmental adaptability, higher nutritive value, good taste and less risk to crop failure are due to various biotic and abiotic factors indicate that there is enough possibility for its promotion. Its popularity to the consumers of urban area is increasing day by day in our country but its cultivation has not spread much beyond the farms of different agricultural organizations. This is mainly due to the lack of awareness among the people about its importance and inadequate information production technology. Cultivation of broccoli are confined into a very limited area with its average yield is only about 10.5 metric tons per hectare (Anonymous, 2004) which is very low compared to other broccoli growing countries like 24 t/ha in Italy, 20 t/ha in Japan and 18 t/ha in Turkey (Ahmed *et al.*, 2004).

Bangladesh is a deltaic country with total area of 147570 km<sup>2</sup>. Coastal area includes 30% of the cultivable land in Bangladesh. About 10 lakh hectares (1m. ha) of land are affected by varying degrees of soil salinity (Karim and Iqbal, 2001). After harvesting of T. Aman rice a remarkable area of land remains fallow in this region. Again, during *rabiseason*, soil salinity level increases through capillary movement. Which constraint for *rabi* crops in saline coastal region.

The planting dates have significant effect on yield and yield contributing characters of broccoli plant. The yield decreased with delay planting time. Curd yield is higher when crops are planted earlier and show a decreasing trend with delay in planting dates (Bianco *et al.*, 1996). Early planted crops resulted in longer duration and produced taller plants with more number of leaves, higher plant spread and more leaf size index as well as the lowest percentage of abnormal curds than late planted crops and finally attributed to higher curd yield (Gautam *et al.*, 1998). So, there is enough scope to identify the optimum planting date to maximize the broccoli yield. Broccoli genotypes have also significant effect on yield of broccoli. Cultivar “Captain” produced the highest total yield as well as top and lateral head yields, the largest top head weight and marked earliness which was followed by cultivars Lucky, General, Griffen, Liberty and Milady (Toth *et al.*, 2007). Several broccoli genotypes are cultivated in our country those differ in yield. So, it is essential to identify high yielding genotypes to maximize broccoli yield. Therefore, the present experiment was undertaken to find out optimum planting date and suitable genotype for maximum yield of Broccoli.

### **Materials and Methods**

This experiment was conducted during 21 November 2019 to 25 February 2020 in the experimental field of Bangladesh Agricultural Research Institute, -Farm Research Division, Dawlatpur, Khulna. The location of the experimental site was at High Ganges River Flood Plain (22.8875 N latitude and 89.5167E longitudes). The soil of the experimental field was Silt loam-Clay of dark grey soil color. The soil contained pH of 6.8 and organic matter 2.1 %. The experiment consists of three planting dates *viz.*, 21 November, 01 December and 11 December, 2019 and four genotypes, namely BARI Broccoli-1, Thiland-1,

Thailand-2 and Japan-1. Thiland-1, Thailland-2 and Japan-1 were collected from the market of Dhaka and BARI Broccoli-1 was collected from Bangladesh Agricultural Research Institute, Gazipur. The field experiment was laid out in a factorial Randomized Complete Block Design with three replications. The unit plot size was 4m x 1.5m accommodating 24 seedlings/plot. The land was fertilized with nitrogen, phosphorous, potassium and molybdenum as cowdung, urea, TSP, MoP and molybdenum @ 1500, 210, 120, 100 and 1kg/ha, respectively. The entire amount of Cowdung, TSP, MoP and Molybdenum were applied at the time of final land preparation and the entire urea was applied as top dressing in two equal split at 15 and 30 days after transplanting (DAP). Seeds were treated by provax @ 2 g/kg seed. Treated seeds were sown in seedbed on 28 October, 7 November, and 17 November 2019. Healthy 25 days old seedlings were transplanted on 21 November, 01 December and 11 December 2019. Weeding was done 6 times to keep the plots free from weeds and the soil was mulched by breaking the soil crust for easy aeration and conservation of soil moisture. The plots were irrigated four times at regular interval during the growth season to keep the field moist for better growth and development of plant. Five broccoli plants from each plot were selected randomly for collecting data. The plants of the outer rows and the extreme end of the middle rows were excluded from data collection. Data on number of leaves/plant, fresh weight of leaves, plant (g), fresh weight of stem (g)/plant and fresh weight of root (g)/plant, curd weight (g)/plant, curd diameter (cm) and curd yield (kg)/plot were recorded. Plot yield was converted to per hectare yield (t/ha). Soil salinity of the experimental plots was recorded in every 15 days interval from planting to harvesting of the crop (Fig. 1). Soil salinity was varied from 2.5 to 4.8dS/m. No diseases and insect attack were observed in the broccoli experiment. Collected data were statistically analyzed by Software R (version 3.5.1). Mean separation was done by LSD at 5% level of significance.

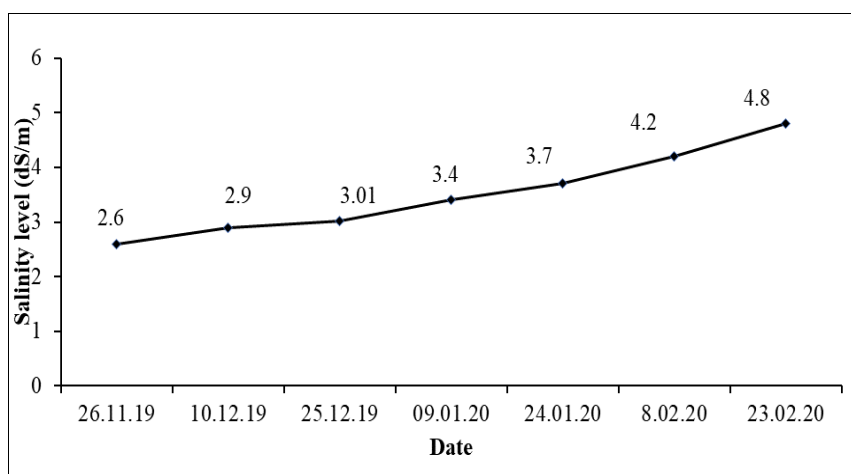


Fig. 1. Salinity level of experimental field during crop growing period.

## Results and Discussion

### Morphological characters of different genotypes

#### *Number of leaves/plant*

The highest number of leaves (25.44) was recorded from the genotype Japan-1 as compared to that of Thailand-1 and Thailand-2 were (23.56 and 20.44, respectively) (Table 1). The lowest number of leaves (15.44) was obtained from BARI Broccoli-1. Variation in number of leaves/plant may be due to the difference in genetic make-up of broccoli genotypes. Significant variation in number of leaves/plant was observed due to different planting dates (table 2). The highest number of leaves/plant was obtained from 21 November planting (27.84). The lowest number of leaves/plant was recorded from 01 December (17.67) which was statistically similar to 11 December (18.17).

The highest number of leaves/plant (35.67) was recorded from the genotype Japan-1 when planted on 21 November and the lowest number of leaves (13.33) was obtained from V<sub>1</sub>T<sub>2</sub> (BARI Broccoli-1 when planted on 11 December and it was statistically similar with V<sub>2</sub>T<sub>3</sub>, V<sub>3</sub>T<sub>2</sub>, V<sub>4</sub>T<sub>3</sub>, respectively. Number of leaves/plant varied from 82.67 to 13.33 (Table 3).

Maximum number of leaves/plant by 21 November was might be due to the optimal environmental conditions in the field. The most suitable temperature range for good quality and yield of broccoli is 19.22°C. When seedlings were transplanted in the field, average temperature remained near about 19.22°C during growth, whereas, 7 December availed comparatively lower temperature (8-14°C) during growth period. The result of the present study was similar to Jamil *et al.*, (2004) who found significant variation in T<sub>3</sub> (15 November) produced maximum leaves per plant. Shapla *et al.*, (2014) and Emam (2005) also reported that early planting increased number of broccoli leaves per plant.

#### *Fresh weight of leaves/plant*

There were significant differences among the genotypes in respect of fresh weight of leaves/plant. The highest fresh weight of leaves/plant was recorded from Japan-1 (830.77 g) which was significantly different from other genotypes and the lowest was obtained from BARI Broccoli-1 (395.56 g). Leaf fresh weight represent leaf biomass (Table 1).

Fresh weight of leaves of broccoli varied significantly with planting dates (table 2). Maximum fresh weight of leaves/plant was obtained from 21 November planting (800.87 g) followed by 01 December planting (448.99 g) and the lowest fresh weight of leaves/plant was recorded from 11 December planting.

The combined effect of genotypes and planting dates was found significant in respect of fresh weight of leaves/plant (table 3). The highest fresh weight of leaves/plant was obtained from V<sub>4</sub>T<sub>1</sub> (Japan-1 planted on 11 November) (1566.46

g). The minimum fresh weight of leaves/plant was obtained from V<sub>3</sub>T<sub>3</sub> followed by V<sub>3</sub>T<sub>2</sub>, V<sub>1</sub>T<sub>3</sub>, V<sub>1</sub>T<sub>1</sub>, V<sub>4</sub>T<sub>3</sub>, respectively.

Since the early planting recorded more number of leaves per plant which has direct relation with fresh weight of leaves. Emam (2005) and Shapla *et al.*, (2014) also reported similar findings. Getachew (2016) also observed significant variation in fresh weight of leaves of Broccoli.

#### ***Fresh weight of stem/plant***

The genotype Thiland-1 produced the highest weight of stem (356.78 g) and the genotype BARI Broccoli-1 gave minimum fresh weight of stem (137.05 g) (Table 1).

Significant variation in fresh weight of stem was observed due to the influence of planting dates (Table 2). Broccoli planted on 21 November produced the maximum fresh (313.73 g) weight of stem. Minimum fresh weight of stem was found from 11 December planting (214.68 g) which was statistically similar to that of 01 December planting (Table 2).

There were significant differences in fresh weight of stem due to interaction of genotypes and planting dates (table 3). This study showed that late planting of seedling lead to weight loss of stem. The highest fresh weight of stem was obtained from V<sub>2</sub>T<sub>1</sub> (Thiland-1 planted on 21 November) (435.23 gm). Treatment combination V<sub>1</sub>T<sub>3</sub> and V<sub>1</sub>T<sub>2</sub> showed the lowest fresh weight of stem

#### ***Fresh weight of root/plant***

The highest fresh weight of root (53.47 g) was recorded from Japan-1 (Table 1). The genotypes Thiland-1(44.31 g) and Thiland-2 (46.59 g) gave statistically similar weight and the lowest weight was recorded from BARI Broccoli-1 (33.20 g) (Table 2).

The 1<sup>st</sup> planting 21 November produced the highest fresh weight of root (60.79 g) (table 2). There was trend to decrease root weight with the advisement of date where the lowest from 01 December followed by 11 December.

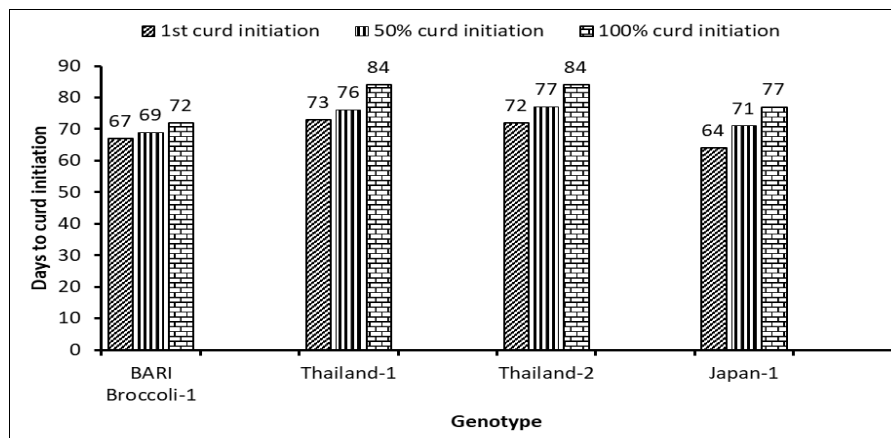
The highest fresh weight of root was obtained from V<sub>4</sub>T<sub>1</sub> (81.06 g) which was statistically similar to V<sub>3</sub>T<sub>1</sub> (72.47 g). The lowest fresh weight of root (29.52 g) was obtained from V<sub>3</sub>T<sub>3</sub> (Table 3). Getachew (2016) observed significant variation fresh weight of root of Broccoli. At early planting fresh weight of root was (35.7 g) and late planting was (15.3 g)

#### ***Curd initiation***

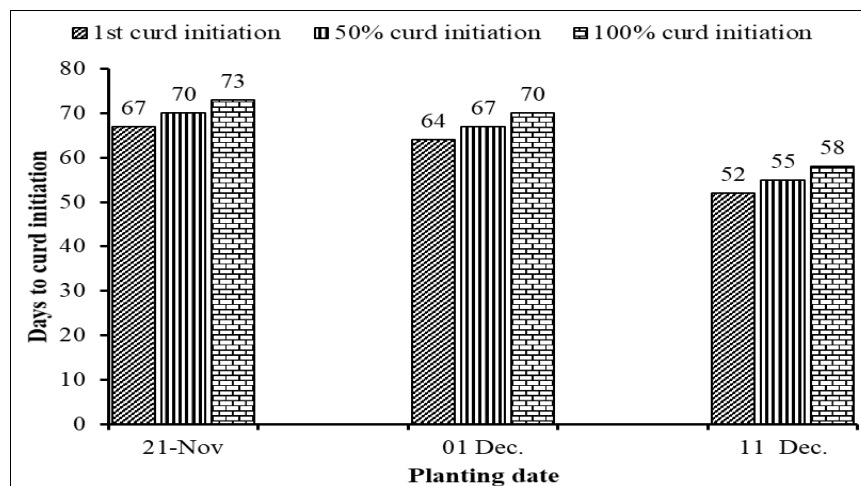
Genotypic differences were observed on days to curd initiation (Fig. 2). BARI Broccoli-1 required minimum number of days 67, 69 and 72, respectively for first curd initiation, 50% curd initiation and total curd initiation while these were maximum in Thiland-2, which were 73, 76 and 84 days, respectively. Similar

results were obtained in broccoli by Hafiz *et al.*, (2015) who reported that early planting (2 October) curd initiation was 89.3% than the late planting (16 December) where curd initiation was 75.3% .

Curd initiation was varied due to planting date (Fig. 3). It was revealed that 67 days for first curd initiation was required in 21 November planting which showed a decreasing trend with the advancement planting. Similar trends were also observed in 50% curd initiation and 100% curd initiation. In both cases maximum number of days 70 and 73 were required for 50% and 100% curd initiation, respectively in 21 November planting, which decreased to 55 to 58 days in 01 December planting. Curd formation in broccoli was quite similar to the curd formation of cauliflower which was primarily influenced by temperature. When broccoli sown late then it was exhibited premature head initiation i.e., curd initiation started before completion of vegetative growth.



**Fig.2. Genotypic differences on days to curd initiation in broccoli.**



**Fig. 3. Effect of planting dates on days to curd initiation in broccoli.**

### *Curd diameter*

Diameter of curd significantly varied among the genotypes and the interaction between genotypes and planting dates. The highest curd diameter was obtained from the genotype Thiland-2 (18.13 cm) while genotype Japan-1 (15.34 cm), statistically identical with Thiland-1 (15.94 cm) and BARI Broccoli-1 (16.46 cm) (Table 1).

Significant difference was not found in planting date but early planting slightly higher in diameter of curd (17.01). The result was in agreement with the Hafiz *et al.*, (2015) who reported that transplanting of broccoli in early planting produced better head (Table 2).

The treatment combination V<sub>3</sub>T<sub>2</sub> produced highest curd diameter (19.43cm), which was identical to V<sub>4</sub>T<sub>1</sub> (19.33 cm), V<sub>3</sub>T<sub>3</sub> (17.50 cm), V<sub>3</sub>T<sub>3</sub> (17.47 cm) and V<sub>2</sub>T<sub>2</sub> (17.33 cm) while it was minimum curd diameter was V<sub>4</sub>T<sub>2</sub> (12.77 cm), V<sub>4</sub>T<sub>3</sub> and V<sub>2</sub>T<sub>2</sub> (Table 3).

Maximum performance of diameter of the curd might be due to more supply of photosynthates from the leaves. Besides early November planting obtained more leaf size, leaf length and number of leaves as compared to all other treatments while late planting showed the minimum diameter of the curd due to small size and number of leaves Jamil *et al.*, (2004) also reported similar finding.

**Table 1. Effect of genotypes on growth, yield contributing characters and yield of broccoli**

Genotypes	Number of Leaves /plant	Fresh weight of leaves/plant (g)	Fresh weight of stem/plant (g)	Fresh weight of root/plant (g)	Curd diameter (cm)	Curd weight (g/Plant)	Curd yield (t ha <sup>-1</sup> )
BARI Broccoli-1 (V <sub>1</sub> )	15.44	395.56	137.05	33.20	16.46	215.01	9.81
Thiland-1 (V <sub>2</sub> )	23.56	525.22	356.78	44.31	15.94	254.02	11.29
Thiland-2 (V <sub>3</sub> )	20.44	423.44	198.11	46.59	18.13	360.19	16.01
Japan-1 (V <sub>4</sub> )	25.44	830.77	311.69	53.47	15.34	251.33	11.17
LSD <sub>(0.05)</sub>	3.58	146.69	24.36	5.94	1.36	35.60	1.43

### *Curd weight/plant:*

Central curd weight was significantly influenced by the genotypes, planting dates and their interaction effects. The maximum weight was recorded from genotype

Thiland-2 (360.19 g) followed by the genotype Thiland-1 (254.02 g) which was statistically identical with Japan-1 (251.33 g) while it was minimum from BARI Broccoli-1. Srivastava (1960) reported that good curd depends on the number of leaves, their size (length and breadth) and ability to store carbohydrates and other nutrients within a particular temperature range (Table 1).

Curd weight varied significantly due to planting dates. The maximum curd weight (285.65 g) was found from 21 November planting, which was statistically identical with 01 December planting (276.65 g) and the minimum curd weight (248.13 g) was found from 11 December planting. This result was in agreement with the findings of Hafiz *et al.*, (2015) (Table 2).

Combined effect of genotype and planting dates curd weight differed significantly ranging from 146.36 g to 419.74 g (Table 3). The maximum curd weight (419.37 g) was recorded from V<sub>3</sub>T<sub>1</sub> (Thiland-2 on 21 November) that was statistically identical with V<sub>3</sub>T<sub>2</sub> (388.49 g) and V<sub>4</sub>T<sub>1</sub>. The minimum curd weight (146.37 g) was obtained from V<sub>4</sub>T<sub>2</sub> (Japan-1 planted on 11 December) and V<sub>2</sub>T<sub>1</sub>. The plants under treatment combination V<sub>3</sub>T<sub>1</sub> and V<sub>3</sub>T<sub>2</sub> performed better because of prevailing suitable temperature for vigorous vegetative growth resulting in higher curd weight. Similar results were obtained by Bianco *et al.*, (1996) who reported that central curd yield was higher when crop planted earlier.

**Table 2. Effect of planting dates on growth, yield contributing characters and yield of broccoli**

Planting date	Number of leaves /plant	Fresh weight of leaves/plant (g)	Fresh weight of stem/plant (g)	Fresh weight of root/plant (g)	Curd diameter (cm)	Curd weight (g/plant)	Curd yield (t ha <sup>-1</sup> )
21 November (T <sub>1</sub> )	27.84	800.87	313.73	60.79	17.01	285.65	12.69
01 December (T <sub>2</sub> )	18.17	448.99	224.32	35.55	16.55	276.65	12.30
11 December (T <sub>3</sub> )	17.67	381.38	214.68	34.83	15.85	248.13	11.22
LSD <sub>(0.05)</sub>	3.10	127.03	21.10	5.14	NS	30.83	1.24

### Curd yield

Significant variation in curd yield (t/ha) was observed among the genotypes. The highest curd yield (16.01 t/ha) was obtained from the genotype Thiland-2. This might be due to highest curd diameter and curd weight. The lowest yield (9.81 t/ha) was recorded from BARI Broccoli-1 due to lower yield attributes (Table 1).

Planting dates also had significant influence on the yield of broccoli. Genotypes of 21 November planting produced the maximum curd yield (12.69 t/ha)



followed by 01 December planting (12.30 t/ha). It might be due to favorable low temperature (10.8°C to 11.6°C) for the curd setting and development. On the other hand, minimum curd yield (11.22 t/ha) was obtained from 11 December planting. It might be due to comparatively higher temperature than the optimum at that time (Table 2). Interaction effect of genotypes and planting dates on yield per hectare was found significant (Table 3). The combination V<sub>3</sub>T<sub>1</sub> produced the maximum curd yield (18.66 t/ha) which was statistically identical to V<sub>3</sub>T<sub>2</sub> (17.27 t/ha) and V<sub>4</sub>T<sub>1</sub> while the lowest curd yield was obtained from V<sub>4</sub>T<sub>2</sub> (6.51 t/ha) which was statistically similar to V<sub>1</sub>T<sub>1</sub> (7.82 t/ha) and V<sub>2</sub>T<sub>1</sub> (7.84 t/ha).

Environmental factors such as light, temperature and rainfall played an important role in growth and yield of broccoli. As the light and temperature remained favorable for 7<sup>th</sup> November planting date ultimately more photosynthates were available for improvement of yield. The results are well in collaboration with the findings of Diputadeo *et al.*, (1989), Patil *et al.*, (1992), Swiader *et al.*, (1992) and on Cole crops. Similar results were obtained in broccoli by Hafiz *et al.*, (2015) who reported that early planting gave higher yield

**Table 3. Interaction effect of genotypes and planting dates on growth, yield contributing characters and yield of Broccoli**

Interaction (V×T)	Number of leaves /Plant	Fresh weight of leaves (g)	Fresh weight of stem (g)	Fresh weight of root (g)	Curd diameter (cm) /plant	Curd weight (g/plant)	Curd yield (t ha <sup>-1</sup> )
V <sub>1</sub> T <sub>1</sub>	16.67	418.13	156.28	32.72	15.67	175.93	7.82
V <sub>1</sub> T <sub>2</sub>	13.33	466.93	143.43	30.54	16.67	248.27	11.03
V <sub>1</sub> T <sub>3</sub>	16.33	301.55	111.44	36.31	17.03	220.76	10.56
V <sub>2</sub> T <sub>1</sub>	32.67	533.26	435.31	56.90	15.56	176.56	7.84
V <sub>2</sub> T <sub>2</sub>	23.00	560.37	352.32	38.91	17.33	323.45	14.37
V <sub>2</sub> T <sub>3</sub>	15.00	482.01	282.71	37.10	14.93	263.05	11.65
V <sub>3</sub> T <sub>1</sub>	26.33	685.56	271.14	72.47	17.46	419.74	18.66
V <sub>3</sub> T <sub>2</sub>	17.00	317.16	155.56	37.78	19.43	388.49	17.27
V <sub>3</sub> T <sub>3</sub>	18.00	267.59	167.63	29.51	17.50	272.34	12.10
V <sub>4</sub> T <sub>1</sub>	35.67	1566.46	392.19	81.06	19.33	370.29	16.46
V <sub>4</sub> T <sub>2</sub>	19.33	451.49	245.95	40.09	12.76	146.36	6.51
V <sub>4</sub> T <sub>3</sub>	21.33	474.35	296.91	39.25	13.93	237.33	10.55
LSD (0.05)	6.22	254.07	42.19	10.66	2.37	61.66	2.37
CV (%)	14.377	27.59	9.93	13.47	8.50	13.47	8.50

V<sub>1</sub> = Broccoli-1, V<sub>2</sub> = Thiland-1, V<sub>3</sub> = Thiland-2, V<sub>4</sub> = Japan-1

T<sub>1</sub> = 21 November, T<sub>2</sub> = 01 December, T<sub>3</sub> = 11 December

### Conclusion

The results of the present experiment indicated that the genotype Thiland-2 performed best among the studied genotypes and 21 November planting was found to be the optimum date of planting for Broccoli. So the genotype Thiland-2 should be planted on 21 November for maximum curd yield of Broccoli in coastal area of Bangladesh.

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