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Growth and yield of cauliflower as influenced by NPKZnB fertilizers

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ABSTRACT

In the study the effect of NPKZnB fertilizers and their combination on growth and yield of cauliflower were observed. Two varieties viz. Snow White (V_1) and White Angel (V_2) were used and the experiment was carried out at vegetable museum, Department of Horticulture, PSTU. The pooled results revealed that the variety Snow White produced maximum plant height (56.51cm), length (6.01cm) and weight (41g) of stem, root length (23.22cm) as compared to White Angel F_1 (55.96cm, 4.781cm, 22.29g, 21.51cm respectively). In contrast, White Angel F_1 recorded the highest number (32.11) and weight (36.87g) of lateral roots, required less time for curd initiation from transplanting (63.44days) and from curd initiation to harvest (18.48days), highest curd diameter (45.36cm), curd yield with leaves (1.067 kg plant^{-1}) and marketable yield (0.876kg), curd yield plot^{-1} (10.51kg or 36.48 ton ha^{-1}) as well as highest dry weight of curd (67.89g) as compared to Snow White (28.95, 36.30g, 68 days, 19.99 days, 43.45cm, 0.984 kg plant^{-1}, 0.757kg, 9.08 kg plot-1 or 31.53 ton ha^{-1} and 57.05g curd^{-1} respectively). In case of treatments, application of 270 kg Urea ha^{-1} + 116 kg P2O5 ha^{-1} + 415 kg K2O ha^{-1} + 22.24 kg ZnSO4 ha^{-1} + 22.8 kg H3BO3 ha^{-1} (T4) produced the highest plant height (67.91cm), no. of leaves plant-1 (21.16), length (63.67cm) and breadth (24.05cm) of the largest leaf, length (5.99cm) and weight (40.40g) of fresh stem, length (24.58cm) and weight (52.26g) of fresh roots, no. of lateral roots (37.72), the minimum day required for curd initiation from transplanting (51.47days) as well as from curd initiation to harvest (12.85days), curd diameter (49.30cm) and curd length (15.03cm), curd yield with leaves (1.417kg plant^{-1}) and marketable yield (1.144kg), also showed the highest curd production per plot (13.73kg or 47.67ton ha^{-1}) and weight of dry curd (92.24g). Besides, lowest production was recorded from control treatment (T_0, without fertilizer) for the above indicating whole characters under natural condition.

INTRODUCTION

Cauliflower (*Brassica oleracea* var. botrytis sub-var. *cauliflora*) contains minimum fat, but higher amount of dietary fiber, folic acid, water, as well as L-ascorbic acid, possessing an affluent nutritional density. A high intake of cauliflower reduces the risk of aggressive prostate cancer (Report on the Productivity Survey of cauliflower Crop, 2014). One cup (100 g) of raw cauliflower supplies 2.5 g Dietary Fiber, 2.4 g Sugar, 37 mg Omega-3 fatty acid, 11 mg Omega-6 fatty acid, 13 IU vitamin A, 46.4 mg vitamin C, 0.1 mg vitamin E (Alpha Tokopherol), 16 mc vitamin k, 0.1 mg Thiamin, 0.1 mg Riboflavin, Niacin 0.5 mg, 0.2 mg vitamin B6, 57 mc Folate, 0.7 mg Pantothenic Acid, 45.2 mg Choline, 22 mg Calcium, 0.4 mg Iron, 15 mg Magnesium, 44.0 mg Phosphorus, 303 mg Potassium, 30 mg Sodium, 0.3 mg Zinc, 0.2 mg Manganese, 0.6 mc Selenium, 1 mc Fluoride, 18 mg Phytosterol, 0.7 g Ash and 91.9 g Water (Self Nutrition Data, 2018).

All types of soil are suitable for cauliflower cultivation. Though, fertility favors growth but uniform manner. Judicious application of fertilizer and proper cultural management are related to getting proper growth and high yield and it responds greatly to major essential elemental nutrients like N, P, K, Zn and B. Most Cole crops

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are vulnerable to calcium diseases and boron insufficiencies and some may require Mg, Mn, Mo, and Cu depending on soil conditions. Soil treatment of required fertilizer is preferable during seedbed preparation or as a side dress for nitrogen and potassium, but foliar sprays can be used for the micronutrients to correct deficiencies based on soil test results, tissue analysis or visual symptoms (Vincent A. Fritz, 2014). Plants require food for growth and development in the form of proper doses of N, P, K, S, B and Zn (Rahman, 2008).

The actual yield of cauliflower is lower than the potential yield. This big gap between the actual and potential yield can be raised by adopting present day agronomic techniques like planting methods, fungicides usage, controlled irrigation and increased nutritional status of the soil. The existing literature regarding to the fertilizer response indicates that N, P, K application to cauliflower improved the yield considerably. Biologically active soils with adequate organic matter usually supply enough of these nutrients (Uddin *et al*., 2009). Addition of different fertilizer enhances vegetative growth and its production suggested that macronutrients N, P, K, Ca and micronutrients B, Zn, Mn, Mo, and Fe are important for cauliflower cultivation. Considering the above factors, the present experiment was undertaken to determine the varietal response of N, P, K, Zn, B fertilizers in relation to the growth, yield and yield components of cauliflower; to select the most productive cauliflower variety, better growth and higher yield and find out the most effective combination of the cauliflower cultivars with N, P, K, Zn, B fertilizers level (s) for getting the proper growth and the best yield of cauliflower.

MATERIALS AND METHODS

Experimental site and period

The research work was conducted at "Vegetable Museum", the research field under the Department of Horticulture, Patuakhali Science and Technology University (PSTU), Dumki, Patuakhali, during November, 2017 to March, 2018 to find out the growth and yield attributes of two cauliflower cultivars as influenced by the combinations of different N, P, K, Zn and B levels.

Experimental materials

The two varieties of cauliflower such as V_1= Snow White and V_2= White Angel F1were used as planting materials for the study. Including control, five different inorganic or chemical fertilizers (IF) based combinations of N, P, K, Zn and B levels were considered as treatments. These are Control (No fertilizers); 108 kg Urea ha-1 + 29 kg P_2O_5 ha^{-1} + 103.75 kg K_2O ha^{-1} + 5.56 kg ZnSO4 ha^{-1} + 5.7 kg H_3BO_3 ha^{-1} (T_1); 162 kg Urea ha^{-1} + 58 kg P_2O_5 ha^{-1} + 207.5 kg K_2O ha-1 + 11.12 kg $ZnSO_4$ ha^{-1} + 11.4 kg H_3BO_3 ha^{-1} (T_2); 216 kg Urea ha^{-1} + 87 kg P_2O_5 ha^{-1} + 311.25 kg K_2O ha^{-1} + 16.68 kg $ZnSO_4$ ha^{-1} + 17.1 kg H_3BO_3 ha^{-1} (T_3); 270 kg Urea ha^{-1} + 116 kg P_2O_5 ha^{-1} + 415 kg K_2O ha^{-1} + 22.24 kg ZnSO4 ha^{-1} + 22.8 kg H_3BO_3 ha^{-1} (T_4). The experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications.

Raising the seedlings

As per BRRI recommendation seed bed was prepared with 1 m wide seed bed adding nutrients as per the requirements of soil. Seeds were sown in the seed bed on November 2, 2017 in order to transplant the seedlings in the plot as per experimental design.

Complete germination of seeds took place within 5 days of sowing. The seedlings were allowed in the seedbed for 30 days. After 30 days of emergence the seedlings were transplanted into main field.

Application of manures and fertilizers

All the experimental plots were treated as 3.3.1 indicating combinations of N, P, K, Zn and B fertilizer in different amount where control treatment did not treated by any amount of N, P, K, Zn and B or any other organic and inorganic manures. The 1/2 (half) of Urea (N), 1/2 (half) of TSP (P), 1/2 (half) of MOP (K) ware applied at 10 days after transplanting of seedling. The rest doses of Urea, TSP, MOP and whole doses of Zn (Zinc Sulphate) and B (Boric acid) were applied at 25 days after transplanting in all the plots except control plots.

Transplanting of seedlings

Thirty days old healthy and uniform seedlings were transplanted in the experimental plots maintaining a spacing of 60 cm x 40 cm. Seedbeds were watered in the morning before uprooting the seedlings to avoid damage of the roots. The seedlings were uprooted carefully from the seedbed to ensure minimum injury to the root systems. Transplanting was done in the afternoon and watered lightly with a watering can immediately after transplanting for better establishment. The transplanted seedlings were kept under shade with pieces of banana leaf sheaths during the day time to protect those from the scorching sunshine. At night seedlings were kept open to receive dew. Shading and watering were continued for 3 days until the seedlings were established. A few of seedlings were planted at the same time in the border of the experimental plot for gap filling.

Pest management

To protect the crops from Cutworm and Epilakhna beetle and other insect foliar spray of the pesticide Decis EC 25@25 ml/liter was used. To protect the plants from fungus foliar spray of the fungicide Rovral was used @20 g per 10 liter of water.

Harvesting

Harvesting was done plot wise at different dates after attaining the harvest maturity from 05 February, 2018 to 08 March, 2018. Before harvesting, the harvest maturity was ensured by watching the color and size of curd. Randomly selected five plants were from each plot for data collection. Five plants, most of which from middle rows, were selected randomly from each unit plot for data collection.

Data analysis

Analysis of variance was done following the Randomized Complete Block Design with the help of MSTAT-C package program developed by Russel (1986). The means for all the treatments were calculated and analysis of variance for each parameter was performed by F- test (Gomez and Gomez, 1984) while means were adjusted by Least Significant Different test (LSD) at 5% level of significant

RESULTS AND DISCUSSIONS

Effect of fertilizers and varieties on the growth, yield and different components of cauliflower

Plant height (cm)

The different doses of chemical fertilizers as well as the variety of cauliflower significantly influenced the plant height at different stages of growth i.e. 20, 40, 60 days after transplanting (DAT) and at harvest. Plant height showed the increasing trend up to harvest for each treatment. Maximum plant height at harvest (67.91 cm) was recorded from, T_4 (270 kg Urea ha^{-1} + 116 kg P_2O_5 ha^{-1} + 415 kg K_2O ha^{-1} + 22.24 kg ZnSO4 ha^{-1} + 22.8 kg H_3BO_3 ha^{-1}) followed by (63.33 cm) from T_3 (216 kg Urea ha-1 + 87 kg P2O5 ha-1 + 311.25 kg K2O ha-1 + 16.68 kg ZnSO4 ha-1 + 17.1 kg H3BO3 ha-1) and (58.32 cm) from T2 (162 kg Urea ha-1 + 58 kg P2O5 ha-1 + 207.5 kg K2O ha-1 + 11.12 kg ZnSO4 ha-1 + 11.4 kg H3BO3 ha-1) and the lowest plant height (39.19 cm) was from To (Control/No fertilizers) (Table 2). No significant difference has been found between two varieties (viz. V1 = Snow White, V2 = White Angel F1) for plant height at harvest (Table 1). Among the treatments it was observed that the plant height increased gradually with the advancement of time. The plant height reached to its maximum at harvest in all the treatments. The effect of treatments on the plant height at different days after transplanting of cauliflower is shown in the Table 2. This observation is consistent with the previous report by other investigators (Islam et al., 2014 in Cauliflower, Abou El-Magd, 2013 as well as Nguillie and Biswas, 2014 in Broccoli).

Table1
Effects of interaction of varieties and different rates of NPKZnB fertilizers on plant height cm) of cauliflower at different DAT (Days after Transplanting).

Variety x treatment	Plant height (cm) at different DAT			
	20 DAT	40 DAT	60 DAT	At harvest
V_1T_0	12.83e	21.10f	30.67g	39.57f
V_1T_1	14.57de	28.45e	43.40de	53.97de
V_1T_2	15.77cd	32.63cd	44.65cde	57.75cd
V_1T_3	17.06bc	34.35cd	48.15bc	63.34b
V_1T_4	19.77a	38.48a	52.47a	67.89a
V_2T_0	10.65f	20.23f	29.68g	38.80f
V_2T_1	14.23de	27.45e	38.88f	50.87e
V_2T_2	15.14cd	31.83d	41.70ef	58.89c
V_2T_3	17.03bc	35.46bc	47.07cd	63.31b
V_2T_4	19.00ab	37.86ab	51.04ab	67.94a
$LSD_{(.005)}$	1.97	3.01	3.75	4.18
CV (%)	7.36	5.7	5.11	4.34
Level of Significance	ns	ns	ns	Ns

In a column figures having harmonious and no letter(s) do not vary significantly at 5% level whereas figures with discordant letter(s) dissent significantly as per LSD at equivalent levels; ns = Non-significant

Table 2
Effects of different rates of NPKZnB fertilizers on plant height (cm) of cauliflower at different DAT.

Fertilizer treatments	Plant height (cm) at different DAT			
	20 DAT	40 DAT	60 DAT	At Harvest
T_0	11.74	20.66	30.18	39.19
T_1	14.4	27.95	41.14	52.42
T_2	15.45	32.23	43.17	58.32
T_3	17.05	34.9	47.61	63.33
T_4	19.39	38.17	51.75	67.91
$LSD_{(0.05)}$	1.39	2.13	2.65	2.96
CV (%)	7.36	5.7	5.11	4.34
Level ofSignificance	**	**	**	**

**= Level of significance at 1% probability and

Table 3
Effect of cauliflower varieties on plant height (cm) at different DAT.

Variety	Plant height (cm)			
	20 DAT	40 DAT	60 DAT	At Harvest
Snow White	16.12	31.13	43.87	56.51
White Angel F1	15.21	29.57	41.67	54.96
$LSD_{(0.05)}$	0.88	1.35	1.68	1.87
CV (%)	7.36	5.7	5.11	4.34
Level of Significance	*	Ns	*	*

.*= Level of significance at 5% probability ; ns = Non-significant

Number of leaves per plant

The variations in the total number of leaves per plant under different doses of NPKZnB fertilizers were found statistically significant at 20, 40 and 60 days after transplanting and also at harvest. Maximum number of leaves (21.16) at harvest was recorded from T4, followed by (19.49) from T3, leaf number (17.07) from T2, (15.93) from T1 and minimum leaves per plant was observed (12.90) from T0. At each DAT, maximum number of leaves per plant was produced with the combination of 270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1(Table 5). The higher number of leaf production per plant may be accounted for higher vegetative growth due to optimum vegetative growth and optimum nutrient supply. But the minimum number of leaves was counted from control (T0) treatment. This result supports to those described earlier byAbou El-Magd (2013) in respect of Brocoli; Uddainet al., (2012) in Kohlrabi; Hasan and Solaiman (2012) in Cabbage.

Table 4
Effects of interaction of varieties and different rates of NPKZnB fertilizers on number of leaves plant¬$^{-1}$ of cauliflower at different DAT**.**

Variety x Treatment	Number of leaves/plant			
	20 DAT	40 DAT	60 DAT	At harvest
V_1T_0	9.243b	11.06c	14.73d	13.02e
V_1T_1	10.08ab	11.27bc	14.67d	15.87d
V_1T_2	9.840ab	12.57abc	14.33d	17.55cd
V_1T_3	9.497ab	11.20bc	14.87cd	18.80bc
V_1T_4	10.74a	12.23abc	15.33bcd	20.25ab
V_2T_0	9.107b	10.87c	14.67d	12.77e
V_2T_1	9.110b	12.87ab	15.13cd	16.00d
V_2T_2	9.710ab	12.53abc	17.20ab	16.58cd
V_2T_3	9.957ab	12.27abc	16.74abc	20.18ab
V_2T_4	10.30ab	13.13a	17.53a	22.07a
LSD(.005)	1.45	1.72	1.97	2.54
CV (%)	8.66	8.36	7.39	8.55
Level of significance	ns	ns	ns	Ns

In a column figures having harmonious and no letter(s) do not vary significantly at 5% level whereas figures with discordant letter(s) dissent significantly as per LSD at equivalent levels.; ns = Non-significant

Table 5
Effects of different rates of NPKZnB fertilizers on number of leaves plant^{-1} of cauliflower at different DAT.

Fertilizer treatments	Number of leaves plant^{-1} at different DAT			
	20 DAT	40 DAT	60 DAT	At Harvest
T_0	9.18	10.97	14.7	12.9
T_1	9.6	11.73	14.9	15.93
T_2	9.73	12.07	15.77	17.07
T_3	9.78	12.55	15.81	19.49
T_4	10.52	12.68	16.43	21.16
$LSD_{(0.05)}$	1.02	1.22	1.39	1.79
CV (%)	8.66	8.36	7.39	8.55
Level of significance	*	*	*	*

*= Level of significance at 5% probability

Table 6
Effect of cauliflower varieties on number of leaves plant^{-1} at different DAT.

Variety	Number of leaves/plant			
	20 DAT	40 DAT	60 DAT	At Harvest
Snow White	9.88	11.67	14.79	17.1
White Angel F1	9.64	12.33	16.26	17.52
LSD(0.05)	0.65	0.77	6.88	1.13
CV (%)	8.66	8.36	7.39	8.55
Level of significance	ns	*	*	*

*= Level of significance at 1% probability

Table 7
Effects of interaction of varieties and different rates of NPKZnB fertilizers on length of the largest leaf (cm) of cauliflower at different DAT**.**

Variety x Treatment	Length of the largest leaf (cm)			
	20 DAT	40 DAT	60 DAT	At harvest
V_1T_0	10.18EF	17.92F	24.92F	35.12F
V_1T_1	12.20CD	24.76E	39.07D	50.07DE
V_1T_2	13.39BC	28.23D	40.74CD	54.82C
V_1T_3	14.20B	30.39CD	44.43BC	59.73B
V_1T_4	16.67A	35.17A	49.69A	62.88AB
V_2T_0	8.370F	15.84F	26.64EF	35.49F
V_2T_1	11.45DE	23.78E	30.23E	47.94E
V_2T_2	12.13CD	27.70D	37.38D	54.44CD
V_2T_3	14.09B	31.42BC	43.67BC	59.90B
V_2T_4	16.38A	33.99AB	47.64AB	64.46A
LSD(0.05)	1.83	2.70	4.55	4.38
CV (%)	8.28	5.85	6.91	4.86
Level of significance	ns	Ns	*	Ns

In a column figures having harmonious and no letter(s) do not vary significantly at 5% level whereas figures with discordant letter(s) dissent significantly; **= Level of significance at 1% probability. ns = Non-significant

Table 8
Effects of different rates of NPKZnB fertilizers on length of the largest leaf (cm) of cauliflower at different DAT.

Fertilizer treatments	Length of the largest leaf (cm)			
	20 DAT	40 DAT	60 DAT	At Harvest
T_0	9.27	16.88	25.78	35.3
T_1	11.82	24.27	34.65	49
T_2	12.76	27.9	39.06	54.63
T_3	14.15	30.91	44.05	59.81
T_4	16.52	34.58	48.66	63.67
$LSD_{(0.05)}$	1.29	1.91	3.22	3.09
CV (%)	8.28	5.85	6.91	4.86
Level of significance	**	**	**	**

Length of the largest leaf (cm)

The length of the biggest leaf varied significantly at 20, 40 and 60 days after transplanting and at harvest due to the application of different levels of combined fertilizers. T4 gave the highest (63.67 cm) length of largest leaf followed by (59.81 cm) from the treatment T3 and T0 gave the lowest length (35.30 cm) of leaf (Table 8). Similar results were reported by Uddain et al. (2012

Breadth of largest leaf (cm)

Application of N, P, K, Zn and B at different concentrations significantly increases the breadth of leaf at 20, 40 and 60 days after transplanting and at harvest. Maximum breadth of leaf (24.05 cm) was recorded from the combination of 270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1 (T4) and minimum breadth of leaf (15.50 cm) was recorded from the control treatment, To (Table 10). Similar results have been reported by Singh et al. (2015). They find that the mixture of Nitrogen and Boron fertilizer has at higher doses had highly effectiveness for maximizing the leaf growth. Rouhi et al. (2014) also agreed those findings in respect of cauliflower.

Table 9
Effects of interaction of varieties and different rates of NPKZnBfertilizerson Breadth of the largest leaves (cm) of Cauliflower at different DAT.

Variety x Treatment	Breadth of largest leaves (cm)			
	20 DAT	40 DAT	60 DAT	At harvest
V_1T_0	4.337d	8.667d	14.20d	16.19fg
V_1T_1	6.007ab	9.200cd	18.87bc	20.01de
V_1T_2	6.057ab	10.13c	19.00b	21.74cd
V_1T_3	5.933b	10.40c	22.60ab	24.77ab
V_1T_4	5.063c	10.19c	19.57b	20.54d
V_2T_0	5.843b	9.210cd	13.00d	14.82g
V_2T_1	5.967b	10.20c	16.78c	17.87ef
V_2T_2	4.847cd	9.833cd	18.07bc	21.73cd
V_2T_3	5.100c	11.93b	20.22b	23.33bc
V_2T_4	6.723a	13.53a	23.35a	26.88a
LSD(.005)	0.72	1.44	2.21	2.61
CV (%)	7.53	8.12	6.94	7.33
Level of significance	**	**	**	**

In a column figures having harmonious and no letter(s) do not vary significantly at 5% level whereas figures with discordant letter(s) dissent significantly. **= Level of significance at 1% probability and ns = Non-significant

Table 10
Effects of NPKZnB fertilizers on breadth of the largest leaf (cm) of Cauliflower at different DAT.

Fertilizer treatments	Breadth of the largest leaf (cm)			
	20 DAT	40 DAT	60 DAT	At Harvest
T_0	5.09	8.94	13.6	15.5
T_1	5.99	9.7	17.82	18.94
T_2	5.45	9.98	18.53	21.74
T_3	5.52	11.17	21.41	24.05
T_4	5.89	11.86	21.46	23.71
$LSD_{(0.05)}$	0.51	1.02	1.56	1.85
$CV_{(\%)}$	7.53	8.12	6.94	7.33
Level of significance	**	*	**	**

Length of the stem (cm)

Snow white F1 (V1) has the highest stem length (6.01 cm) as compared to White angel (4.781 cm) in this experiment (Table 13). This was found might be due to the genetic variation between the both studied varieties. Similar results were also found in Kohlrabi in Broccoli by earlier investgators (El-Bassionyet al., 2014) compare to the present study.

The length of Cauliflower stem varied significantly from 4.928 to 5.995cm due to the effect of different doses of synthetic N, P, K, Zn and Biofertilizers (Table 12). From above mentioned database, it was found that the maximum length of stem was found from T4 (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1+ 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) while it was the minimum from T1 (108 kg Urea ha-1 + 29 kg P2O5 ha-1 + 103.75 kg K2O ha-1 + 5.56 kg ZnSO4 ha-1 + 5.7 kg H3BO3 ha-1)

Fresh weight of the stem (g)

The fresh stem weight of the variety Snow white was significantly highest (41 g plant-1) than that of White angel F1 (22.29 g plant-1) in this experiment (Table 13). Maximum fresh of the stern (40.40 g plant-1) was found from T4 (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) and minimum (21.37 g plant-1) from T0 (no fertilizer). The variation in weight of fresh stem was found due to the variation in genotypic variation of the experimented varieties while similar observation was also found in previous report investigated by Islam et al.,(2014). The effect of the treatments on fresh stem of cauliflower at harvest is shown in the Table 12.

Length of root (g)

There was a significant difference has been found between two varieties after applying different doses of combined chemical fertilizers in terms of length of root (g). Varietal response had also statistically significant on length of root of V1 (Snow white) was the highest (23.22 cm) compared to as V2 (White angel F1) had 21.51 cm in this study (Table 13). The length of root was varied significantly from 19.43 cm to 24.58 cm at harvest due to the application of different levels of N, P, K, Zn and B fertilizers. Maximum length of the root (24.58 cm) was recorded from the plants treated with treatment T4 (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) and minimum length of root (19.43 cm) was recorded from the plants treated with control treatment T_0 (no fertilizers) (Table12).

Number of lateral roots plant-1

The variations in total number of lateral roots per plant at harvest under different doses of some essential macro and micro nutrients viz. Nitrogen, Phosphorus, Potassium, Zinc and Boron; were found statistically significant. White Angel F1 (V1) showed significantly the maximum number of lateral roots plant-1(32.11) than that of Snow White (28.93) which might be due to the variation in genetic makeup of the studied both varieties (Table 13). Maximum number of lateral roots (37.72) was founded from the treatment T4(270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) and minimum number of lateral roots (25.39) was founded from control, T0(no fertilizer).

Fresh weight of the root (g)

The root weight of the variety Snow white (V1) and White angel F1 (V2) was more or less similar (Table 13). But there is significant variation has been found while treated with different rates (T0, T1, T2, T3 and T4) of fertilizers viz. N, P, K, Zn and B. Among the fertilizer treatments, the maximum fresh weight of root (52.56 g plant-1) was recorded from the treatments T4 (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) followed by (45.88 g plant-1) the treatment T3 (216 kg Urea ha-1 + 87 kg P2O5 ha-1 + 311.25 kg K2O ha-1 + 16.68 kg ZnSO4 ha-1 + 17.1 kg H3BO3 ha-1). On the other hand, the treatment T¬0 (no fertilizer) showed the lowest weight of fresh root (21.93 g plant-1) in this experiment (Table 12). The higher weight of fresh root was found under higher rates of N, P, K, Zn & B fertilizers which might be due to the macro and micro nutrients of the studies soil were highly utilize by this application.

Table 11
Effects of interaction of varieties and different rates of NPKZnB fertilizers on yield components of Cauliflower.

Variety x Treatment	Length of stem (cm)	Fresh weight of stem (g)	Length of the root (cm)	Number of lateral roots	Fresh weight of root (cm)
V_1T_0	6.200a	23.26ef	19.77ef	21.47f	18.08g
V_1T_1	5.433cd	35.86c	22.38cd	34.67b	32.54e
V_1T_2	6.047ab	42.30b	23.25bc	30.68cd	35.17e
V_1T_3	5.973abc	45.17b	25.05ab	25.00e	47.54bc
V_1T_4	6.387a	58.39a	25.68a	32.84bc	48.18b
V_2T_0	4.517e	19.48g	19.09f	29.31d	25.78f
V_2T_1	4.423e	17.27g	20.24def	21.61f	18.34g
V_2T_2	4.873de	25.38de	22.04cde	33.79bc	39.10d
V_2T_3	4.487e	26.93d	22.72bc	33.25bc	44.21c
V_2T_4	5.603bc	22.41f	23.48abc	42.59a	56.94a
LSD(.005)	0.57	2.87	2.38	3.36	3.62
CV (%)	6.12	5.29	6.21	6.41	5.77
Level of significance	ns	**	ns	**	**

In a column figures having harmonious and no letter(s) do not vary significantly at 5% level whereas figures with discordant letter(s) dissent significantly as per LSD at equivalent levels. **= Level of significance at 1% probability and *= Level of significance at 5% probability; ns = Non-significant

Table 12
Effects of different rates of NPKZnB fertilizers on yield components of Cauliflower at different DAT.

Fertilizer treatments	Length of stem	Weight of stem	Length of roots	No. of lateral roots	Weight of roots
T_0	5.36	21.37	19.43	25.39	21.93
T_1	4.93	26.56	21.31	28.14	25.44
T_2	5.46	33.84	22.65	32.23	37.13
T_3	5.23	36.05	23.88	29.13	45.88
T_4	5.99	40.4	24.58	37.72	52.56
$LSD_{(0.05)}$	0.40	2.03	1.69	2.37	2.56
$CV_{(\%)}$	6.12	5.29	6.21	6.41	5.77
LS	**	**	**	**	**

Table 13
Effect of varieties on different yield components of Cauliflower at harvest.

Variety	Length of largest leaf (cm)	Breadth of the largest leaf (cm)	Length of stem (cm)	Weight of stem (cm)	Length of roots (cm)	No. of lateral roots	Weight of roots (g)
Snow White	52.52	20.65	6.01	41	23.22	28.93	36.3
White Angel F1	52.45	20.92	4.78	22.29	21.51	32.11	36.87
$LSD_{(0.05)}$	1.96	2.08	0.25	1.28	1.07	1.50	1.62
$CV_{(\%)}$	4.86	2.61	6.12	5.29	6.21	6.41	5.77
LS	ns	ns	**	**	**	**	Ns

Days taken to curd initiation from transplanting

The days from transplanting to curd initiation were decreased significantly due the application of higher doses of chemical fertilizers. Due to the application of T4 (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) to the days taken to curd initiation became the lowest (51.47) and the control treatment T0 took the highest (75.86) days to curd initiation from transplanting (Table 15).

Days taken from curd initiation to harvest

Both the varieties showed the significant variation in respect of days taken from curd initiation to harvest, where the White Angel F1 gave the better result (18.48 days) than that of Snow White (19.99 days) (Table 16).Days required from curd initiation to harvest were decreased significantly due to the application of combined doses of N, P, K, Zn and B. By the application of the treatment T4 (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1), the days taken from curd initiation to harvest became the lowest (12.85) and the control treatment, T0 took the highest (25.31) days from curd initiation to harvest (Table 15).

Curd diameter at harvest (cm)

Application of N, P, K, Zn and B fertilizers at different rates significantly increases the curd diameter at harvest. The highest curd diameter (49.30 cm) was recorded from the highest combined viz. N, P, K, Zn and B treatment T4 (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) and the lowest curd diameter (35.67 cm) was recorded from the control treatment T0(no fertilizers). The Effect of treatments on curd diameter of cauliflower at harvest is shown in the Table 15.

Curd length at harvest (cm)

The curd length of the variety White Angel F1(V2) was significantly the highest (16.12 cm) due to application of treatment T4; which is close to the interaction V1T4(Snow White x 270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) at harvest. On the other hand, the lowest curd length (10.28 cm) was recorded from the interaction treatment of V1T0 (Snow White x no fertilizer) which was statistically differed from all other interactions. (Table 14).

Table 14
Effects of interaction of varieties and different rates of NPKZnB fertilizers on yield components of Cauliflower.

Variety x Treatment	Days taken for curd initiation from transplanting	Days taken for curd initiation to harvest	Curd diameter at harvest (cm)	Curd length at harvest (cm)
V_1T_0	75.58ab	27.01a	34.57e	10.28f
V_1T_1	76.73a	23.26b	43.28cd	13.82cd
V_1T_2	70.28bc	20.40cd	45.98bcd	13.81cd
V_1T_3	62.49d	15.59e	46.42bcd	15.24ab
V_1T_4	54.91e	13.70ef	47.00bc	13.94bc
V_2T_0	76.13ab	23.60b	36.77e	10.69f
V_2T_1	71.48abc	21.88bc	42.27d	12.60de
V_2T_2	66.63cd	19.44d	46.87bc	12.10e
V_2T_3	54.94e	15.47e	49.30ab	14.71bc
V_2T_4	48.03f	12.01f	51.60a	16.12a
LSD(.005)	5.861	2.245	4.354	1.329
CV (%)	5.2	6.8	5.72	5.81
Level of significance	ns	ns	Ns	**

In a column figures having harmonious and no letter(s) do not vary significantly at 5% level whereas figures with discordant letter(s) dissent significantly as per LSD at equivalent levels. **= Level of significance at 1% probability and *= Level of significance at 5% probability; ns = Non-significant

Table 15
Effects of different rates of NPKZnB fertilizers on yield components of Cauliflower at different DAT

Fertilizer treatments	Days taken for curd intn. from transplanting	Days taken for curd initiation to harvest	Curd diameter at harvest (cm)	Curd length at harvest (cm)
T_0	75.86	25.31	35.67	10.48
T_1	74.1	22.57	42.78	13.21
T_2	68.45	19.92	46.42	12.95
T_3	58.72	15.53	47.86	14.97
T_4	51.47	12.85	49.3	15.03
$LSD_{(0.05)}$	4.14	1.59	3.07	0.94
CV (%)	5.20	6.80	5.72	5.81
Level of significance	**	**	**	**

Table 16
Effect of varieties on different yield components of Cauliflower at harvest.

Variety	Days taken for curd intn. from transplanting	Days taken for curd intn. to harvest	Curd diameter at harvest (cm)	Curd length at harvest (cm)
Snow White	68	19.99	43.45	13.42
White Angel F1	63.44	18.48	45.36	13.24
$LSD_{(0.05)}$	2.62	1.00	1.94	0.59
$CV_{(\%)}$	5.20	6.80	5.72	5.81
Level of significance	**	**	*	ns

Curd weight with leaves at harvest (kg/plant)

Varietal response had also statistically significant on curd weight with leaves where White Angel F1 showed the maximum (1.067 kg/plant) at harvest than that of Snow White (0.984 kg/plant). This was found might be due to the growing condition of the studied region was more favorable for White Angel F1 (V2¬¬) as well as the genetic variation between the both varieties, which ultimately increased the growth attributes of Cauliflower (Table 19).

The curd weight of leaves varied significantly from 0.727 to 1.417 kg due to the effect of different rates of N, P, K, Zn and B fertilizers (Table18). From the above variation it was found that the maximum curd weight with leaves (1.42kg plant-1) was found from the highest levels of N, P, K, Zn, B fertilizer treatment (T4: 270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) while it was the lowest in without fertilizer (T0).

Dry weight of the individual curd (g)

Dry weight of the individual curd(g) also varied significantly due to the effect of varieties where White Angel F1 produced the highest dry weight of the individual curd (67.89 g) than Snow White (57.05 g plant-1) in this experiment. This might be due to the variation in genetic makeup of the variety and the regional condition of the studied region were also varied the growth of both varieties (Table 19).

Different types and rates of N, P, K, Zn and B fertilizer was significantly influenced the dry weight of the individual curd. Among the different rates of N, P, K, Zn and B fertilizer treatments, the highest dry weight of curd (92.24 g) was recorded in T4 (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) followed by (75.08 g plant-1) the treatment T3 (216 kg Urea ha-1 + 87 kg P2O5 ha-1 + 311.25 kg K2O ha-1 + 16.68 kg ZnSO4 ha-1 + 17.1 kg H3BO3 ha-1). On the other hand, control treatment (T0: No fertilizer) showed the

lowest dry matter content of curd (35.49 g plant-1) (Table 18). Similarly, Rouhi et al. (2014) found that the dry matter of the curd (g) of Cauliflower was higher from the application of RDF. Ogedegbe et al. (2013) also revealed that the corresponding values for total dry weight were 183.30 to 923.30 g. These parameters were responsible for highest cabbage girth and yield while the igher total dry weight was obtained from N, P, K fertilizers applied at 150 kg N ha-1. Kandil and Gad (2009) also reported that the dry weight of shoots and roots of Broccoli were highest by application of N, P, K fertilizers at formula 19: 19: 19. Scientists of the related fields also found indicative different in total dry matter content due to the effect of fertilizer while their higher rates maximizing the total dry weight. So, the above all findings were more or less statistically similar with the present findings.

Dry weight of the individual curd (g) significantly varied from 30.39 to 96.20 g plant-1 due to the effect of interaction where it was the highest in V2T4 (White Angel F1 x 270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) and the lowest in V1T0 (Snow White x No fertilizer) in this experiment (Table 17).

Marketable curd weight (kg/plant)

Marketable curd weight (kg plant-1) showed significant variation due to the effect if both varieties where White Angel F1 produced the highest marketable curd weight (0.876 kg plant-1) than that of Snow White (0.757 kg plant-1) in this experiment (Table 19).

Significant variation has been found in case of marketable curd weight (kg/plant) from 0.522 to 1.144 kg plant-1 due to the effect of NPKZnB fertilizers. The above variation in marketable curd weight (kg plant-1) obtained from Table 18 showed that the treatment T4 (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) produced the highest marketable curd weight (1.144 kg/plant) while the treatment T3 (216 kg Urea ha-1 + 87 kg P2O5 ha-1 + 311.25 kg K2O ha-1 + 16.68 kg ZnSO4 ha-1 + 17.1 kg H3BO3 ha-1) produced comparatively close yield (0.928 kg/plant) to the treatment T4. On the other hand, without any chemical fertilizers viz. N, P, K, Zn and B showed the lowest marketable curd weight (0.522 kg/plant). Halim et al. (1994) also found significant variation in cabbage due to the effect of different doses of NPK where marketable head weight plant-1were maximum with 150 kg N2 + 100 Kg P2O5 + 150 kg K2O. Sultana et al. (2012) in Kohlrabi, Naher et al. (2014) Hossain et al. (2011) in cabbage were also found similar result with the present experiment.

There was no significant variation has been found for the marketable curd weight of Cauliflower due to the effects of interaction of varieties and fertilizers at the 5% level of significance.

Curd yield (kg/plot or ton ha-1)

The yield of curd (kg/plot) under different doses of chemical fertilizers viz. N, P, K, Zn and B were significantly influenced. It was found that the curd yield of Cauliflower was the highest (10.51 kg/plot or 36.48 ton ha-1) in White Angel F1 compared to Snow White (9.080 kg/plot or 31.51 ton ha-1) (Table 19). The differences in varietal genetic characteristics of the studied varieties varied the curd yield of Cauliflower. However, White Angel F1 gave the highest performance regarding growth and yield components of Cauliflower which was helpful for getting the greater production of Cauliflower in this experiment. Similarly, Islam et al. (2014) also showed the variation among varieties and described that those varieties have unique genetic characteristics which may be reason to require different period for curd initiation as well as the marketable curd maturity of different varieties in a same planting date. Obaidullah et al. (2012) also supported the present findings in respect of cabbage production.

Effect of the chemical fertilizers also significantly affected the curd yield of Cauliflower where the treatment T4 (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) produced numerically the highest curd yield (13.73 kg/plant or 47.67 ton ha-1) followed by the treatment T3 (216 kg Urea ha-1 + 87 kg P2O5 ha-1 + 311.25 kg K2O ha-1 + 16.68 kg ZnSO4 ha-1 + 17.1 kg H3BO3 ha-1) which produced comparatively less yield (11.14 kg/plot

or 38.69 ton ha-1). In contrast, the lowest curd yield (6.272 kg/plot or 21.78 ton ha-1) has been produced from control treatment, T0 (no fertilizer) (Table 18). Halim et al. (1994) had found much variation for total yield of cabbage due to the effect of different doses of N, P, K where total yield plot-1 were maximum with 150 kg N2 + 100 Kg P2O5 + 150 kg K2O or 200 kg N2 + 100 Kg P2O5 + 150 kg K2Ocombination.

There was no significant variation has been found for the curd yield of Cauliflower due to the effects of interaction of varieties and fertilizers at the 5% level of significance (Table 17).

Table17
Effects of interaction of varieties and different rates of NPKZnB fertilizers on yield components of Cauliflower**.**

Variety x Treatment	Curd yield with leaves at harvest (kg/plant)	Marketable curd yield (kg/plant)	Curd yield (kg/plant)	Curd yield (ton/ha)	Dry matter content (g/curd)
V_1T_0	0.7633fg	0.403h	4.836g	16.79g	30.39h
V_1T_1	0.8402ef	0.669fg	8.036ef	27.90ef	38.54g
V_1T_2	0.9045de	0.756ef	9.076de	31.51de	56.78f
V_1T_3	1.090c	0.879d	10.55c	36.62c	71.24d
V_1T_4	1.323b	1.075b	12.90b	44.80b	88.28b
V_2T_0	0.6920g	0.642g	7.708f	26.76f	40.58g
V_2T_1	0.9237de	0.754ef	9.060de	31.46de	60.51ef
V_2T_2	0.9853cd	0.789de	9.477cd	32.90cd	63.27e
V_2T_3	1.224b	0.978c	11.74b	40.75b	78.91c
V_2T_4	1.510a	1.213a	14.56a	50.54a	96.20a
$LSD_{(.005)}$	0.13	0.09	1.18	4.12	5.43
$CV_{(\%)}$	7.25	7.07	7.06	7.06	5.07
Level of significance	*	ns	Ns	ns	**

In a column figures having harmonious and no letter(s) do not vary significantly at 5% level whereas figures with discordant letter(s) dissent significantly as per LSD at equivalent levels. **= Level of significance at 1% probability and *= Level of significance at 5% probability; ns = Non-significant

Table 18
Effects of different rates of NPKZnB fertilizers on yield components of Cauliflower at harvest.

Fertilizer treatments	Curd yield with leaves at harvest (kg/plant)	Marketable curd yield (kg/plant)	Curd yield (kg/plant)	Curd yield (ton/ha)	Dry matter content (g/curd)
T_0	0.728	0.523	6.27	21.78	35.49
T_1	0.88	0.712	8.55	29.68	49.53
T_2	0.945	0.773	9.28	32.21	60.02
T_3	1.16	0.929	11.14	38.69	75.08
T_4	1.42	1.14	13.73	47.67	92.24
$LSD_{(0.05)}$	0.09	0.07	0.84	2.91	3.84
$CV_{(\%)}$	7.25	7.07	7.06	7.06	5.07
LS	**	**	**	**	**

Table 19
Effect of varieties on different yield components of Cauliflower at harvest

Variety	Curd yield with leaves at harvest (kg/plant)	Marketable curd yield (kg/plant)	Curd yield (kg/plot)	Curd yield (ton/ha)	Dry matter content of the curd (g/curd)
Snow White	0.984	0.757	9.08	31.53	57.05
White Angel F_1	1.067	0.876	10.51	36.48	67.89
$LSD_{(.005)}$	0.06	0.04	0.53	1.84	2.43
$CV_{(\%)}$	7.25	7.07	7.06	7.06	5.07
LS	**	**	**	**	**

CONCLUSION

This study enlightened us with the further conclusion that the cultivation of the variety White Angel F1 (V2) with the application of 270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1 (T4) was more satisfied combination (V2T4) of N, P, K, Zn and B fertilizers rather than that of the variety Snow White (V1T4) for the noteworthy production of Cauliflower under the agro-climatic circumstance of Patuakhali region. So that, it could be suggested by reviewing the concluded observations of this experiment that the farmer(s) can be applied the combined treatment of NPKZnB (270 kg Urea ha-1 + 116 kg P2O5 ha-1 + 415 kg K2O ha-1 + 22.24 kg ZnSO4 ha-1 + 22.8 kg H3BO3 ha-1) for tremendous production of Cauliflower under Patuakhali region as well as all over the country.Consideringthe all resolved results and facts of this study, the successive solicitations may be suggested.Superfluous and advance experiment may be ameliorated to ascertain the studied achievements in another agro-ecological region of our country for regarding conformation.Diversified types of Cauliflower varieties along with excessive proportions and forms of fertilizers are required for further analysis to justify the current outcomes of this experiment.

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