**Original Research Article**

# GROWTH AND YIELD RESPONSES OF CABBAGE CULTIVARS AS INFLUENCED BY ORGANIC AND INORGANIC FERTILIZERS


## ABSTRACT

An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka from November 2015 to February 2016 to evaluate the growth and yield responses of cabbage cultivars as influenced by organic and inorganic fertilizers. The experiment comprised of two different factors such as (1) three varieties viz. $V_1$ (Atlas 70), $V_2$ (Keifu 65) and $V_3$ (Autumn 60) and (2) Four different fertilizers viz. $F_0$ (Control), $F_1$ (Cow dung), $F_2$ (Poultry manure), and $F_3$ (Inorganic fertilizer). The experiment was set up in Randomized Complete Block Design with three replications. The experimental plot was fertilized as per treatment with organic and inorganic fertilizers. Among the varieties, Atlas 70 ($V_1$) achieved the highest results of Plant height (31.94 cm), Leaf length with petiole (32.00 cm), Stem length (4.194 cm), Diameter of head (20.24 cm), Weight of whole plant (2.23 kg/plant), gross yield (46.67 t/ha), marketable yield (45.29 t/ha) and Economic production (1.576 kg/plant) at the time of harvest. But the highest Number of leaves/plant (22.75) and Root length (22.62 cm) were obtained with Autumn 60 ($V_3$) and leaf breadth (22.39 cm) were maximum in Keifu 65 ($V_2$) cultivars. On the contrary, inorganic fertilizer ($F_3$) treatment showed the highest results on Plant height (32.55 cm), Number of leaves/plant (22.02), Leaf length with petiole (31.48 cm), Leaf breadth (22.59 cm), Root length (20.79 cm), Stem length (4.043 cm), Thickness of head (13.78 cm), Diameter of head (20.25 cm), Weight of whole plant (2.41 kg/plant), gross yield (49.34 t/ha), marketable yield (47.64 t/ha) and Economic production (1.58 kg/plant) at the time of harvest. With the interaction effect of variety and fertilizer; $V_1F_2$ (Atlas 70 × Poultry manure) represented the highest Weight of whole plant (2.56 kg/plant), gross yield (62.14 t/ha), marketable yield (61.52 t/ha) and Economic production (1.85 kg/plant).


***Keywords***: *Growth, Yield, Cabbage, Cultivars, Organic, Inorganic, Fertilizers.*

## 1. INTRODUCTION

Cabbage (*Brassica oleracea* L.) is a cole crops, member of the Brassicaceae family. Cabbage is a vegetable crop and generally is grown in Rabi season in Bangladesh. Cabbage is an important fresh and processing vegetable crop in most of the countries of the world. Cabbage is an important and nutritious winter leafy vegetable in our country. It contains a range of essential vitamins and minerals as well as small amount of protein and good caloric value **(**Haque, 2006). The productivity of cabbage per unit area is quite low as compared to the developed countries of the world (Anon., 2006). Various factors such soil nutrient management, irrigation, variety, plant population per unit area, are involved for better growth of cabbage. Among the factors, suitable variety and nutrient supply is the important inputs for realizing higher cabbage yield and its nutrient content.

Variety is an important factor for successful crop yield. An improved variety represents higher yield than wild one. Generally nutrient requirement is determined by the variety of

crops. High yielding variety requires more nutrients than the local or wild variety. Generally it depends on its vegetative and reproductive characters. And it was also mentioned that vegetable variety and history of fertilizer use are important factors to be considered in the development of a soil nutrient management program (Huang, 2006).

The cultivation of cabbage is required proper supply of plant nutrients. The requirement of these plants nutrients can be provided by applying inorganic fertilizer or organic manure or both. 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. Besides, the excess application of inorganic fertilizer causes hazard to public health and to the environment. But the application of both organic and inorganic fertilizer combined, can increase the yield as well as keep the environment sound (Hsieh *et al.*, 1996). Considering the above factors, the present experiment was undertaken to compare the growth and yield of cabbage under organic & inorganic fertilizer regimes.

## 2. MATERIAL AND METHODS

The experiment was conducted at the Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh located $23^0 74^/$N latitude and $90^0 35^/$E longitude and at an elevation of 8.2 m from sea level (Anon., 1989). The experiment was laid out in Randomized Complete Block Design with three replications. Factor A: Variety (3 cultivars), $V_1$: Atlas – 70, $V_2$: Keifu – 65 and $V_3$: Autumn – 60 and Factor B: Fertilizers (4 levels): $F_0$: Control, $F_1$: Cowdung@15 t/ha, $F_2$: Poultry manure@15 t/ha and $F_3$: Inorganic fertilizer- Urea@330 kg/ha, TSP@200 kg/ha, and MP@250 kg/ha. There were 12 treatment combinations such as $F_0V_1$, $F_0V_2$, $F_0V_3$, $F_1V_1$, $F_1V_2$, $F_1V_3$, $F_2V_1$, $F_2V_2$, $F_2V_3$, $F_3V_1$, $F_3V_2$ and $F_3V_3$. Total number of plots was 36 and the size of the each unit plot was 2.4 m × 1.6 m. The distance maintained between two blocks and two plots were 1.0 m and 0.5 m, respectively. Plant spacing 60 cm × 40 cm was maintained in this experiment. All the intercultural operations were done timely and appropriately. The data obtained for different parameters and the mean values of all the characters were calculated and analysis of variance was performing by the 'F' (variance ratio) test. The significance of the difference among the treatment combinations means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

## 3. RESULTS AND DISCUSSION

### 3.1 Growth parameters

#### 3.1.1 Plant height

Variety is an important factor considering plant height. Under the present study, plant height was significantly influenced by different varieties of cabbage cultivar at different days after transplanting (DAT) (Figure 1). Results showed that the cabbage cultivar Atlas 70 ($V_1$) was evident for highest plant height at all growth stages. The tallest plant at 15, 30, 45 DAT and at harvest were 26.81, 29.29, 30.88 and 31.94 cm respectively was obtained with Atlas 70 ($V_1$). The competition in accordance with plant height among the cultivars the smallest plant was demonstrated with Autumn 60 ($V_3$) and the lowest plant height at 15, 30, 45 DAT and at harvest were 23.83, 27.68, 29.58 and 31.04 cm respectively which was statistically identical with Keifu 65 ($V_2$) at 30, 45 DAT and at harvest respectively. The varietal effect on plant height was supported by Haque (2005).

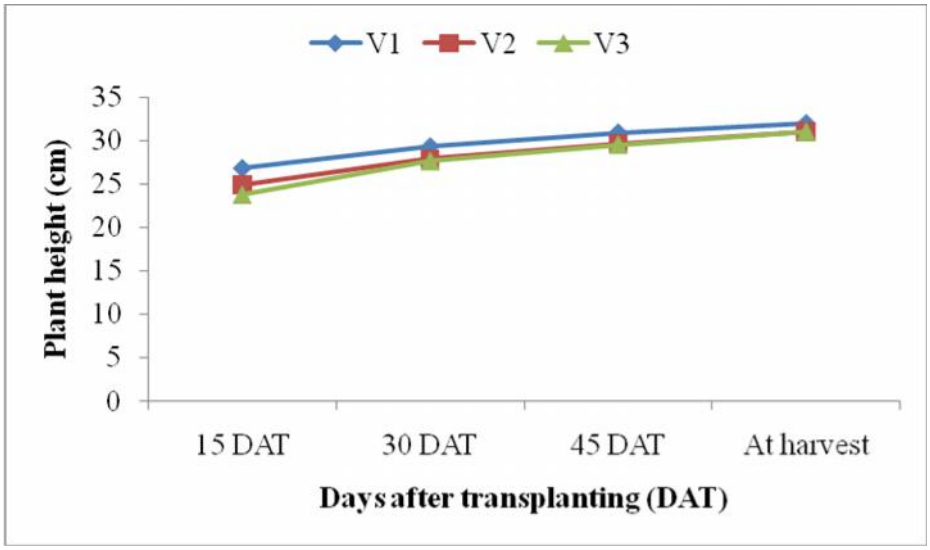



**Fig.1: Plant height at different growth stages of three Cabbage Cultivars ($LSD_{0.05}$ = 1.961, 1.243, 0.845 and 0.2395, at 15, 30, 45 DAT and at harvest respectively)**

Plant height was significantly affected by different manures and fertilizers under the present study (Figure 2). It is evident that plant height was the highest with inorganic fertilizer ($F_3$) at different growth stages of different varieties of cabbage cultivars. The highest plant height was 26.00, 29.39, 31.03 and 32.55 cm at 15, 30, 45 DAT and at harvest respectively. On the other hand, the lowest plant height (24.48, 26.98, 29.12 and 30.52 cm at 15, 30, 45 DAT and at harvest respectively) was with control treatment ($F_0$) which was statistically identical with cow dung ($F_1$) treated crop at harvest. This result might be due to cause of rapid performance on growth characters and rapid release of nutrients of inorganic fertilizer for plant height where organic fertilizer has slow nutrient release capacity that caused lower plant height. Results under the present experiment on plant height were supported by Souza *et al*. (2008).

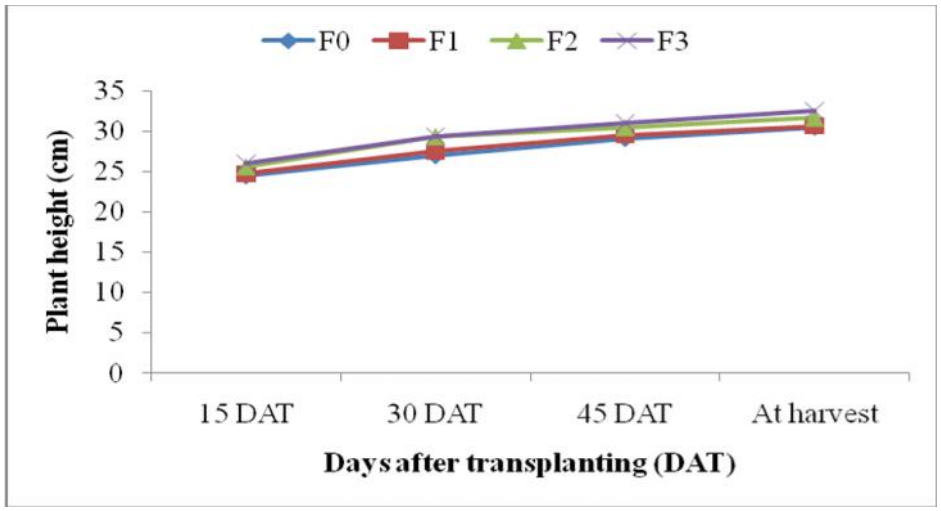


**Fig 2: Effect of different fertilizer on plant height of different cabbage cultivar at different growth stages ($LSD_{0.05}$ = 1.141, 1.436, 0.9757 and 0.2765 at 15, 30, 45 DAT and at harvest respectively)**

Interaction effect of variety and different type manure and fertilizer affected plant height significantly under the present study (Table 1). Different treatment combination viewed different plant height at different days after transplanting (DAT). It was observed that highest plant height was achieved with $V_1F_3$ and that was 28.30, 30.37, 32.00 and 33.11 cm at 15, 30, 45 DAT and at harvest respectively which was closely followed by $V_1F_2$ at 15, 30 DAT and $V_3F_3$ at harvest. On the other hand the lowest plant height; 22.46, 25.60, 27.80 and 29.93 cm at 15, 30, 45 DAT and at harvest respectively was obtained with $V_3F_0$ which was statistically identical with $V_2F_1$ and $V_3F_1$ at harvest.

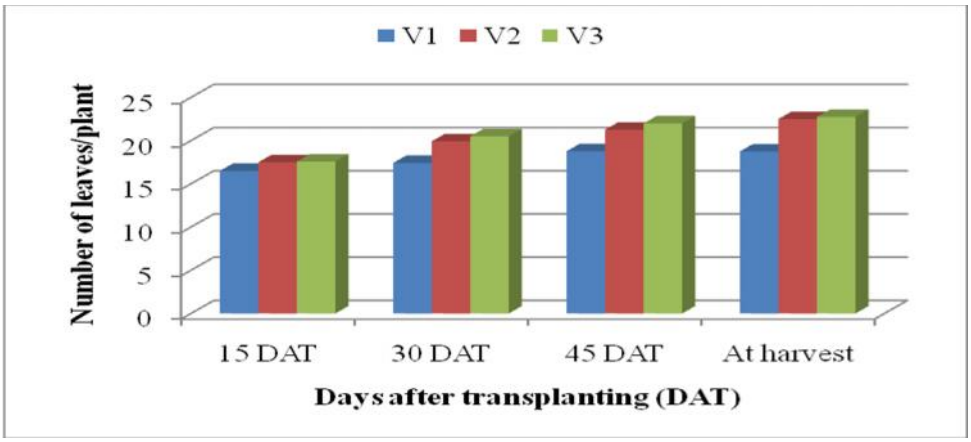
**Table 1: Interaction effect of fertilizer management and three different cabbage cultivars on plant height at different growth stages**

| Treatments | Plant height (cm) | | | |
|---|---|---|---|---|
| | 15 DAT | 30 DAT | 45 DAT | At harvest |
| ***Interaction effect of variety and fertilizer*** | | | | |
| $V_1F_0$ | 25.97 bc | 28.40 de | 30.10 cd | 31.12 de |
| $V_1F_1$ | 26.03 bc | 28.40 de | 30.32 bc | 31.51 cd |
| $V_1F_2$ | 26.92 ab | 30.00 ab | 31.10 b | 32.03 bc |
| $V_1F_3$ | 28.30 a | 30.37 a | 32.00 a | 33.11 a |
| $V_2F_0$ | 25.02 bc | 26.93 f | 29.47 de | 30.51 ef |
| $V_2F_1$ | 24.18 cd | 26.37 f | 29.10 e | 30.13 f |
| $V_2F_2$ | 25.63 bc | 28.97 cd | 30.10 cd | 31.52 cd |
| $V_2F_3$ | 24.95 bc | 28.47 d | 30.00 cd | 32.03 bc |
| $V_3F_0$ | 22.46 d | 25.60 g | 27.80 f | 29.93 f |
| $V_3F_1$ | 23.91 cd | 27.73 e | 29.20 e | 30.31 f |
| $V_3F_2$ | 24.20 cd | 29.03 cd | 30.20 cd | 31.40 cd |
| $V_3F_3$ | 24.77 bc | 29.35 bc | 31.10 b | 32.52 ab |
| $LSD_{0.05}$ | 1.976 | 0.6709 | 0.7497 | 0.7184 |
| CV (%) | 5.62 | 7.19 | 6.44 | 8.24 |

*Means in a same column followed by different letter (s) are significantly different at P<0.05; ($V_1$-Atlas 70, $V_2$-Keifu 65; $V_3$ -Autumn 60 & $F_0$ -Control, $F_1$ -Cow dung, $F_2$ -Poultry manure,$F_3$ -Inorganic fertilizer)*

**3.1.2 Number of leaves/plant**

**Fig 3: number of leaves/plant at different growth stages of three different cabbage cultivars ($LSD_{0.05}$ = 0.996, 1.756, 1.442 and 1.081 at 15, 30, 45 DAT and at harvest respectively).**




Number of leaves/plant is an important parameter considering the highest performance of cabbage yield (Figure 3). Autumn – 60 ($V_3$) gave an idea about highest number of leaves/plant at all growth stages of cabbage cultivar. The highest number of leaves/plant at 15, 30, 45 DAT and at harvest (17.58, 20.50, 22.00 and 22.75 respectively) was with autumn – 60 which was statistically identical with Keifu – 65 ($V_2$) at all growth stages. On the contrary the lowest number of leaves/plant at 15, 30, 45 DAT and at harvest (16.50, 17.42, 18.77 and 18.75 respectively) was obtained with Atlas – 70 ($V_1$). These results might be due to cause of genetical characters of cultivars that caused higher and lower number of leaves/plant.

**Si**gnificant variation was observed in the case of number of leaves/plant at different days after transplanting (DAT) (Figure 4). It was measured that the highest number of leaves/plant was obtained with inorganic fertilizer ($F_3$) and the highest number of leaves/plant was 18.00, 20.44, 21.35 and 22.02 at 15, 30, 45 DAT and at harvest respectively which was statistically identical with treatment of Poultry manure ($F_2$) at all growth stages of cabbage cultivars. The lowest number of leaves/plant was found to be at 15, 30, 45 DAT and at harvest 15.78, 18.11, 19.01 and 19.67 respectively with control treatment ($F_0$). The results obtained from the experiment on number of leaves/plant were conformity with Vimala (2006), Pankaj (2006) and Muhammad and Javed (2001).

Interaction effect of variety and different types manure and fertilizer affected number of leaves/plant significantly under the present study (Table 2). Different treatment combination viewed different number of leaves/plant according to the treatment at different days after transplanting (DAT). It was observed that highest number of leaves/plant was achieved with $V_3F_3$ and that was 18.33, 22.33, 24.00 and 25.00 at 15, 30, 45 DAT and at harvest respectively which was closely followed by $V_2F_1$, $V_2F_2$, $V_3F_1$ and $V_3F_2$ at harvest. On the other hand the lowest number of leaves/plant; 15.33, 16.67, 18.03 and 18.00 at 15, 30, 45 DAT and at harvest respectively was obtained with $V_1F_0$ which was statistically identical with $V_1F_1$ at all growth stages of cabbage cultivars.

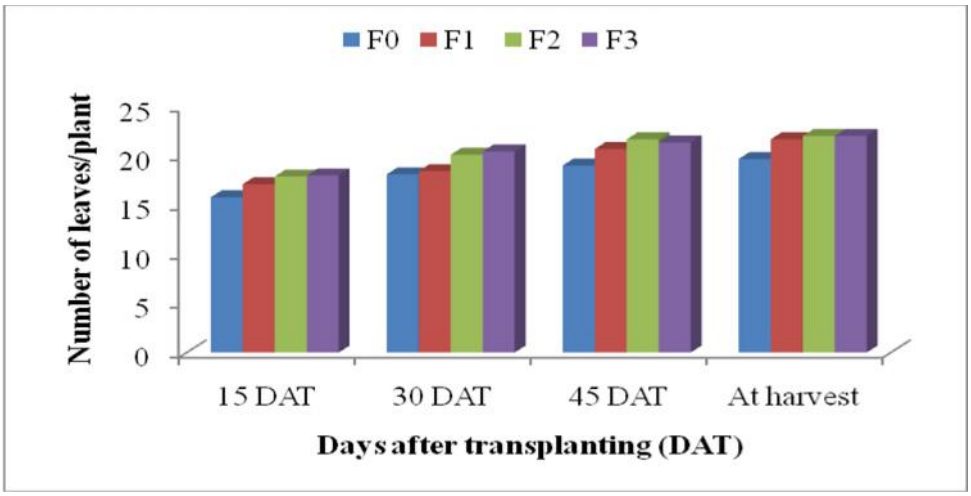



**Fig 4: Effect of different fertilizer on number of leaves/plant of different cabbage cultivar at different growth stages ($LSD_{0.05}$ = 0.884, 1.027, 0.965 and 0.848 at 15, 30, 45 DAT and at harvest respectively)**

**Table 2: Interaction effect of fertilizer management and three different cabbage cultivars on number of leaves/plant at different growth stages**

| Treatments | Number of leaves/plant | | | |
|---|---|---|---|---|
| | 15 DAT | 30 DAT | 45 DAT | At harvest |
| *Interaction effect of variety and fertilizer* | | | | |
| $V_1F_0$ | 15.33 d | 16.67 f | 18.03 e | 18.00 d |
| $V_1F_1$ | 15.35 d | 15.67 f | 17.03 e | 18.04 d |
| $V_1F_2$ | 18.33 a | 18.67 e | 20.00 d | 20.00 cd |
| $V_1F_3$ | 17.00 a-d | 18.67 e | 20.00 d | 19.00 d |
| $V_2F_0$ | 15.67 cd | 19.33 c-e | 21.00 cd | 22.00 bc |
| $V_2F_1$ | 17.68 ab | 19.00 de | 22.00 bc | 23.00 ab |
| $V_2F_2$ | 18.00 ab | 21.00 b | 22.00 bc | 23.00 ab |
| $V_2F_3$ | 18.36 a | 20.33 b-d | 20.04 d | 22.00 bc |
| $V_3F_0$ | 16.33 b-d | 18.33 e | 18.00 e | 19.00 d |
| $V_3F_1$ | 18.33 a | 20.67 bc | 23.00 ab | 24.00 ab |
| $V_3F_2$ | 17.33 a-c | 20.67 bc | 23.00 ab | 23.00 ab |
| $V_3F_3$ | 18.69 a | 22.33 a | 24.00 a | 25.00 a |
| $LSD_{0.05}$ | 1.704 | 1.313 | 1.607 | 2.161 |
| CV (%) | 5.78 | 4.24 | 7.11 | 8.42 |

*Means in a same column followed by different letter (s) are significantly different at P<0.05; ($V_1$-Atlas 70, $V_2$-Keifu 65; $V_3$ -Autumn 60 & $F_0$ -Control, $F_1$ -Cow dung, $F_2$ -Poultry manure,$F_3$ -Inorganic fertilizer)*

### 3.1.3 Stem length

Stem length is also an important phenotypic plant character controlled genetically which differs within the varieties. Under the present study, stem length was significantly influenced by different cabbage cultivars (Table 3). Different varieties showed different stem length and it was deliberate at the time of harvest. It was defined that Atlas – 70 ($V_1$) verified the highest stem length at harvest (4.194 cm) which was closely followed by Keifu – 65 ($V_2$) and the

lowest stem length (3.678 cm) among the cultivars was obtained autumn – 60 ($V_3$) at harvest. Varietal effect was observed on shoot/stem length due to its phenotypical characters (Haque, 2005) and this result on stem length is supported by Haque, 2005.

Manure and fertilizer effect on stem length was significant under the present study. It is evident that different types of manure and fertilizer showed different stem length (Table 3). The highest stem length (4.203 cm) was indicated with the treatment of Cow dung ($F_1$) which was statistically identical with control ($F_0$) treatment and Inorganic fertilizer ($F_3$) treated plot. On the other hand, the lowest root length was measured with Poultry manure ($F_2$) treatment. Data of stem length under the present study was in agreement with Souza *et al*. (2008).

Interaction effect of different variety and manures and fertilizer had significant effect on stem length. Different treatment combination showed different root length (Table 3). The highest root length (4.557 cm) was observed whit $V_1F_1$ which was statistically identical with $V_2F_1$ and statistically similar with $V_3F_0$. On the other hand, the lowest stem length (3 cm) was observed with $V_3F_2$ which was closely followed by $V_2F_0$.

**Table 3: Interaction effect of fertilizer management and three different cabbage cultivars on growth parameters; root length and stem length at harvest**

| Treatments | Root length at harvest (cm) | Stem length at harvest (cm) |
|---|---|---|
| ***Effect variety*** | | |
| $V_1$ | 18.03 b | 4.194 a |
| $V_2$ | 22.31 a | 3.938 ab |
| $V_3$ | 22.62 a | 3.678 b |
| $LSD_{0.05}$ | 1.319 | 0.4300 |
| ***Effect of fertilizer*** | | |
| $F_0$ | 21.22 a | 4.019 a |
| $F_1$ | 20.26 b | 4.203 a |
| $F_2$ | 21.67 a | 3.481 b |
| $F_3$ | 20.79 ab | 4.043 a |
| $LSD_{0.05}$ | 1.167 | 0.4966 |
| ***Interaction effect of variety and fertilizer*** | | |
| $V_1F_0$ | 18.45 c | 4.333 ab |
| $V_1F_1$ | 16.11 d | 4.557 a |
| $V_1F_2$ | 18.89 c | 3.777 c-e |
| $V_1F_3$ | 18.67 c | 4.110 a-c |
| $V_2F_0$ | 22.94 a | 3.333 fg |
| $V_2F_1$ | 22.39 a | 4.546 a |
| $V_2F_2$ | 22.89 a | 3.667 d-f |
| $V_2F_3$ | 21.00 b | 4.193 a-c |
| $V_3F_0$ | 22.27 a | 4.390 ab |
| $V_3F_1$ | 22.27 a | 3.943 b-d |
| $V_3F_2$ | 23.22 a | 3.000 g |
| $V_3F_3$ | 22.71 a | 3.380 e-g |
| $LSD_{0.05}$ | 1.105 | 0.4078 |
| CV (%) | 5.33 | 7.58 |

*Means in a same column followed by different letter (s) are significantly different at P<0.05; ($V_1$-Atlas 70, $V_2$-Keifu 65; $V_3$ -Autumn 60 & $F_0$ -Control, $F_1$ -Cow dung, $F_2$ -Poultry manure,$F_3$ -Inorganic fertilizer)*

### 3.2 Yield Parameters

#### 3.2.1 Thickness of head

Generally thickness of head of cabbage cultivar control yield and quality of the crop and it is greatly influenced by different varietal characters. Result showed that there was no significant effect among the three cabbage cultivar considering thickness of head (Table 4). In spite of non-significant variation, the highest (13.44 cm) and lowest (12.76 cm) thickness of head was achieved by autumn – 60 ($V_3$) and Keifu – 65 ($V_2$) respectively. The data obtained on thickness of head was conformity with Haque (2005).

Thickness of head was significantly influenced by manure and fertilizer under the present study (Table 4). It is evident that the highest thickness of head (13.78 cm) was obtained with the treatment of Inorganic fertilizer ($F_3$) which was significantly different from all other treatment. On the other hand, the lowest thickness of head (12.55 cm) was measured with Control ($F_0$) treatment which was significantly same with Cow dung ($F_1$). Souza *et al*. (2008), Bimova (2008) showed the similar results which supported the data on thickness of head under the present study.

Interaction effect of different variety and manures and fertilizer had significant effect on thickness of head. Different treatment combination showed different thickness of head (Table 4). The highest thickness of head (14.44 cm) was observed whit $V_3F_3$ and the lowest thickness of head (11.83 cm) was with $V_1F_0$. The results obtained from all other treatments were significantly different from highest and lowest thickness of head.

#### 3.2.2 Diameter of head

Diameter of head is a measurement of the size of actual cabbage shape which indicates yield amount and/or market value. Significant variation was observed in case of diameter of head among the cabbage cultivar (Table 4). Result revealed that the highest diameter of head (2024 cm) was achieved with Atlas – 70 ($V_1$) where the lowest (18.03 cm) was with Autumn – 60 ($V_3$). Similar results were obtained by Haque (2005) and Muhammad and Javed (2001) with their experiments.

Diameter of head was significantly influenced by manure and fertilizer under the present study (Table 4). It is evident that the highest diameter of head (20.25 cm) was obtained with the treatment of Inorganic fertilizer ($F_3$) which was significantly different from all other treatment. On the other hand, the lowest diameter of head (18.06 cm) was measured with Control ($F_0$) treatment. Data measurement on head diameter was in agreement with Souza *et al*. (2008) and Vimala (2006).

Interaction effect of different variety and manures and fertilizer had significant effect on diameter of head. Different treatment combination showed different diameter of head (Table 4). The highest diameter of head (21.44 cm) was observed whit $V_1F_3$ which was statistically same with $V_1F_2$ and the lowest diameter of head (16.56 cm). The results obtained from all other treatment were significantly different from highest and lowest diameter of head.

**Table 4: Interaction Effect of fertilizer management and three different cabbage cultivars on yield contributing parameters Thickness of head and Diameter of head at harvest**

| Treatments | Thickness of head (cm) at harvest | Diameter of head (cm) at harvest |
|---|---|---|
| ***Effect variety*** | | |
| $V_1$ | 13.03 | 20.24 a |
| $V_2$ | 12.76 | 18.85 b |
| $V_3$ | 13.44 | 18.03 c |
| $LSD_{0.05}$ | NS | 0.8160 |
| ***Effect of fertilizer*** | | |
| $F_0$ | 12.55 c | 18.06 d |
| $F_1$ | 12.63 c | 18.46 c |
| $F_2$ | 13.36 b | 19.37 b |
| $F_3$ | 13.78 a | 20.25 a |
| $LSD_{0.05}$ | 0.2375 | 0.3511 |
| ***Interaction effect of variety and fertilizer*** | | |
| $V_1F_0$ | 11.83 f | 19.45 bc |
| $V_1F_1$ | 12.48 e | 19.17 c |
| $V_1F_2$ | 13.48 bc | 20.89 a |
| $V_1F_3$ | 13.89 b | 21.44 a |
| $V_2F_0$ | 13.09 cd | 18.18 d |
| $V_2F_1$ | 12.28 e | 18.11 d |
| $V_2F_2$ | 13.11 cd | 19.11 c |
| $V_2F_3$ | 13.01 d | 19.99 b |
| $V_3F_0$ | 12.52 e | 16.56 e |
| $V_3F_1$ | 13.33 cd | 18.11 d |
| $V_3F_2$ | 13.48 bc | 18.11 d |
| $V_3F_3$ | 14.44 a | 19.33 c |
| $LSD_{0.05}$ | 0.4113 | 0.6082 |
| CV (%) | 4.48 | 5.66 |

*Means in a same column followed by different letter (s) are significantly different at P<0.05; ($V_1$-Atlas 70, $V_2$-Keifu 65; $V_3$ -Autumn 60 & $F_0$ -Control, $F_1$ -Cow dung, $F_2$ -Poultry manure,$F_3$ -Inorganic fertilizer)*

### 3.2.3 Weight of whole plant

Determination of whole plant weight is an important measurement for comparing yield performance among the cabbage cultivars under the present study. Weight of whole plant was significantly influenced by different cabbage cultivar (Table 5). Results showed that the highest whole plant weight (2.23 kg/plant) was with Atlas – 70 ($V_1$) where the lowest (1.96 kg/plant) was with Autumn – 60 ($V_3$). Supported results with the present study was achieved by Haque (2005), Muhammad and Javed (2001).

Weight of whole plant was significantly influenced by manure and fertilizer under the present study (Table 5). It is evident that the highest whole plant weight (2.41 kg/plant) was obtained with the treatment of Inorganic fertilizer ($F_3$) which was significantly same with Poultry manure ($F_2$) treated plot. On the other hand, the lowest whole plant weight (1.80 kg/plant) was measured with Control ($F_0$) treatment which was significantly same with Cow dung ($F_1$) treated plot that is suggested by Pankaj (2006) and Hsieh (2004)

Interaction effect of different variety and manures and fertilizer had significant effect on whole plant weight. Different treatment combination showed different whole plant weight (Table 5). The highest whole plant weight (2.56 kg/plant) was observed with the treatment combination of $V_1F_2$. The lowest s whole plant weight (1.57 kg/plant) was obtained with $V_3F_0$ which was statistically identical with $V_3F_1$. The results obtained from all other treatment were significantly different from highest and lowest whole plant weight.

### 3.2.4 Marketable yield

Marketable yield was significantly affected by different variety used in the experiment (Table 5).The highest marketable yield (27.42 kg/plot and 45.29 t/ha) was obtained from Atlas – 70 ($V_1$) but the variety, Autumn – 60 ($V_3$) viewed lowest marketable yield (21.57 kg/plot and 35.95 t/ha) which was statistically different from others varieties. The results achieved by Haque (2005), Muhammad and Javed (2001) was similar to the present study.

**Table 5: Interaction effect of fertilizer management and three different cabbage cultivars on yield parameters; weight of whole plant at harvest, gross yield, marketable yield and economic production (kg/plant) at harvest**

| Treatments | Weight of whole plant at harvest (kg/plant) | Gross yield (kg/plot) | Marketable yield (kg/plot) | Gross yield (t/ha) | Marketable yield (t/ha) | Economic production (kg/plant) at harvest |
|---|---|---|---|---|---|---|
| ***Effect of variety*** | | | | | | |
| $V_1$ | 2.23 a | 28.00 a | 27.42 a | 46.67 a | 45.29 a | 1.576 a |
| $V_2$ | 2.10 b | 23.57 b | 22.51 b | 39.27 b | 37.51 b | 1.311 b |
| $V_3$ | 1.96 c | 22.75 b | 21.57 c | 37.91 c | 35.95 c | 1.226 b |
| $LSD_{0.05}$ | 0.093 | 0.9466 | 0.8169 | 1.100 | 1.199 | 0.2159 |
| ***Effect of fertilizer*** | | | | | | |
| $F_0$ | 1.80 b | 15.65 c | 14.34 c | 26.08 c | 23.90 c | 1.178 b |
| $F_1$ | 1.86 b | 24.38 b | 23.32 b | 40.64 b | 38.87 b | 1.198 b |
| $F_2$ | 2.30 a | 29.61 a | 28.92 a | 49.34 a | 47.92 a | 1.523 a |
| $F_3$ | 2.41 a | 29.45 a | 28.75 a | 49.09 a | 47.64 a | 1.584 a |
| $LSD_{0.05}$ | 0.339 | 1.093 | 0.9433 | 1.270 | 1.384 | 0.2492 |
| ***Interaction effect of variety and fertilizer*** | | | | | | |
| $V_1F_0$ | 2.09 de | 16.57 e | 15.31 g | 27.61 f | 25.52 f | 1.450 cd |
| $V_1F_1$ | 1.88 f | 26.93 c | 26.17 d | 44.89 c | 43.62 c | 1.257 de |
| $V_1F_2$ | 2.56 a | 37.28 a | 36.91 a | 62.14 a | 61.52 a | 1.853 a |
| $V_1F_3$ | 2.39 a-c | 31.24 b | 31.31 b | 52.06 b | 50.51 b | 1.743 ab |
| $V_2F_0$ | 1.87 f | 15.77 e | 14.43 gh | 26.28 fg | 24.05 fg | 1.107 ef |
| $V_2F_1$ | 1.97 ef | 23.86 d | 22.79 e | 39.76 d | 37.98 d | 1.250 de |
| $V_2F_2$ | 2.23 cd | 27.53 c | 26.50 d | 45.88 c | 44.17 c | 1.463 cd |
| $V_2F_3$ | 2.34 bc | 27.10 c | 26.30 d | 45.16 c | 43.84 c | 1.423 cd |
| $V_3F_0$ | 1.57 g | 14.60 e | 13.28 h | 24.34 g | 22.13 g | 0.977 f |
| $V_3F_1$ | 1.63 g | 22.36 d | 21.01 f | 37.26 e | 35.02 e | 1.087 ef |
| $V_3F_2$ | 2.11 de | 24.01 d | 22.85 e | 40.01 d | 38.08 d | 1.253 de |
| $V_3F_3$ | 2.51 ab | 30.02 b | 29.15 c | 50.04 b | 48.58 b | 1.587 bc |
| $LSD_{0.05}$ | 0.186 | 1.893 | 1.634 | 2.199 | 2.398 | 0.2074 |
| CV (%) | 6.14 | 4.51 | 5.83 | 7.18 | 4.62 | 7.46 |

*Means in a same column followed by different letter (s) are significantly different at P<0.05; ($V_1$-Atlas 70, $V_2$-Keifu 65; $V_3$ -Autumn 60 & $F_0$ -Control, $F_1$ -Cow dung, $F_2$ -Poultry manure,$F_3$ -Inorganic fertilizer)*

Marketable yield was significantly influenced by application of different manure and fertilizer according to the treatment under the present study (Table 5). It is evident that the highest marketable yield (28.92 kg/plot and 47.92 t/ha) was obtained with the treatment of poultry manure ($F_2$) which was statistically identical with inorganic fertilizer treated plot ($F_3$). On the other hand, the lowest marketable yield (14.34 kg/plot 23.90 t/ha) was measured with Control ($F_0$) treatment. The results obtained from the experiment were conformity with Hsieh (2004) and Chan *et al*. (2008).

Interaction effect of different variety and manures and fertilizer had significant effect on marketable yield of cabbage cultivars. Different treatment combination showed different yield (Table 5). The highest marketable yield (36.91 kg/plot and 61.52 t/ha) was observed with the treatment combination of $V_1F_2$. The treatment combination, $V_1F_3$ and $V_3F_3$ also showed higher yield but significantly lower than $V_1F_2$. The lowest marketable yield (13.28 kg/plot and 22.13 t/ha) was obtained with $V_3F_0$ which was closely related to $V_2F_0$. The results obtained from all other treatments were significantly different from highest and lowest yield. Similar findings are observed with Yau (2006).

## 4. CONCLUSION

It may be concluded from the result that $V_1F_2$ (Atlas – 70 × Poultry manure) performed best in producing higher yield than other treatments comprised with other variety and fertilizer application under the present study. On the other hand interactions of variety (Atlas – 70) and organic fertilizer (Poultry manure) showed its superiority in producing higher cabbage yield and economic production.

## REFERENCES

Altieri, M. and Nicholls, F. N. Tolerance and effect of leaf fertilization treatments on vegetables. *Gartebauwissenscharf*t. 2003;51 (2): 58-62.

Bimova Impact of organic fertilizers on total antioxidant capacity in head cabbage. Faculty of Horticulture, Mendel University of Agriculture and Forestry in Brno, Lednice, Czech Republic. 2000.

Edris, K. M., Islam, A. T. M. T., Chowdhury, M. S. and Haque, A. K. M. Detailed Soil Survey of Bangladesh Agricultural University Farm, Mymensingh. Dept. Soil Survey, Govt. People's Republic of Bangladesh. 1979;118 p.

FAO. Food and Agricultural Organization of the United Nations, Soil Survey Project of Bangladesh. Soil Resources Tech. Rep. 1988; pp. 101-159.

FAO. Production Year Book. Food and Agricultural of the United Nations. Rome, Italy. 1988; 42: 190-193.

Gomez, K. A. and A. A. Gomez. Statistical Procedure for Agricultural Research (2nd ed.), A Wiley Inter Science Publication, John Wiley and Sons, New York. 1984; 680p.

Haque, K.M.F. Influence of variety and time of planting on the yield performance and nutrient contents of cabbage (Brassica oleracea L.). Dhaka, Bangladesh: Bangladesh Council of Scientific and Industrial Research. Bangladesh-Journal-of-Scientific-and-Industrial-Research. 2005; 40(3/4): 211-218.

307 Hsieh, C. F., H. C. Fang, K. Nan and K. N. Hsu. Effect of continuous use of organic manures
308 on the growth and yield of vegetable soybean' and cabbage. Bulletin of Taichung District.
309 Agric. Improvement Sta., Japan, 1995; 46: 1-10.

310 Huang, F. Varietal influence in organic farming on autumn cabbage. Hangzhou, China:
311 Zhejiang Academy of Agricultural Sciences. Acta-Agriculturae-Zhejiangensis. 2006; 18(1):
312 58-61.

313 Letourneau, A. F. The characteristics of mineral nutrition and yield formation in cabbage
314 cultivar in relation to fertilizers and mineral uptake by cabbage plants. Agrokhimiya, 1996; 9:
315 61-67.

316 Muhammad, I. and Javed, U. Response of Chinese cabbage cultivars to different levels of
317 nitrogen with constant doses of phosphorus and potassium under the agro-climatic
318 conditions of Chilas (Diamer). Peshawar, Pakistan: NWFP Agricultural University. Sarhad-
319 Journal-of-Agriculture. 2001; 17(1): 81-85.

320 Pankaj, S. Integrated effect of bio-inoculants, organic and inorganic fertilizer on growth and
321 yield of cabbage. Hisar, India: Agricultural Research Information Centre. Crop-Research-
322 Hisar. 2006; 32(2): 188-191.

323 Souza, P. A., Souza, G. L. F. M., Menezes, J. B. and Bezerra, N. F. Evaluations of cabbage
324 cultivar grown under organic compost and mixed mineral fertilizers. *Horticultura Brasileira*.
325 2008; 26(1): 143-145.

326 Tindall, M. Mineral and organic fertilizing in cabbage. Residual effect for commercial
327 cultivation on yield and quality performance with organic farming. Hort. Bras., 2000; 6(1) :
328 15-20.

329 UNDP. Land Resource Apprisal of Bangladesh for Agricultural Development Report 2: Agro-
330 ecological Regions of Bangladesh, FAO, Rome, Italy, 1988. p. 577.

331 Vimala, P. Effect of rates of organic fertilizer on growth, yield and nutrient content of
332 cabbage (*Brassica oleracea* var. *capitata*) grown under shelter. Leuven, Belgium:
333 International Society for Horticultural Science (ISHS). Acta-Horticulturae. 2006; (710): 391-
334 397.

335 Yau, P.Y.. Evaluation of cabbage cultivars (Brassica oleracea var. capitata) under plastic
336 rain-shelter on mineral soils in the lowlands. Leuven, Belgium: International Society for
337 Horticultural Science (ISHS). Acta-Horticulturae, 2006.

338