Growth and Yield Responses of Cabbage Cultivars as Influenced by Organic and Inorganic Fertilizers

Original Research Article

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 . 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).Therefore, Atlas 70 coupled with poultry manure can be the most suitable for enhanced yield and economic production of cabbage.

Keywords: Growth; yield; cabbage; cultivars; organic; inorganic; fertilizers.

1. INTRODUCTION

Cabbage (*Brassica oleracea* L.) is one of the cole crops, member of the Brassicaceae family. Cabbage is an important fresh and processing vegetable crop in most of the countries of the world. Cabbage is generally grown during Rabi season in Bangladesh. Cabbage is an important and nutritious winter leafy vegetable in Bangladesh. It contains a range of essential vitamins and minerals as well as a small amount of protein and good caloric value **(**Haque, 2006). The productivity of cabbage per unit area is quite low (15 t ha^{-1} per unit area) as compared to the developed countries of the world (Hasan *et. al.,*2003). 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 are 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 a higher yield than a wild one. Generally, nutrient requirement is determined by the variety of crops. High yielding variety requires more nutrients than the local or wild variety. Usually, it depends on its vegetative and reproductive characters. And it was also mentioned that the 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 a proper supply of plant nutrients. The requirement of these plants nutrients can be provided by applying inorganic fertilizer or organic manure or

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both. However, farmers are now showing interest in organic farming because of, they are more aware of the residual effect of chemical substances used in the crops field and environmental degradation. Besides, the excess application of inorganic fertilizer causes a hazard to public health and 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 identify the best variety that could be suggestive for the production of cabbage for the farmers of Bangladesh. In addition, an attempt was undertaken to determine the best organic fertilizer option for better growth of cabbage and to determine the combination of variety and fertilizer management of cabbage.

2. MATERIAL AND METHODS

2.1 Experimental Site

The experiment was conducted at the Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh from November 2015 to February 2016. The location of the experimental site was $23^0 74^/$N latitude and $90^0 35^/$E longitude and at an elevation of 8.2 m from sea level. The climate of experimental site was under the subtropical climate, characterized by three distinct seasons, the winter season from November to February and the pre-monsoon or hot season from March to April and the monsoon period from May to October. The soil of the experimental area belongs to the Modhupur Tract (AEZ No 28). It had shallow red brown terrace soil. The selected plot was medium high land and the soil series was Tejgaon.

2.2 Planting Material

Three varieties were used as planting materials viz. (i) Atlas – 70, (ii) Keifu – 65 and (iii) Autumn – 60. Seeds of cabbage cultivars were used in the experiment and the seeds were collected from a commercial seed trader.

2.3 Organic and Inorganic Materials

Fertilizers (4 levels): F_0: Control, F_1: Cowdung at the rate of 15 t/ha, F_2: Poultry manure at the rate of 15 t/ha and F_3: Inorganic fertilizer- Urea at the rate of 330 kg/ha, TSP (Triple Super Phosphate) at the rate of 200 kg/ha, and MP (Murate of Potash) at the rate of 250 kg/ha.

2.4 Experimental Design and Treatments

The experiment was laid out in Randomized Complete Block Design with three replications. 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. A total number of plots was 36 and the size of 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.

2.5 Growth Condition of Cabbage and Measurements of Parameters

Seedlings were grown following proper methods and all of the cultural practices were done properly. Application of manure and fertilizers were applied as per treatment. Healthy and uniform sized seedlings were transplanted in the main field. Intercultural practices were done as per requirements. For controlling leaf caterpillars Nogos @ 1 ml/L water was applied two times at an interval of 10 days starting soon after the appearance of infestation. All cabbage head was not matured at the same time; harvesting was done from 15 February to 02 March. Different yield contributing data have been recorded from the mean of five harvested plants which was selected at random of each unit plot of every harvesting stage.

2.6 Data Collection and Analysis

Five plants were randomly selected from each unit plot for the collection of data. The plants in the outer rows and the extreme end of the middle rows were excluded from the random selection to avoid the border effect. The height of the plants was measured from the ground level to the tip of the highest leaves. To record the diameter, the cabbage heads were sectioned vertically at the middle position and the horizontal distance from one side to the other side of the widest part of the sectioned head was measured. The thickness of head was measured as the vertical distance from the lower to the uppermost leaves of head. The data obtained for different parameters were statistically analyzed to find out the significant difference of variety and different fertilizer application on yield and yield contributing characters of cabbage. The mean values of all the characters were calculated and analysis of variance was performed 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) (Fig. 1). Results showed that the cabbage cultivar Atlas 70 (V_1) was evident for the 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 (V3) 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 (V2) at 30, 45 DAT and at harvest respectively. This might be due to the genetic variations among the varieties used in the present study. The varietal effect on plant height was supported by Haque (2005).

Plant height was significantly affected by different manures and fertilizers under the present study (Fig. 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 a slow nutrient release capacity that caused lower plant height. Results under the present experiment on plant height were supported by Souza *et al*. (2008).

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.

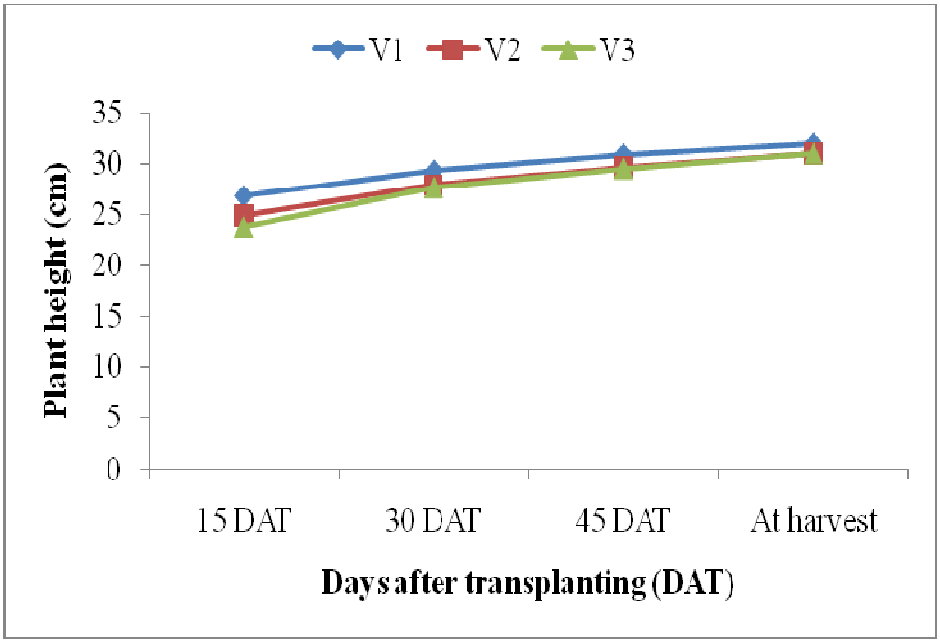

Fig.1. Plant height at different growth stages of three Cabbage cultivars

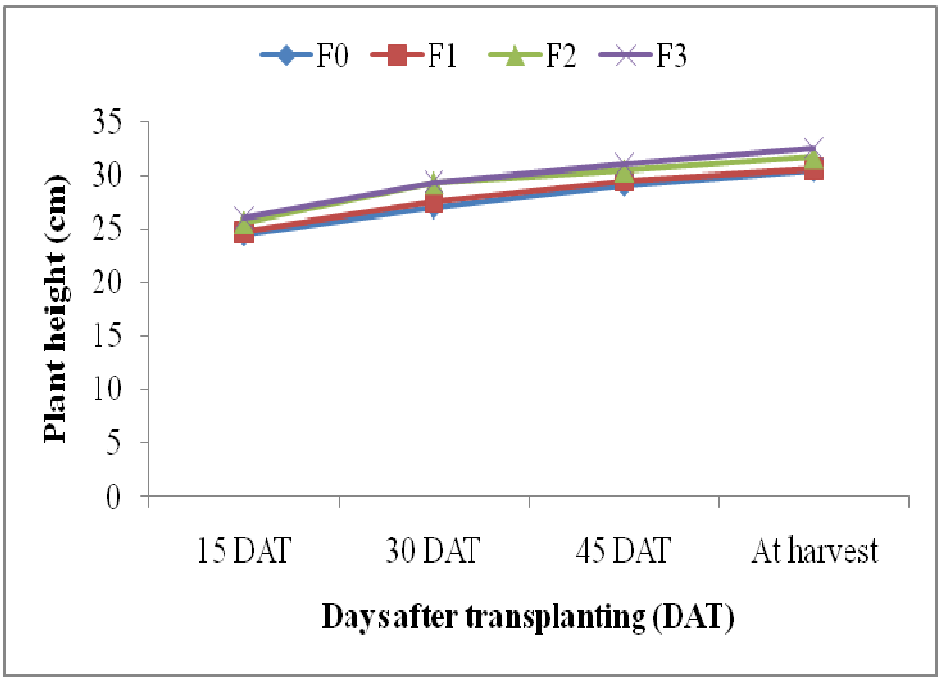

Fig. 2. Effect of different fertilizer on plant height of different cabbage cultivar at different growth stages

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

Number of leaves/plant is an important parameter considering the highest performance of cabbage yield (Fig. 3). Autumn – 60 (V_3) gave an idea about the 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 the cause of genetical characters of cultivars that caused a higher and lower number of leaves/plant.

Significant variation was observed in the case of a number of leaves/plant at different days after transplanting (DAT) (Fig. 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 a number of leaves/plant were conformity with Vimala (2006), Pankaj (2006) and Muhammad and Javed (2001) who reported an increase in the number of leaves per plant with the application of different manures and fertilizers.

The 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 a 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.

3.1.3 Stem length

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. The varietal effect was observed in shoot/stem length due to its phenotypical characters (Haque, 2005) and this result on stem length is supported by Haque, 2005.

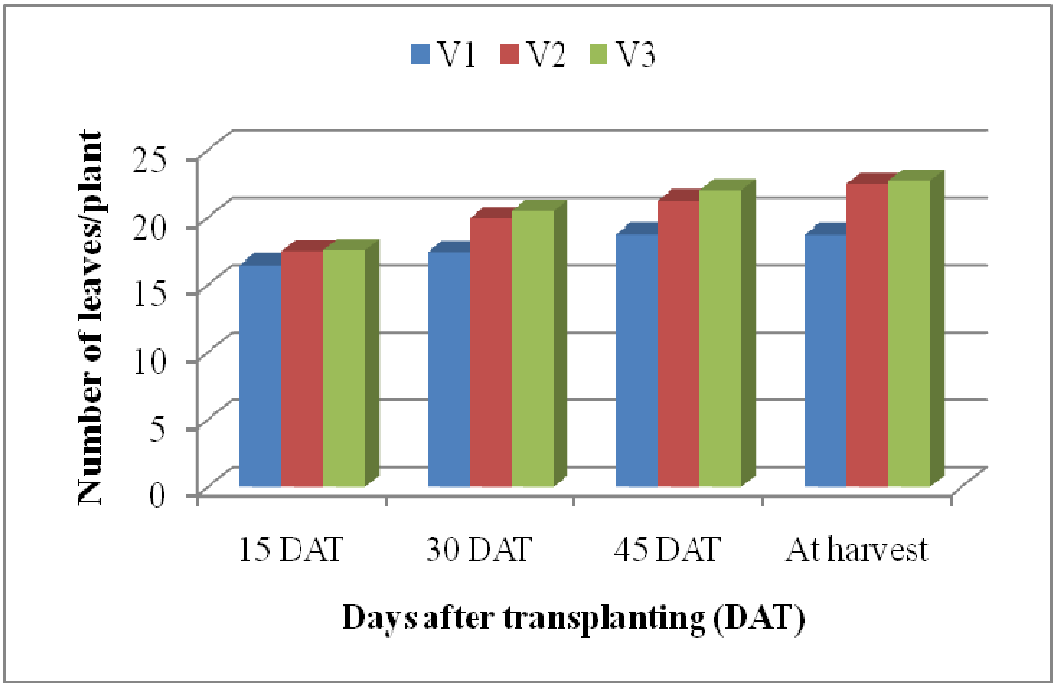

Fig. 3. Number of leaves/plant at different growth stages of three different cabbage cultivars

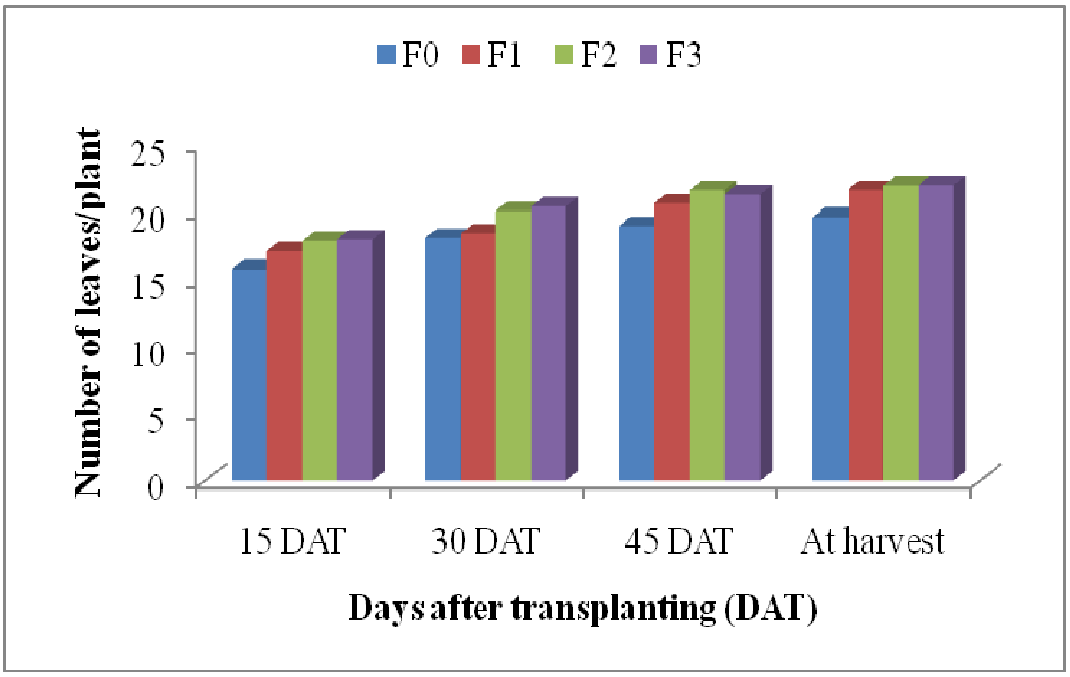

Fig. 4. Effect of different fertilizer on number of leaves/plant of different cabbage cultivar at different growth stages

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 the same column followed by a 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)

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 a 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.

3.2 Yield Parameters

3.2.1 Thickness of head

Generally, the thickness of the head of cabbage cultivar control yield and quality of the crop and it is greatly influenced by different varietal characters. The results 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 the head was achieved by autumn – 60 (V_3) and Keifu – 65 (V_2) respectively. The data obtained on the thickness of the head was conformity with Haque (2005).

The thickness of the 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 by 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 the thickness of the head under the present study.

The interaction effect of different variety and manures and fertilizer had a significant effect on thickness of head. Different treatment combination showed the 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 the lowest thickness of the head.

3.2.2 Diameter of head

Diameter of head is a measurement of the size of actual cabbage shape which indicates the 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 by Atlas – 70 (V_1) were 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.

Manure and fertilizer significantly influenced diameter of head 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 a 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.

3.2.3 Weight of whole plant

The 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 were achieved by Haque (2005), Muhammad and Javed (2001) who reported the higher weight of plant found in Atlas- 70.

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 of 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)

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 of 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)

The 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 a 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 as they found higher marketable yield with the similar variety.

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

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)

experiment were conformity with Hsieh (2004) and Chan *et al*. (2008) who reported better marketable yield with the application of different manures and fertilizers.

Interaction effect of different variety and manures and fertilizer had a significant effect on marketable yield of cabbage cultivars. Different treatment combination showed a 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

Judicial application of organic and inorganic fertilizers can minimize the application of inorganic fertilizer to reduce the hazardous effect on public health and the environment. The result showed that V_1F_2 (Atlas – 70 × Poultry manure) performed best in producing a 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. Therefore, it may be concluded that Atlas – 70 can be used along with poultry manure for higher yield and economic production of cabbage.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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