EFFECT OF DIFFERENT LEVELS OF VERMICOMPOST ON THE GROWTH AND YIELD OF CABBAGE

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EFFECT OF DIFFERENT LEVELS OF VERMICOMPOST ON THE GROWTH AND YIELD OF CABBAGE

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CERTIFICATE

*This is to certify that the thesis entitled, "**EFFECT OF DIFFERENT LEVELS OF VERMICOMPOST ON THE GROWTH AND YIELD OF CABBAGE**" submitted to the Department of Horticulture, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **HORTICULTURE**, embodies the result of a piece of bona fide research work carried out by **KOHINUR AKTER** Registration No. **08-02717** under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has been duly acknowledged.

Dated: DECEMBER, 2014
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Dedicated to
My
Beloved Parents

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The Author

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ABSTRACT

The field experiment was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from 15 October, 2013 to 23 February, 2014 to evaluate the effect of different levels of vermicompost on the growth and yield of cabbage. The experiment comprised of two different factors such as Factor A: Three varieties viz; V_1: Atlas 70, V_2: Autumn Queen and V_3: Profit and Factor B: Four vermicompost levels; VC_0: control, VC_1: 3.6 t/ha, VC_2: 7.2 t/ha, and VC_3: 10.8 t/ha of vermicompost. The experiment was set up in Randomized Complete Block Design (RCBD) with three replications. There were 12 treatment combinations. In case of varieties, Autumn Queen gave the highest (39.17 t/ha) yield and the lowest (36.84 t/ha**)** from Atlas 70. For vermicompost levels, VC_3 gave the highest (64.78 t/ha) yield and lowest (14.79t/ha) from VC_0. For interaction effect, V_2VC_3 gave the highest (71.80 t /ha) yield and the lowest (14.44 t/ ha) from V_3VC_0. So, Autumn Queen with vermicompost level 10.8 t/ha gave the best performance.

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LIST OF ABBRIVIATIONS

FAOSTAT=Food and Agricultural Organization Corporate Statistical Database

BBS= Bangladesh Bureau of Statistics

FAO = Food and Agriculture Organization

AEZ=Agro Ecological Zones

UNDP=United Nations Development Program

RCBD=Randomized Complete Block Design

LSD= Least Significant Difference

CV= Coefficient of variation

BCR= Benefit Cost Ratio

DAT = Days After Transplant

et al. = and others *(at elli)*

SAU = Sher-e-Bangla Agricultural University

ANOVA= Analysis of variance

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CHAPTER I

INTRODUCTION

CHAPTER 1

INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata* L.) locally known as 'Bhadha Kopi' or 'Pata Kopi' is the most common winter vegetable crop grown in Bangladesh as well as in the other countries (Daly and Tomkins 1995, Nyambo and Lohr 2005). Cabbage is grown on 3.1 million ha globally excluding Chinese cabbage (*Brassica campestris*). It has been recognized as a very important vegetable to the farmers in providing income and nutrition worldwide (Oruku and Ndungu 2001, FAOSTAT 2007).

Cole crops are biennials, but are generally grown as annuals. Cabbage is one of the most important leafy vegetables in Bangladesh, and one of the five leading vegetables in the world (Rashid, 1999). Cabbage is most popular vegetable around the world in respect to area, production, and availability almost round the year (Swiader *et al.,* 1992). Among the vegetables grown in Bangladesh, cabbage ranks second in respect to production and area. The production in Bangladesh under cabbage increased 79% in 2007-2008 compared to 2002-2003 (BBS, 2008).

Cabbage is rich in vitamin C and tryptophan, an important amino acid for human (Rashid, 1993). Consumption rate of vegetables in our country is 30 kg/head/yr but in developed countries it is 7-8 times higher. FAO claimed that at least 5% total calories should have come from vegetables and fruits, which may fulfill the requirement of vitamins and minerals for human.

Cabbage is believed to have originated in Western Europe and it was the first cole crop. Prior to cultivation and use as food, cabbage was mainly used for medicinal purposes. In addition to the fresh market, cabbage is now processed into Kraut, egg rolls and cole slaws and there is the potential for other special markets for the various types including red, savoy and mini cabbage.

As a vegetable, cabbage has high nutritive value and high consumer's demand. The edible portion of cabbage plant is head which is formed by the fleshy leaves overlapping one another. It has been reported that 100g of green edible portion of cabbage contains 92% water, 24 K Cal of food energy, 1.5g of protein, 4.8g of carbohydrate, 40mg of calcium, 0.6mg of iron, 600 IU of carotene, 0.05mg of riboflavin, 0.3mg of niacin and 60mg of vitamin C (Rashid, 1993). Besides, its nutritive value, it is a profitable cash crop for the farmers in Bangladesh. In recent years vegetable consumption has increased. However, the productivity of cabbage per unit area is quite low in our country as compared to the developed countries of the world (Anon. 2006).

Organic Agriculture has a significant role to play in addressing two of the world's biggest and most urgent issues: climate change and food security. Climate change mitigation and adaptation and food security are inseparable and inherent beneficial characteristics of Organic Agriculture. There is more and more evidence that chemical based fertilizers, herbicides and pesticides are extremely harmful to our health and environment. It is an established fact that use of inorganic fertilizer for the crops is not so good for health because of residual effect but in the case of organic fertilizer such problem does not arise and on the other hand it increase the productivity of soil as well as crop quality and yield (Tindall, 2000).

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. 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.

Global movement for the second "Green revolution" ought to emphasize on composting, particularly vermicomposting (Buchanan *et al*., 1988). Vermicompost are produced through the interactions between earthworms and microorganism in the breakdown of organic wastes and to convert into nutritional rich humus. Vermicompost has a lower value of NPK than any standard chemical fertilizer (Tomlin, 1983). However the unique way in which vermicompost is produced, even right in the field and at low cost makes it very attractive for practical application (Talashilkar *et al.*, 2003). The vermicompost promote growth from 50-100% over conventional compost and 30-40% over chemical fertilizers (Sinha *et al*., 2010). The responses of various field crops to vermicompost are well recognized.

Vermicompost play a significant role on growth and yield of cabbage (Chaudhary *et al.,* 2004). Considering the above mentioned facts, the present study was undertaken with the following objectives:

- To identify the best variety of cabbage in respect to yield that could be suggestive for the farmers of Bangladesh

- To determine the appropriate dose of vermicompost for better growth and yield of cabbage

- To determine the interaction effect of cabbage variety and vermicompost on the growth and yield of cabbage

CHAPTER II

REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

Cabbage is important fresh and processing leafy vegetable crop in most of the countries of the world but in Bangladesh it is mainly used as a vegetable. Though plants get major nutrient from the soil, they are not adequate to meet the increasing demand for higher production. In cabbage growing areas of country, many soils are unable to supply the required nutrients. Hence, the importance of organic source of energy in promoting soil health and better plant nutrition has gained much attention on a global level. Vermicompost can be practiced successfully for Cabbage cultivation in order to improve the physiochemical characteristics, fertility of soil and increase crop yield. Since, the literature on the effect of vermicompost on growth and yield attributes is very less in cabbage; the literature on other crops is also included in this chapter for better understanding of the subject.

Chatterjee *et al.* (2013) conducted a field experiments at UBKV, Pundi bari, West Bengal, India to access the influence of different organic amendments on growth, head yield and nitrogen use efficiency in cabbage. The experiment comprised of 15 different nutrients source combining inorganic fertilizers, organic manures (farmyard manure and vermicompost) and Azophos biofertilizers were laid out in RBD with 3 replications. Growth and head attributes of cabbage were significantly influenced by different nutrient combination and vermicompost emerged as better organic nutrient source over farmyard manure. Inoculation with biofertilizers exerted more positive result over uninoculated treatments. The nutrient schedule comprising of higher amount of vermicompost (5 t/ha) along with 75% of recommended inorganic fertilizers in presence of biofertilizer inoculation emerged as potential nutrient source and resulted in many fold improvement in the form of vigorous growth, advanced head maturity, maximum curding percent and highest head yield as compared other nutrient combination. The different parameters of nitrogen use

efficiency (PFP, AE, PUE and AR) were markedly enhanced by the same nutrient combination.

Pour *et al.* (2013) conducted an experiment to evaluate the possible effects of different concentrations of vermicompost on the growth and physiology of cabbage seedling (*Brassica oleracea var. capitata*). Vermicompost were used at five different levels (0, 10%, 20%, 40% and 80%). The seeds were planted in five different prepared soil mixtures with vermicompost and grouped in five different treatment groups including control (C), vermicompost of 10% (V10), vermicompost of 20% (V20), vermicompost of 40% (V40) and vermicompost of 80% (V80). The utilization of different levels of vermicompost had significantly enhancing effects on the Zn and auxin contents in leaf tissues. The results indicated that there were significantly positive correlations between the Zn and auxin contents. The applied vermicompost affected the leaf characteristics including the number of produced leaves, leaf area, fresh and dry mass. These findings indicated that the effects of vermicompost on plant growth and development not only were nutritional but also hormonal and biochemical and the utilization of high levels of vermicompost, especially at seedling stage, neither is not only economic but also may have adverse effects on the plant growth and development.

Getnet and Raja (2013) conducted an experiment during October 2011 to February 2012 to study impact of vermicompost on growth and development of Cabbage, *Brassica oleracea* Linn. and their sucking pest. Vermicompost was applied at the rate of 25, 50, 100 and 200 gm/plant individually. Each application 10 plants were selected and vermicompost application was continued on bimonthly basis. Totally 40 plants were used for control group in which 10 plants were selected randomly. Total number of leaves per plant; leaf length and width; plant stand height and root length; cabbage head round distance and weight and aphid population built-up were the parameters studied in experimental and control cabbage plants. Significant differences ($p<0.05$;

LSD) were observed in the growth and development and pest infestation level between vermicompost applied and control plants. The number of plant stand height, cabbage head, leaves of cabbage were also significantly different ($p<0.05$; LSD) in experimental cabbage compared to control. Maximum number of cabbage plant was infested by aphid in control than experimental groups. In conclusion vermicompost have significant impact on cabbage growth promotion and reduce the aphid infestation.

Rai *et al*. (2013) studied an experiment to assess the effect of vermicompost, integrated with different rates of recommended doses of NPK for growth, yield and quality of cabbage. The investigation was laid out in RBD with ten treatments viz., T_1: 100% NPK (RR), T_2:75% NPK (RR)+VC 3 ton/ha, T_3:75% NPK (RR)+VC 2 ton/ha, T_4:75%NPK (RR)+VC 1 ton/ha, T_5:75% NPK (RR), T_6:50% NPK (RR)+VC 3 ton/ha, T_7:50% NPK (RR)+VC 2 ton/ha, T_8: 50% NPK (RR)+VC 1 ton/ha, T_9:50% NPK (RR) and T_{10}: VC 5 ton/ha. The results revealed that combined use of vermicompost and recommended dose of NPK were statistically significant towards the growth and yield of cabbage. The combined use of recommended dose of 75% NPK (RR) +VC 3 ton/ha, had recorded the maximum gross weight of the plant and net weight of the head. Application of vermicompost along with inorganic fertilizers reduced the days taken to maturity. The minimum days to 100% head maturity was also obtained from combined application of vermicompost. Most of the quality attributes like, total protein, total sugar, starch and ascorbic acid were found to be highest with 75% NPK (RR)+VC 3 ton/ha vermicompost except total chlorophyll content. It was concluded that application of vermicompost in combination with inorganic NPK fertilizers increased the productivity of cabbage besides sustaining soil fertility status.

Chaudhary *et al*. (2003) conducted a field experiment in Orissa, India starting from 1999 to investigate the use of vermicompost in cabbage cv. S-22 and tomato cv. Golden Acre production. Vermicompost was prepared using Gliricidia leaves and *Eisenia fetida* and was applied at 100 and 200 g/plant with or without farmyard manure (FYM), at 250 and 500 g/plant. The treatment received VC at 200 g/plant + FYM at 250 g/plant was the best for obtaining sustainable yields in both crops.

Ghuge *et al*. (2007) conducted a field experiment during 2002-03 in Parbhani, Maharashtra, India to assess the effect of combined use of organic and inorganic nutrients sources on the growth and yield of cabbage. The experiment was consisted of 10 treatments. Among the treatments 50% RDF + 50% Vermicompost i.e. treatment T2 gave the maximum plant spread, head circumference and head weight.

Ramírez *et al.* (2014) conducted a field experiment to evaluate different vermicompost doses in tomato crops (*Solanum lycopersicum* L.) in northern Sinaloa, Mexico. Vermicompost doses of 0, 500, 1 000, 1 600, 2 000 and 4 000 kg ha-1 were tested including a control, in a completely randomized design with three replicates per treatment. The estimated variables were fruit size, number and weight. The addition of more than 4 000 kg/ha of vermicompost significantly increased the fruit number and size in tomato plants hence it is considered a viable option for use in commercial tomato crops.

Azarmi *et al.* (2008) in their study analyzed the effects of vermicompost on growth, yield and fruit quality of tomato (*Lycopersicon esculentum var. super beta*) in a field condition. The experiment was a randomized complete block design with four replications. The different rates of vermicompost (0, 5, 10 and 15 t ha (-1)) was incorporated into the top 15 cm of soil. During experiment period, fruits were harvested twice in a week and total yield were recorded for two months. At the end of experiment, growth characteristics such as leaf number, leaf area and shoot dry weights were determined. The results revealed

that addition of vermicompost at rate of 15 t ha (-1) significantly (at $p < 0.05$) increased growth and yield compared to control. Vermicompost with rate of 15 t ha (-1) increased EC of fruit juice and percentage of fruit dry matter up to 30 and 24%, respectively. The content of K, P, Fe and Zn in the plant tissue increased 55, 73, 32 and 36% compared to untreated plots respectively. The result of our experiment showed addition of vermicompost had significant ($p <0.05$) positive effects on growth, yield and elemental content of plant as compared to control.

An experiment was conducted by Jahan *et al*. (2014) at experimental field of the Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh during the period from October 2008 to March 2009 to study the effect of vermicompost and conventional compost on the growth and yield of cauliflower. The experiment comprised of twelve treatments viz. T1: 100% Recommended Dose of Chemical Fertilizer (RDCF; RDCF= N250P35K65S40 Zn5B1 kgha-1); T2: 80% RDCF; T3: 60% RDCF; T4: 100% RDCF + Vermicompost @ 1.5 tha-1; T5: 80% RDCF + Vermicompost @ 3 tha-1; T6: 60% RDCF +Vermicompost @ 6 tha-1; T7: Vermicompost @ 6 tha-1; T8: 100% RDCF +Conventional compost @ 1.5 tha-1; T9: 80% RDCF +Conventional compost @ 3 tha-1; T10: 60% RDCF + Conventional compost @ 6 tha-1; T11: Conventional compost @ 6 tha-1 and T12: Control (No fertilization) following Randomized Complete Block Design with three replications. Maximum plant height (49.4 cm), number of leaves plant-1 (16.3), circumference of curd (46.5 cm), curd height (20.7 cm), total weight (1.60 kg plant-1), marketable weight (13.0 kg plant-1), curd yield (37.6 tha-1) and stover yield (29.7 tha-1) were found from T4 which was statistically identical with or followed by T8 and T5. From the experiment it was found that vermicompost was better that conventional compost in combination with chemical fertilizers.

John *et al.* (2013) studied the effect of vermicompost on the growth and yield of Capsicum annum. Their study revealed that the total macronutrients and micronutrients showed elevated levels in vermicompost when compared to control. The vermicompost applied plant Capsicum annum showed an increased shoot length and number of leaves when compared to the inorganic fertilizer applied plant.

A field experiment was conducted by Reddy and Rao (2004) to study the Growth and yield of bitter gourd (*Momordica charantia* L.) as influenced by vermicompost and nitrogen management practices in Hyderabad, Andhra Pradesh, India, consisting of 4 levels of vermicompost (0, 10, 20 and 30 t/ha) and 3 levels of N (20, 40 and 80 kg/ha). Application of vermicompost and N significantly increased the vine length, number of branches, number of fruits per vine and fruit yield/ha. Delayed flowering was observed with higher levels of N and Vermicompost. Application of 13.8 t vermicompost and 34.18 kg N (through urea)/ha was found beneficial in improving the yield of bitter gourd.

A study was conducted by Reddy and Reddy (2005) in Andhra Pradesh, India during 1996-98 to determine the effects of different levels of vermicompost (0, 10, 20 and 30 t/ha) and nitrogen fertilizer (0, 50, 100, 150 and 200 kg/ha) on the growth and yield of onion (cv. N-53) and their residual effect on succeeding radish in an onion-radish (cv. Sel-7) cropping system. The plant height, number of leaves per plant, leaf area, bulb length, diameter and weight and yield of onion increased significantly with increasing levels of vermicompost (from 10 to 30 t/ha) and nitrogen fertilizer (from 50 to 200 kg/ha). A similar increase in radish yield was also observed due to the residual effect of different levels of vermicompost and nitrogen applied to the preceding crop (onion). Among the various treatment combinations, vermicompost at 30 t/ha + 200 kg N/ha recorded the highest plant height and number of leaves per plant in onion and radish, but was at par with the treatment with vermicompost at 30 t/ha + 150 kg N/ha in terms of bulb length, bulb weight and onion yield recorded.

A study was conducted by Vadiraj *et al.* (1998) at Saklespur, Karnataka, India, on a red sandy loam soil, with 7 turmeric [*Curcuma longa*] cultivars. Rhizomes were planted on raised beds which had well rotted farmyard manure (20 t/ha) incorporated. Immediately after planting, vermicompost was applied at 0 or 10 t/ha. All plots were mulched uniformly with forest litter. A second application of vermicompost (10 t/ha) was made 90 days after planting. Rhizomes were harvested after 240 days. The cultivars responded positively to vermicompost application, plant height varying from 18.3 to 26.6 cm in control plots and from 28.9 to 33.9 cm in the treated plots. Among the cultivars, Armoor and Suroma responded best to vermicompost. Yield increases for the treated plots, over the control, ranged from 6.7% (BSR-1) to 25.5% (Armoor).

Mahtoj and Yadav (2005) conducted a pot culture experiment during winter season of 2001-02 to investigate the effect of vermicompost on growth and productivity in vegetables peas. The dry weight in vegetable peas was significantly influenced by vermicompost.

Arancon *et al.,* (2002) reported significantly increased growth and yield of tomatoes (*Lycopersicon esculentum*) and peppers (*Capsicum anuumgrossum*) when vermicompost, produced commercially from cattle manure, food waste or recycled paper, were applied to field plots at rates of 20t/ha and 10t/ha in 1999 and at rates of 10 t/ha and 5 t/ha in 2000 compared with those receiving equivalent amounts of inorganic fertilizer

Rodriguez *et al*., (2000) investigated the effect of vermicompost on plant nutrition, yield and incidence of root and crown rot of gerbera. Vermicompost incorporation at 20%, with or without chemical fertilizer, reduced the incidence of diseased plants and the disease growth rate. The macro and micronutrient content except (K and Mn) were at optimum level in plants treated with 20% vermicompost with or without chemical fertilizer. In contrast, plants from treatments without vermicompost had the lower content of macro and micronutrient, except K and Mn.

Singh *et al.,* (2005) conducted a study to assess the effect of vermicompost on cauliflower productivity and profitability considering soil health under small production systems. The data were gathered through farmer participatory verification trials during 2002-04 in five villages of Rajaulatu Panchayats of Namkum Block in Ranchi district, Jharkhand. It was found that the return per rupee spent in plots with vermicompost was Rs. 3.30, Rs 1.98 in plots applied with chemical fertilizers. The farmer's reaction on the use of vermicompost was highly positive because of its simplicity and compatibility with the farming system components and with the household internal resources, as well as its cost effectiveness.

Sohrab and Sarwar (2001) conducted an experiment and found that in case of Lady's finger (okra), the vermicompost had played very effective role in all economic aspects of the vegetables crop. The yield of lady's finger was 18.40 t ha-1 from the experimental plots treated with vermicomposts in one season. On the 13 contrary, production of 12.43 t ha-1 was estimated on the basis of harvested crop from untreated plots.

A number of field experiments have reported positive effect of quit low application rate of vermicompost to field crop. These applications were comparable with rates that improved growth on the same crops in greenhouse experiment. When cabbage was grown in compressed blocks made from pig waste vermicompost, after transplanting to the field they were larger and more mature at harvest compared to those grown in commercial blocking material (Edwards and burrows, 1988).

An experiment was conducted by Siag and Yadav (2004) in Rajasthan, India, during 1999-2001 to study the effect of vermicompost (0, 1, 2 and 3 t ha-1) and fertilizers (0, 50 and 100% recommended dose) on mungbean (*Vignaradiata*) yield. Significant increase in seed yield was observed by the application of vermicompost up to 2 t ha-1 owing to increased secondary branches per plant, pods per plant. Increased in secondary branches and nodules per plant resulted in improved yield attributes and seed yield over the control. Application of

vermicompost (2 t ha-1) along with 50% recommended dose of fertilizers (10 kg N and 8.7 kg P ha-1) was found to be the optimum dose for mugbean grown on sandy-loam soil.

Chan and Griffiths (1988) reported stimulating effect of pig manure vermicompost on the growth of soybeans (*Glycine max*), particularly in terms of increased root lengths, lateral root numbers and inter node lengths of seedling. In another rooting experiment, that used vermicompost involved in the establishment of vanilla (*Vanilla planifolia)* cuttings better than other growth media such as mixtures of coir pith and sand (Siddagangaiah *et al.,* 1996*).*Similar responses in growth were observed from gloves (*Syzygium aromaticum*) and black peppers (*Piper nigrum*) sown in 1:1 mixture of vermicompost and soil (Thankamani *et al*.,1996). Black pepper cuttings raised in vermicompost were significantly taller and had more leaves than those grown in commercial potting mixtures. Plant heights, number of branches and the longest taproots were on clove growth in the vermicompost mixtures.

Subler (1998) reported that in all growth trials the best growth responses were exhibited when the vermicompost constituted a relatively small portion (10% - 20%) of the total volume of the container medium. Valani (2009) found that 200g of vermicompost applied in plot soils performed better growth in wheat crop than those of 400g and 500g of vermicompost. Sinha *et al*., (2009) found that vermicompost was applied in the 2^{nd}, 3^{rd} and 4^{th} successive years, the growth and yield of wheat crops increased gradually over the years at the same rate of application of vermicomposti.e @20 Q/ha.

Theunissen *et al*., (2010) reported vermicompost contains plant nutrients including N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B, the uptake of which has a positive effect on plant nutrition, photosynthesis, the chlorophyll content of the leaves and improves the nutrient content of the different plant components (roots, shoots and the fruits). The high percentage of humic acids in vermicompost contributes to plant health, as it promotes the synthesis of

phenolic compounds such as anthocyanins and flavonoids which may improve the plant quality and act as a deterrent to pests and diseases.

Patil (1995) reported that application of vermicompost at 75 and 95 days after planting helps in obtaining maximum plant height in onion. He also indicated that application of vermicompost and 50% of recommended dose of fertilizer helps in increasing the number of leaves per plant compare to control in potato.

Vadiraj *et al.* (1998) compared vermicomposts application rates of 5 t/ha up to 25 t/ha in 5 t/ha increments on growth of three varieties of coriander. The responses to the vermicompost applications differed for all three varieties tested. However, he reported RCr-41 produced the most herbage among the three. Maximum herbage yields from all three were occurred 60 days after sowing. The varieties RCr-41, Bulgarian, and Sakalespur Local attained largest yields at vermicompost applications rates of 15T/ha, 10-25T/ha, and 20T/ha, respectively.

Food waste and recycled paper vermicomposts were applied at rates of 10 t/ha and 5 t/ha in 2000 to strawberries (*Fragaria spp*.). All of the vermicompost-treated plots were supplemented with inorganic fertilizers to equalize the available N levels in all plots at transplanting. The marketable tomato yields in the vermicompost (plus fertilizers) plots were consistently and significantly greater than those from inorganic-fertilizer only treated plots. There were significant increases in shoot weights, leaf areas and marketable fruit yields of pepper plants grown in plots that were treated with vermicomposts compared to those of plants grown in inorganic fertilizers. Leaf areas, numbers of strawberry suckers, numbers of flowers, shoot weights, and marketable fruit yields of strawberries all increased significantly in response to supplemented vermicompost applications compared to those from strawberries that received inorganic fertilizers only (Arancon *et al*, 2004).

Reddy and Reddy (1999) reported significant increases in micronutrients in field soils after vermicompost applications compared to those in soils treated with animal manures. In other experiments, amounts of soil nitrogen increased significantly after incorporating vermicomposts into soils (Sreenivas *et al,* 2000; Kale *et al,* 1992; Nethra *et al,* 1999) and the amounts of P and K available also increased (Venkatesh *et al*, 1998). Field experiments at The Ohio State University (Arancon *et al,* 2002) demonstrated that soils treated with vermicompost supplemented to recommended rates with inorganic fertilizers, and planted with tomato, had total amounts of N, orthophosphates, dehydrogenase enzyme activity, and the microbial biomass, that were usually greater than those that received equivalent amounts of inorganic fertilizers only.

Masciandro *et al*. (1997) investigated the effects of direct applications of vermicomposts produced from sewage sludge into the soil as well ferti-irrigation with humic extracts from vermicomposts. They reported a greater growth index of garden cress (*Lepidium sativum)* treated with vermicomposts than in control treatments with no vermicompost applications. Soil analyses after the vermicompost applications showed marked improvements in the overall physical and biochemical properties of the soil. A surface application of vermicompost derived from grape marc, spread under grape vines covered with a straw and paper mulch increased yields of a grape variety Pinot Noir by 55% (Buckerfield and Webster, 1998).

Mahewarappa *et al*. (1999) reported increased amounts organic carbon, improvements in pH, decreased bulk density, improved soil porosities and water-holding capacities, increased microbial populations and dehydrogenase activity of soils in response to vermicompost treatments.

CHAPTER III

MATERIALS AND METHODS

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from October 2013 to February 2014 to study the effect of different levels of vermicompost on the growth and yield of cabbage. The materials and methods that were used for conducting the experiment are presented under the following headings:

3.1 Experimental site

The research work was carried out at the Horticultural farm, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The trial was carried out during rabi season (14 October, 2013 to 23 February, 2014). The experimental plot was situated at $23^0 74^/$N latitude and $90^0 35^/$ E longitudes at an elevation of 8.2 m from sea level (Anon., 1989).

3.2 Climatic condition

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 (Edris *et al*., 1979). Details of the meteorological data during the period of the experiment was collected from the Bangladesh Meteorological Department, Agargoan, Dhaka and presented in Appendix I.

3.3 Characteristics of soil

The soil of the experimental area belongs to the Modhupur Tract (UNDP, 1988) under AEZ No. 28. It had shallow red brown terrace soil. The selected plot was high land and the soil series was Tejgaon (FAO, 1988). Details of the recorded soil characteristics were presented in Appendix II.

3.4 Materials used for the experiment

Three varieties were used as planting materials viz. (i) Atlas-70, (ii) Autumn Queen and (iii) Profit. Seeds were collected from a commercial seed trader named Manik seed traders, Siddique Bazar, Dhaka.

3.5 Treatment of the experiment

The experiment was conducted to find out the effect of different levels of vermicompost on the growth and yield of Cabbage. The experiment consisted of two factors.

Factor A: Variety (3 Varieties)

(i) V_1 : Atlas – 70

(ii) V_2 : Autumn Queen

(iii) V_3: Profit

Factor B: Vermicompost (4 Levels)

(i) VC_0: Control: No manure and fertilizer were applied

(ii) VC_1: 3.6 t /ha

(iii) VC_2: 7.2 t/ha

(iv) VC_3: 10. 8t/ha

There were 12 treatment combinations that are as follows:

V_1VC_0 V_2VC_0 V_3VC_0

V_1VC_1 V_2VC_1 V_3VC_1

V_1VC_2 V_2VC_2 V_3VC_2

V_1VC_3 V_2VC_3 V_3VC_3

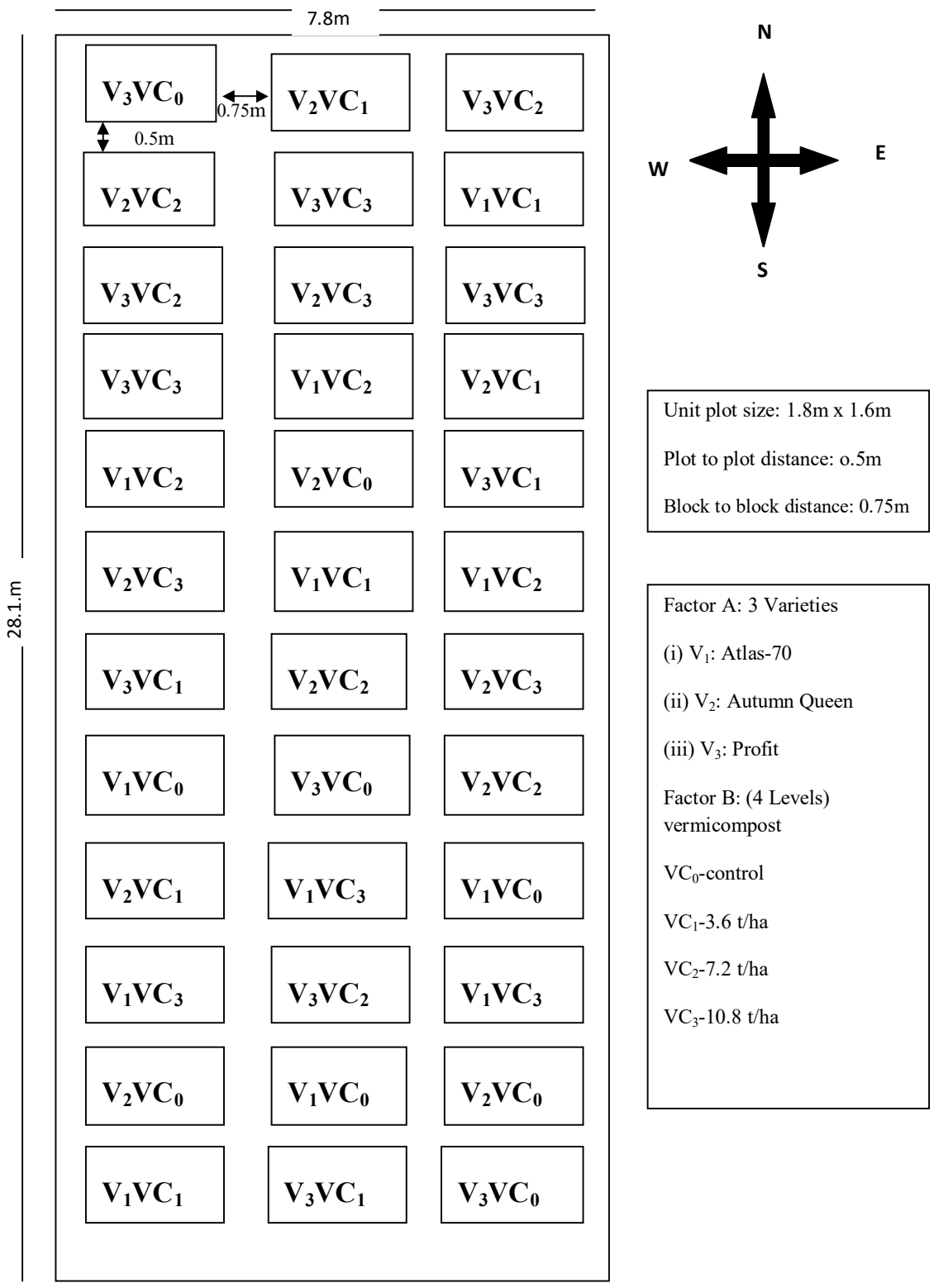


Fig. 1: Layout and design of the experimental plot

3.6 Design and layout of the experiment

The two factors experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. An area of 28.1m × 7.8 m was divided into three equal blocks. Each block was divided into 12 plots where 12 treatment combinations were allotted at random. There were 36 unit plots and the size of the each unit plot was 1.8 m × 1.6 m. The distance maintained between two blocks and two plots were 0.75 m and 0.5 m, respectively. The seedlings were transplanted maintaining distance row to row 60 cm and plant to plant 40 cm. The layout of the experiment is shown in Figure1.

3.7 Preparation of the main field

The selected experimental plot was opened with a power tiller and was exposed to the sun for a week. After 2 days the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed and finally obtained a desirable tilth of soil for planting of Cabbage seedlings. The experimental plot was partitioned into the unit plots in accordance with the experimental design and vermicompost was applied as per treatments of each unit plot.

3.8 Raising of seedlings

The seedlings were raised at Horticulture Farm of the Sher-e-Bangla Agricultural University, Dhaka under special care in a 1 m × 1 m size 3 seed beds for 3 cultivars. The soil of the seed bed was well ploughed with a spade and prepared into loose friable dried masses and to obtain good tilth to provide a favorable condition for the vigorous growth of young seedlings. Weeds, stubbles and dead roots of the previous crop were removed. The seedbed was dried in the sun to destroy the soil insect and protect the young seedlings from the attack of damping off disease. Ten grams of seed were sown in each seed bed on 15 October, 2013 to get seedling of 25 days of old at the time of transplanting. After sowing, the seeds were covered with finished light soil.

Seed were completely germinated within 7 days of after sowing. Shading given polyethylene bags over the seedbed to protect the young seedling from scorching sunlight and rainfall. Weeding, mulching and irrigation were done from time to time to provide a favorable condition for good growth and raising quality seedling.

3.9 Application of vermicompost

Four levels of vermicompost were applied in the field according to the treatments were as follows:

(i) VC_0: Control: No manure and fertilizer were applied

(ii) VC_1: 3.6 t/ha

(iii) VC_2: 7.2 t/ha

(iv) VC_3: 10.8 t/ha

3.10 Transplanting of seedling

Twenty five days old healthy and uniform sized seedlings were transplanted in the experimental plots. The seedbed was watered one hour before uprooting the seedlings to minimize the damage to the roots of the seedlings. Transplanting was done in the afternoon. During transplanting of seedling, spacing between rows 60cm and plant 40cm were followed. Twelve plants were transplanted in each unit plot. The seedlings were watered immediately after transplanting. The transplanted seedlings were kept under careful observation to find out any damage and dead seedling for its replacement. Replacement was done with healthy seedling having a boll of earth, which was also planted on the scheduled date by the side of the unit plot. The transplants were watered up to one week for their establishment.

3.11Intercultural operations

When the seedlings established in the beds it was always kept under careful observation. Various intercultural operations viz. irrigation and drainage, gap filling, weeding, earthing up was accomplished for better growth and development of cabbage seedlings.

3.11.1 Irrigation and drainage

Over-head irrigation was provided with a watering can to the plots once immediately after transplanting in every alternate day in the evening upto 1st harvest. Further irrigation was done and when needed. Stagnant water was effectively drained out at the time of excess irrigation.

3.11.2 Gap filling

At the time of each transplanting few seedlings were transplanted in the border of the experimental plots for gap filling. Very few seedlings were damaged after transplanting and such seedlings were replaced by healthy seedlings from the same stock planted earlier on the border of the experimental plot. The seedlings were transplanted with a mass of soil with roots to minimize the transplanting shock.

3.11.3 Weeding

Weeding was done to keep the plots free from weeds, easy aeration of soil, which ultimately ensured better growth and development. First weeding was done after 20 days of planting and the rest were carried out at an interval of 15 days. Breaking the crust of the soil was done when needed.

3.11.4. Earthing up

Earthing up was done to provide more soil at the base of each plant. It was done 40 and 60 days after transplanting.

3.12 Plant protection

No remarkable attack of disease was found in cabbage field under study.

3.13 Harvesting

Harvesting of the crop was not possible on a particular date because head initiation as well as head maturation period in plants were not similar. When the plants formed compact heads, the harvesting of the crop was done plot wise after testing the compactness of the cabbage head by hand. The compact head showed comparatively a hard feeling. Each head was cut by a sharp knife at the base of the plant.

3.14 Methods of data collection

Data were recorded on the following parameters from the sample plants during the course of experiment. Five plants were randomly selected from each unit plot for the collection of data.

3.14.1 Plant height

The height of the plant was measured by placing a meter scale from ground level up to the tip of the growing point at 30, 45, 60 days after transplanting (DAT). Thus, mean of five selected plants of a single plot was recorded and expressed in centimeter (cm).

3.14.2 Number of loose leaves per plant

The number of loose leaves per plant was counted and mean of five plants was recorded at 30, 45, 60 days after transplanting (DAT). At the time of counting of number of loose leaves dead leaves were excluded.

3.14.3 Leaf length with petiole

Length of 3rd large leaf with petiole from the base was measured by placing a meter scale from leaf base to the tip of the leaf of an individual plant and was recorded at 30, 45, 60 days after transplanting (DAT). Then the average length was measured. The average leaf length of selected five plants of a single plot was recorded and was expressed in centimeter (cm).

3.14.4 Leaf breadth

The breadth of 3rd large leaves of an individual plant was measured by placing a meter scale horizontally of the leaf and recorded at 30, 45, 60 days after transplanting (DAT). The mean leaf breadth of selected five plants of a single plot was recorded and the mean value expressed in centimeter (cm).

3.14.5 Spreading of plant

Horizontal space covered by the plant was measured at 30, 45, 60 days after transplanting (DAT) in centimeter (cm) with a meter scale for determining spread of plant.

3.14.6 Days required to head formation

Days required to head formation was counted from the date of transplanting to the starting of head formation of selected five plants of each plot and mean value was taken for computing days required to head formation.

3.14.7 Days to head maturity

The date from transplanting to head harvesting was counted of selected five plants of each plot and mean value was taken for computing days required to head maturity

3.14.8 Root length

A distance between bases to the top of the root was measured after harvesting in centimeter (cm) with the help of meter scale for determining the length of roots.

3.14.9 Stem length at harvest

Length of stem at harvest measured in centimeter with the help of a meter scale as the distance from ground level to the base of the unfolded leaf.

3.14.10 Fresh weight of roots

The fresh weight of root was measured in gram with the help of a digital balance.

3.14.11 Fresh weight of stem

The fresh weight of stem was measured in gram with the help of a digital balance.

3.14.12 Fresh weight of loose leaves at harvest

Weight of loose leaves per plant was recorded in grams.

3.14.13 Diameter of head

Two heads out of five were selected randomly. Then sectioning of head was done vertically with a sharp knife at the middle portion. The diameter of head was measured as the horizontal distance from one side to another side of the selected head and was expressed in centimeter (cm).

3.14.14 Thickness of head

With the help of a meter scale the vertical distance from the top to the bottom of the head was measured as thickness. The thickness of head was measured in centimeter (cm).

3.14.15 Fresh weight of head / plant

Harvesting done plot wise after testing the compactness of the cabbage head. Personal judgment involved in it. Cabbage head were collected from inner rows of plants of each unit plot to avoid any border effect. The fresh weight of head per plant was found from the average weight of selected five plants and was expressed in kilogram (kg).

3.14.16 Yield of cabbage / plot

Yield / plot was recorded by weighing of all compact heads excluding unfolded leaves in each unit plot (1.8 m×1.6m) and was expressed in kilogram (kg).

3.14.17 Yield of cabbage /ha

The weight of all compact head excluding unfolded leaves, stem, and root produced in a plot was taken and converted into yield /ha and was expressed in tones (t).

3.14.18 Cost analysis

The cost of production was analyzed in order to find out the most economic treatment in respect of variety and vermicompost. All input cost, cost of land and running capital were considered for computing cost of production. The cost and return analysis was done in details according to the procedure of Alam *et al*. (1989). The benefit cost ratio (BCR) was calculated as follows:

$$\text{Benefit cost ratio} = \frac{\text{Gross return per hectare (Tk.)}}{\text{Total cost of production per hectare (Tk.)}}$$

3.15 Statistical analysis

The collected data on various parameters under study were statistically analyzed using MSTAT package program. The means of all the treatments were calculated and analysis of variances for all the characters was performed by F variance test. The significance of differences between the pair of treatment means was evaluated by the Least Significant Differences (LSD) test at 5% and 1% level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER 4

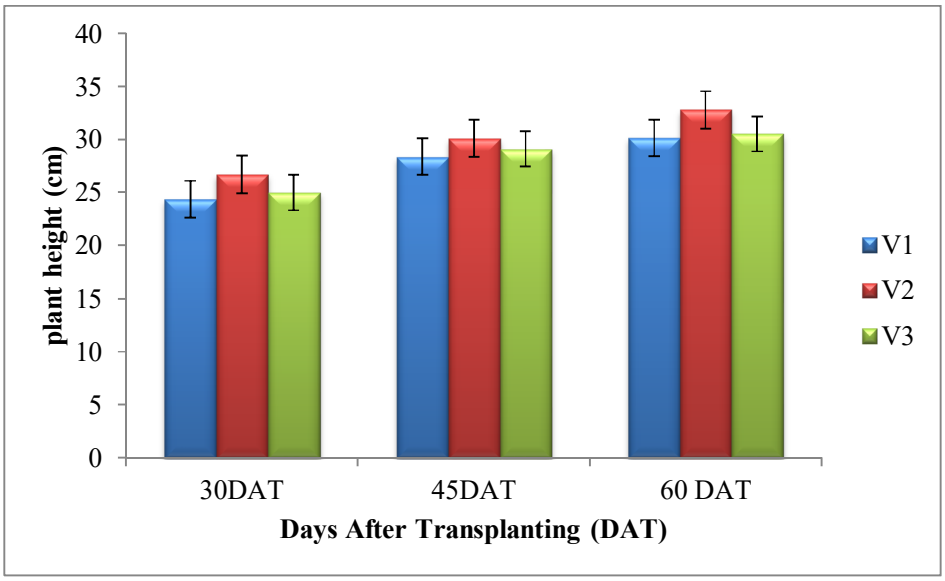
RESULTS AND DISCUSSION

The present experiment was conducted to find out the effects of different levels of vermicompost on the growth and yield of cabbage. Therefore, the effects of variety and vermicompost and their interaction effects on growth and yield of cabbage have been presented in different tables and figures and discussed in this chapter. The analysis of variance (ANOVA) of the data of different yield contributing characters and the different level of yield of cabbage has been presented in Appendices. The results of the experiment and possible interpretations have been made under the following headings.

4.1 Plant height

4.1.1 Effect of variety on plant height

Variety is an important factor considering plant height. Under the present study, plant height was significantly influenced by different varieties of cabbage at different days after transplanting (DAT) (Figure 2 and Appendix III). Results showed that the variety Autumn Queen (V_2) was evident for highest plant height at all growth stages. The tallest plants height at 30, 45 and 60 DAT were 26.6, 30.1 and 32.7 cm respectively was obtained with Autumn Queen (V_2). The competition in accordance with plant height among the varieties the smallest plant was demonstrated with Atlas 70 (V_1) and the lowest plant height at 30, 45 and 55 DAT were 24.3, 28.3 and 30.1 cm respectively, which was statistically identical at 30 and 60 DAT by variety Profit (V_3). The similar varietal effect of cabbage on plant height was supported by Haque (2005).

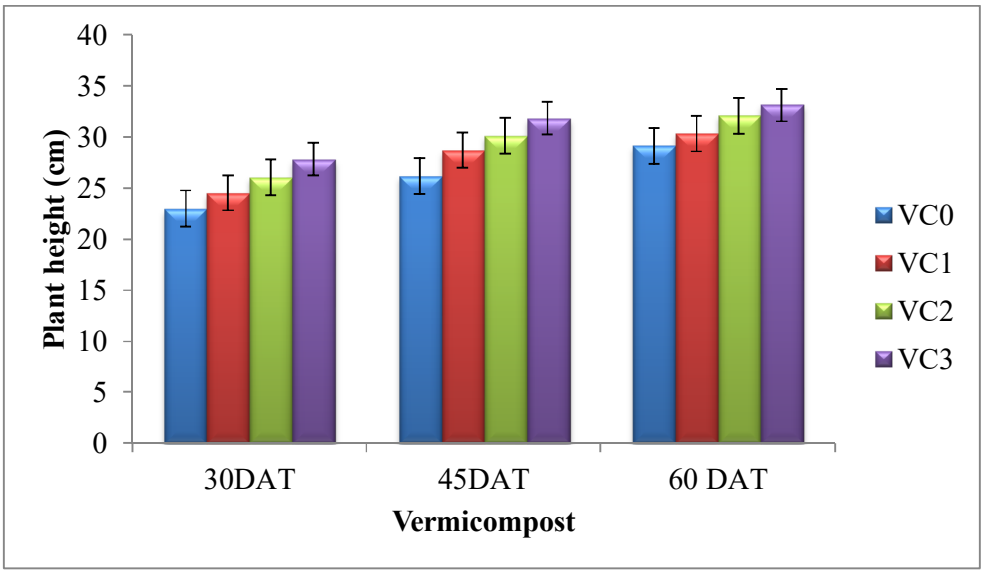


V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

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

4.1.2 Effect of vermicompost on plant height

Fertilizer is the most important factor for achieving best yield of crop. Plant height was significantly affected by different levels of vermicompost under the present study (Figure 3 and Appendix III).It is evident that plant height was the highest with maximum dose of vermicompost (VC_3) at different growth stages of different varieties of cabbage cultivars. The highest plant height was 27.8, 31.8 and 33.1 cm at 30, 45 and 60 DAT respectively. On the other hand, the lowest plant height (22.9, 26.1 and 29.0 cm at 30, 45 and 60 DAT respectively) was with control treatment (VC_0). Plant height increased with increased application of vermicompost. Vermicompost ensured favorable condition for the growth of cabbage with cell division and elongation of cell and the ultimate result was the tallest plant. Results under the present experiment on plant height were supported by Getnet and Raja (2013).



VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

Fig.3. Effect of vermicompost on plant height at different growth stages of cabbage

4.1.3 Interaction effect of variety and vermicompost on plant height

Interaction effect of variety and different levels of vermicompost on plant height were significant at 30, 45 and 60 DAT under the present study (Table 1 and appendix III).The tallest plant height was 29.4cm, 33.3cm and 34.7cm at 30 DAT, 45 DAT and 60 DAT recorded from V_2VC_3 treatment combination. On the other hand, the shortest plant height was observed 21.8 cm, 25.6 cm and 27.7 cm at 30, 45 and 60 DAT from V_1VC_0 treatment combination respectively. At 60 DAT, the tallest plant height 34.7 cm was recorded from V_2VC_3 treatment combination, which was statistically similar to V_2VC_2 treatment combination and the shortest plant height 27.7 cm was observed from V_1VC_0 treatment combination, which was statistically similar to V_1VC_1 and V_3VC_0 treatment combination.

Table 1. Interaction effect of variety and vermicompost on plant height at different growth stages of cabbage

Treatments	Plant Height (cm) at		
	30DAT	45DAT	60DAT
V_1VC_0	**21.8g**	**25.6g**	**27.7 f**
V_1VC_1	23.6f	27.6efg	28.8ef
V_1VC_2	25.1de	29.4cde	30.8cd
V_1VC_3	26.9bc	30.3bcd	32.1bc
V_2VC_0	23.7ef	26.1fg	30.8 cd
V_2VC_1	25.9cd	29.9bcd	31.8 cd
V_2VC_2	27.6b	31.4abc	33.7ab
V_2VC_3	**29.4a**	**33.3a**	**34.7 a**
V_3VC_0	23.4f	26.7fg	28.7ef
V_3VC_1	24.0ef	28.5def	30.2 de
V_3VC_2	25.5d	29.4de	31.5 cd
V_3VC_3	27.0b	31.7ab	32.5bc
$LSD_{0.05}$	1.368	2.040	1.743
% CV	3.19	4.13	3.30

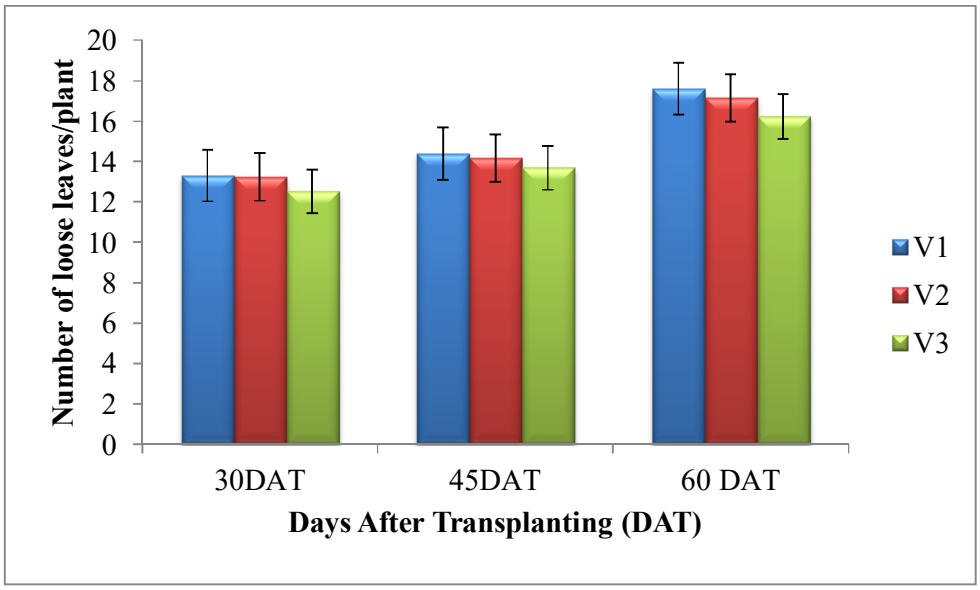
V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

4.2 Number of loose leaves/plant

4.2.1 Effect of variety on number of loose leaves/plant

Number of loose leaves per plant is an important parameter considering the highest performance of cabbage yield (Figure 4 and Appendix III). Number of loose leaves per plant of cabbage showed significant variation at 30, 45 and 60 DAT. Result showed that the variety Atlas 70 (V_1) was evident for maximum number of loose leaves. The highest number of loose leaves/plant at 30, 45 and 60 DAT (13.3, 14.4 and 17.6) was with Atlas 70 (V_1) which was statistically identical with autumn queen (V_2) at 30, 45 and 60DAT. On the contrary the minimum number of loose leaves/plant was demonstrated with Profit (V_3) and the minimum number of loose leaves at 30, 45 and 60DAT were 12.5, 13.6 and 16.2 cm respectively. This higher and lower number of leaves/plant might be due to cause of genetic characters of different variety.



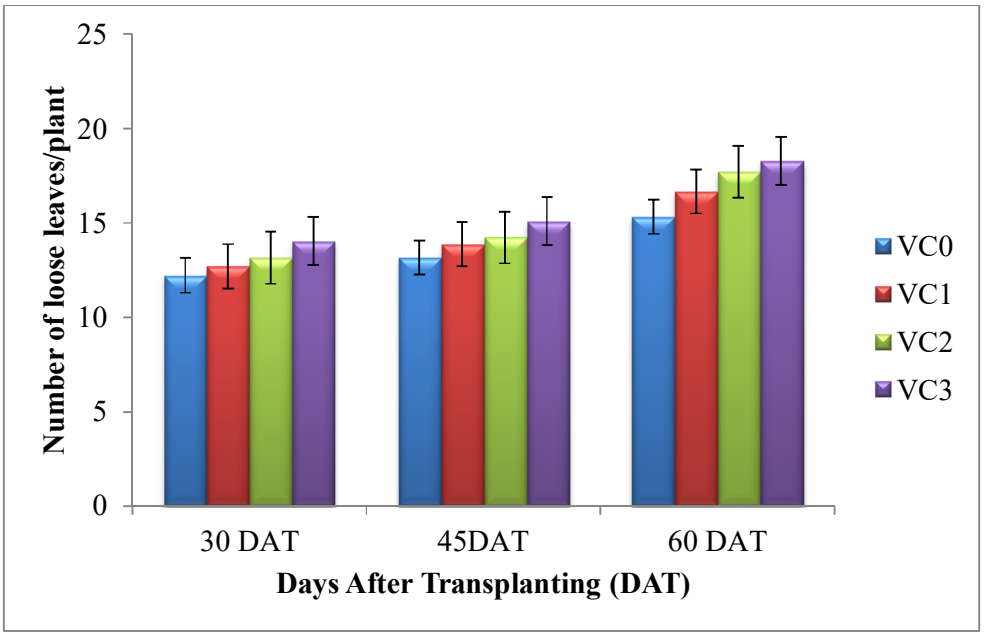
V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

Fig.4. Effect of variety on number of loose leaves/plant at different growth stages of cabbage

4.2.2 Effect of vermicompost on number of loose leaves/plant

In cabbage, leaves play an important role in photosynthesis. For this reason, the number of loose leaves per plant was an important yield-contributing factor. In this experiment, it was found that different levels of vermicompost had significant effect on number of leaves per plant (Appendix III). The number of loose leaves was increased gradually from 30 DAT and reached its peak at 60 DAT. It may be observed that VC_3treatment gave maximum number of loose leaves per plant (14.0, 15.1 and 18.3) at 30, 45 and 60 DAT respectively, which is statistically identical with VC_2 at 60 DAT and VC_0 gave minimum number of loose leaves per plant (12.2, 13.1 and 15.3) at 30, 45 and 60 DAT respectively which was closely followed by VC_1 at 30 DAT (Figure 5). As VC_3treatment provided maximum amount of available nutrient and ideal condition for growth which might have attributed to the production of maximum number of unfold leaves in that treatment. On the other hand, VC_0treated plots received less available nutrients and ideal growing condition for the production of leaves of cabbage. In the present study total number of leaves developed for each plant

significantly increased in approximate amount of vermicompost applied plants compared to untreated cabbage plants. These findings are in agreement with the report of Canellas *et al*. (2002). They have reported that the growth of the plant was associated with humus content excreted by earthworm which contains humic acid.



VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

Fig.5. Effect of vermicompost on number of loose leaves /plant at different growth stages of cabbage

4.2.3 Interaction effect of variety and vermicompost on number of loose leaves/plant of cabbage

Interaction effect of variety and different levels of vermicompost on number of loose leaves/plant had significant variation at 30, 45 and 60 DAT under the present study (Table 2 and Appendix III). It was observed that highest number of loose leaves/plant was 14.5, 15.6 and 19.1 at 30, 45 and 60 DAT respectively from treatment combination V_1VC_3. At 60 DAT, V_1VC_3 treatment combination was statistically similar with V_3VC_2 and V_3VC_3. On the other hand the lowest number of loose leaves/plant; 11.6, 12.6 and 14.7 at 30 DAT, 45 DAT and 60

DAT was recorded from treatment combination V_3VC_0 in which, at 60 DAT V_3VC_0 was statistically similar with V_2VC_0 treatment combination.

Table 2. Interaction effect of variety and vermicompost on number of loose leaves/plant at different growth stages of cabbage

Treatments	Number of loose leaves/plant at		
	30DAT	45DAT	60DAT
V_1VC_0	12.4 de	13.0 de	15.9 de
V_1VC_1	13.0 cd	14.0 bc	17.1 c
V_1VC_2	13.2 cd	14.3 b	18.3 ab
V_1VC_3	**14.5 a**	**15.6 a**	**19.1 a**
V_2VC_0	12.5 cde	13.8bcd	15.4 ef
V_2VC_1	12.7 cd	14.2 b	15.9 de
V_2VC_2	13.4 bc	14.3 b	16.5 cde
V_2VC_3	14.2 ab	15.2 a	17.2 bc
V_3VC_0	**11.6 e**	**12.6 e**	**14.7 f**
V_3VC_1	12.4 de	13.3 cde	16.9 cd
V_3VC_2	12.7 cd	14.1 bc	18.4 a
V_3VC_3	13.3 bcd	14.4 b	18.5 a
LSD $_{0.05}$	0.9489	0.8085	1.118
% CV	4.30	3.39	3.89

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

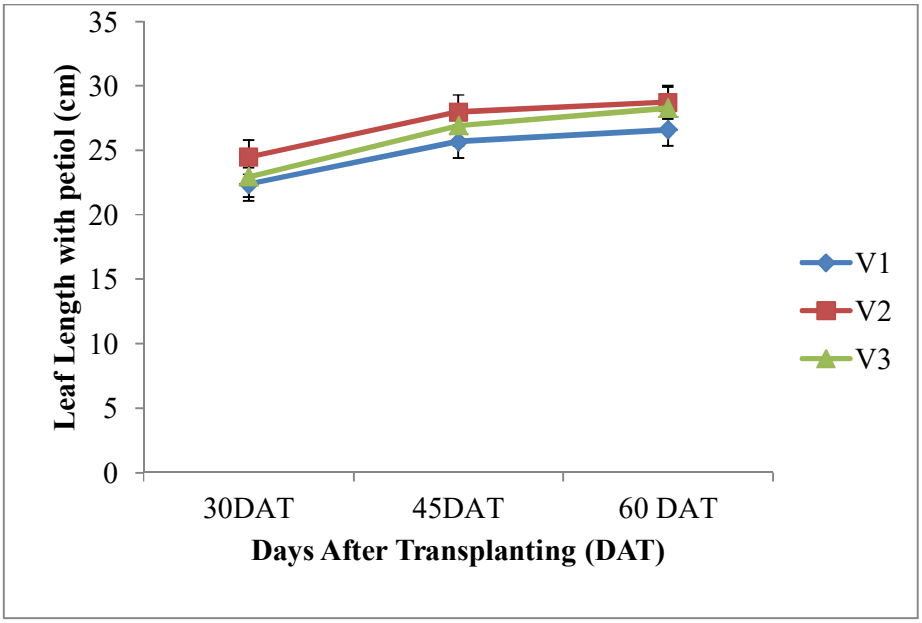
VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

4.3 Leaf Length with petiole

4.3.1 Effect of variety on leaf length with petiole

Leaf length/plant is one of the important parameter for measuring yield performance of cabbage variety (Figure 6 and Appendix III). Under the present study, leaf length/plant with petiole was significantly influenced by different cabbage varieties. Different varieties showed different leaf length with petiole at different growth stages. It was measured that Autumn Queen (V_2) gave the highest leaf length per plant with petiole (24.4 cm, 27.9 cm and 28.7 cm) at 30, 45 and 60 DAT which was statistically similar with profit (V_3) at 60DAT. At 30, 45 and 60 DAT (22.3, 25.7 and 26.6 cm respectively) Atlas 70 (V_1) showed

lowest leaf length/plant with petiole. The results obtained from the experiment on leaf length/plant with petiole might be due to cause of varietal effect, soil type, nutrient availability etc. and these results are agreement with Muhammad and Javed (2001).

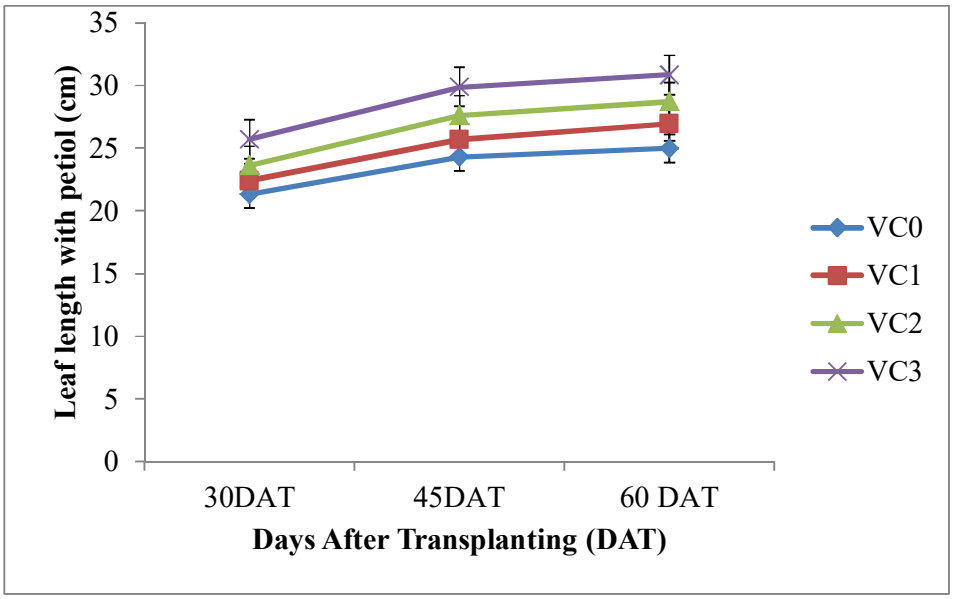


V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

Fig.6. Effect of variety on leaf length with petiole at different growth stages of cabbage

4.3.2 Effect of vermicompost on leaf length with petiole

The effect of different level of vermicompost on leaf length of cabbage at 30, 45 and 60 DAT was significant (Appendix III). At 30, 45 and 60 DAT the lowest leaf length (21.3cm, 24.2 and 25.0) was found in VC_0 treatment and the highest leaf length (25.7, 29.8 and 30.8 cm) in VC_3treatment. The leaf length gradually increased due to the effect of vermicompost treatment with the advancement of time to harvest (Figure 7). These were due to the supply of available nutrient and ideal growing condition provided by VC_3treatment and low nutrient supply and insufficient growing condition in VC_0 treatment up to harvest. Getnet and Raja (2013) showed the similar results in their experiment on length of leaf.



VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

Fig.7. Effect of vermicompost on leaf length with petiole at different growth stages of cabbage

4.3.3 Interaction effect of variety and vermicompost on leaf length with petiole of cabbage

Leaf length/plant with petiole varied significantly at 30, 45 and 60 DAT with interaction effect of variety and different level of vermicompost under the present study (Table 3 and Appendix III). Different treatment combination viewed different leaf length/plant with petiole at different days after transplanting (DAT). It was observed that highest leaf length/plant with petiole was achieved with V_2VC_3 and that was 26.5, 31.0 and 31.9 cm at 30, 45 and 60 DAT respectively which was statistically identical with V_3VC_3 at 45 and 60 DAT. On the other hand the lowest leaf length/plant with petiole; 20.1, 23.8 and 24.8 cm at 30, 45and 60 DAT were recorded from treatment combination V_1VC_0.

Table 3: Interaction effect of variety and vermicompost on leaf length with petiole at different growth stages of cabbage

Treatments	Leaf length with petiole (cm) at		
	30DAT	45DAT	60DAT
V_1VC_0	**20.1 f**	**23.8 e**	**24.8 f**
V_1VC_1	21.3 e	24.8 de	25.5 f
V_1VC_2	22.7 cd	26.0 cd	26.9 e
V_1VC_3	25.5 ab	28.0 b	29.2 bc
V_2VC_0	22.3 de	25.1 de	25.4 f
V_2VC_1	23.5 c	27.3 bc	28.3 cd
V_2VC_2	25.5 ab	28.5 b	29.3 bc
V_2VC_3	**26.5 a**	**31.0 a**	**31.9a**
V_3VC_0	21.6 de	24.0 e	24.8f
V_3VC_1	22.3 de	24.9 de	27.1 de
V_3VC_2	22.7 cd	28.4 b	29.9 b
V_3VC_3	25.2 b	30.6 a	31.4 a
LSD $_{0.05}$	1.122	1.473	1.295
% CV	2.85	3.24	2.74

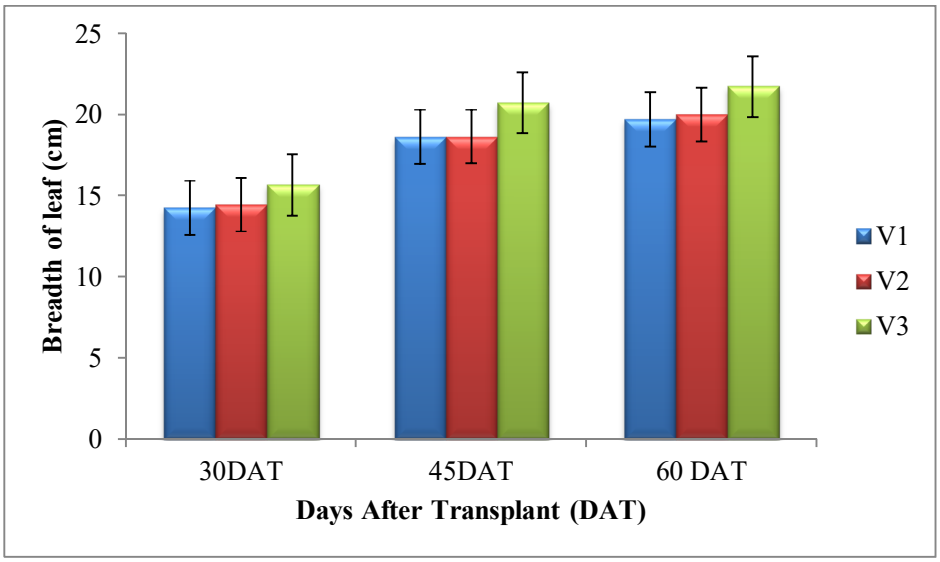
V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

4.4 Leaf breadth

4.4.1 Effect of variety on leaf breadth

Leaf breadth/plant is also another important parameter for measuring yield performance of cabbage variety (Figure 8 and Appendix IV). Under the present study, leaf breadth/plant was significantly influenced by different varieties. Different varieties showed different leaf breadth at different growth stages. It was precise that Profit (V_3) demonstrated the highest leaf breadth/plant at 30, 45 and 60 DAT was 15.6, 20.7 and 21.7 cm respectively. And the lowest leaf breadth was 14.2, 18.6 and 19.6 cm obtained with Atlas – 70 (V_1) at 30, 45 and at 60 DAT which was statistically similar with Autumn Queen (V_2) at 30, 45 and 60 DAT. The results obtained from the experiment on leaf breadth might be due to cause of varietal effect, soil type, nutrient availability etc.

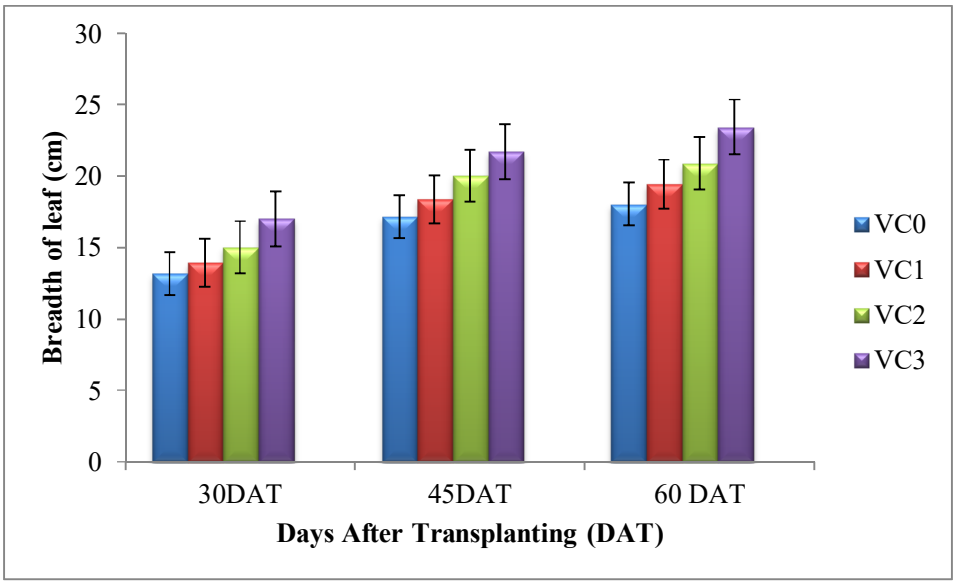


V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

Fig. 8: Effect of variety on leaf breadth at different growth stages of cabbage

4.4.2 Effect of vermicompost on leaf breadth

Different levels of vermicompost management practices showed significant effect on leaf breadth per plant for the growth and development of cabbage varieties at different days after transplanting (DAT) (Figure 9 and Appendix IV). At all growth stages, the lowest leaf breadth (13.2, 17.2 and 18.4 cm at 30, 45 and 60 DAT respectively) were obtained from VC_0 treatment and the highest leaf breadth (17.0, 21.7 and 23.4 cm at 30, 45 and 60 DAT respectively) was observed in VC_3 treatment, which was significantly differed from all other treatments. The leaf breadth gradually increased due to the effect of vermicompost treatment with the time to harvest.



VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

Fig.9. Effect of vermicompost on leaf breadth at different growth stages of cabbage

4.4.3 Interaction effect of variety and vermicompost on leaf breadth

Breadth of leaf showed significant variation at 30, 45 and 60 DAT due to interaction effect of variety and different levels of vermicompost under the present study (Table 4 and Appendix IV). It was observed that the highest leaf breadth/plant was achieved with V_3VC_3 and that was 18.1, 23.6 and 24.4 cm at 30, 45 and 60 DAT respectively, which was statistically similar with V_1VC_3 at 60 DAT. On the other hand the lowest leaf breadth/plant;12.6,16.2 and 17.3 cm at 45 and 60 DAT respectively with treatment combination V_1VC_0.

Table 4. Interaction effect of variety and vermicompost on leaf breadth at different growth stages of cabbage

Treatments	Leaf breadth (cm) at		
	30DAT	45DAT	60DAT
V_1VC_0	**12.6f**	**16.2h**	**17.3g**
V_1VC_1	12.9ef	17.1fgh	17.7fg
V_1VC_2	14.1de	19.3cde	20.3de
V_1VC_3	16.9ab	21.8b	23.4ab
V_2VC_0	13.0ef	16.7gh	17.6fg
V_2VC_1	14.2de	18.1efg	19.5ef
V_2VC_2	15.1cd	19.9cd	20.3de
V_2VC_3	15.9bc	19.7cde	22.5abc
V_3VC_0	13.9def	18.5def	19.1efg
V_3VC_1	14.7cd	19.9cde	21.2cde
V_3VC_2	15.8bc	20.9bc	22.1bcd
V_3VC_3	**18.1a**	**23.6a**	**24.4a**
LSD $_{0.05}$	1.537	1.796	2.019
% CV	6.14	5.49	5.83

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

4.5 Spreading of plant

4.5.1 Effect of variety on spreading of plant

Statistically no significant variation was recorded by different varieties in case of spreading of cabbage plant (Table 5 and Appendix IV). The higher spreading of plant (31.05, 46.71 and 49.47 cm) was recorded at 30, 45 and 60 DAT with Autumn Queen (V_2) and lower spreading (29.77, 44.67 and 48.52 cm) was achieved with Atlas-70 (V_1).

4.5.2 Effect of vermicompost on spreading of plant

Spreading of plant varied significantly due to the application of different levels of vermicompost (Table 5 and Appendix IV). The highest spreading of plant at 30 DAT (34.17 cm), 45 DAT (48.18 cm) and 60 DAT (51.78 cm) were found in VC_3 treatment, which was closely followed by VC_2 at 45 DAT. On the contrary,

the lowest spreading of canopy at 30 DAT (27.58 cm), 45DAT (43.42 cm) and 60 DAT (45.68 cm) was observed from VC_0 treatment. It was found that canopy spreading of plant increased with the higher levels of vermicompost application.

Table 5. Effect of variety and vermicompost on spreading of plant at different growth stages of cabbage

Treatments	Spreading of plant (cm) at		
	30DAT	45DAT	60DAT
Effect of variety			
V_1	29.77	44.67	48.52
V_2	31.05	46.71	49.47
V_3	30.86	46.22	49.31
$LSD_{0.05}$	NS	NS	NS
% CV	7.73	4.87	3.00
Effect of vermicompost			
VC_0	27.58 c	43.42 c	45.68 d
VC_1	28.98 c	45.78 b	48.69 c
VC_2	31.51b	46.10 ab	50.26 b
VC_3	34.17 a	48.18 a	51.78 a
$LSD_{0.05}$	2.308	2.185	1.442
% CV	7.73	4.87	3.00

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

4.5.3 Interaction effect of variety and vermicompost on spreading of plant

Highly significant variation was observed in case of spreading of plant with interaction effect of variety and different levels of vermicompost under the present study (Table 5 and Appendix IV). It was observed that the highest spreading of plant was obtained at 30, 45 and 60 DAT was 35.33, 49.33 and 52.40 cm from V_2VC_3 which was statistically identical with V_3VC_3 treatment combination at 30, 45 and 60 DAT. On the other hand the lowest spreading of

plant was achieved with V_1VC_0 and that was 26.20, 42.60 and 44.87 cm at 30, 45 and 60 DAT respectively.

Table 6. Interaction effect of variety and vermicompost on spreading of plant at different growth stages of cabbage

Treatments	Spreading of plant (cm) at		
	30DAT	45DAT	60DAT
V_1VC_0	**26.20 d**	**42.60c**	**44.87 e**
V_1VC_1	27.53 d	45.83abc	47.80 cd
V_1VC_2	30.00bcd	43.93bc	50.47 ab
V_1VC_3	33.10 ab	46.33abc	50.93 ab
V_2VC_0	28.00 cd	45.00 bc	47.03 de
V_2VC_1	29.67bcd	45.77abc	48.93bcd
V_2VC_2	32.67 ab	46.73 ab	49.93abc
V_2VC_3	**35.33a**	**49.33 a**	**52.40a**
V_3VC_0	28.53 cd	42.67 c	45.13 e
V_3VC_1	29.73bcd	45.73abc	49.33bcd
V_3VC_2	31.87abc	47.63 ab	50.37 ab
V_3VC_3	34.07a	48.87 a	52.00 a
$LSD_{0.05}$	3.998	3.784	2.498
CV%	7.73	4.87	3.00

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

4.6 Days required to head formation

4.6.1 Effect of variety on days required to head formation

Cabbage varieties showed significant effect on days required to head formation (Appendix IV). The maximum time (44.28 days) required to head formation was in V_3 treatment, which was statistically similar with Autumn Queen (V_2). While V_1 required the minimum days (36.77 days) to head formation (Table 6).

4.6.2. Effect of vermicompost on days required to head formation

Different levels of vermicompost management had significant influence on days required to head formation (Appendix IV).The control treatment VC_0required the longest time (44.47 days) to start head formation which was statistically similar with VC_1 treatment. On the contrary, the shortest time (39.24 days) was taken by VC_3 treatment, which was closely followed by VC_2 treatment (Table 6). In VC_3 treatment the supply of nutrient was possibly balanced and exactly what needed by the plant. Therefore, the head formed earlier than that of the control treatment. These findings are in agreement with the observation of Subhan (1988) who reported that application of manure reduced the number of days for cabbage head formation as well as maturity.

4.6.3 Interaction effect of variety and vermicompost on days required to head formation

Treatment combinations of cabbage variety and vermicompost levels significantly influenced the days required to head formation (Appendix IV and Table 6). Lowest days to start head formation (33.67 days) were obtained from the treatment combination of V_1VC_3. Highest days to start head formation (48.00 days) were recorded from the treatment combination $V_3VC_{0,}$ which was statistically identical to V_2VC_0 and V_3VC_1 and similar to V_2VC_1.

4.7 Days to head maturity

4.7.1 Effect of variety on days to head maturity

Variety showed significant effect in respect of days to head maturity (Appendix IV and Table 6). Variety Profit (V_3) required the longest time (92.95 days), which was statistically identical with Autumn Queen (V_2). The minimum time (89.03 days) was taken by the Atlas-70 (V_1).

4.7.2 Effect of vermicompost on days to head maturity

Days to head maturity of cabbage varied significantly due to different levels of vermicompost (Table 6 and appendix IV). Minimum days to head maturity

(88.98 days) were obtained from treatment VC_3, which was statistically identical with VC_2. Highest days to head maturity (94.29 days) were found in the control treatment VC_0.Subhan (1988) reported that application of organic manure reduce the days to head maturity.

4.7.3 Interaction effect of variety and vermicompost on days to head maturity

There was significant effect between the cabbage varieties and level of vermicompost on days required to head maturity (Table 6 and appendix IV). The longest time (94.67 days) was taken by the treatment combination of V_3VC_0 which was statistically identical to V_1VC_0, V_2VC_0, V_2VC_1, V_3VC_1 and V_3VC_2 treatment combination and the shortest time (82.93 days) was taken by V_1VC_3 treatment combination.

Table 7. Effect of variety and vermicompost on days required to head formation and days to head maturity

Treatments	Days starting to head formation	Days to head maturity
Effect of variety		
V_1	36.77 b	89.03 b
V_2	44.27 a	92.07 a
V_3	44.28 a	92.95 a
LSD $_{0.05}$	1.426	0.8827
% CV	4.03	1.14
Effect of vermicompost		
VC_0	44.47 a	94.29 a
VC_1	43.07 ab	92.18 b
VC_2	40.31bc	89.97 c
VC_3	39.24c	88.98 c
LSD $_{0.05}$	1.646	1.019
% CV	4.03	1.14

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha,

VC_3: Vermicompost 10.8 t/ha

Table 8. Interaction effect of variety and vermicompost on days required to head formation and days to head maturity

Treatments	Days required to head formation	Days to head maturity
V_1VC_0	39.53 de	93.87 a
V_1VC_1	35.93 fg	89.27 b
V_1VC_2	37.93 ef	90.07 b
V_1VC_3	33.67 g	82.93 c
V_2VC_0	46.33 a	94.33 a
V_2VC_1	45.27 ab	92.93 a
V_2VC_2	43.13 bc	89.93 b
V_2VC_3	42.30 cd	90.77 b
V_3VC_0	48.00 a	94.67 a
V_3VC_1	47.53 a	94.33 a
V_3VC_2	40.93cd	94.07 a
V_3VC_3	40.67cde	89.07 b
$LSD_{0.05}$	2.852	1.735
CV %	4.03	1.14

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha,

VC_3: Vermicompost 10.8 t/ha

4.8 Roots length

4.8.1 Effect of variety on root length

Root length is an important plant character for contributing higher yield performance and it differs with varieties in accordance with genetical characters of the variety. Under the present study, root length had significant influence by different cabbage varieties (Table 7 and Appendix V). Different varieties showed different root length and it was measured at the time of harvest. It was defined that Autumn Queen (V_2) treatment verified the highest root length at harvest (20.0 cm), which was statistically identical with Profit (V_3) treatment. But the lowest root length (15.1 cm) among the varieties was obtained with Atlas – 70 (V_1) at harvest. The results was represented under the present

experiment might be due to cause of water and nutrient availability on soil characteristic that cause higher and lower root length of plants.

4.8.2. Effect of vermicompost on root length

Vermicompost effect on root length was significant under the present study. It is evident that different levels of vermicompost showed different root length (Table 7 and Appendix V). The highest root length (20.6 cm) was indicated with the treatment of (VC_3). On the other hand, the lowest root length (15.6 cm) was measured with control (VC_0) treatment.

4.8.3 Interaction effect of variety and vermicompost on root length

Significant variation was found in case of length of root with interaction effect of cabbage varieties and different levels of vermicompost under the present study (Table 7 and Appendix V). Different treatment combination viewed different length of root. It was found that the highest root length (23.5 cm) was recorded with V_2VC_3 treatment combination. On the other hand, the lowest root length (12.3 cm) was recorded with V_1VC_0.

4.9 Stem length

4.9.1 Effect of variety on 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 varieties (Table 7 and Appendix V). Different varieties showed different stem length and it was deliberate at the time of harvest. It was defined that Autumn Queen (V_2) treatment verified the highest stem length (9.6) at harvest and the lowest stem length (7.7 cm) among the varieties was with Profit (V_3) at harvest. Varietal effect was observed on stem length due to its phonotypical characters (Haque, 2005) and this result on stem length is supported by Haque, 2005.

4.9.2 Effect of vermicompost on stem length

Vermicompost effect on stem length was significant under the present study. It is evident that different levels of vermicompost showed different stem length (Table 7 and Appendix V). The highest stem length (9.2 cm) was indicated with the treatment of (VC_3) which was closely followed by VC_2. On the other hand, the lowest stem length (7.9 cm) was measured with control (VC_0) treatment.

4.9.3 Interaction effect of variety and vermicompost on stem length

Significant variation was observed in case of length of stem with interaction effect of cabbage varieties and different levels of vermicompost under the present study (Table 7 and Appendix V). Different treatment combination viewed different length of stem. It was observed that the highest length of stem (9.9 cm) was observed with V_2VC_3 treatment combination, which was statistically similar with V_2VC_2, V_1VC_3 and V_2VC_1 treatment combination. On the other hand, the lowest stem length (7.2 cm) was observed with V_3VC_0 treatment combination, which was statistically identical with V_1VC_0 and V_3VC_1 similar to V_1VC_1, V_3VC_2 and V_3VC_3 treatment combination.

Table 9. Effect of variety and vermicompost on root and stem length

Treatments	Root length (cm)	Stem length (cm)
Effect of variety		
V_1	15.1 b	8.5 b
V_2	20.0 a	9.6 a
V_3	19.3 a	7.7 c
LSD $_{0.05}$	0.8580	0.5274
% CV	5.58	7.25
Effect of vermicompost		
VC_0	15.6 c	7.9 c
VC_1	17.8 b	8.4 bc
VC_2	18.6 b	8.9 ab
VC_3	20.6 a	9.2 a
LSD $_{0.05}$	0.9912	0.6090
% CV	5.58	7.25

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha VC_3: Vermicompost 10.8 t/ha

Table 10. Interaction effect of variety and vermicompost on root and stem length

Treatments	Root length (cm)	Stem length (cm)
V_1VC_0	**12.3 g**	7.5 e
V_1VC_1	15.0 f	8.3 de
V_1VC_2	15.7 f	8.8 cd
V_1VC_3	17.5 de	9.6 abc
V_2VC_0	16.7 ef	8.9 bcd
V_2VC_1	19.7 bc	9.6 abc
V_2VC_2	20.2 bc	9.9 ab
V_2VC_3	**23.5 a**	**9.9 a**
V_3VC_0	17.8 cd	**7.2 e**
V_3VC_1	18.8cd	7.5 e
V_3VC_2	20.0 bc	7.9 de
V_3VC_3	20.7 b	8.0 de
$LSD_{0.05}$	1.717	1.055
% CV	5.58	7.25

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

4.10 Fresh weight of root

4.10.1 Effect of variety on fresh weight of root

Due to different variety for fresh weight of root of cabbage differed significantly (Table 8 and Appendix V). The maximum fresh weight of root (40.17 g) was recorded from Profit (V_3) and the minimum (22.25 g) was found from Atlas-70 (V_1).

4.10.2 Effect of vermicompost on fresh weight of root

Fresh weight of root varied significantly due to the application of different levels of vermicompost in cabbage (Table 8 and Appendix V). The maximum fresh weight of root (38.33 g) was recorded from VC_3 treatment. Moreover, the minimum fresh weight of root (25.56 g) was recorded from VC_0 treatment. It

was revealed that fresh weight of root increased with the increase in vermicompost.

4.10.3 Interaction effect of variety and vermicompost on fresh weight of root

Significant variation was observed in case of fresh weight of root with interaction effect of variety and different levels of vermicompost under the present study (Table 8 and Appendix V). Different treatment combination viewed different fresh weight of root. It was observed that the maximum (44.33g) fresh weight of root was recorded from V_3VC_3 treatment combination which was statistically identical with V_3VC_2 treatment combination, while V_1VC_0 gave the minimum (16 g) fresh weight of root.

4.11 Fresh weight of stem

4.11.1 Effect of variety on fresh weight of stem

Due to different variety for fresh weight of stem of cabbage differed significantly (Table 8 and Appendix V). The maximum fresh weight of stem (56.83 g) was recorded from variety Profit (V_3) and the minimum (52.67 g) was found from variety Atlas-70 (V_1) which was statistically identical with Autumn Queen (V_2).

4.11.2 Effect of vermicompost on fresh weight of stem

Fresh weight of stem varied significantly due to the application of different levels of vermicompost in cabbage (Table 8 and Appendix V). The maximum fresh weight of stem (60.56 g) was recorded from VC_3 treatment. Moreover, the minimum fresh weight of stem (45.44 g) was recorded from VC_0 treatment. It was revealed that fresh weight of stem increased with the increase in vermicompost.

4.11.3 Interaction effect of variety and vermicompost on fresh weight of stem

Statistically significant variation was observed in case of fresh weight of stem with interaction effect of cabbage varieties and different levels of vermicompost under the present study (Table 8 and Appendix V). Different treatment combination viewed different fresh weight of stem. It was observed that the maximum (66 g) fresh weight of stem was recorded from V_3VC_3 treatment combination, while V_1VC_0 gave the minimum (44g) fresh weight of stem, which was closely followed by V_3VC_0 treatment combination.

4.12 Fresh weight of loose leaves at harvest

4.12.1 Effect of variety on fresh weight of loose leaves

Significant effect of variety was found on fresh weight of loose leaves per plant at harvest (Appendix V). The maximum fresh weight of loose leaves (624.2 g) was observed in V_3Variety and the minimum weight of loose leaves (537.0g) was observed in V_1variety at harvest (Table 8).

4.12.2. Effect of vermicompost on fresh weight of loose leaves

Weight of loose leaves at harvest was significantly influenced by different vermicompost doses (Appendix V). The maximum weight of loose leaves (686.8 g) was observed in VC_3treatment and the minimum weight of loose leaves (482.4 g) was observed in VC_0 treatment at harvest (Table 8).

4.12.3. Interaction effect of variety and vermicompost on fresh weight of loose leaves

There was significant variation was observed in case of fresh weight of loose leaves with interaction effect of cabbage varieties and different levels of vermicompost under the present study (Table 8 and Appendix V). Different treatment combination viewed different fresh weight of loose leaves. It was observed that the maximum (765.7 g) fresh weight of loose leaves was recorded from V_3VC_3 treatment combination, while V_1VC_0 treatment combination gave

the minimum (443.3g) fresh weight of loose leaves, which was closely followed by V_3VC_0 treatment combination.

Table 11. Effect of variety and vermicompost on fresh weight of root, stem and loose leaves

Treatments	Fresh weight of root (g)	Fresh weight of stem (g)	Fresh weight of loose leaves (g)
Effect of variety			
V_1	22.25 c	52.67 b	537.0 c
V_2	31.75 b	52.92 b	579.5 b
V_3	40.17 a	56.83 a	624.2 a
LSD $_{0.05}$	1.031	1.432	17.41
% CV	3.88	3.12	3.54
Effect of vermicompost			
VC_0	25.56 d	45.44 d	482.4 d
VC_1	29.67 c	53.33 c	539.4 c
VC_2	32.00 b	57.22 b	612.2 b
VC_3	38.33 a	60.56 a	686.8 a
LSD $_{0.05}$	1.190	1.654	20.10
% CV	3.88	3.12	3.54

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha,

VC_3: Vermicompost 10.8 t/ha

Table 12. Interaction effect of variety and vermicompost on fresh weight of root, stem and loose leaves

Treatments	Fresh weight of root (g)	Fresh weight of stem (g)	Fresh weight of loose leaves (g)
V_1VC_0	**16.00 h**	**44.00 g**	**443.3 h**
V_1VC_1	19.00 g	54.33 de	488.0 g
V_1VC_2	22.33 f	53.67 e	564.7 ef
V_1VC_3	31.76 d	58.67 c	652.0 b
V_2VC_0	25.67 e	47.00 f	532.7 f
V_2VC_1	31.33 d	52.67 e	533.3 f
V_2VC_2	31.00 d	55.00 de	609.3 cd
V_2VC_3	29.00 b	57.00 cd	624.7 bc
V_3VC_0	35.00 c	45.33 fg	471.3 gh
V_3VC_1	38.67 b	53.00 e	579.0 de
V_3VC_2	42.67 a	63.00 b	662.7 b
V_3VC_3	**44.33 a**	**66.00 a**	**765.7 a**
LSD $_{0.05}$	2.061	2.864	34.81
% CV	3.88	3.12	3.54

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

4.13 Diameter of head

4.13.1 Effect of variety on diameter of head

Diameter of head is a measurement of the size of actual cabbage shape which indicates yield amount and/or market value. It is found that in case of diameter of head among the cabbage varieties there was no significant variation (Table 9 and Appendix V). Result revealed that the highest diameter of head (18.75 cm) was achieved with Autumn Queen (V_2), where the lowest (18.29 cm) was with Profit (V_3).

4.13.2 Effect of vermicompost on diameter of head

Diameter of head was significantly influenced by different vermicompost doses under the present study (Table 9 and Appendix V). It is evident that the highest diameter of head (20.20 cm) was obtained with the treatment VC_3, which was statistically identical with VC_2 treatment. On the other hand, the lowest diameter of head (16.61 cm) was measured with control (VC_0) treatment.

4.13.3 Interaction Effect of variety and vermicompost on diameter of head

The interaction effect of cabbage varieties with different levels of vermicompost showed significant variation on diameter of head under the present study (Table 9 and Appendix V). Different treatment combination viewed different diameter of head. It was observed that the highest diameter of head (20.50 cm) was achieved with V_2VC_3 treatment combination, which was statistically identical with V_1VC_3 and V_2VC_2 and similar to V_1VC_2, V_3VC_2 and V_3VC_3 treatment combination. On the other hand the lowest diameter of head (16.33 cm) was obtained from V_3VC_0 treatment combination.

4.14 Thickness of head

4.14.1 Effect of variety on thickness of head

It appeared from the result that there was no significant effect of variety on thickness of cabbage head (Table 9 and Appendix V). Profit (V_3) produced the minimum thickness (10.41 cm) of head whereas (V_2) Autumn Queen gave the maximum thickness (10.81cm) of head (Table 8).

4.14.2 Effect of vermicompost on thickness of head

Vermicompost management practices showed significant effect on the development of thickness of cabbage head (Appendix V). The highest thickness (11.86 cm) was found in VC_3 treatment while the minimum thickness (9.611 cm) was observed in VC_0 treatment which was statistically similar with VC_1 (Table 9).

4.14.3 Interaction effect of variety and vermicompost on thickness of head

Significant variation was observed in case of thickness of head with interaction effect of varieties and different levels of vermicompost under the present study (Table 9 and Appendix V). Different treatment combination viewed different thickness of head. It was observed that the highest thickness of head (13.17cm) was achieved with V_2VC_3 treatment combination. On the other hand the lowest thickness of head (8.833cm) was obtained from V_3VC_0 treatment combination.

Table 13. Effect of variety and vermicompost on diameter and thickness of head

Treatments	Diameter of head (cm)	Thickness of head (cm)
Effect of variety		
V_1	18.69	10.57
V_2	18.75	10.81
V_3	18.29	10.41
LSD $_{0.05}$	NS	NS
% CV	4.75	5.83
Effect of vermicompost		
VC_0	16.61 c	9.611 c
VC_1	17.78 b	10.02 c
VC_2	19.72 a	10.90 b
VC_3	20.20 a	11.86 a
LSD $_{0.05}$	0.8623	0.6042
% CV	4.75	5.83

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha,

VC_3: Vermicompost 10.8 t/ha

Table 14. Interaction effect of variety and vermicompost on diameter and thickness of head

Treatments	Diameter of head (cm)	Thickness of head (cm)
V_1VC_0	17.17 cd	9.733 fg
V_1VC_1	18.50 bc	10.00 ef
V_1VC_2	19.67 ab	11.50 b
V_1VC_3	20.33 a	11.27 bc
V_2VC_0	16.33 d	10.00 ef
V_2VC_1	16.33 d	10.17 def
V_2VC_2	20.17 a	10.87 b-e
V_2VC_3	**20.50 a**	**13.17 a**
V_3VC_0	**16.33 d**	**8.833 g**
V_3VC_1	18.50 bc	10.17 def
V_3VC_2	19.33 ab	10.33 c-f
V_3VC_3	19.77 ab	11.13 bcd
LSD $_{0.05}$	1.494	1.047
% CV	4.75	5.83

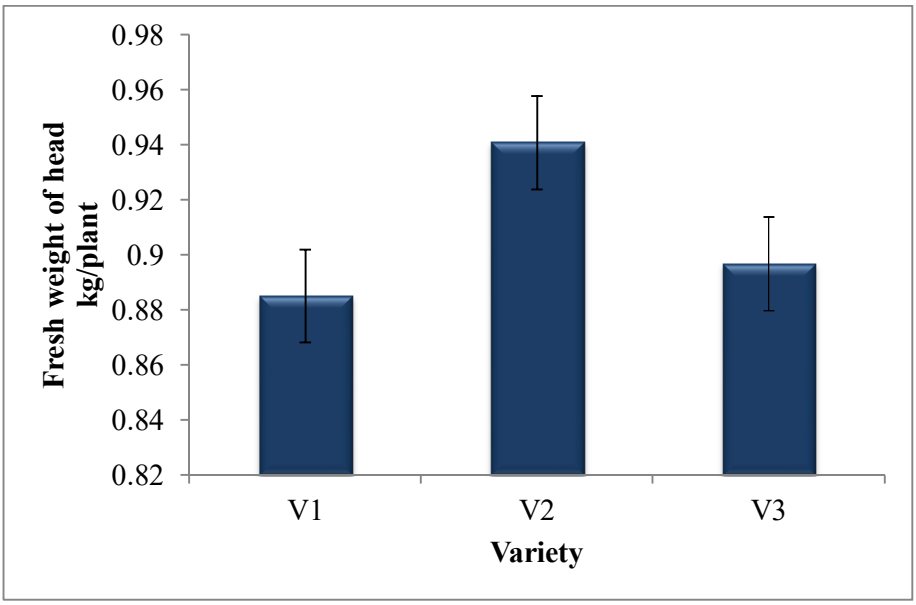
V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

4.15 Fresh weight of head per plant

4.15.1 Effect of variety on fresh weight of head/plant

Fresh weight of individual head was significantly influenced by different cabbage varieties (Figure10 and Appendix VI). The maximum fresh weight of head (0.941kg) was observed in Autumn Queen (V_2) and the minimum weight of head (0.885kg) was observed in Atlas 70 (V_1) which was statistically similar with variety Profit (V_3).

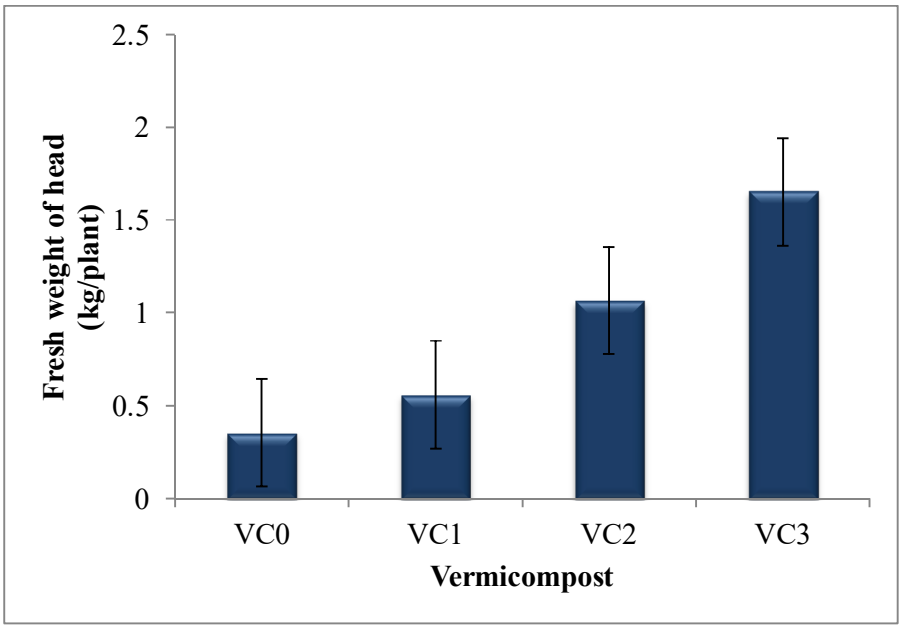


V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

Fig.10. Effect of variety on fresh weight of head/plant of cabbage

4.15.2 Effect of vermicompost on fresh weight of head/plant

Fresh weight of individual cabbage head varied significantly among different levels of vermicompost management (Figure 11 and Appendix VI).The maximum fresh weight of individual cabbage head (1.65 kg) was recorded in VC_3treatment. On the other hand, minimum fresh weight (0.35kg) of individual head was recorded inVC_0 treatment. In the present study cabbage plant grown in vermicompost applied plot received all the essential nutrients thereby cabbage head weight was increased significantly compared to untreated control.



VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

Fig. 11: Effect of vermicompost on fresh weight of head/plant of cabbage

4.15.3 Interaction effect of variety and vermicompost on fresh weight of head/plant

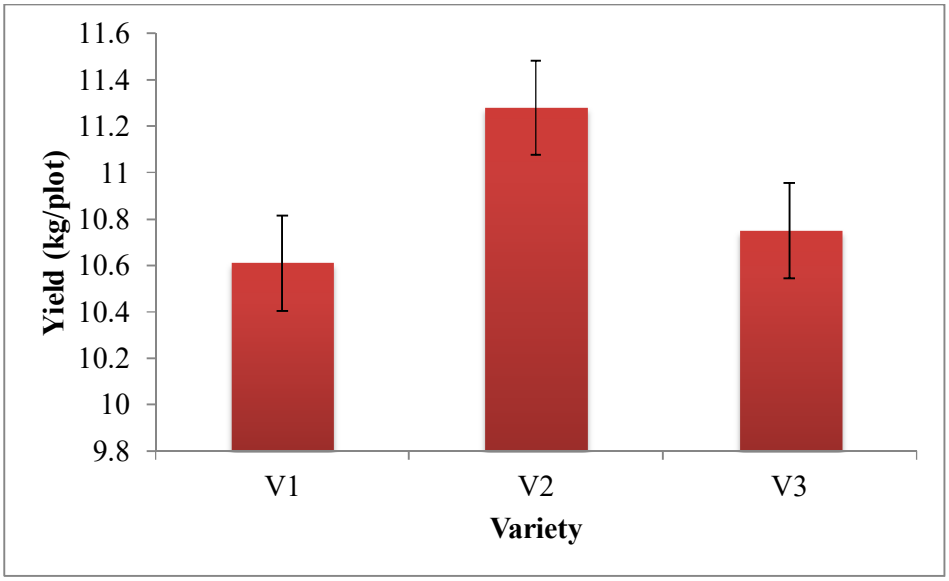
Significant variation was observed in case of fresh weight of head/plant with interaction effect of cabbage variety and different levels of vermicompost under the present study (Table 10 and Appendix VI). Different treatment combination viewed different fresh weight of head/ plant. It was observed that the maximum (1.73kg) fresh weight of head/plant was achieved with V_2VC_3. On the other hand the lowest (0.34kg) fresh weight of head/plant was obtained from V_3VC_0 treatment combination, which was statistically identical to V_1VC_0 and V_2VC_0 treatment combination.

4.16 Yield of cabbage/plot

4.16.1 Effect of variety on yield of cabbage/plot

Yield of cabbage/plot was found to have significant variation due to the effect of variety (Figure 12 and Appendix VI). In this experiment Autumn Queen (V_2)

gave the maximum yield (11.28 kg /plot) and Atlas 70 (V_1) gave the minimum (10.61 kg /plot) yield which was statistically similar with variety V_3 (Profit).

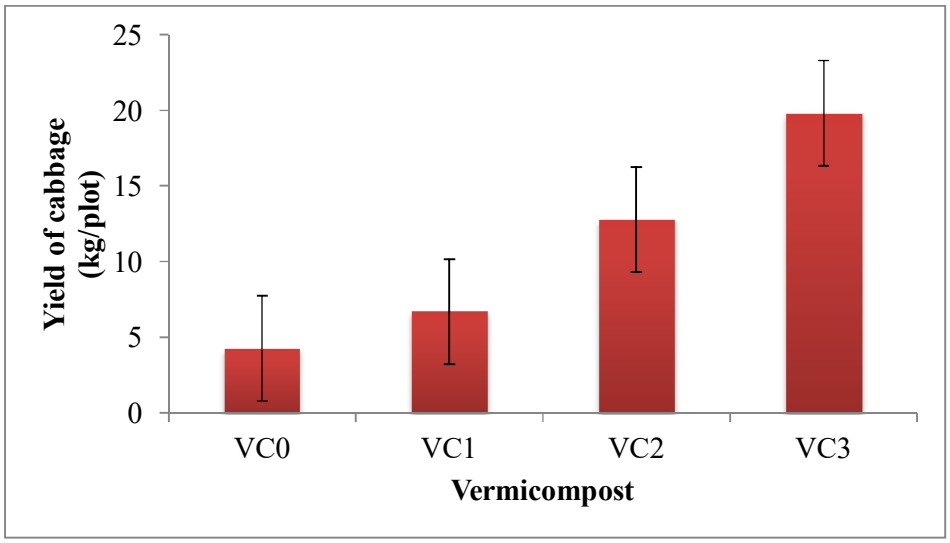


V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

Fig. 12: Effect of variety on yield of cabbage/plot

4.16.2 Effect of vermicompost on yield of cabbage/plot

Yield of cabbage/plot was significantly influenced by vermicompost management (Appendix VI). Different treatment showed different range of yield. The lowest yield (4.26 kg/ plot) was obtained from the crop which was planted in treatment VC_0 and the highest yield (19.81 kg/plot) was obtained from the crop which was planted in treatment VC_3 (Figure 13). This was probably due to the plants getting more favorable nutrient conditions contributing to bigger cabbage head formation. Getnet and Raja (2013) got the same findings on cabbage yield in their experiment by the same dose of vermicompost application.



VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

Fig. 13: Effect of vermicompost on yield of cabbage/plot

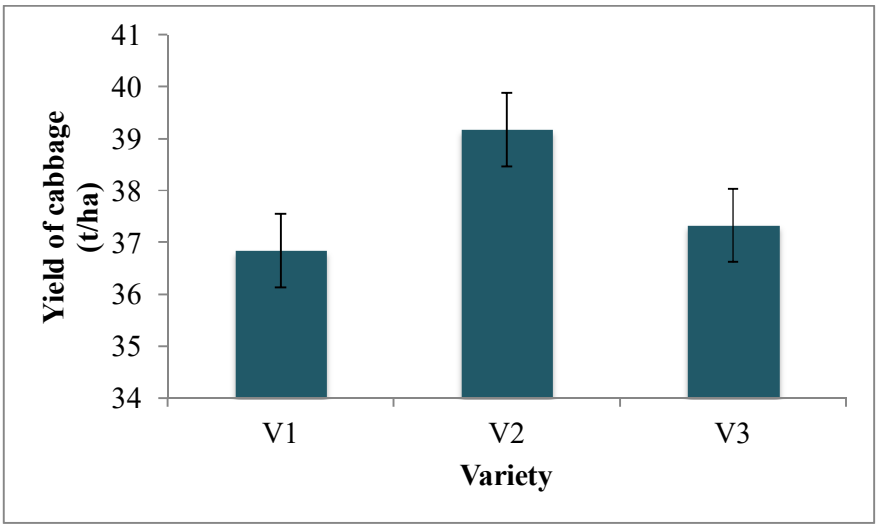
4.16.3 Interaction effect of variety and vermicompost on yield of cabbage/plot

The interaction effect of variety and vermicompost had significant effect on yield of cabbage/plot (Table 10 and Appendix VI). Among the treatment combinations V_2VC_3 produced the maximum yield (20.68 kg/plot) of cabbage and the minimum (4.16 kg/plot) was obtained from the treatment combination of V_3VC_0, which was statistically identical to V_1VC_0 treatment combination.

4.17 Yield of cabbage /ha

4.17.1 Effect of variety on yield of cabbage/ha

The yield of cabbage/ha was found to have significant variation due to the effect of variety (Figure 14 and Appendix VI). Result revealed Autumn Queen (V_2) gave maximum yield (39.17 t /ha). On the other hand Atlas 70 (V_1) gave the minimum yield (36.84 t/ ha) which was statistically similar with V_3.

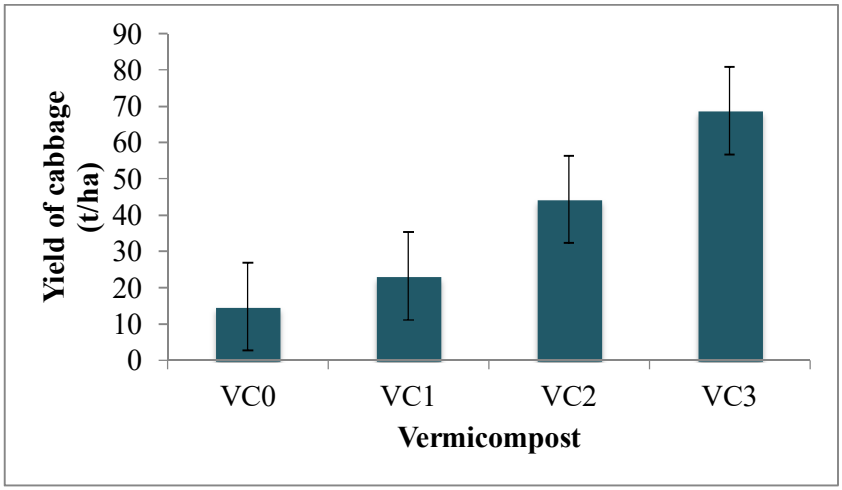


V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

Fig.14. Effect of variety on yield of cabbage /ha

4.17.2 Effect of vermicompost on yield of cabbage/ha

Yield of cabbage/ha was significantly influenced by vermicompost management (Appendix VI). The highest yield/ha (64.78 ton) was obtained from VC_3 treatment which was significantly varied from all other treatments and the lowest yield/ha (14.79 ton) was obtained from the crop which was planted in control treatment VC_0 (Figure 15).



VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha, VC_3: Vermicompost 10.8 t/ha

Fig. 15: Effect of vermicompost on yield of cabbage/ha

4.17.3 Interaction effect of variety and vermicompost on yield of cabbage/ha

The interaction effect of variety and vermicompost levels had significant effect on yield of cabbage/ha (Table 10). Among the treatment combinations V_2VC_3 showed the maximum yield (71.80 t /ha) of cabbage and the lowest (14.44 t/ ha) was obtained from the treatment combination of V_3VC_0.

Table 15. Interaction effect of variety and vermicompost on fresh weight of head/plant, yield/plot and yield/ha

Treatment combination	Fresh weight of head (kg /plant)	Yield of cabbage (kg /plot)	Yield of cabbage (t /ha)
V_1VC_0	0.35 e	4.24 e	14.72 e
V_1VC_1	0.55 d	6.57 d	22.81 d
V_1VC_2	1.04 c	12.51c	43.43 c
V_1VC_3	1.59 b	19.14b	66.46 b
V_2VC_0	0.36 e	4.38 e	15.20 e
V_2VC_1	0.59 d	7.00 d	24.30 d
V_2VC_2	1.09 c	13.05c	45.31 c
V_2VC_3	**1.73 a**	**20.68a**	**71.80 a**
V_3VC_0	**0.34e**	**4.16 e**	**14.44 e**
V_3VC_1	0.54 d	6.50 d	22.57 d
V_3VC_2	1.07 c	12.76c	44.30 c
V_3VC_3	1.63 b	19.59b	68.02b
LSD $_{0.05}$	0.07573	0.9119	1.825
CV%	4.97	4.94	4.95

V_1: Atlas 70 V_2: Autumn Queen V_3: Profit

VC_0: Control, VC_1: Vermicompost 3.6 t/ha, VC_2: Vermicompost 7.2 t/ha,

VC_3: Vermicompost 10.8 t/ha

4.19 Economic analysis of cabbage production

Economic analysis in details was done according to the procedure of Alam *et al.* (1989). Material, non-material and overhead cost including harvesting of the marketable head were recorded for all the treatments and calculated on per hectare basis. The price of cabbage in Dhaka local market was monitored. The cost and return were worked out and the data were presented in Table 11 and appendix VII.

4.19.1 Cost of production

Total cost of production ranged from Tk. 41325 to Tk. 162825 /ha. Among the treatments the cost variation was due to different levels of vermicompost (Table 11 and Appendix VII). The total production cost was the lowest for control treatment and the highest in the treatment where maximum amount (5.4 kg/plot) of vermicompost were used.

4.19.2 Gross return

Gross return from different treatments ranged from Tk. 72200 to Tk. 502600 per hectare (Table 11). The highest gross return was obtained from the treatment V_2VC_3 (Variety: Autumn Queen with vermicompost application @ 5.4 kg/plot) and the lowest gross return from V_3VC_0 (Variety: Profit with no vermicompost application).

4.19.3 Net return

Net return or net profit was calculated through excluding the production cost from the gross return (Table 11). It varied from Tk. 30875 to Tk. 339775 /ha. The highest net return was obtained from the treatment of V_2VC_3 (Variety: Autumn Queen with vermicompost @ 5.4 kg/plot) while the lowest net return was found from V_3VC_0 (Variety: Profit with no vermicompost application).

4.19.4 Benefit cost ratio (BCR)

The benefit cost ratio was the highest (3.1) in the treatment V_2VC_3 (Variety: Autumn Queen with vermicompost @ 5.4kg/plot) (Table 11) while the lowest (1.7) benefit cost ratio was recorded from V_3VC_0 (Variety: Profit with no

vermicompost application). From the economic point of view the above results indicated that treatment V_2VC_3 (Variety: Autumn Queen with vermicompost application @ 5.4 kg/plot) was more profitable than the other treatments for the cabbage production.

Table 16. Cost and return analysis of cabbage production as influenced by variety and vermicompost

Treatment combinations	Yield of cabbage (t/ha)	Gross return (Tk/ha)	Total cost of production (Tk/ha)	Net return (Tk/ha)	Benefit cost ratio (BCR)
V_1VC_0	14.72	73600	41325	32275	1.8
V_1VC_1	22.81	159670	81825	77845	1.9
V_1VC_2	43.43	304010	122325	181685	2.4
V_1VC_3	66.46	465220	162825	302395	2.8
V_2VC_0	15.20	76000	41325	34675	1.8
V_2VC_1	24.30	170100	81825	88275	2.1
V_2VC_2	45.31	317170	122325	194845	2.6
V_2VC_3	71.80	502600	162825	339775	3.1
V_3VC_0	14.44	72200	41325	30875	1.7
V_3VC_1	22.57	157990	81825	76165	1.9
V_3VC_2	44.30	310100	122325	187775	2.5
V_3VC_3	68.02	476140	162825	313315	2.9

V_1: Atlas 70

V_2: Autumn Queen

V_3: Profit

VC_0: Control

VC_1: Vermicompost 3.6 t/ha

VC_2:Vermicompost 7.2 t/ha

VC_3: Vermicompost 10.8 t/ha

Market price of cabbage @ Tk. 7,000/ton

Gross return = Total yield (t/ha) × Tk. 7,000

Net return = Gross return - Total cost of production

Benefit Cost Ratio (BCR) = Gross return/Total cost of production

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER 5

SUMMERY AND CONCLUSION

Summary:

An experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka to evaluate the effect of different levels of vermicompost on the growth and yield of cabbage. The experiment comprised of two different factors such as (1) three varieties viz. V_1: Atlas – 70, V_2: Autumn Queen and V_3: Profit (2) Four levels of vermicompost application viz; VC_0: Control, VC_1:3.6 t/ha, VC_2:7.2 t/ha and VC_3: 10.8 t/ha.

The experiment was set up in Randomized Complete Block Design (RCBD) with three replications. There were 12 treatment combinations. The experimental plot was fertilized as per treatment with vermicompost. Data on different growth and yield parameters were recorded and analyzed statistically.

Data were collected on Plant height, Number of leaves/plant, Leaf length with petiole (cm), Leaf breadth (cm), Spreading of plant, Days starting to head formation, Days to head maturity, Root length at harvest (cm), Stem length at harvest (cm), Fresh weight of root (g), Fresh weight of stem (g), Fresh weight of loose leaves (g), Thickness of head (cm) at harvest, Diameter of head (cm) at harvest, Fresh weight of head/plant (g), marketable yield/plot and marketable yield/ha. Cost of production, gross return, net return and benefit cost ration (BCR) were also evaluated to identify the higher performance of variety and vermicompost effect in respective of highest return. Three effects have been considered to evaluate the experiment such as (i) Effect of variety, (ii) Effect of vermicompost and (iii) Interaction effect of variety and vermicompost. Results showed maximum parameters studied in the present experiment were significantly influenced by different varieties of cabbage, different levels of vermicopost and their interaction effect.

It was observed that the highest results of growth and yield performance of different cabbage varieties; Plant height (32.8 cm), Leaf length with petiole (28.7 cm), Spreading of plant (49.47 cm), Root length (20 cm), Stem length (9.6 cm), Diameter of head (18.75 cm), Thickness of head (10.81 cm), Fresh weight of head per plant (0.941 kg) and Yield (11.28 kg/plot and 39.17 t /ha)at the time of harvest were with the variety of Autumn Queen (V_2). The best results on Number of leaves/plant (17.6), Days starting to head formation (36.77 days) and Days starting to head maturity (89.03 days) were obtained with Atlas 70 (V_1) and Leaf breadth (21.7 cm), Fresh weight of root (40.17 g), Fresh weight of stem (56.83 g) and Fresh weight of loose leaves at harvest (624.2 g) was by variety Profit (V_3).

Growth and yield performance of different cabbage variety was the lowest in case of Plant height (30.1 cm), Leaf length with petiole (26.6 cm), Leaf breadth (19.7cm), Spreading of plant (48.52cm), Root length (15.1 cm), Fresh weight of root (22.25g), Fresh weight of stem (52.67 g), Fresh weight of loose leaves at harvest (537.0g), Fresh weight of head per plant (0.885 kg)and Yield (10.61 kg/plot and 36.84 t /ha) at the time of harvest were with the variety Atlas 70 (V_1) and for number of leaves (16.2), Days starting to head formation (44.28 days), Days starting to head maturity (92.95 days), Stem length (7.7 cm), Diameter of head (18.29 cm) and Thickness of head (10.41 cm) were obtained with variety Profit (V_3).

Different levels of vermicompost had also significant effect on different parameters as considering under the present study. In case of vermicompost application the best results of all parameters were found with maximum (vermicompost @10.8 t/ha) treatment (VC_3) and among all the parameters, the lowest results were obtained with control (no fertilizer and manure application) treatment (VC_0).

Interaction effect of variety and vermicompost managed under the present study had significant result. Considering growth and yield contributing parameters highest and lowest results showed diversified comparison. The highest interaction result on Plant height (34.7cm), Leaf length with petiole (31.2cm), Spreading of plant (52.40 cm), Root length (23.5 cm), Stem length (9.9 cm), Diameter of head (20.50 cm), Thickness of head (13.17cm), Fresh weight of head per plant (1.73 kg) and Yield (20.68 kg/plot and 71.80 t /ha) were obtained with V_2VC_3. And highest results on Number of leaves/plant (19.1), Days starting to head formation (33.67 days), and Days starting to head maturity (82.93 days) were obtained with V_1VC_3 and Leaf breadth (24.4 cm), Fresh weight of root (44.33g), Fresh weight of stem (66 g) and Fresh weight of loose leaves at harvest (765.7 g) were achieved with V_3VC_3.

On the other hand the lowest interaction result on Plant height (27.7 cm), Leaf length with petiole (24.8 cm), Leaf breadth (17.3 cm), Spreading of plant (87 cm), Root length (12.3 cm), Fresh weight of root (16 g), Fresh weight of stem (44g) and Fresh weight of loose leaves at harvest (443.3g were obtained with V_1VC_0. Lowest results on Number of leaves/plant (14.7), Days starting to head formation (48.00 days), Days starting to head maturity (94.67 days), Diameter of head (16.33 cm), Thickness of head (8.833cm), Fresh weight of head/plant (0.347kg) and yield (4.16 kg/plot and 14.44 t/ ha) and Stem length (7.2 cm) were obtained with V_3VC_0.

The economic analysis showed that the highest net return (Tk. 3,39,775) and benefit cost ratio (3.1) were obtained from the combination of V_2VC_3 (Variety: Autumn Queen with vermicompost application @ 10.8 t/ha) and the second and third highest net return (TK. 3,13,315 and 3,02,395) and their benefit cost ration (2.9 and 2.8) were obtained from the interaction of V_3VC_3 (Variety: Profit with vermicompost @ 10.8 t/ha) and V_1VC_3 (Variety: Atlas-70 with vermicompost @ 10.8 t/ha) respectively.

Conclusion

From the present study it may be concluded that in case of variety, Autumn Queen gave the highest (39.17 t/ha) yield/ha and in case of vermicompost levels, VC_3 (10.8 t/ha) gave the highest (64.78 t/ha) yield/ha. For interaction, V_2VC_3 (Autumn Queen × vermicompost @ 10.8 t/ha) performed best in producing higher yield (71.80 t/ha) than other treatments comprised with other variety and vermicompost application.

Recommendation

The present research work was carried out at Horticulture Farm of Sher-e-Bangla Agricultural University and one season only. Considering the present study following recommendation may be suggested:

I. Further investigation is needed in different Agro Ecological Zones (AEZ) of Bangladesh to justify the result for economic returns.

II. After consecutive trial, best cabbage variety could be proposed for commercial cultivation in all over the country.

III. Levels of vermicompost could be increased for obtaining more yield and maximum economic returns.

CHAPTER VI

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CHAPTER 6

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APPENDICES

APPENDICES

Appendix I. Monthly record of air temperature, rainfall, relative humidity, rainfall and sunshine of the experimental site during the period from October, 2013 to February, 2014

Month	*Air temperature (°c)		*Relative humidity (%)	*Rainfall (mm)	*Sunshie (hr)
	Maximum	Minimum			
October, 2013	26.5	19.4	81	22	6.9
November, 2013	25.8	16.0	78	00	6.8
December, 2013	22.4	13.5	74	00	6.3
January, 2014	24.5	12.4	68	00	5.7
February, 2014	27.1	16.7	67	30	6.7

* Monthly average,

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka – 1207

Appendix II. Characteristics of the soil of experimental field analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the soil of experimental field

Morphological features	Characteristics
Location	Horticulture Garden , SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

Source: SRDI, 2014

Appendix II.Contd.

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% Clay	30
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: SRDI, 2014

Appendix III: Analysis of variance of data on growth parameter of cabbage as influenced by variety and vermicompost and their interaction

Source of variation	Degrees of Freedom	Mean square								
		Plant height (cm)			Number of leaves			Leaf Length with petiole (cm)		
		30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT
Replication	2	2.058	1.281	0.091	0.563	2.470	5.684	2.343	3.943	0.610
Variety (A)	2	17.471 **	8.92 **	24.413 **	2.263 **	1.564 **	5.745 **	13.923 **	15.558 **	15.130 **
Vermicompost (B)	3	38.540 **	50.955 **	29.040 **	5.397 **	5.768 **	15.082 **	31.772 **	52.809 **	56.007 **
Interaction (A×B)	6	0.704 **	2.324 **	0.743 **	0.109 **	0.467 **	1.005 **	1.095 *	1.982 *	1.513 *
Error	22	0.653	1.452	1.059	0.314	0.228	0.436	0.439	0.757	0.585

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix IV. Analysis of variance of the data on growth parameter and time duration of cabbage as influenced by variety and vermicompost and their interaction

Source of variation	Degrees Degrees of Freedom	Mean square							
		Breadth of leaf (cm)			Spreading of plant (cm)			Days starting to head formation	Days to head maturity
		30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT		
Replication	2	8.091	10.270	14.542	41.256	28.145	5.956	0.908	0.697
Variety (A)	2	7.021 **	17.643 **	14.352 **	5.751 NS	13.541 NS	3.146 NS	225.501 **	50.715 **
Vermicompost (B)	3	24.889 **	35.349 **	47.701 **	75.929 **	34.137 **	61.159 **	52.380 **	50.590 **
Interaction (A×B)	6	0.983 **	1.916 **	1.177 **	4.271 **	3.686 **	1.635 **	12.956 **	22.505 **
Error	22	0.824	1.125	1.422	5.575	4.993	2.177	2.836	1.087

**: Significant at 0.01 level of significance NS- Not significant

Appendix V. Analysis of variance of the data on yield contributing characters of cabbage as influenced by variety and vermicompost and their interaction

Source of variation	Degrees of Freedom	Mean square						
		Root length (cm)	Stem length (cm)	Fresh weight of root (g)	Fresh weight of stem (g)	Fresh weight of loose leaves (g)	Diameter of head (cm)	Thickness of head (cm)
Replication	2	0.111	1.080	10.028	12.194	265.528	5.172	4.795
Variety (A)	2	83.840 **	10.760 **	964.194 **	65.528 **	22798.778 **	0.747 NS	0.484 NS
Vermicompost (B)	3	37.637 **	2.919 **	256.778 **	380.769 **	70804.222 **	25.347 **	8.934 **
Interaction (A×B)	6	2.164 **	0.265 **	12.194 **	29.602 **	4583.000 **	1.871 **	1.990 **
Error	22	1.028	0.388	1.482	2.861	422.679	0.778	0.382

**: Significant at 0.01 level of significance NS- Not significant

Appendix VI. Analysis of variance of the data on yield of cabbage as influenced by variety and vermicompost and their interaction

Source of variation	Degrees of Freedom	Mean square		
		Fresh weight of head (kg/plant)	Yield (kg /plot)	Yield (t /ha)
Replication	2	0.001	0.115	0.456
Variety (A)	2	0.010 *	1.488 *	5.937 *
Vermicompost (B)	3	3.023 **	433.864 **	1735.909 **
Interaction (A×B)	6	0.002 **	0.295 **	1.184 **
Error	22	0.002	0.290	1.162

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix VII. Production cost of cabbage /ha

(A)Material cost (Tk. / ha)

Treatment combinations	Seed cost	Fertilizer and manure	Sub total
		Vermicompost	1 (A)
V_1VC_0	5000	0	5000
V_1VC_1	5000	36000	41000
V_1VC_2	5000	72000	77000
V_1VC_3	5000	108000	113000
V_2VC_0	5000	0	5000
V_2VC_1	5000	36000	41000
V_2VC_2	5000	72000	77000
V_2VC_3	5000	108000	113000
V_3VC_0	5000	0	5000
V_3VC_1	5000	36000	41000
V_3VC_2	5000	72000	77000
V_3VC_3	5000	108000	113000

Appendix VII.Contd.

(B) Non-material cost (Tk. / ha)

Treatment combination	Land preparation	Seed sowing and transplanting	Intercultural operation	Harvesting	Sub total 1 (B)	Total input cost 1 (A) + 1 (B)
V_1VC_0	4000	6200	7000	1200	18400	23400
V_1VC_1	4000	6200	7000	1200	18400	59400
V_1VC_2	4000	6200	7000	1200	18400	95400
V_1VC_3	4000	6200	7000	1200	18400	131400
V_2VC_0	4000	6200	7000	1200	18400	23400
V_2VC_1	4000	6200	7000	1200	18400	59400
V_2VC_2	4000	6200	7000	1200	18400	95400
V_2VC_3	4000	6200	7000	1200	18400	131400
V_3VC_0	4000	6200	7000	1200	18400	23400
V_3VC_1	4000	6200	7000	1200	18400	59400
V_3VC_2	4000	6200	7000	1200	18400	95400
V_3VC_3	4000	6200	7000	1200	18400	131400

Appendix VII.Contd.

(C) Overhead cost and total cost of production (Tk./ha)

Treatment combinations	Cost for lease of land (for 6 month)	Miscellaneous cost (5% of input cost)	Interest on running capital for 6 months @15% of the total input cost	Sub total (C)	Total cost of production (Total input cost + Total overhead cost /C)
V_1VC_0	15000	1170	1755	17925	41325
V_1VC_1	15000	2970	4455	22425	81825
V_1VC_2	15000	4770	7155	26925	122325
V_1VC_3	15000	6570	9855	31425	162825
V_2VC_0	15000	1170	1755	17925	41325
V_2VC_1	15000	2970	4455	22425	81825
V_2VC_2	15000	4770	7155	26925	122325
V_2VC_3	15000	6570	9855	31425	162825
V_3VC_0	15000	1170	1755	17925	41325
V_3VC_1	15000	2970	4455	22425	81825
V_3VC_2	15000	4770	7155	26925	122325
V_3VC_3	15000	6570	9855	31425	162825

3 Varieties	V_1: Atlas 70
	V_2: Autumn Queen
	V_3: Profit
4 Levels of Vermicompost	VC_0: Control i.e. no manure application
	VC_1: Vermicompost@ 1.8 kg/plot
	VC_2: Vermicompost@ 3.6 kg/plot
	VC_3: Vermicompost @ 5.4 kg/plot

Market price of vermicompost @ Tk.10, 000 /ton

Source: Agic Agro (vermicompost sell centre)

South thonthonia

Bograsadar, Bogra - 5800.

Market price of cabbage @ Tk. 7,000/ton

Gross return = Total yield (t/ha) × Tk. 7,000

Net return = Gross return - Total cost of production

Benefit Cost Ratio (BCR) = Gross return/Total cost of production

Plate 1. Photograph showing raising of seedling in the seed bed

Plate 2. Photograph showing general view of experimental plot at growth stage

V_1 V_2

V_3

Plate 3. Photograph showing head size of three variety at maximum growth stage; (V_1): Atlas- 70, (V_2): Autumn Queen and (V_3): Profit

(V_1) **(V_2)**

(V_3)

Plate 4. Photograph showing head size of three varieties at harvest; (V_1): Atlas- 70, (V_2): Autumn Queen and (V_3): Profit

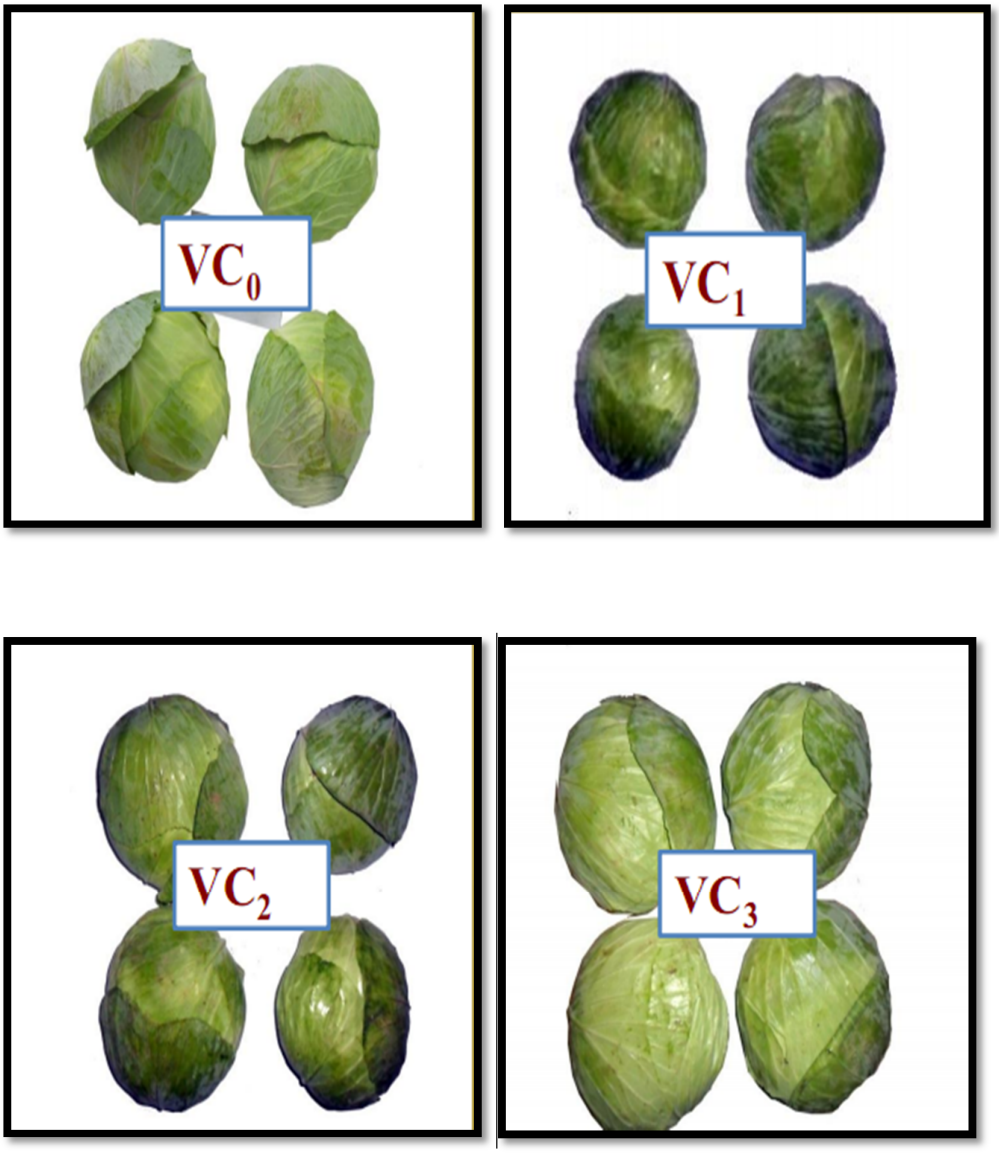

Plate 5. Photograph showing head size at different treatment; (VC_0): Control, (VC_1): Vermicompost 3.6 t/ha, (VC_2): Vermicompost 7.2 t/ha and (VC_3): Vermicompost 10.8 t/ha