INFLUENCE OF VERMICOMPOST ON GROWTH AND YIELD OF KOHLRABI CULTIVARS

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INFLUENCE OF VERMICOMPOST ON GROWTH AND YIELD OF KOHLRABI CULTIVARS

BY

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CERTIFICATE

This is to certify that the thesis entitled, **"INFLUENCE OF VERMICOMPOST ON GROWTH AND YIELD OF KOHLRABI CULTIVARS"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTERS OF SCIENCE IN OF HORTICULTURE** embodies the result of a piece of bona fide research work carried out by **RUBANA TABASSUM; Registration No. 13-05264,** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

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

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Dedicated to
My Beloved Parents

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ABSTRACT

The present study was undertaken with the aim to investigate the “Influence of vermicompost on growth and yield of kohlrabi cultivars”. This study was conducted at the Horticulture farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from October 2018 to January 2019. The experiment consisted of two factors: Factor A: three kinds of cultivar (V_1= Quick star, V_2 = White vienna, V_3 = Early 005), Factor B: Four levels of vermicompost (M_0 = Control, M_1 = 6 t/ha, M_2 = 8 t/ha, M_3 = 10 t/ha). The experiment was performed with Randomized Complete Block Design with three replications. The results indicate that the morphological parameters and the reproductive components, as well as yield were influenced significantly among the treatments. With applying vermicompost (M_3) maximum yield per hectare was found (13.12 t/ha) in White vienna (V_2) and minimum (7.00 t/ha) in Early 005 (V_3). In case of interaction effect maximum yield per hectare (16.29 t/ha) was obtained from V_2M_3, while minimum (6.48 t/ha) was obtained from the V_3M_0. So, it can be concluded that applying M_3 = 10 t/ha vermicompost among three cultivars white Vienna gave the highest yield.

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LISTS OF ABBREVIATIONS

BARI	=	Bangladesh Agricultural Research Institute
BCR	=	Benefit Cost Ratio
cm	=	Centimeter
^{0}C	=	Degree Centigrade
DAS	=	Days after sowing
et al.	=	and others *(at elli)*
Kg	=	Kilogram
Kg/ha	=	Kilogram/hectare
g	=	gram (s)
LER	=	Land Equivalent Ratio
LSD	=	Least Significant Difference
MP	=	Muriate of Potash
m	=	Meter
P^{H}	=	Hydrogen ion conc.
RCBD	=	Randomized Complete Block Design
TSP	=	Triple Super Phosphate
t/ha	=	ton/hectare
%	=	Percent

CHAPTER-I

INTRODUCTION

Kohlrabi (*Brassica oleraceae* var. *gongylodes*) is also known as knolkhol, German turnip, Olkopi, Ganthgabhi. It is one kind of Cole crop and is a part of the botanical family brassica species. Its edible part is the swollen stem known as a knob which arises from the thickening of stem tissue above the cotyledon. In some areas, young leaves are used as a vegetable. It is a minor crop grown in temperate and some sub-tropical countries. Kohlrabi is widely cultivated in countries across Europe and America. It is grown in very small scattered areas of Bangladesh and is almost unknown for the total cultivated area. Kohlrabi is planted in Bangladesh during the winter season and needs around 15-25^0 C for optimum growth. It is well known that kohlrabi has enormous nutritional and medicinal values due to its high contents of vitamins (A, B_1, B_2, B_5, B_6, and E), minerals (Ca, Mg, Zn, and Fe), and antioxidant substances which prevent the formation of cancer-causing agents (Beecher, 1994). Kohlrabi can consume raw or cooked vegetables. In a kohlrabi one hundred gram edible portion contains 92.7g moisture, 1.1g protein, 0.2g fat, 0.7g minerals, 1.5g fiber, 3.8g carbohydrates, 25 cal. Energy, 20 mg calcium, 18 mg magnesium, 35 mg phosphorus, 0.12 mg sodium etc. Besides these, it also contains riboflavin, nicotinic acid, thiamin, and vitamin C.

Kohlrabi production depends on many factors, such as the quality of seed, cultivar, and plant density, fertilizer, and management procedures. Organic manures such as cowdung, poultry manure, and vermicompost boost soil structure, aeration, the release of nutrients slowly, thus promoting root production leading to higher growth and yield of kohlrabi plants (Abou El-Magd et al. 2005).

Since not all varieties of Kohllrabi produce the same, the selection of suitable varieties is a very important factor. Different cultivars need a different level of vermicompost to produce the same yield. There are some varieties which give early production with a minimum level of vermicompost than other cultivar. From this study, we can know which cultivar is the best for cultivation.

Vermicompost is currently the most common and successful organic manure for the practice of organic farming. Vermicompost contains a higher percentage of available nutrients (Edwards and Burrows 1988), humic acid (Senesi et al . 1992), substances that encourage plant growth such as auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah 1986), bacteria, enzymes, and vitamins that solubilize N-fixing and P (Ismail 1997). Vermicompost is a rich source of both macro and micronutrients, vitamins, growth hormones, and enzymes, and derived from earthworms (Bhavalkar 1991). Proper management, including ensuring the availability of essential nutrient components, is crucial to achieving considerable output and quality yield for kohlrabi. Organic manure can provide standardized nutrients throughout the season.

It is important for plant nutrient replenishment, improving soil quality, reducing the issue of pollution, and creating job opportunities, which are increasingly being recognized as a sustainable organic farming strategy. Vermicompost is a very successful and environmentally friendly alternative in the field of crop production and crop protection. Because of these considerations, the present investigation was carried out with the following objectives:

1. to identify the suitable kohlrabi cultivar for growth and yield potential;
2. to assess the optimum level of vermicompost for growth and yield of the required kohlrabi cultivar; and
3. to determine the combined effect of the suitable cultivar and vermicompost on growth and yield potential.

CHAPTER-II

REVIEW OF LITERATURE

A brief review of research work done on "Influence of vermicimpost on growth and yield of kohlrabi cultivars'' is being discussed in this chapter. It includes brief results of the research work done in Bangladesh and elsewhere which is similar to or closely related to the present investigation.

Uddin *et al*. (2009) researched at Sher-e-Bangla Agricultural University Horticultural Farm, Dhaka, Bangladesh, to study the impact of various organic manures on kohlrabi plant growth and yield. Three kinds of organic manure were contrasted with control (no manure). Total plant height (36.50 cm), canopy of the plant (63.50 cm), length of the leaf (30.42 cm), width of the leaf (14.25 cm), weight of the fresh leaves per plant (131.10 g), diameter of the knob (8.23 cm), weight of the knob (331.10 g), the diameter of the knob (8.23cm), Knob weight (366.60 g), yield per hectare (22.90 t ha G) were found in poultry manure application. Only the maximum number of leaves (20.00) was found in the control treatment. The minimum plant height (32.25 cm), plant canopy (55.75 cm), leaf length (24.92 cm), leaf breadth (10.75 cm), fresh leaves weight per plant (86.97g), the diameter of the knob (7.95 cm), Knob weight (177.50 g), yield per hectare (15.40 t ha G) were found in the control treatment. A minimum number of 1 leaf (14.33) was found with cowdung application.

Ismail *et al*. (2017) experimented to investigate the effect of vermicompost application on red cabbage cultivation under the field conditions. There were six treatments 1. (Control), 2. (0 kg vermicompost + N: P: K), 3. (100 kg da-1 vermicompost + N: P: K), 4. (200 kg da-1 vermicompost + N: P: K), 5. (400 kg da-1 vermicompost + N: P: K) and 6. (800 kg da-1 vermicompost + N: P: K).The findings showed that the yield was positively influenced by the application of vermicompost at increased doses. Vermicompost applications have been successful in achieving adequate foliar N , P, Fe , Zn, and Mn levels, and red cabbage yields have been found to be 52.65 percent higher than control levels. Based on these results and economic factors, it was concluded that the application of vermicompost at the rate of 400 kg ha^{-1} may be recommended for the cultivation of red cabbage in addition to mineral fertilizers.

Ahmed *et al*. (2017) conducted a study at the Central Laboratory for Agricultural Environment, Agricultural Research Center, Egypt during two successive winter seasons of 2014-2015 and 2015-2016 under the conditions of the green roof system to maximize the use of local substrates (sand and rice husk) and provide a vermicomposting technique for the recycling of urban organic waste through investigation. The results showed that an increase in the volume of the pot from 4 to 8 L of substrate resulted in an increase in vegetation and red cabbage yield, reversed by economic efficiency. Compared with the other sizes, the medium pot volume of the substrate gave the highest economic yield of red cabbage. Increasing the amount of vermicompost from 10 % to 20% had a negative effect, leading to an improvement in the vegetative and yield characteristics of red cabbage and an improvement of up to 30%.

Alam *et al*. (2017) performed an On-Farm Research Division experiment at the Bangladesh Agricultural Research Institute (BARI), Bangladesh during the 2014-15 and 2015-16 Rabi seasons to estimate the effects of vermicompost on cabbage growth and yield. Seven treatments were used in the experiment, namely: T_1 = 100% recommended chemical fertilizer (RCF), T_2 = 80% RCF, T_3 = 60% RCF, T_4 = 100% RCF+ Vermicompost (VC) @ 1.5 t ha^{-1}, T_5 = 80% RCF+ VC @ 3 t ha^{-1}, T_6 = 60% RCF+ VC @ 6 t ha^{-1} and T_7 = absolute control. During 2014-15 and 2015-16 (59.21 t ha^{-1} and 72.61 t ha^{-1}, respectively), the highest head yield was recorded from T_4, where the lowest yield was obtained from T_7 (27.11 t ha^{-1} and 24.05 t ha^{-1}, respectively). In T_4 (203,060 and 270,060 Tk. ha^{-1} in 2014-15 and 2015-16, respectively), the highest gross margin was recorded and the lowest was in T_7 (74,300 and 59,000 Tk. ha^{-1} in 2014-15 and 2015-16, respectively).

An experiment conducted by Reza *et al*. (2016) to analyze the cabbage's nutrient uptake, growth, and yield as affected by the application of various organic fertilizers. Treatments were based on T_1= Soil Test 100% Recommended Chemical Fertilizer Dose (RDCF), T_2= 5 t/ha Cow dung (CD) + Chemical fertilizers (CF), T_3= 5 t/ha Poultry Manure (PM) + Chemical fertilizers (CF), T_4= 5 t/ha vermicompost (VC) + Chemical fertilizers (CF), T_5= Control. The results of the experiment showed that substantial variations in plant height, unfolded leaves, head diameter, marketable yield, total yield, and nutrient content of cabbage were found in the same quantities of N, P, K, and S from cowdung, poultry manure, and vermicompost.

A pot experiment was performed by Nurhidayati *et al*. (2016) to evaluate the effect on plant yield and quality of cabbage under organic growing media of three types of vermicompost materials and *P. corethrurus* population compared to inorganic treatment. Three-level vermicompost factor (mixture of mushroom media waste, cow manure and vegetable waste (V_1), fungal media waste, cow manure and leaf litter (V_2), mushroom media waste, cow manure, vegetable waste and leaf litter (V_3). The findings showed that the yield of different vermicompost applications was substantially higher than that of inorganic treatment. The highest yield was offered by Vermicompost V_1 and V_2. The outcome showed that vermicompost application would increase the yield and quality of cabbage.

Sajib *et al.* (2015) in Hogladanga village under Botiaghata Upazila, Khulna studied an experiment with cabbage on its yield output under various combinations of manures and fertilizers. The treatments were T_1 = recommended NPK doses (urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1}, MoP @ 300 kg $ha^{-1,}$ respectively), T_2 = cowdung @ 10 t ha^{-1} , T_3 = vermicompost @ 10 t ha^{-1},T_4 =

Trichoderma compost @ 10 t ha^{-1}, T_5 = 50% cowdung + 50% recommended fertilizer doses, T_6 = 50% vermicompost + 50% recommended fertilizer doses, and T_7 = 50% Trichoderma compost The application of vermicompost with the recommended dose of NPK and cowdung compost with the recommended dose of NPK had a positive and important effect on the growth yield. In most cases, there was a better output of 50 percent vermicompost + 50 percent prescribed doses of fertilizer receiving treatment. However, the highest cabbage yield (57.16 t ha^{-1}) was obtained from treatment receiving 50 percent vermicompost + 50 percent prescribed fertilizer doses, and the lowest cabbage yield (38.48 t $ha^{-1)}$ was obtained from the control fertilizer. However, given the highest benefit-cost ratio of cabbage (3.63), 50 percent of cowdung + 50 percent of recommended fertilizer doses were used for sustainable crop production when applied.

In an experiment conducted by Getnet and Raja (2013), the aim was to generate vermicompost from various organic solid waste using red earthworm, *Eisenia fetida*, and to check the properties of growth-promoting and pest suppression on cabbage. Vermicompost was individually applied at the rate of 0, 25, 50, 100, and 200 gm/plant. Ten plants were chosen for each application and the vermicompost application was continued on a bimonthly basis. The total number of leaves per plant was studied by the parameters; leaf length and width; plant stand height and root length; round distance and weight of the cabbage head. In experimental cabbage, the number of plants standing height, cabbage head, and cabbage leaves were also significantly different compared to control. Vermicompost, in conclusion, has a major impact on the promotion of cabbage growth.

In Pundi bari, West Bengal, India, Chatterjee *et al*. (2013) conducted field experiments to find out the effect of various organic manures on the efficiency of growth, head yield, and nitrogen use in cabbage. Combining inorganic fertilizers, organic manures (farmyard manure and vermicompost), and *Azophos* bio-fertilizers, there were 15 separate nutrient sources in the experiment.

Different nutrient combinations and vermicompost were greatly affected by the growth and head of cabbage.

Compared to other nutrient combinations, the greater quantity of vermicompost (5 t/ha) along with 75 percent of recommended inorganic fertilizers in the presence of bio-fertilizer resulted in many fold improvement in the form of vigorous growth, early head maturity, maximum curding percent, and highest yield.

Pour *et al*. (2013) experimented with various vermicompost concentrations on cabbage seedling growth and physiology to determine the potential results. Five different amounts (0, 10 percent, 20 percent, 40 percent and 80 percent) of Vermicompost were used. The seeds were planted in five different prepared vermicompost soil mixtures and grouped into five different treatment classes, including control (C), 10% vermicompost (V_{10}), 20% vermicompost (V_{20}), 40% vermicompost (V_{40}), and 80% vermicompost (V_{80}). The result showed that the effects of vermicompost were not only nutritional but also hormonal and biochemical on plant growth and development. Usage of high levels of vermicompost, on the other hand, is not only unprofitable, but can also have adverse effects on plant growth and development. In the experiment vermicompost showed excellent performance on cabbage yield.

Rai *et al*. (2013) conducted an experiment to estimate the impact of vermicompost, which was integrated with different rates of recommended NPK doses for cabbage growth, yield, and head quality. T_1: 100% NPK (RR), T_2: 75% NPK (RR) + VC 3 t/ha, T_3: 75% NPK (RR) + VC 2t /ha, T_4: 75% NPK (RR) + VC 1t /ha, T_5: 75% NPK (RR), T_6: 50% NPK (RR) + VC 3t /ha, T_7: 50% NPK (RR) + VC 2 t/ha, T_8: 50% NPK (RR) + VC 1 t/ha, T_9: 50% NPK (RR) and T_{10}: VC 5 t/ha. The results obtained showed that the combined use of vermicompost with the prescribed dose of NPK was statistically important for cabbage growth and yield. In combined use, the recommended dosage of 75 percent NPK (RR) + VC 3 ton/ha was found to be the maximum plant and head weight. It takes less time to apply vermicompost along with inorganic fertilizers to proper maturity. It was concluded that cabbage productivity improved with the application of vermicompost combination.

An experiment to assess the efficacy of vermicompost on two crops was carried out by Zhenyu and Yongliang (2005). The results showed that vermicompost could increase the nutrients available, promote leaf area growth, increase yield and accelerate dry matter accumulation. Compared with the treatment of control fertilizer, when the first and second crops were done, only applying vermicompost increased cabbage yield by 45.5 percent and 77.5 percent, using vermicompost with inorganic fertilizer increased yield by 76.1 percent and 103.9 percent, the difference was greatly significant.

In Orissa, India, Chaudhary *et al*. (2003) conducted a field experiment to examine the use of vermicompost in the production of cabbage and tomatoes. Using *Gliricidia* leaves and *Eisenia fetida*, Vermicompost was prepared and applied at 100 and 200 g / plant with or without farmyard manure (FYM), at 250 and 500 g / plant.   The treatment with Vermicompost at 200 g/plant + FYM at 250 g/plant gave sustainable yield of cabbage by ensuring proper growth and development.

A field trial was performed by Jayalaxmi Devi *et al*. (2002) to test the response of brinjal to a different source of nitrogen. The result of the experiment showed that the combined application of organic manure, biofertilizer and a 50% decrease in chemical fertilizer increased the growth, yield characteristics and fruit yield of brinjal when compared to the single application of chemical fertilizer or low-dose chemical fertilizer when combined with bio-fertilizer.

Kanwaret *et al*. (2002) stated that the weight of curd, diameter, plant height, and curd yield increased with the application of NPK fertilizer. However, when organic manure (vermicompost or FYM) was used, a substantial increase in all these parameters was observed at the level of 50 percent NPK. Compared to NPK fertilizer alone, organic carbon content in the soil increased when organic fertilizers were supplied alone. Organic fertilizer improves the condition of the soil and helps increase growth and yield.

Barani and Anburani (2004) investigated the effect of vermicomposting on major nutrients in bhendi and reported that the maximum plant height was obtained by the application of an inorganic form of NPK at 40:50:30 kg / ha along with organic sources such as FYM and vermicompost. In the treatment where FYM @ 25 t + 75 percent of the recommended inorganic fertilizers + vermicompost @ 5 t (6.82 cm) was added, the highest stem growth and length were observed. The FYM application, along with 75% of the recommended inorganic fertilizer and vermicompost @ 4 t/ha, significantly increased the number of branches, nodes, and dry matter production.

Bahadur *et al*. (2004) conducted experiments to test the effects of organic manures and bio-fertilizers on cabbage growth and yield. In combination with 3 bio-fertilizers (*Azospirillum*, vesicular-arbuscular mycorrhiza (VAM) and phosphate solubilizing microorganisms (PSM)) plus control (recommended NPK only), 13 treatments consisting of 4 organic manures (farmyard manure, press mud, digested sludge, and vermicompost) were performed. Digested FYM sludge and pressmud were applied at 10 t/ha, while vermicompost was applied at 5 t/ha. For all the parameters studied, Pressmud + VAM reported the highest values , i.e. number of outer leaves (13.3), fresh leaf weight (476.67g), number of inner leaves (31.7), head weight (1616.67 g), head length (16.8 cm), head diameter (15.5 cm) and head yield (602.67 q/ha).

Hangarge *et al*. (2004) noted that the application of vermicompost at 5 tha^{-1} + organic boosters at 1 L m^{-2} in spray form, soil conditioner (Tetra care) at 2.5 t ha^{-1} + organic boosters at 1 L m^{-2} in spray form increased the availability of soil N , P , K and organic carbon content. In addition, higher yields of chilli (105.67

qha^{-1}) and spinach (743.03 q ha^{-1}) with soil conditioner (2.5 tha^{-1}), vermicompost (5 tha^{-1}) and organic booster (1 lit) were recorded.

Rafi *et al*. (2005) stated that the application of the recommended 50 percent FYM dose @ 12.5 t/ha along with the recommended fertilizer dose (50 percent of the recommended 100:50:50 NPK kg/ha fertilizer dose) resulted in the highest vegetative growth and tomato yield. In this analysis, conventional organic manure, viz., FYM, and vermicompost, were used to estimate tomato growth and yield.

A research to estimate the impact of vermicompost on cauliflower production was conducted by Singh *et al.* (2005), considering soil health under limited production systems. The reaction of farmers to the use of vermicompost was highly positive because of its simplicity and compatibility with the components of the farming system and internal resources of households, as well as its cost-effectiveness. In addition, vermicompost was also adopted by resource-rich farmers in place of chemical fertilizers because of environmental concerns and to tackle health hazards and the availability of organic sources, the obtained outcome revealed that in adopted villages as well as in neighboring regions, approximately 55% of cauliflower growers adopted vermicompost.

Shukla *et al*. (2006) found that application of the recommended dose of N, P , and K (100, 75, and 55 kg ha^{-1}) to farmyard manure and vermicompost (250 and 12.5 q ha^{-1}) improved yield per plant, yield per ha, number of fruits per plant, number of fruits per cluster, and average tomato fruit weight.

In order to research the impact of organic and inorganic nutrient sources on cabbage growth, yield, and quality parameters, Ghuge *et al*. (2007) conducted a field experiment. The combined effect of organic and inorganic sources is greater than the individual effect of their use. Among the different combinations tested, the performance of 50 percent RDF + 50 percent vermicompost @ 2.5 t/ha was higher among the remaining treatments, followed by 50 percent RDF + 50 percent Terracare @ 1.25 t/ha and 50 percent RDF + 50 percent organic booster @ 1.0 liter/plant in 4 splits over control in terms of plant spread, head circumference, average head/plant yield, yield of plant spread, head circumference, yield of organic booster @ 1.0 liter/plant.

Murlee *et al.* (2007) determined the influence of organic and inorganic fertilizers on the growth and yield of cauliflower. Treatment (150 kg Gromor + 96 kg urea + 32 kg MOP/acre) showed significantly higher curd length (17.00 cm), curd weight (560 g), yield per plot (7.89 kg), yield (392 q/ha) and cost-benefit ratio (1:2.88), while treatment reported maximum plant height (53.33 cm) (104 kg urea + 32 kg DAP + 32 kg MOP / acre).

Dass *et al*. (2008) reported that vermicompost improves the quality of the soil and improves crop yield, net economic return and efficiency of water use (WUE). The use of VC+50 percent recommended rate of synthetic fertilizers (RRF) in bell pepper provided a substantially greater yield over 100 percent RRF, with a 29.8 percent increase in net return. The yield of cabbage had a similar effect. WUE was 32.6 percent higher in bell pepper and 6.2 percent higher in cabbage over treatment with 100 percent RRF in the 50 percent RRF+VC treatment. The bulk density of the surface soil decreased after 3 years; its organic carbon and available N and P status improved as a result of CM and VC treatment. The data indicate that 5 $Mt.ha^{-1}$ of VC will meet 50 percent of the bell pepper and cabbage fertilizer requirement while providing greater production, revenue, and residual soil fertility.

Madhavi *et al*. (2008), experimented a study in order to determine the effect of various levels of vermicompost, castor cake, poultry manure, biofertilizers on dry matter production, nutrient uptake, and economics on Indian spinach. With the application of the recommended dose of fertilizer (80 N: 40 P_2O_5: 50 K_2O kg / ha) and poultry manure (8 t/ha + Azospirillum (2 kg/ha) + PSB (2 kg/ha), the highest nutrient uptake and output of dry matter was recorded. Output economics revealed that poultry manure 8 t/ha + Azospirillum (2 kg/ha) + PSB (2 kg/ha) yielded a higher net return and benefit-cost ratio.

An experiment was performed by Mamatha *et al*. (2008) to estimate the effect of organic manure on onion growth and yield. Higher neck and bulb diameter, dry matter accumulation in leaves and bulbs, and maximum onion yield were reported with the application of 75 and 100 percent RDN via FYM and vermicompost. As compared to other treatments, these treatments also reported a maximum percentage of TSS, a lower percentage of weight loss, and maximum nutrient uptake.

An experiment to observe the effect of organic manure on various crops was performed by Peyvast *et al*. (2008). The use of organic fertilizers in tested vegetables (Chinese cabbage, parsley, spinach, broccoli and garlic) has been shown to avoid the high-risk absorption of inedible nitrate components, and hence their use as organic matter (OM) is recommended. There was no substantial positive relation between nitrate accumulation and MSWC levels for Chinese cabbage; however, the highest amount of vermicompost in cattle manure resulted in slightly lower accumulation of nitrate for parsley and spinach. For broccoli and garlic, application of MSWC at more than 25 and 50 t/ha is recommended, respectively. For garlic, cattle manure compost can also be applied at 50 t/ha.

Supe and Marbhal (2008) found that the average weight of the cabbage head, the average weight of the leaves, the number of leaves per plant, the head diameter and days needed for harvesting were significantly superior in treatment where 50 percent N was applied from organic sources over inorganic sources @ 100:50:50 NPK kg / ha. However, treatment with 50 percent nitrogen was found to be equivalent to treatment with the application of an increased dose of NPK (125:62.5:62.5 kg/ha). As regards the compactness of the head, the treatment

50% N through neem cake+50% N through the inorganic source@ 100:50:50 kg/ha.

A greenhouse research was performed by Hernandez *et al*. (2010) to determine the impact on total lettuce growth and leaf nutritional quality (*Lactuca sativa L*). Three forms of treatment were examined for fertilization: two organic and one traditional or inorganic .Both vermicompost and compost were produced from cattle manure. The findings showed variations in weight and leaf content for the N and K variables, with the urea treatment providing the highest mean values for these variables. In organic fertilizer treatments, the leaf content of Ca, Mg, and Mn showed higher values. In comparison with compost use, vermicompost treatment showed a higher contribution of Mg, Fe, Zn, and Cu and lower Na to the lettuce leaf content.

Devi and Singh (2012) experimented with varying levels of chemical fertilizers (NPK) and vermicompost. The yield attributing characters and growth and biomass development in cabbage (*Brassica oleraceae var. capitata*) were significantly affected by NPK and vermicompost. India's Pride. There were six treatments i.e. T_1: control i.e. without fertilizer; T_2: NPK@140:140:140 kg/ha, T_3: NPK@105:105:105 kg/ha + Vermicompost @ 1 ton/ha; T_4: NPK@70:70:70 kg/ha + Vermicompost @ 2 tons/ha; T_5: NPK@35:35:35 kg/ha + Vermicompost @ 3 tons / ha; T_6: Vermicompost @ 4 tons/ha). T_1: control i.e. without fertilizer; the maximum increase in yield over control of 58.67 percent was observed in a combined NPK application.

A research was conducted by Getnet and Raja (2013) to generate vermicompost from organic waste using red earthworm (*Eisenia fetida*) and to test cabbage growth-promoting and pest suppression properties (*Brassica oleracea*). Vermicompost was added individually at the rate of 25, 50, 100, and 200 gm/plant. There were 10 plants chosen for each application and the vermicompost application proceeded. For the control group, a total of 40 plants were used, with 10 plants randomly chosen. Significant differences were observed in growth and development and in the number of plants compared to control. Vermicompost has a significant effect on the promotion of cabbage growth and decreases aphid infestation and other insect infestations. Using vermicompost for all types of crops in the future and accepting it as a commercial fertilizer will create employment opportunities for small-scale farming societies.

Sajib *et al*. (2015) performed an investigation of cabbage yield output (Brassica oleracea var. capitata) under various manure and fertilizer combinations. Treatments were T_1 = recommended doses of NPK (urea @ 350 kg ha^{-1}, TSP @ 250 kg ha^{-1}, MoP @ 300 kg ha^{-1}respectively), T_2 = cowdung @ 10 t ha^{-1}, T_3 = vermicompost @ 10 t ha^{-1}, T_4 = Trichoderma compost @10 t ha^{-1}, T_5 = 50% cowdung + 50% recommended fertilizer doses, T_6 = 50% vermicompost + 50% recommended fertilizer doses, and T_7 = 50% Trichoderma compost. The use of vermicompost with the recommended dose of NPK and cowdung compost with the recommended dose of NPK had a positive and important effect on growth, yield characteristics, and yield. In most cases, 50 percent of vermicompost + 50 percent of the prescribed treatment fertilizer doses performed better.However, the maximum yield of cabbage (57.16 t ha^{-1}) was obtained from the treatment receiving 50% vermicompost + 50% recommended doses of fertilizers, and the lowest yield of cabbage (38.48 tha^{-1}) was obtained from the control. But considering the highest benefit-cost ratio of cabbage (3.63) was noted when applied 50% cowdung + 50% recommended doses of fertilizer were applied for sustainable crop production.

Ali and Kashem (2018) conducted a field experiment to determine the effect on the growth and yield of cabbage of various levels of fertilizers, cowdung, and vermicompost. T_1 = 392-330-150-133-8-5 kg $ha^{-1}$of urea-TSP-MoP-Gypsum-Zinc- sulfate-Solubor boron (BFRG-2012), $T_2 = T_1$ + Cowdung (5 t ha^{-1}), $T_3 = T_1$ + Vermicompost (5 tha^{-1}) and T_4 = Vermicompost (10 tha^{-1}) were the experiments. By using the tretments, substantial variation was observed in various growth and yield. In T_3, the tallest plant (14.03 cm) was observed at 30

DAT, while in T_4, the shortest (9.01 cm) was observed. The highest leaf length and width of the leaf (11.40 cm and 7.73 cm, respectively) were found for T_3 treatment at 45 DAT. The maximum root length and weight (25.75 cm and 30.97 g) were indicated when T_3 was applied. With T_3 treatment, the highest fresh stem weight (14.17 g) was indicated. The highest head yield of T_3 (42.12 t ha-1) was observed.The result revealed that vermicompost was given better performance with recommended doses of chemical fertilizers than applying chemical fertilizers alone.

A field experiment to test various doses of vermicompost in tomato crops (*Solanum lycopersicum L.)* in northern Sinaloa, Mexico, was performed by Ramirez *et al*. (2014). Vermicompost doses of 0, 500, 1000, 1600, 2000 and 4000 kg ha^{-1}were tested in a fully randomized design with 3 replicates per procedure, including control. Fruit size, number, and weight were the parameters estimated. The addition of more than 4000 kg/ha of vermicompost has dramatically increased the number and size of fruit in tomato plants, making it a viable choice for commercial tomato crops.

In their research, Azarmi *et al*. (2008) analyzed the effects of vermicompost on tomato (*Lycopersicon esculentum var. super beta)* growth, yield, and fruit quality in field conditions. A randomised complete block design with four replications was the experiment. Different vermicompost concentrations (0, 5, 10, and 10) at top 15 cm of soil was incorporated into 15 t ha^{-1}. Fruits were harvested twice a week during the experiment period and the total yield was registered for two months. Growth parameters such as leaf number, leaf area, and dry shot weights were calculated at the end of the experiment. The results showed that the addition of vermicompost at a rate of 15 t ha^{-1} increased growth and yield significantly compared with control. Vermicompost increased fruit juice EC and fruit dry matter percentage by up to 30 and 24 percent, respectively, at a rate of 15 t ha^{-1}. Compared to untreated pots, the content of K, P, Fe and Zn in plant tissue increased by 55, 73, 32 and 36 percent, respectively.

During the time from October 2008 to March 2009, Jahan *et al.* (2014) conducted an experiment in the experimental sector of the Soil Science Division, impact of vermicompost and traditional compost on cauliflower growth and yield. There have been twelve treatments. T_1: 100% recommended Chemical Fertilizer Dose (RDCF; RDCF= N:250, P:35, K:65,S:40,Zn:5,B:1 kg ha^{-1}; T_2: 80% RDCF; T_3: 60% RDCF; T_4: 100% RDCF + Vermicompost @ 1.5 t ha^{-1}; T_5: 80% RDCF + Vermicompost @ 3 t ha^{-1}; T_6: 60% RDCF + Vermicompost @ 6 t ha^{-1} T7: Vermicompost @ 6 t ha^{-1}; T_8: 100% RDCF + Conventional compost @ 1.5 t ha^{-1}, T_9: 80% RDCF + Vermicompost @ 6 t ha^{-1}, T_7: Vermicompost @ 6 t ha^{-1}; T_8: 100% RDCF +Conventional compost @ 1.5 t ha^{-1}; T_9: 80% RDCF +Conventional compost @ 3 t ha^{-1}; T_{10}: 60% RDCF + Conventional compost @ 6 t ha^{-1}; T_{11}: Conventional compost @ 6 t $ha^{-1}$and T_{12}: Control (no fertilization) with three replications following Randomized complete Block Design. 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 t ha^{-1}) and stover yield (29.7 t ha^{-1}) were found from T_4 which was statistically identical with or followed by T_8 and T_5. 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. The result obtained 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.

Reddy and Rao (2004) conducted a field experiment to study the growth and yield of bitter gourd (*Momordica charantia L.*) in Hyderabad, Andhra Pradesh, India, as affected by vermicompost and nitrogen management practices, consisting of 4 vermicompost levels (0, 10, 20 and 30 t/ha) and 3 N levels (20, 40 and 80 kg/ha). Vermicompost and N application significantly increased vine length, number of branches, number of fruits per vine, and fruit yield/ha Higher N and vermicompost levels delay bitter gourd flowering . In improving the yield of bitter gourds, the application of 13.8 t vermicompost and 34.18 kg N (through urea)/ha was considered beneficial.

Reddy and Reddy (2005) conducted a study in Andhra Pradesh, India to determine the effects of various levels of vermicompost (0, 10, 20 and 30 t/ha) and nitrogen fertilizer (0, 5, 100, 150 and 200 kg/ha) on the growth and yield of onions and radishes. With growing concentrations of vermicompost (from 10 to 30 t / ha) and nitrogen fertilizer (from 50 to 200 kg / ha), plant height, number of leaves per plant, leaf area, bulb length, diameter, and weight and yield of onions increased significantly. Due to the residual effect of different levels of vermicompost and nitrogen added to the preceding crop (onion), a similar increase in radish yield was also observed. Among the different treatment combinations, the highest plant height and the number of leaves per plant in onion and radish were reported by vermicompost at 30 t/ha + 200 kg N/ha.

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

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

The influence of vermicompost on plant nutrition, yield, root and crown rot of gerbera was investigated by Rodriguez *et al*. (2000). At 20 percent, with or without chemical fertilizer, vermicompost incorporation decreased the incidence of diseased plants and the rate of growth of the disease. In plants treated with 20% vermicompost with or without chemical fertilizer, the macro and micronutrient content except (K and Mn) was at an optimum level; in plants without vermicompost, the macro and micronutrient content was lower, except K and Mn.

Sohrab and Sarwar (2001) investigated and found that the vermicompost played a very effective role in all economic aspects of the vegetable crop in the case of the Lady's finger (okra). The yield from the lady's finger was 18.40 t $ha^{-1}$from the vermicompost-treated experimental plots in one season. On the contrary, the output of 12.43 t ha^{-1} was calculated on the basis of the untreated crop harvested.

Theunissen *et al*. (2010) reported that vermicompost contains plant nutrients including N , P , K, Ca , Mg, S, Fe , Mn , Zn, Cu, and B, whose absorption has a positive impact on plant nutrition, photosynthesis, leaf chlorophyll content, and improves the nutrient content of the various components of the plant (roots, shoots, and fruits). The high percentage of vermicompost contributes humic acid to plant health by encouraging the synthesis of phenolic compounds such as anthocyanins and flavonoids, which can improve the quality of the plant and serve as a deterrent against pests and diseases.

Patil (1995) stated that the application of vermicompost helps to achieve maximum plant height in onions at 75 and 95 days after planting. He also suggested that the use of vermicompost and 50% of the prescribed fertilizer dose helps to increase the amount of leaves per plant compared to control in potato.
Warman (1986) said that chicken manure has a potential impact on soil chemical properties and crop yield. In addition, because of its high content of nitrogen, phosphorus, and potassium, the need and usage of chicken manure has overtaken the use of other animal manure (e.g. pig manure, kraal manure).

Duncan (2005) noted that the use of chicken manure serves as a good amendment to the soil. This fertilizer supplies N, P, and k, which can also increase the concentration of N, P, K, Ca, and Mg in the soil and leaves. These chemical properties of the soil improve the fertility of the soil and the yield of crops.

Akter et al. (1996) experimented at Joydebpur to find out the effects of poultry manure (PM) and cow dung (CD) on the growth and yield of broccoli in the presence and absence of chemical fertilizer and reported that 10 ton/ha of poultry manure provided the highest curd yield of broccoli with the recommended dose of nutrients. Yield depression was caused even at higher doses by the application of only PM and CD. With PM and CD, the highest curd yield was obtained at 20.70 and 16.75 tons per hectare. In the absence of NKPS, a higher yield of curd could not be obtained by organic manure alone.

An experiment to investigate the yield of cabbage, head consistency, and leaf nutrient status for poultry manure fertilization was studied by Hochmuth *et al.* (1993). They stated that growing rates of poultry manure replied to the yield of cabbage, with a maximum yield (24.4 t/ha) of 18.8 t/ha. It showed that the manure performance of commercial fertilizers was initially higher than that of poultry manure alone, as lower quantities of total nutrients were used in commercial fertilizers.

Ewulo (2005) said that a high percentage of nitrogen and phosphorus for safe plant growth is found in poultry manure. Nitrogen is equally said to be the promotor of plant growth.

Akanbi *et al*. (2005) observed that the application of broiler litter at the rate of 15 ton/ha, N at 40 kg/ha, P at 30 kg/ha, and K at 30 kg/ha gave higher growth and fruit yield.

A greenhouse pot experiment was performed by Losák *et al*. 2008) to estimate the joint impact of N and S, on kohlrabi growth and yield. Fertilization with S did not impact the yield of tubers. The N content ranges were low in the tubers and the leaves were narrow and the effect of S fertilization was negligible. S fertilization had a more pronounced effect on the leaf tissue concentration of S. In tubers, the NO_3^- content was greater than in leaves. If the S level increases in the soil, the concentration of NO_3^- in the tubers decreases dramatically. If the S content in the soil becomes high, the cysteine + methionine concentration decreases by 16-28 percent. There were constant values of valine, tyrosine, aspartic acid, and serine. The amounts of threonine, iso-leucine, leucine, arginine, the number of essential amino acids, and alanine fell from 37 to 9 percent in the S_0, S_1, and S_2 treatments.

Atiyeh *et al.* (2000) stated that there is a higher amount of 'ammonium' in traditional compost, while it was determined that the vermicompost has a higher amount of 'nitrates,' which is the form of nitrogen readily available to support superior growth and yield. Vermicompost was also found to have higher N availability and other plant nutrients such as Phosphorus (P), Potassium (K), Sulphur (S) and Magnesium (Mg) showed a substantial increase compared to traditional compost when vermicompost was added to the soil.

Suhane (2007) professes that vermicompost is at least 4 times more nutritive compared to cattle dung and compost. Farmers, in Argentina, prefer vermicompost over conventional composts as they believe that it is up to seven times richer in nutrients and growth-enhancing values (Pajon, 2007). Studies suggest that vermicompost has higher soil moisture retention hence it reduces the need for water for irrigation by around 30- 40% (Suhane, 2007; Suhane *et al.*, 2008).

Bouche and Ferries (1986) summarized that earthworm nitrogen was easily and almost completely consumed by plants. When the budding worms were fed a soil consisting of nitrogen-containing finely ground leaf litter, about 6 percent of the nitrogen consumed was emitted to the plants in bio-available forms. Compared to the control soil containing 45 ppm, the soil with living worms contained 75 ppm of nitrate nitrogen for 28 weeks. In the urine released by worms, nitrogen is primarily excreted as ammonium; it is therefore blended with the soil and contained in the casts (Laverack, 1963; Lee, 1985). Earthworms form sites with high denitrification potential and in their castings there is a high concentration with ammonium and water retention capacity (Elliot et al., 1990).

Bhat and Limaye (2012) investigated the preparation of potential nutrient status and development of plants by vermicompost. Compost and plain soil were kept as control. Different physicochemical properties were examined at regular intervals, over 48 days, such as pH, organic carbon, nitrogen, phosphorus, calcium, magnesium, and chloride material. The vermicompost's moisture content was 78.05 percent with a water keeping capability of 79 percent. In comparison with controls, flowering capacity, plant height, width, and leaf length were found more in vermicompost.

Roe (1998) carried an experiment on Brocolli by using compost obtained from dairy manure and municipal solid waste to find out the beneficial effects. He founded beneficial effect on yield, growth and nutrient contents by using compost on Brocolli production.

Krupkin *et al.* (1994) studied poultry manure, a mixture of poultry manure and hydrolysis lignin, poultry manure compost and hydrolysis lignin as organic fertilizer with and without irrigation on potatoes, cabbage, and carrots. The findings showed that the yield and quality of crops were improved by organic fertilizer. The effect of lignin-based fertilizer, i.e. poultry manure mixture and hydrolysis lignin, poultry manure compost, and hydrolysis lignin, was similar to poultry manure.

Zhang Yong Chun et al. (2004) experimented with the effect of organic-inorganic compound fertilizers and inorganic nitrogen fertilizer on yields and quality of Chinese cabbage.

Venter and Fritz (1979) reported that various sources of nitrogen were examined in greenhouse and field experiments on the nitrate content of kohlrabi plants. Increasing nitrogen amounts applied are followed by an increase in the nitrate contents of kohlrabi. Nitrate fertilizers resulted in the highest and calcium cyanamide in the lowest nitrate contents. The nitrate contents of kohlrabi tubers sharply decreased along with a prolonged period between the last nitrogen fertilization and harvesting. Nitrate contents of greenhouse kohlrabi cultivated at a time of year poor in light were considerably higher than those of field-grown kohlrabi in the summer time.

Antonova et al. (2014) suggested that in two organic crop production systems, the new Bulgarian kohlrabi cultivar Niki was studied: an organic system without fertilizer and pesticide treatment of plants and an organic system using biological fertilizer and biological insecticide and bio-fungicide plant protection. The morphological characteristics were investigated: the size of the leaf rosette, the number and weight of the leaves of the rosette, and the weight, height and diameter of the kohlrabi (knob). The new kohlrabi cultivar was developed to demonstrate a relatively good biological potential for development in organic crop production systems, although the values recorded for almost all morphological characteristics studied were lower compared to those recorded under conventional crop production conditions. With the use of bio products for fertilization and plant defense, the phenotypical manifestations of the cultivar were better in organic system development, where the morphological character values were 6 to 23 percent lower than those reported in the conventional system of production. The values of the studied characteristics of kohlrabi cultivated in organic production without the application of fertilizer and plant protection products were 15% to 34% lower than those reported in conventional production.

The mean kohlrabi (knob) weight was 1.110 kg in organic system production with the use of bio products for fertilization and 0.897 μg in organic production without the use of fertilizer and plant protection products, which was lower than the recorded knob weight of 1.256 kg in conventional production.

Sultana et al. (2012) conducted a study of the effects of cowdung and potassium on the growth and yield of Kohlrabi at the Horticulture Farm of the Bangladesh Agricultural University, Mymensing, during the period from November 2010 to January 2011. The experiment consisted of three cowdung concentrations (0, 20 and 40 t/ha) and four potassium concentrations (0, 20, 50, 80 kg /ha). In a randomised complete block design with three replications, the experiment was laid out. The application of cowdung and potassium affected all the parameters significantly. The maximum plant height (44.65 cm), the number of leaves per plant (12.11), the largest leaf length (37.54 cm) and the largest leaf width (18.66 cm) were obtained from the maximum cowdung and potassium dose (40 t cowdung + 80 kg K/ha) while the lowest plant height (33.64 cm), the number of leaves (9.01), the largest leaf length (27.94 cm) and the largest leaf width (11.00 cm) were obtained

The highest fresh weight of leaves (49.33 g), fresh weight of knob (328.66 g), and fresh weight of roots (66.55 g) per plant were also recorded under the treatment combination of 40 t cowdung + 80 kg K/ha, while the lowest fresh weight of leaves (22.11g), fresh weight of knob (136.00 g) and fresh weight of roots (23.33g) were obtained from control treatment combination. Similarly, the dry weight of leaves (19.34%), knob (15.19%), and roots (32.75%) were highest under the same treatment combination of 40 t cowdung + 80 kg K/ha and the lowest dry weight of leaves (11.71%), dry weight of knob (7.38%) and dry weight of roots (15.29%) were obtained from control treatment combination C_0K_0. The marketable yields of knob per plot (7.86 kg) and per hectare (39.58 tons) were also the highest under the treatment combination 40 t cowdung/ha and 80 kg potassium per hectare.

Shams (2012) recorded that 'Purple Vienna cv.' field experiments were performed on Kohlrabi (*Brassica oleracea* var. *gongylodes*) at the Experimental Farm of the Faculty of Agriculture, Moshtohor, Benha University, Egypt, under a drip irrigation system during the winter seasons of 2009 and 2010. The goal of this study was to investigate the effect of organic manure and/or mineral N fertilizers with or without inoculation of bio fertilizers on the growth, yield and quality of kohlrabi knobs. Results show that, compared to other N-fertilizer systems, using 50 percent mineral-N + 50 percent organic-N combined with bio fertilizer improved plant growth, yield, and knob quality. Inoculation of bio fertilizer kohlrabi transplants yielded good results in this regard. Therefore, as opposed to the uninoculated one, this treatment provided the best growth and increased total yield with the best quality of the knob.

Abou *et al.* (2006) conducted two field experiments at El-Kassasein, Ismailia Governorate, Egypt to study the response of vegetative growth and yield of some broccoli varieties to apply organic manures (Cattle and poultry manures) compared with mineral fertilization. The highest vegetative growth of broccoli plants was recorded by plants that were supplied with 100 percent cattle manure. However, the highest total yield and quality of broccoli were recorded by adding poultry manure in the two seasons.

IFA (2000) noted that organic matter is the supreme determinant of soil fertility in most tropical soils and that the fertility of the soil could be preserved with the addition of poultry manure due to its use to grow seedlings in tropical areas.

Shubhan (1988) used 15, 20, 25, or 30 t/ha cattle manure, composted maize straw, composted rice straw, to experiment on cabbage. At 60 days after transplanting, composted organic manure increased head diameter, the number of leaves/plant was higher, and the number of days to maturity decreased. The highest result was the application of cattle manure (25 or 30 t/ha) and the greatest amount of cabbag.

CHAPTER-III

MATERIALS AND METHOD

This chapter describes the materials and methods used in the field during the period from OCTOBER 2018 to January 2019 to perform the experiment entitled "influence of vermicompost on growth and yield of kohlrabi." It includes a brief overview of the experimental site, soil and environment, cultivar, crop cultivation, design and treatment of the experiments, and data collection provided under the following headings.

3.1 Experimental site

At Sher-e - Bangla Agricultural University, Horticulture farm, the research was conducted. University, Dhaka-1207, Bangladesh. The experimental region is situated geographically at an elevation of 8.2 m above sea level at latitude $23^{0}4'$ N and longitude $90^{0}22'$ E (FAO, 1988).

3.2 Characteristics of soil

The soil of the experimental field was silty loam in texture. The soil of the experimental area belongs to the Madhupur Tract under AEZ No. 28. Before experimenting and analyzing, the soil sample of the experimental plot was collected from a depth of 0-30 cm at the Soil Resources Development Institute (SRDI), Soil Testing Laboratory, Khamarbari, Dhaka, and provided in Appendix- I.

3.3 Climate and weather

The climate of the experimental site was under the subtropical climate, characterized by three distinct seasons, 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. Details of the meteorological data during the period of the experiment were collected from the Bangladesh Meteorological Department, Agargaon, Dhaka, and presented in Appendix II.

3.4 Plating material

The “Quick star”, ‘’White vienna’’, ‘’Early OO5’’, a cultivar of Kohlrabi was used in the experiment. The seeds of the cultivar were collected from Siddique Bazar, Dhaka.

3.5 Seedbed preparation

In october 2018, the seedbed was prepared for growing kohlrabi seedlings and the size of the seedbed was 3 m × 1 m. The soil was well ploughed to loosen friable and dried masses to obtain sufficient tilth for making seedbed. From the seedbed, weeds, stubbles, and dead roots were removed. Cowdung was added to the seedbed that was prepared. To protect the young plants from the attack of mole crickets, ants and cutworms, the soil was treated with Sevin 50WP @ 5 kg/ha.

Plate 1: prepared seedbed

3.6 Seed treatment

Seeds were treated by Provax 200WP @ 3g/kg seeds to protect against some seed-borne diseases.

3.7 Seed sowing

Seeds in the seedbed were sown on 20 October 2018. The seeding was performed thinly in rows spaced at a distance of 5 cm. At a depth of 2 cm, the seeds were sown and covered with a thin layer of soil, accompanied by light watering with a watering can. The beds were subsequently filled with dry straw to maintain the necessary temperature and humidity. Immediately after the emergence of the seed sprout, the dry straw cover was removed. White polythene shade was provided when the seeds were germinated to shield the young seedlings from scorching sunlight and rain.

3.8 Raising of seedlings

Light watering and weeding were done several times. No chemical fertilizers were applied for the raising of seedlings. Seedlings were not attacked by any kind of insect or disease. Healthy and 25 days old seedlings were transplanted in to experimental field on 15 November 2018.

Plate 2: Rising seedlings on seedbed

3.9 Treatment of the experiment

Factor A: Three kinds of varieties

V_1: Quick star

V_2: White vienna

V_3: Early OO5

Factor B: Four levels of vermicompost

M_0: 0 t/ha

M_1: 6 t/ha

M_2: 8 t/ha

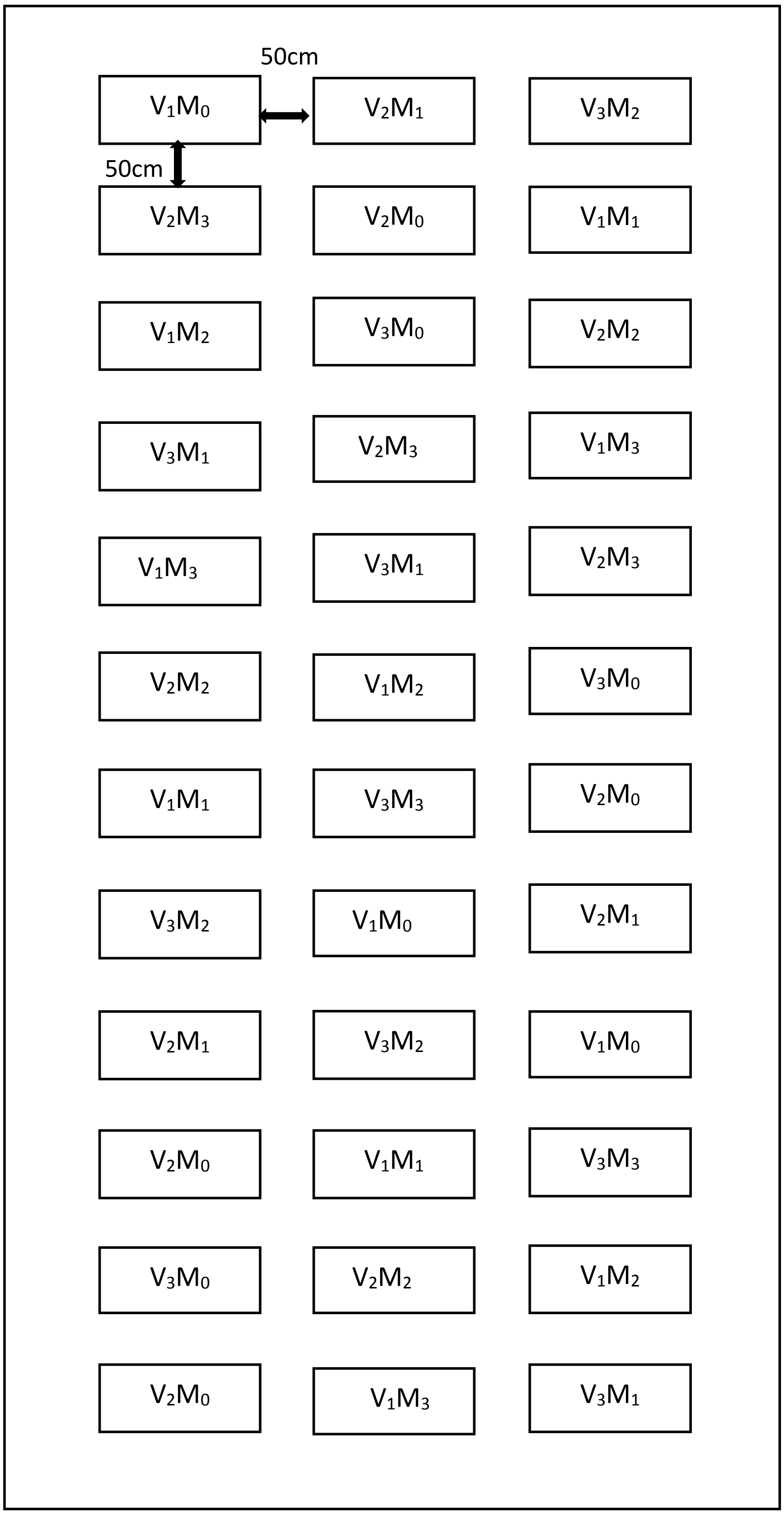
M_3: 10 t/ha

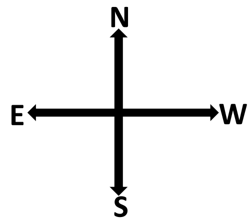
There are 12 treatment combinations such as V_1M_0, V_1M_1, V_1M_2, V_1M_3, V_2M_0, V_2M_1, V_2M_2, V_2M_3, V_3M_0, V_3M_1, V_3M_2, and V_3M_3.

3.10 Design and layout of the experiment

The two-factorial experiment was laid out with three replications in a Randomized Complete Block Design (RCBD). The overall plot was divided into three blocks of equal size. Each block was divided into 12 plots in which 12 combinations of treatments were randomly distributed. In the experiment, there were 36-unit plots overall. Each plot was 0.9 by 1.2 m in scale. The gap between the two blocks was maintained and the two plots were 1 m and 0.5 m, respectively. They increased the parcels to 10 cm. In the plot, the distance between row to row and plant to plant was held at 30 cm and 30 cm.

Layout:

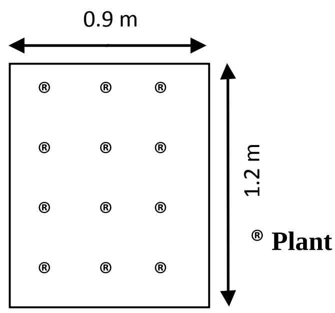




Legend:
Plot size: 0.9 m x1.2m
Plant-plant distance: 30cm
Row-row distance: 30cm
Block-block distance: 50cm
Plot-plot distance: 50cm

Factor A: Different Carrot Cultivars:
V_1= Quick star
V_2=White Vienna
V_3= Early 005

Factor B: Levels of Vermicompost
M_0: 0 t/ha
M_1: 6 t/ha
M_2: 8 t/ha
M_3: 10 t/ha



Layout of a unit plot

Fig. 1: Layout of the experimental field

3.11 Land preparation

The plot selected for experimenting was opened in with a power tiller and left exposed to the sun for a week. The land was harrowed, plowed and cross-plowed several times followed by laddering to obtain good tilth. Weeds and stubbles were removed and finally obtained a desirable tilth of soil was obtained for transplanting of the seedling. To avoid water logging due to rainfall during the study period, drainage channels were made around the land. The soil was treated with Furadan 5G @ 15 kg ha^{-1} when the plot was finally plowed to protect the young seedlings from the attack of the cutworm.

3.11.1 Application of Fertilizer

Vermicompost was used as the source of nitrogen, phosphorus, and potassium. The total amount of vermicompost was applied during final land preparation as per treatment.

3.11.2 Transplanting

Before rooting out the seedlings, the seedbed was watered to mitigate the damage to the roots. In November 2018, twenty-five days of old healthy seedlings were transplanted into experimental plots at a spacing of 30 cm by 30 cm. The afternoon planting was completed. Immediately following transplanting around each seedling for their better establishment, light irrigation was given. Watering was carried out before they were able to develop their root system for up to five days.

3.12 Intercultural operations

3.12.1 Gap filling

For this reason, very few seedlings were harmed after transplanting duo to root damage because new seedlings from the same stock were replaced.

3.12.2 Weeding

Under close observation, the plants were kept. Weeding was performed on two times. First, two weeks after transplantation, weeding was carried out. After 30 days of the first weeding, another weeding was performed.

3.12.3 Irrigation

For their better establishment, light irrigation was provided immediately after transplanting around each seedling. Watering was done before they were able to develop their root system for up to five days. Irrigation was given by observation of the state of soil moisture. During the cultivation era, irrigation was carried out four times.

3.12.4 Earthing up

Earthing up was done by taking the soil from the space between the rows at 15 days after transplanting.

3.12.5 Insects and diseases management

The crop was attacked by cutworms, mole cricket, and field cricket during the early stages of growth of seedlings in December. This insect was controlled by spraying Dursban 20 EC @ 0.1%.

3.12.6 General observation

Any changes in plants, pests, and disease attacks have been regularly noted in the field and appropriate steps have been taken to monitor plant growth.

3.12.7 Harvesting

At the correct maturing period, whole plants with knobs were harvested. As the plants shaped compact knobs, the main knobs were harvested. In January 2019, the final harvesting was completed.

3.13 Collection of data

The data about the following characters were recorded from five plants randomly selected from each plot except the yield of knobs which was recorded plot wise. The following parameters were studied for the present experiment:

1. Plants height (cm)
2. Number of leaves per plant
3. Leaf Length (cm)
4. Leaf Breadth (cm)
5. Canopy (cm)
6. Fresh weight of knob (g)
7. Dry weight of knob (g)
8. Diameter of the knob (cm)
9. Fresh weight of root (g)
10. Root Length (cm)
11. Knob weight with leaves (g)
12. Knob weight without leaves (g)
13. Dry weight of shoots, root, and leaf (g)
14. Yield per plot (kg/plot)
15. Yield per hectare (t/ha)

3.14 Data collection procedure

3.14.1 Plant height (cm)

Plant height was measured from base to the tip of the longest leaf at 30, 45 days after transplanting (DAT) and harvest time. A meter scale was used to measure plant height of the plant and expressed in centimeter (cm).

3.14.2 Number of leaves per plant

The total number of leaves produced by each plant was counted at 25, 35 DAT, and harvest time. The time of main knob harvesting excluding the small leaves.

3.14.3 Diameter of knob

Knob diameter was taken by using a meter scale at the final harvest. The diameter of the knob was measured in different directions and finally, the average of all directions was recorded and expressed in centimeter (cm).

3.14.4 Knob weight with and without leaves (g)

The weight of the knob was recorded including leaves and excluding leaves and expressed in gram (g).

3.14.5 Root length (cm)

The root of kohlrabi was measured using the measuring tape and express as a centimeter (cm).

3.14.6 Yield per plot

The yield per unit plot was calculated by adding the yields of all plants of each unit plot and expressed in kilograms (kg).

3.14.7 Yield per hectare

The yield of knob per hectare was calculated by conversion of the knob weight per plot and recorded in the ton.

3.14.8 Dry weight (g)

The 100 g fresh of stem, roots, and leaves was taken and kept in oven. Then the dry weight of 100 g of the stem, roots, and leaves was calculated and expressed in gram (g).

3.15 Statistical analysis

The data collected from the experimental plots were statistically analyzed according to final out the variation(s) resulting from experimental treatments following F-variance test. The significance of the difference between pair of means was performed by Duncan’s Multiple Range Test (DMRT) test at 5% levels of probability (Gomez and Gomez, 1984).

CHAPTER-IV
RESULTS AND DISCUSSION

The experiment was conducted to observe "Influence of vermicompost on growth and yield of kohlrabi cultivars" at Sher-e-Bangla Agricultural University (SAU), Dhaka. Data on different growth and yield parameter were recorded. The analyses of variance (ANOVA) of the data on different growth and yield parameters are presented in Appendix III-XVIII. The results have been presented and discusses with the help of table and graphs and possible interpretations given under the following headings:

4.1 Plant height (cm)

Effect of cultivar on plant height

Cultivar is an important factor considering plant height. Under the present study, plant height was significantly influenced by different varieties of Kohlrabi at different days after transplanting (DAT) (Figure: 2 and Appendix IV-VI). Results showed that the cultivar White Vienna (V_2) was evident for maximum plant height at all growth stagess. The plant height was recorded at different stagess of growth i.e. 25, 35, 45, and at harvest day after transplanting (DAT). The plant height varied significantly in different cultivars. During the period of plant growth, the tallest plant (24.55 cm) was observed in White Vienna (V_2) while the shortest plant (22.9 cm) was obtained from Early 005 (V_3) at 25 days. At 35 days, the tallest plant (26.05 cm) was obtained from V_2 while the shortest plant (24.68cm) was obtained from V_3. At 45 days, the tallest plant height (27.57 cm) was obtained from V_2 while the shortest plant (26.23cm) was obtained from the V_3.

The variation in plant height among Kohlrabi varieties might be due to congenial environment to express the dominant genes in the genotypes and different genetic makeup of the varieties.

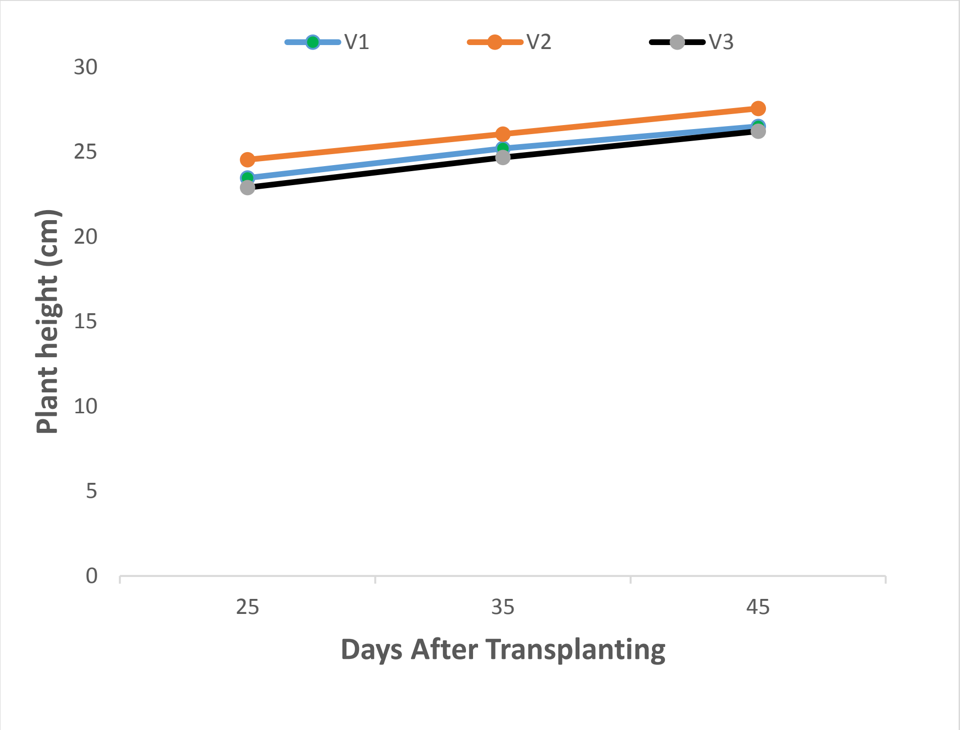


Figure 2: Effect of Kohlrabi Cultivars on plant height
Here, (V_1 = Quick Star, V_2 = White Vienna, V_3 = Early 005**)**

Effect of vermicompost on plant height

Fertilizer is the most important factor in achieving the best yield of the crop. Plant height was significantly affected by different levels of vermicompost under the present study (Figure: 3 and Appendix IV-VI). Plant height was the maximum with a maximum dose of vermicompost (M_3) at different growth stagess of different varieties of cabbage cultivars. The plant height varied significantly due to the application of vermicompost. During the period of plant growth, the tallest plant (25.6 cm) was observed in vermicompost treatment (M_3) while the shortest plant (21.15 cm) was obtained from the control treatment (M_0) at 25 days. At 35 days, the tallest plant (27.84 cm) was obtained from M_3 while the shortest plant (23.07 cm) was obtained from M_0. At 45 days the tallest plant (29.67 cm) was obtained from M_3 while the shortest plant (24.48cm) was obtained from the control (M_0).

All the treatments recorded more height with higher doses of vermicompost as compared to the control because Vermicompost contains a higher percentage of available nutrients (Edwards and Burrows 1988), humic acid (Senesi et al. 1992), substances that encourage plant growth such as auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah 1986), bacteria, enzymes, and vitamins that solubilize N-fixing and P (Ismail 1997). Vermicompost is a rich source of both macro and micronutrients, vitamins, growth hormones, and enzymes, and derived from earthworms (Bhavalkar 1991).

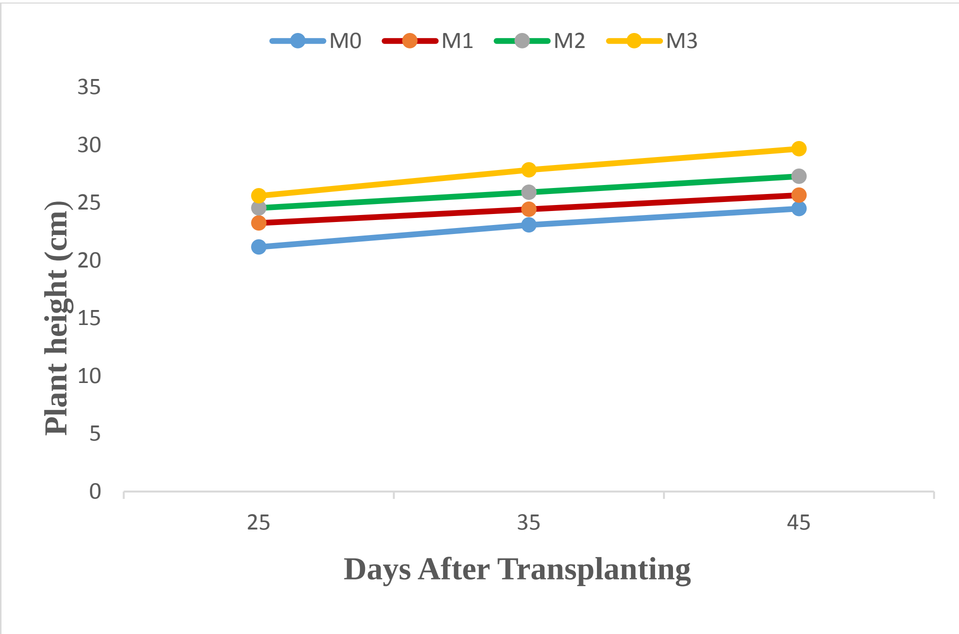


Figure 3: Effect of Vermicompost on plant height
Here, M_0 = Control, M_1 = 6 t/ha, M_2 = 8 t/ha, M_3 =10 t/ha.

Interaction effect of cultivar and vermicompost on plant height

The interaction effect of cultivar and different levels of vermicompost on plant height were significant at 25, 35, and 45 DAT under the present study (Table 1 and appendix IV-VI). In case of interaction effect,at 25, 35, 45 (harvest), the tallest plant 26.93 cm, 28.87 cm, and 31.07 cm respectively were obtained from V_2M_3, while the shortest plant 20.73 cm, 22.6 cm, and 23.87 cm respectively were obtained from the V_3M_0 treatment.

Table 1: Interaction effect of cultivar and different levels of vermicompost on plant height at different growth stagess of Kohlrabi

Treatment combinations	Plant height after transplanting (Days)		
	25	35	45
$V_1 M_0$	20.80 ± 0.23 f	23.13 ± 0.24 fg	24.80 ± 0.41 ef
$V_1 M_1$	23.40 ± 0.11 cd	24.57 ± 0.03 cde	25.46 ± 0.37 de
$V_1 M_2$	24.33 ± 0.13 bc	25.67 ± 0.27 c	26.93 ± 0.35 c
$V_1 M_3$	25.33 ± 0.17 b	27.46 ± 0.35 b	28.86 ± 0.63 b
$V_2 M_0$	21.93 ± 0.74 ef	23.46 ± 0.59 efg	24.80 ± 0.61 ef
V_2M_1	23.80 ± 0 .34 c	24.73 ± 0.40 cde	26.06 ± 0.17 cd
$V_2 M_2$	25.53 ± 0.26 b	27.13 ± 0.33 b	28.33 ± 0.35 b
$V_2 M_3$	26.93 ± 0.54 a	28.86 ± 0.66 a	31.06 ± 0.46 a
$V_3 M_0$	20.73 ± 0.06 f	22.60 ± 0.40 g	23.86 ± 0.35 f
$V_3 M_1$	22.53 ± 0.63 de	24.00 ± 0.11 def	25.40 ± 0.12 de
$V_3 M_2$	23.80 ± .46 c	24.93 ± 0.48 cd	26.60 ± 0.11 cd
$V_3 M_3$	24.53 ± .35 bc	27.20 ± 0.50 b	29.06 ± 0.24 b
Significant level	***	***	***

4.2 Number of leaves

Effect of cultivar on number of leaves

Cultivar is an important factor considering plant height. Under the present study, the Number of leaves was significantly influenced by different varieties of Kohlrabi at different days after transplanting (DAT) (Figure: 4 and Appendix VII-IX). Results showed that the cultivar White Vienna (V_2) was evident for maximum leaves numbers at all growth stagess. Leaves number was recorded at different stagess of growth i.e. 25, 35, 45, and at harvest day after transplanting (DAT). The plant height varied significantly in different cultivars. During the period of plant growth, the maximum leaves (8.75) were observed in White Vienna (V_2) while the minimum (8.5) was obtained from Early 005 (V_3) at 25 days. At 35 days after transplanting maximum leaf per plant was (9.96) in V_2

cultivar and the minimum plant was (9.4) in V_3 cultivar. The maximum number of leaves per plant of kohlrabi was recorded in theV_2 (White Vienna) (11.00) and the minimum number of leaves was in V_3 (Early 00) cultivar (10.5) in 45 days after transplant.

The variation in leaves number among Kohlrabi varieties might be due to congenial environment to express the dominant genes in the genotypes and different genetic makeup of the varieties.

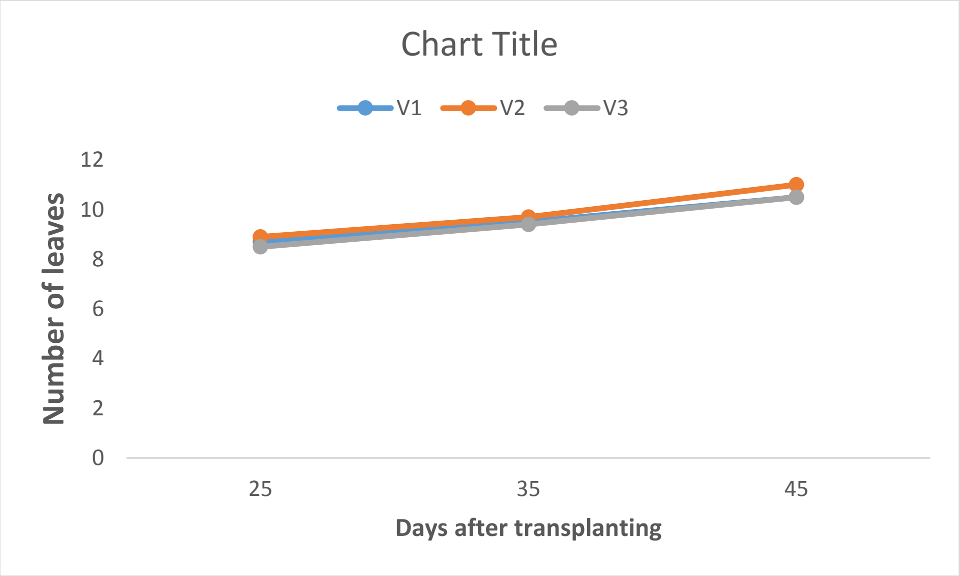


Figure 4: Effect of Kohlrabi Cultivars on number of leaves
(V_1 = Quick Star, V_2 = White Vienna, V_3 = Early 005)

Effect of vermicompost on number of leaves

Fertilizer is the most important factor in achieving the best yield of the crop. The number of leaves was significantly affected by different levels of vermicompost under the present study (Figure: 5 and Appendix VII-IX). The number of leaves was the maximum with the maximum dose of vermicompost (M_3) at different growth stagess of different varieties of kohlrabi cultivars. The number of leaves varied significantly due to the application of vermicompost. During the period of plant growth, the maximum leaves (9.78) was observed in vermicompost treatment (M_3) while the minimum number of the plant (7.67) was obtained from the control treatment (M_0) at 25 days. At 35 days, the tallest plant (10.44) was obtained from M_3 while the shortest plant (8.67) was obtained from M_0. At 45 days the tallest plant (11.89) was obtained from M_3 while the shortest plant (9.67) was obtained from the control (M_0).

All the treatments recorded more leaves number with higher doses of vermicompost as compared to the control because Vermicompost contains a higher percentage of available nutrients (Edwards and Burrows 1988), humic acid (Senesi et al. 1992), substances that encourage plant growth such as auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah 1986), bacteria, enzymes, and vitamins that solubilize N-fixing and P (Ismail 1997). Vermicompost is a rich source of both macro and micronutrients, vitamins, growth hormones, and enzymes, and derived from earthworms (Bhavalkar 1991).

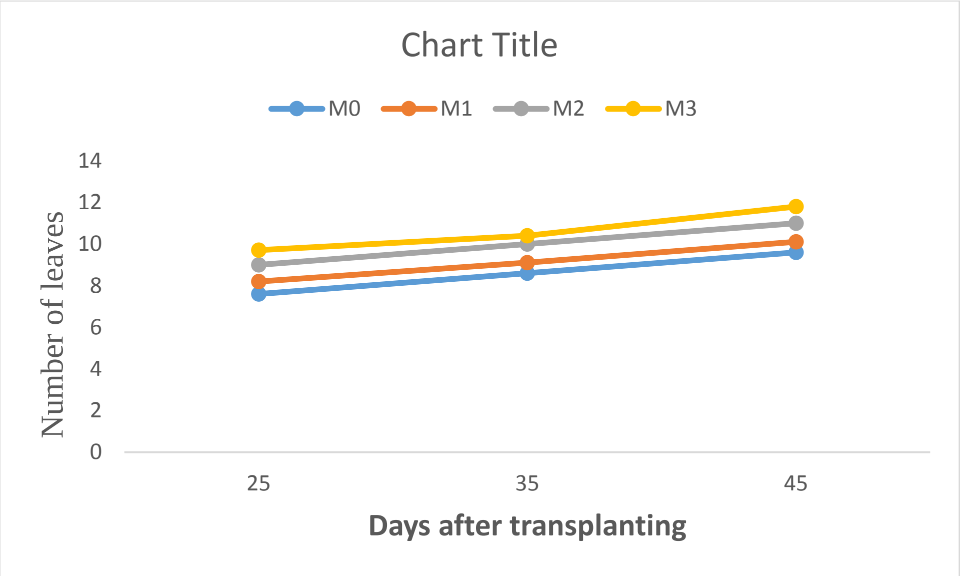


Figure 5: Effect of Vermicompost on number of leaves

Here. M_0 = Control, M_1 = 6 t/ha, M_2 = 8 t/ha, M_3=10 t/ha.

Interaction effect of cultivar and vermicompost on number of leaves:

Significant variation was observed in the number of leaves with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table: 2 and Appendix VII-IX). Different treatment combination viewed different breadth of stem. It was observed that the maximum leaf number (10) was observed with a V_2M_3 treatment combination. On the other hand, the minimum leaf number (7.67) was observed with the V_3M_0 treatment combination at 25 DAT. It was observed that the maximum leaf number (11) was observed with the V_2M_3 treatment combination. On the other hand, the minimum leaf number (8.67) was observed with the V_3M_0 treatment combination at 35 DAT. It was observed that the maximum leaf number (13.33) was observed with the V_2M_3 treatment combination.On the other hand, the minimum leaf number (9.67) was observed with the V_3M_0 treatment combination at 45 DAT.

Table 2: Interaction effect of Cultivar and different levels of Vermicompost on number of leaves at different growth stages of kohlrabi.

Treatment combinations	Number of leaf at different days after Transplanting (DAT)		
	25	**35**	**45**
V_1M_0	7.67 ± 0.33 d	8.67 ± 0.33 d	9.67 ± 0.33 d
V_1M_1	8.33 ± 0.33 cd	9.33 ± 0.33 cd	10.33 ± 0.33 cd
V_1M_2	9.00 ± 0.00 bc	10.00 ± 0.00 bc	11.00 ± 0.00 bc
V_1M_3	10.00 ± 0.00 a	10.33 ± 0.33 b	11.00 ± 0.00 bc
V_2M_0	7.67 ± 0.33 d	8.67 ± 0.33 d	9.67 ± 0.33 d
V_2M_1	8.33 ± 0.33 cd	9.00 ± 0.00 d	10.00 ± 0.00 d
V_2M_2	9.00 ± 0.00 bc	10.00 ± 0.00 bc	11.00 ± 0.00 bc
V_2M_3	10.00 ± 0.00 a	11.00 ± 0.00 a	13.33 ± 0.33 a
V_3M_0	7.67± 0.33 d	8.67 ± 0.33 d	9.67 ± 0.33 d
V_3M_1	8.00 ± 0.00 d	9.00 ± 0.00 d	10.00 ± 0.00 d
V_3M_2	9.00 ± 0.00 bc	10.0 ± 0.00 bc	11.00 ± 0.00 bc
V_3M_3	9.33 ± 0.33 ab	10.00 ± 0.00 bc	11.33 ± 0.33 b
Significant level	***	***	***

4.3 Leaf length

Effect of cultivar on length of leaf

Cultivar is an important factor considering leaf length. Under the present study, the Length of leaves was significantly influenced by different varieties of Kohlrabi at different days after transplanting (DAT) (Figure: 6 and Appendix X-XII). Results showed that the cultivar White Vienna (V_2) was evident for maximum leaf length at all growth stagess. Leaves' length was recorded at different stagess of growth i.e. 25, 35, 45, and at harvest day after transplanting (DAT).

Leaf length varied significantly in different cultivars. During the period of 25 DAT maximum leaf length (23.53 cm) as observed in White Vienna (V_2) while the minimum (22.82 cm) was obtained from Quick star (V_1). During the period of 35 DAT maximum leaf length (25.2 cm) was observed in White Vienna (V_2) while the minimum (24.9 cm) was obtained from Early 005 (V_3) and in cultivar Quick star (V_1) was found (24.2 cm) which is statistically similar to cultivar (V_3). During the period of 45 DAT maximum leaf length (26.9 cm) was observed in White Vienna (V_2) while the minimum (25.9 cm) was obtained from a cultivar of Quick star (V_1).

The variation in leaves length among Kohlrabi varieties might be due to congenial environment to express the dominant genes in the genotypes and different genetic makeup of the varieties.

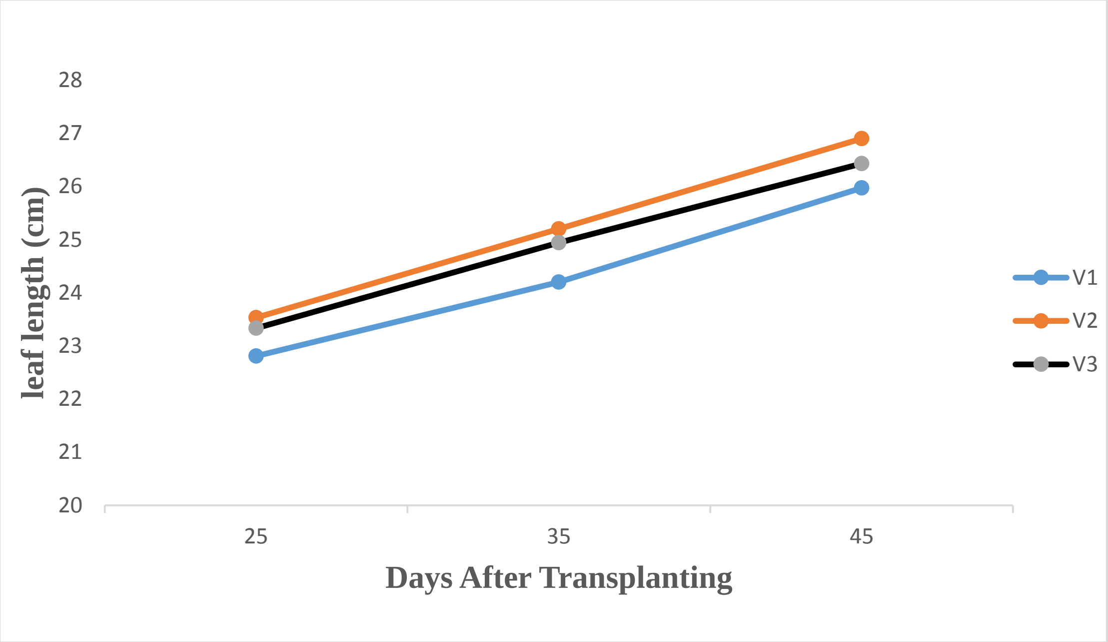


Figure 6: Effect of Kohlrabi Cultivars on leaf length
Here, (V_1 = Quick Star, V_2 = White Vienna, V_3 = Early 005)

Effect of vermicompost on length of leaf

Different levels of vermicompost application exposed significant variation on the length of the leaf. Fertilizer is the most important factor in achieving the best yield of the crop. Leaf length was significantly affected by different levels of vermicompost under the present study (Figure: 7 and Appendix X-XII). The length of the leaf was the maximum with the maximum dose of vermicompost (M_3) at different growth stagess of different varieties of kohlrabi cultivars. During the period of plant growth, the maximum length of leaf (25.64 cm) was observed in vermicompost treatment (M_3) while the minimum leaf length (20.4 cm) was obtained from the control treatment (M_0) at 25 days after transplanting. At 35 DAT the maximum leaf length (27.28 cm) was observed in vermicompost treatment (M_3) while the minimum leaf length (22.4 cm) was obtained from the control treatment (M_0). At 45 DAT the maximum length leaf (29.15 cm) was observed in vermicompost treatment (M_3) while the minimum leaf length (24.00 cm) was obtained from the control treatment (M_0).

All the treatments recorded more leaves length with higher doses of vermicompost as compared to the control because Vermicompost contains a higher percentage of available nutrients (Edwards and Burrows 1988), humic acid (Senesi et al. 1992), substances that encourage plant growth such as auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah 1986), bacteria, enzymes, and vitamins that solubilize N-fixing and P (Ismail 1997). Vermicompost is a rich source of both macro and micronutrients, vitamins, growth hormones, and enzymes, and derived from earthworms (Bhavalkar 1991).

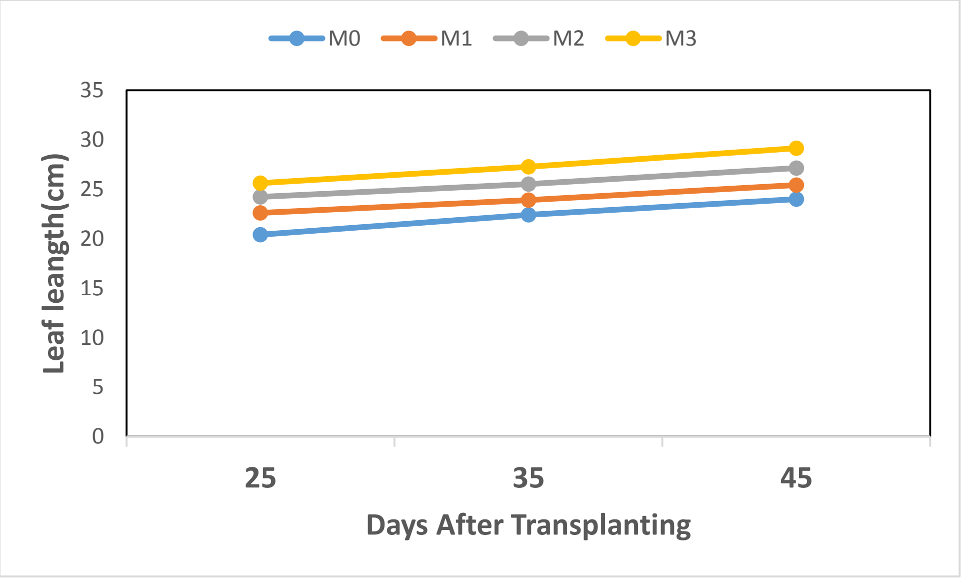


Figure 7: Effect of Vermicompost on leaf length
Here. M_0 = Control, M_1 = 6 t/ha, M_2 = 8 t/ha, M_3 =10 t/ha

Interaction effect of cultivar and vermicompost on Length of leaves:

Significant variation was observed in the length of leaves with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table: 3 and appendix X-XII). Different treatment combination viewed different length of the stem. It was observed that the maximum leaf length (26.2 cm) was observed with the V_2M_3 treatment combination, which was statistically similar to the treatment V_1M_3 combination.

On the other hand, the minimum leaf length (20.3 cm) was observed with the V_3M_0 treatment combination, which was statistically identical with V_2M_0 and V_1M_0 treatment combination at 25 DAT. At 35 DAT maximum leaf length (28.53 cm) was observed with V_2M_3 treatment combination, which was statistically similar with treatment V_1M_3 combination On the other hand, the minimum leaf length (21.73 cm) was observed with V_2M_0 treatment combination, which was statistically identical with V_2M_0 and V_1M_0 treatment combination. . At 45 DAT maximum leaf length (31.07 cm) was observed with V_2M_3 treatment combination, On the other hand, the minimum leaf length (22.87 cm) was observed with V_2M_0 treatment combination, which was statistically identical with V_2M_0 and V_1M_0 treatment combination.

Table 3: Interaction effect of Cultivar and different levels of Vermicompost on leaf length at different growth stages of kohlrabi.

Treatment combinations	Leaf length at different days after transplanting (DAT)		
	25	35	45
V_1M_0	20.53 ± 0.93 e	23.03 ± 1.69 fg	24.93 ± 1.63 def
$V_1 M_1$	22.46 ± 0.44 d	23.13 ± 0.59 fg	24.93 ± 0.68 def
$V_1 M_2$	23.60 ± 0.52 bcd	24.47 ± 0.65 cde	26.07 ± 0.13 cde
$V_1 M_3$	24.67 ± 0.37 abc	26.20 ± 0.20 ad	27.93 ± 0.47 bc
$V_2 M_0$	20.40 ± 0.91 e	21.73 ± 1.12 fg	22.87 ± 1.10
$V_2 M_1$	22.67 ± 0.47 cd	24.00 ± 0.41 def	25.40 ± 0.20 de
$V_2 M_2$	24.87 ± 0.40 ab	26.53 ± 0.17 abc	28.26 ± 0.40 bc
$V_2 M_3$	26.20 ± 0.50 a	28.53 ± 0.70 a	31.06 ± 1.04 a
$V_3 M_0$	20.33 ± 1.24 e	22.47 ± 0.59 fg	24.20 ± 0.34 f
$V_3 M_1$	22.73 ± 0.58 cd	24.60 ± 0.72 cde	26.00 ± 0.11 cde
$V_3 M_2$	24.20 ± 0.20 ad	25.60 ± 0.41 bcd	27.06 ± 0.35 bcd
$V_3 M_3$	26.06 ± 0.27 a	27.10 ± 0.40 ab	28.47 ± 0.17 b
Significant level	***	***	***

4.4 Leaf breadth

Effect of cultivar on breadth of leaf

Cultivar is an important factor considering leaf breadth. Under the present study, the Breadth of leaves was significantly influenced by different varieties of Kohlrabi at different days after transplanting (DAT) (Figure: 8 and Appendix XIII-XV). Results showed that the cultivar White Vienna (V_2) was evident for maximum leaf breadth at all growth stagess. Leaves number was recorded at different stagess of growth i.e. 25, 35, 45, and at harvest day after transplanting (DAT). Leaf breadth varied significantly in different cultivars. During the period of 25 DAT leaf breadth (10.16 cm) was observed in White Vienna (V_2) while the minimum (8.39 cm) was obtained from a cultivar Quick star (V_1). During the period of 35 DAT maximum leaf breadth (13.67 cm) was observed in White Vienna (V_2) while the minimum (12.23 cm) was obtained from Early 005 (V_3) and in cultivar Quick star (V_1) was found (12.23 cm) which is statistically similar to cultivar (V_3). During the period of 45 DAT maximum leaf breadth (14.85 cm) was observed in White Vienna (V_2) while the minimum (13.25 cm) was obtained from Early 005 (V_3) and in cultivar Quick star (V_1) was found (13.71 cm).

The variation in leaf breadth among Kohlrabi varieties might be due to congenial environment to express the dominant genes in the genotypes and different genetic makeup of the varieties.

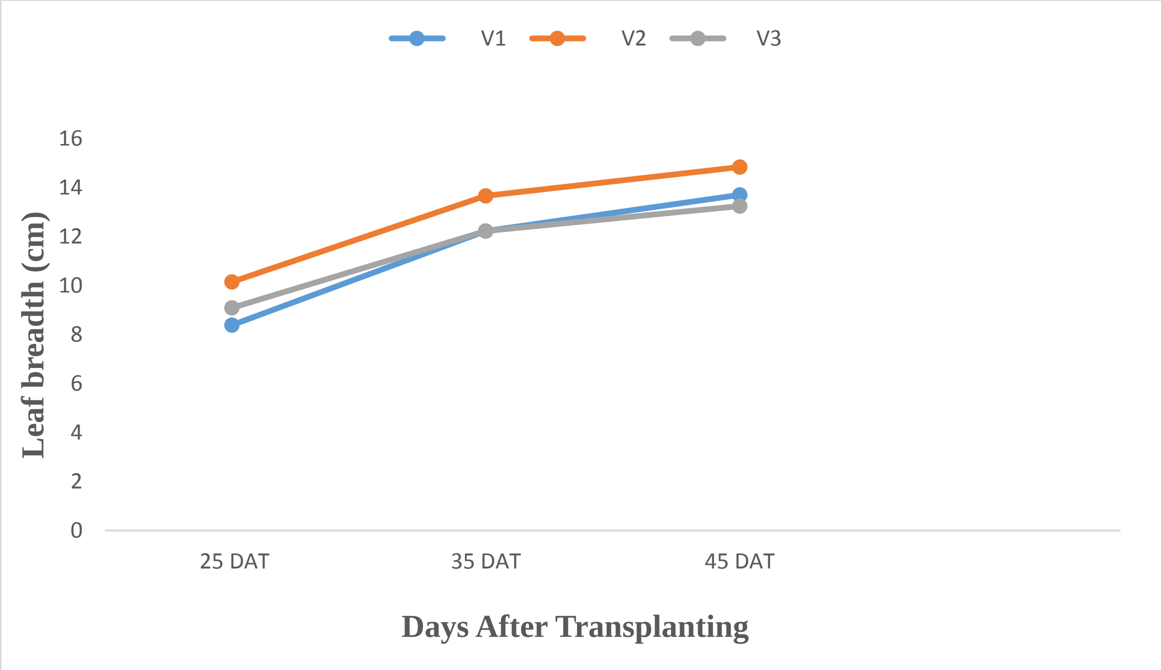


Figure 8: Effect of Kohlrabi Cultivars on leaf breadth
(V_1 = Quick Star, V_2 = White Vienna, V_3 = Early 005)

Effect of vermicompost on breadth of leaf:

Different levels of vermicompost application exposed significant variation on the breadth of leaf. Fertilizer is the most important factor in achieving the best yield of the crop. Leaf breadth was significantly affected by different levels of vermicompost under the present study (Figure: 9 and Appendix XIII-XV). Breadth of leaf was the maximum with a dose of vermicompost (M_3) at different growth stagess of different varieties of kohlrabi cultivars. During the period of plant growth, the maximum breadth of leaf (10.48 cm) was observed in vermicompost treatment (M_3) while the minimum leaf breadth (7.89 cm) was obtained from the control treatment (M_0) at 25 days after transplanting. At 35 DAT the maximum breadth of leaf (14.53 cm) was observed in vermicompost treatment (M_3) while the minimum leaf breadth (11.18 cm) was obtained from the control treatment (M_0).

At 45 DAT the maximum breadth of leaf (15.84 cm) was observed in vermicompost treatment (M_3) while the minimum leaf breadth (12.18 cm) was obtained from the control treatment (M_0).

All the treatments recorded more leaves breadth with higher doses of vermicompost as compared to the control because Vermicompost contains a higher percentage of available nutrients (Edwards and Burrows 1988), humic acid (Senesi et al. 1992), substances that encourage plant growth such as auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah 1986), bacteria, enzymes, and vitamins that solubilize N-fixing and P (Ismail 1997). Vermicompost is a rich source of both macro and micronutrients, vitamins, growth hormones, and enzymes, and derived from earthworms (Bhavalkar 1991).

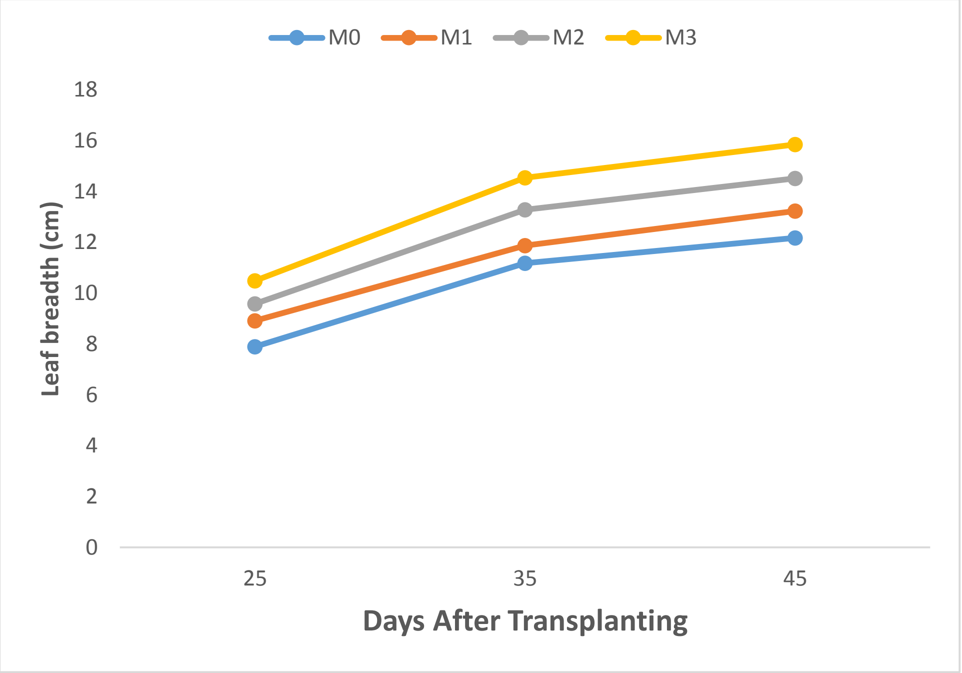


Figure 9: Effect of Vermicompost on leaf breadth

Here. M_0 = Control, M_1 = 6 t/ha, M_2 = 8 t/ha, M_3 =10 t/ha

Interaction effect of cultivar and vermicompost on breadth of leaves:

Significant variation was observed in breadth of leaves with interaction effect of kohlrabi varieties and different levels of vermicompost under the present study

(Table: 4 and appendix XIII-XV). Different treatment combination viewed different breadth of leaf. It was observed that the maximum leaf breadth (12.00 cm) was observed with V_2M_3. On the other hand, the minimum leaf breadth (7.13 cm) was observed with V_1M_0 treatment combination, which was statistically identical with V_2M_0 25 DAT.

At 35 DAT maximum leaf breadth (16.07 cm) was observed with V_2M_3. On the other hand, the minimum leaf breadth (10.87 cm) was observed with V_3M_0 treatment combination, which was statistically identical with V_1M_0 treatment combination. At 45 DAT maximum leaf breadth (17.73 cm) was observed with V_2M_3 treatment combination, On the other hand, the minimum leaf breadth (11.60cm) was observed with V_3M_0 treatment combination.

Table 4: Interaction effect of Cultivar and different levels of Vermicompost on leaf breadth at different growth stages of kohlrabi.

Treatment combinations	Leaf breadth after transplanting (days)		
	25	35	45
$V_1 M_0$	7.13 ± 0.37 e	10.93 ± 0.40 d	12.47± 0.24 ef
$V_1 M_1$	8.20 ± 0.34 de	11.53 ± 0.13 cd	13.00 ± 0.46 de
$V_1 M_2$	8.83 ± 0.49 cd	12.60 ± 0.34 bc	14.40 ± 0.30 bc
$V_1 M_3$	9.40 ± 0.70 bcd	13.87 ± 0.35 b	15.00 ± 0.30 bc
$V_2 M_0$	8.20 ± 0.20 de	11.73 ± 0.58 cd	12.46 ± 0.35 ef
V_2M_1	9.80 ± 0.20 bc	12.67 ± 0.43 bc	13.87 ± 0.54 cd
$V_2 M_2$	10.67 ± 0.35 b	14.20 ± 0.92 b	15.33 ± 0.35 b
$V_2 M_3$	12.00 ± 0.90 a	16.06 ± 0.81 a	17.73 ± 0.52 a
$V_3 M_0$	8.33 ± 0.17 de	10.87 ± 0.13 d	11.60 ± 0.34 f
$V_3 M_1$	8.73 ± 0.29 cd	11.40 ± 0.20	12.80 ± 0.20 ef
$V_3 M_2$	9.27± 0.13 cd	13.00 ± 0.20 bc	13.80 ± 0.30 cd
$V_3 M_3$	10.07 ± 0.29 bc	13.67± 0.59 b	14.80 ± 0.52 bc
Significant level	***	***	***

4.5 Plant canopy

Effect of cultivar on canopy of plant

Cultivar is an important factor considering the canopy of a plant. Under the present study, the canopy of plants was significantly influenced by different varieties of Kohlrabi at different days after transplanting (DAT) (Figure: 10 and Appendix XVI-XVIII). Results showed that the cultivar White Vienna (V_2) was evident for the maximum canopy of plants at all growth stagess. The canopy of plants was recorded at different stagess of growth i.e. 25, 35, and 45 after transplanting (DAT). The canopy of the plant varied significantly in different cultivars. During the period of 25 DAT maximum canopy of the plant (43.73cm) was observed in White Vienna (V_2) while the minimum (40.05 cm) was obtained from Early 005 (V_3) and in cultivar Quick star (V_1) was found (39.6 cm) .During the period of 35 DAT maximum canopy of the plant (47.16 cm) was observed in White Vienna (V_2) while the minimum (43.63 cm) was obtained from Early 005 (V_3) and in cultivar Quick star (V_1) was found (43.71 cm). During the period of 45 DAT maximum canopy of the plant (48.40 cm) as observed in White Vienna (V_2) while the minimum (45.21 cm) was obtained from Early 005 (V_3) and in cultivar Quick star (V_1) was found (45.33 cm).

The variation in plant canopy among Kohlrabi varieties might be due to congenial environment to express the dominant genes in the genotypes and different genetic makeup of the varieties.

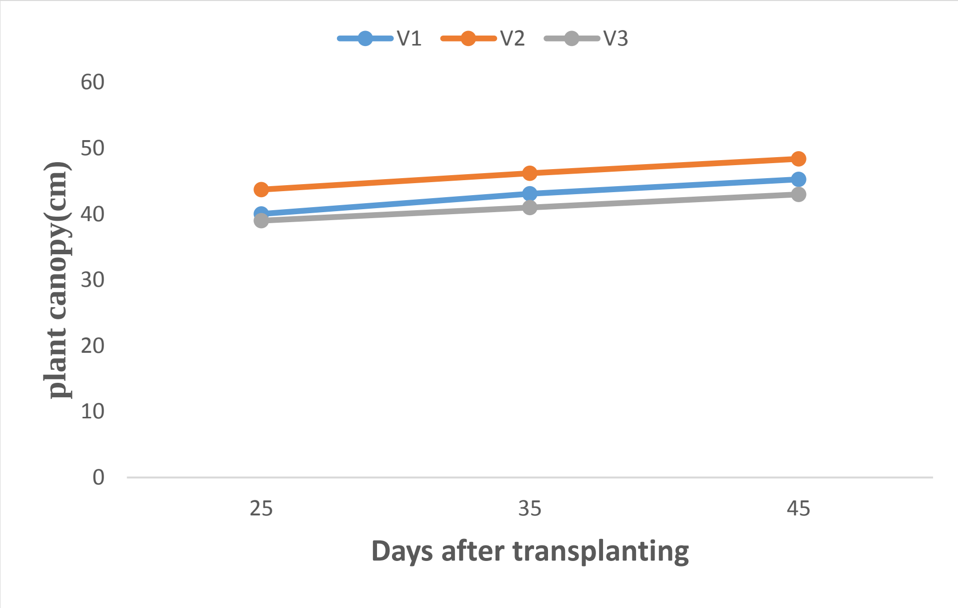


Figure 10: Effect of Kohlrabi Cultivars on plant canopy
(V_1 = Quick Star, V_2 = White Vienna, V_3 = Early 005)

Effect of vermicompost on canopy of plant

Different levels of vermicompost application exposed significant variation on the canopy of the plant. Fertilizer is the most important factor in achieving the best yield of the crop. The canopy of the plant was significantly affected by different levels of vermicompost under the present study (Figure: 11 and Appendix XVI-XVIII). The canopy of the plant was the maximum with a maximum dose of vermicompost (M_3) at different growth stagess of different varieties of kohlrabi cultivars. During the period of plant growth, the maximum canopy of the plant (44.17 cm) was observed in vermicompost treatment (M_3) while the minimum canopy of the plant (37.31 cm) was obtained from the control treatment (M_0) at 25 days after transplanting. At 35 DAT the maximum canopy of the plant (46.53 cm) was observed in vermicompost treatment (M_3) while the minimum canopy of the plant (41.22 cm) was obtained from the control treatment (M_0). At 45 DAT the maximum canopy of the plant (49.75 cm) was observed in vermicompost treatment (M_3) while the minimum canopy of the plant (42.87 cm) was obtained from the control treatment (M_0).

All the treatments recorded more canopy with higher doses of vermicompost as compared to the control because Vermicompost contains a higher percentage of available nutrients (Edwards and Burrows 1988), humic acid (Senesi et al. 1992), substances that encourage plant growth such as auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah 1986), bacteria, enzymes, and vitamins that solubilize N-fixing and P (Ismail 1997). Vermicompost is a rich source of both macro and micronutrients, vitamins, growth hormones, and enzymes, and derived from earthworms (Bhavalkar 1991).

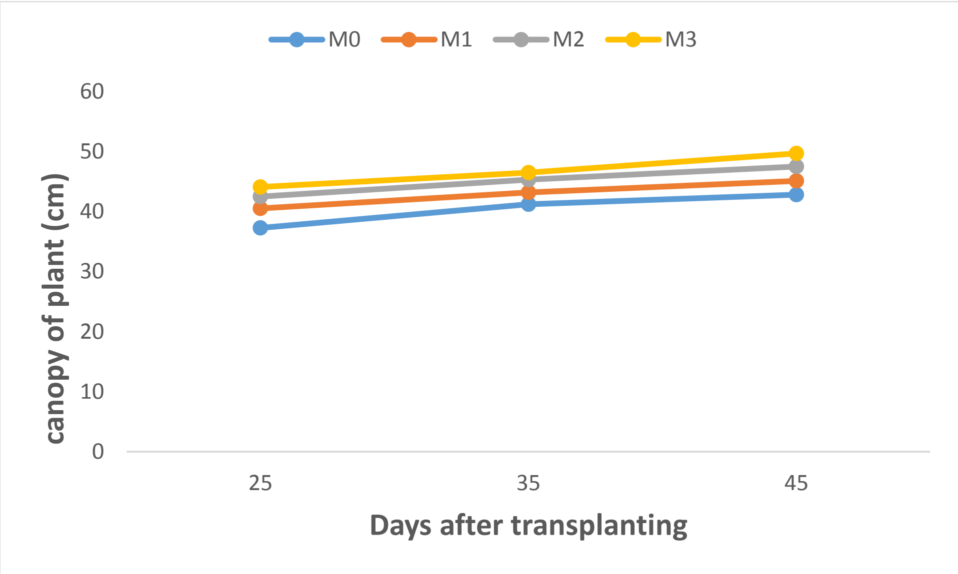


Figure 11: Effect of Vermicompost on canopy of plant

Here. M_0 = Control, M_1 = 6 t/ha, M_2 = 8 t/ha, M_3 =10 t/ha

Interaction effect of cultivar and vermicompost on canopy of plant

Significant variation was observed in the canopy of the plant with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table: 5 and Appendix XVI-XVIII). Different treatment combinations viewed different canopy of the plant. It was observed that the maximum canopy of the plant (47.00 cm) was observed with V_2M_3. On the other hand, the minimum canopy of the plant (35.33 cm) was observed with the V_1M_0 treatment combination, which was statistically identical with the V_2M_0 and V_1M_0 treatment combination at 25 DAT. At 35 DAT maximum canopy of the plant

(50.00 cm) was observed with V_2M_3. On the other hand, the minimum canopy of the plant (39.6 cm) was observed with V_3M_0 treatment combination, which was statistically identical with V_1M_0 treatment combination. . At 45 DAT maximum canopy of the plant (53.33 cm) was observed with V_2M_3 treatment combination, On the other hand, the minimum leaf number (41.8 cm) was observed with V_3M_0 treatment combination, which was statistically identical with and V_1M_0 treatment combination.

Table 5: Interaction effect of Cultivar and different levels of Vermicompost on canopy at different growth stages of kohlrabi.

Treatment combinations	Canopy(cm)		
	25 (DAT)	35(DAT)	45 (DAT)
V_1M_0	36.40 ± 1.83 ef	40.93 ± 1.31 ef	42.20 ± 1.20 e
V_1M_1	39.93 ± 0.75 cd	43.46 ± 0.63 cde	45.20 ± 0.41 cd
V_1M_2	41.53 ± 1.18 bcd	44.06 ± 0.52 cd	46.53 ± 0.29 bcd
V_1M_3	42.33 ± 1.20 bcd	44.07 ± 1.33 cd	47.40 ± 1.40 bc
V_2M_0	40.20± 0.69 cd	43.13 ± 1.33 cde	44.60 ± 0.60 cde
V_2M_1	42.67 ± 0.43 bcd	44.33 ± 0.59 cd	46.43 ± 0.67 bcd
V_2M_2	45.06 ± 0.07 ab	47.67 ± 0.77 ac	49.27 ± 0.59 b
V_2M_3	47.00 ± 0.57 a	50.00 ± 1.15 a	53.33 ± 1.76 a
V_3M_0	35.33 ± 0.57 f	39.60 ± 1.00 f	41.80 ± 1.11 e
V_3M_1	38.93 ± 1.67 de	42.00 ± 0.23 def	43.73 ± 0.13 de
V_3M_2	40.93 ± 0.83 cd	44.33 ± 0.94 cd	46.80 ± 0.92 bc
V_3M_3	43.20 ± 0.34 bc	45.53 ± 0.65 bc	48.53 ± 0.33 b
Significant level	***	***	***

4.6 Fresh weight of knob

Effect of cultivar on fresh weight of knob

Cultivar is an important factor considering the fresh weight of the knob. Under the present study, the fresh weight of knobs was significantly influenced by different varieties of Kohlrabi (Table: 6 and Appendix XIX). Results showed that the cultivar White Vienna (V_2) was evident for the maximum fresh weight of knob. The fresh weight of knobs was recorded after harvesting the crops. The fresh weight of the knob varied significantly in different cultivars. Maximum Fresh weight of knob (180.94 g) was observed in White Vienna (V_2) while the minimum (140.80g) was obtained from Early 005 (V_3) and in cultivar Quick star (V_1) was found (153.47g).

Effect of vermicompost on fresh weight of knob

Different levels of vermicompost application showed significant variation on fresh weight of knob. Fresh weight of knob was significantly affected by different levels of vermicompost under the present study (Table: 7 and Appendix XIX).It is evident that fresh weight of knob was the maximum with dose of vermicompost (M_3) treatment. Maximum fresh weight of knob (209.98g) was observed in vermicompost treatment (M_3) while the minimum fresh weight of knob (112.07g) was obtained from the control treatment (M_0).

Interaction effect of cultivar and vermicompost on fresh weight of knob

Significant variation was observed in the fresh weight of knob with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table: 8 and Appendix XIX). Different treatment combination viewed different fresh weight of knob. It was observed that the maximum fresh weight of knob (260.67g) was observed with V_2M_3. On the other hand, the minimum fresh weight of knob (103.6g) was observed with a V_3M_0 treatment combination, which was statistically identical with V_2M_0 and V_1M_0 treatment combination.

4.7 Dry weight of knob

Effect of cultivar on dry weight of knob

Cultivar is an important factor considering the dry weight of the knob. Under the present study, the dry weight of knobs was significantly influenced by different varieties of Kohlrabi (Table: 6 and Appendix XX).Results showed that the cultivar White Vienna (V_2) was evident for the maximum dry weight of the knob. The dry weight of knobs was recorded after harvesting the crops. The dry weight of the knob varied significantly in different cultivars. Maximum Dry weight of knob (6.17g) was observed in cultivar Quick star (V_1) while the minimum (5.67g) was obtained from Early 005 (V_3) and in White Vienna (V_2) dry wt. of the knob was found (5.67g) which is statistically similar to (V_3).

Effect of vermicompost on dry weight of knob

Different levels of vermicompost application showed a significant variation in the dry weight of the knob. The dry weight of the knob was significantly affected by different levels of vermicompost under the present study (Table:7 and Appendix XX) .It is evident that the dry weight of the knob was the maximum with a dose of vermicompost (M_3) treatment. The maximum dry weight of knob (6.44g) was observed in vermicompost treatment (M_3) while the minimum dry weight of knob (4.89g) was obtained from the control treatment (M_0).

Interaction effect of cultivar and vermicompost on dry weight of knob

Significant variation was observed in the dry weight of knob with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table: 8 and Appendix XX). Different treatment combination viewed different dry weight of knob. It was observed that the maximum dry weight of knob (6.67g) was observed with V_2M_3. On the other hand, the minimum dry weight of knob (4.67g) was observed with the V_3M_0 treatment combination.

4.8 Diameter of knob

Effect of cultivar on diameter of knob

Cultivar is an important factor considering the diameter of the knob. Under the present study, the diameter of knobs was significantly influenced by different varieties of Kohlrabi (Table: 6 and Appendix XXI). Results showed that the cultivar of White Vienna (V_2) was evident for the maximum diameter of the knob. The diameter of knobs was recorded after harvesting the crops. The diameter weight of the knob varied significantly in different cultivars. Maximum Diameter of the knob (7.53cm) was observed in cultivar White Vienna (V_2) while the minimum (6.73cm) was obtained from Early 005 (V_3) and in Quick star (V_1) diameter of the knob was found (6.96 cm).

Table 6: Effect of varieties on fresh weight of knob, dry weight of knob and diameter of knob at different growth stages of kohlrabi

Treatment	Fresh wt. of knob	Dry wt. of knob	Diameter of knob
V_1	153.46 ± 9.46	6.16 ± 0.29	6.96 ± 0.16 b
V_2	180.94 ± 16.56	5.66 ± 0.33	7.53 ± 0.18 a
V_3	140.80 ± 9.08	5.66 ± 0.22	6.73 ± 0.19 b
Significant level	Non-significant	Non-significant	***

Effect of vermicompost on diameter of knob

Different levels of vermicompost application showed a significant variation in the diameter of the knob. The diameter of the knob was significantly affected by different levels of vermicompost under the present (Table: 67and Appendix XXI).The diameter of the knob was the maximum with a dose of vermicompost (M_3) treatment. The maximum diameter of the knob (7.79 cm) was observed in vermicompost treatment (M_3) while the minimum diameter of knob (6.41 cm) was obtained from the control treatment (M_0).

Table 7: Effect of different levels of vermicompost on fresh weight of knob, dry weight of knob and diameter of knob at different growth stages of kohlrabi.

Treatment	Fresh wt. of knob	Dry wt. of knob	Diameter of knob
M_0	112.06 ± 6.64 d	4.89± .35 b	6.41± 0.15 c
M_1	141.11 ± 7.34 c	5.78 ± .22 a	6.82± 0.16 bc
M_2	170.45 ± 6.07 b	6.22± .22 a	7.28± 0.10 b
M_3	209.97 ± 12.95 a	6.44 ± .29 a	7.78± 0.19 a
Significant level	***	***	***

Interaction effect of cultivar and vermicompost on diameter of knob

Significant variation was observed in the diameter of the knob with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table: 8 and Appendix XXI). Different treatment combination viewed different diameter of the knob. It was observed that the maximum diameter of the knob (8.49 cm) was observed with V_2M_3. On the other hand, the minimum diameter of the knob (6.02 cm) was observed with the V_3M_0 treatment combination, which was statistically identical with the V_2M_0 treatment combination.

Table 8: Interaction effect of Cultivar and different levels of Vermicompost on Fresh wt. of knob, Dry wt. of knob and Diameter of knob

Treatment combinations	Fresh weight of knob	Dry weight of knob	Diameter of knob
$V_1 M_0$	112.53 ± 2.03 fg	5.33 ± 0.67 ab	6.34 ± 0.16 ef
$V_1 M_1$	134.40± 2.80 def	6.00 ± 0.00 ab	6.82 ± 0.03 de
$V_1 M_2$	178.06 ± 1.55 bc	6.67 ± 0.67 a	7.22 ± 0.24 bcd
$V_1 M_3$	188.86 ± 3.02 b	6.67± 0.67 a	7.48± 0.31 bc
$V_2 M_0$	120.06 ± 19.08 efg	4.67 ± 0.67 b	6.87 ± 0.05 cde
V_2M_1	158.40 ± 16.69 cd	5.33 ± 0.67 ab	7.26 ± 0.02 bcd
$V_2 M_2$	184.63 ± 8.39 bc	6.00 ± 0.00 ab	7.51 ± 0.07 b
$V_2 M_3$	260.67 ± 5.71 a	6.67 ± 0.67 a	8.4933 ± 0.04 a
$V_3 M_0$	103.60 ± 9.67 g	4.67 ± 0.67 b	6.02 ± 0.28 f
$V_3 M_1$	130.53 ± 11.53 dg	6.00 ± 0.00 ab	6.39 ± 0.34 ef
$V_3 M_2$	148.67 ± 1.85 de	6.00 ± 0.00 ab	7.10 ± 0.14 bcd
$V_3 M_3$	180.40 ± 5.21 bc	6.00 ± 0.00 ab	7.39 ± 0.08 bcd
Significant level	***	Non-significant	***

4.9 Fresh weight of root

Effect of cultivar on fresh weight of root

Cultivar is an important factor considering fresh weight of root. Under the present study, fresh weight of roots was significantly influenced by different varieties of Kohlrabi (Table: 9 and Appendix XXII).Results showed that the cultivar White Vienna (V_2) was evident for maximum fresh weight of root. Fresh weight of roots was recorded after harvesting the crops. Fresh weight of root varied significantly in different cultivars. Maximum Fresh weight of root (3.55g) was observed in White Vienna ($V_{2)}$ while the minimum (2.85g) was obtained from Early 005 (V_3) and in cultivar Quick star ($V_{1)}$ was found (3.14g).

Effect of vermicompost on fresh weight of root

Different levels of vermicompost application showed a significant variation in the fresh weight of root. The fresh weight of root was significantly affected by different levels of vermicompost under the present study (Table: 10 and Appendix XXII). The fresh weight of root was the maximum with a dose of vermicompost (M_3) treatment. A maximum fresh weight of root (3.76g) was observed in vermicompost treatment (M_3) while the minimum fresh weight of root (2.71g) was obtained from the control treatment (M_0).

Interaction effect of cultivar and vermicompost on fresh weight of root

Significant variation was observed in the fresh weight of root with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (table: 11 and appendix XXII).. Different treatment combination viewed different fresh weight of root. It was observed that the maximum fresh weight of root (4.3g) was observed with V_2M_3. On the other hand, the minimum fresh weight of root (2.5g) was observed with the V_3M_0 treatment combination, which was statistically identical with the V_2M_0 and V_1M_0 treatment combination.

4.10 Root length (cm)

Effect of cultivar on root length

Cultivar is an important factor considering root length. Under the present study, root length was significantly influenced by different varieties of Kohlrabi (Table: 9 and Appendix XXIII). Results showed that the cultivar of White Vienna (V_2) was evident for maximum root length. Root length was recorded after harvesting the crops with a measuring scale. Root length varied significantly in different cultivars. Maximum Root length (7.33 cm) was observed in White Vienna (V_2) while the minimum (6.58cm) was obtained from Early 005 (V_3) and in cultivar Quick star (V_1) was found (6.73 cm).

Effect of vermicompost on root length

Different levels of vermicompost application showed a significant variation on root length. Root length was significantly affected by different levels of vermicompost under the present study (Table: 10 and Appendix XXIII). Root length was the maximum with the maximum dose of vermicompost (M_3) treatment. Maximum root length (7.7 cm) was observed in vermicompost treatment (M_3) while the minimum root length (6.03 cm) was obtained from the control treatment (M_0).

Interaction effect of cultivar and vermicompost on root length

Significant variation was observed in root length with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table: 11 and Appendix XXIII). It was observed that the maximum root length (8.33 cm) was observed with V_2M_3. On the other hand, the minimum root length (5.83 cm) was observed with the V_3M_0 treatment combination.

4.11 Fresh wt. of knob with leaf

Effect of cultivar on fresh wt. of knob with leaf

Under the present study, fresh wt. of the knob with leaf was significantly influenced by different varieties of Kohlrabi (Table: 9 and Appendix XXIV). Results showed that the cultivar of White Vienna (V_2) was evident for maximum fresh wt. of the knob with leaf. Fresh wt. of the knob with leaf was recorded after harvesting the crops by weight machine. Fresh wt. of the knob with leaf varied significantly in different cultivars. Maximum fresh wt. of the knob with leaf (243.18g) was observed in cultivar White Vienna (V_2) while the minimum (213.38 g) was obtained from Early 005 (V_3) and in Quick star (V_1) fresh wt. of the knob with leaf was found (232 g).

The variation in fresh wt. of knob with leaf Kohlrabi varieties might be due to congenial environment to express the dominant genes in the genotypes and different genetic makeup of the varieties.

Table 9: Effect of cultivars on fresh weight of root, root length and knob weight with leaf at different growth stages of kohlrabi

Treatment	Fresh wt. of root	Root Length	Knob wt. with leaf
V_1	3.14 ± 0.10 b	6.73 ± 0.21 ab	232.00 ± 12.80 b
V_2	3.55 ± 0.18 a	7.33 ± 0.24 a	243.18 ± 13.77 ab
V_3	2.85 ± 0.11 b	6.58 ± 0.18 b	213.38 ± 6.80 a
Significant level	***	**	Non-significant

Effect of vermicompost on fresh wt. of knob with leaf

Different levels of vermicompost application showed a significant variation in fresh wt. of the knob with leaf. Fresh wt. of the knob with leaf was significantly affected by different levels of vermicompost under the present study (Table: 10 and Appendix XXIV). It is evident that fresh wt. of the knob with leaf was the maximum with a dose of vermicompost (M_3) treatment. Maximum fresh wt. of the knob with leaf (270.84g) was observed in vermicompost treatment (M_3) while the minimum fresh wt. of the knob with leaf (193.73g) was obtained from the control treatment (M_0).

Table 10: Effect of different levels of vermicompost on fresh weight of root, root length and knob weight with leaf

TREATMENT	Fresh wt. of root	Root Length	Knob wt. with leaf
M_0	2.7111 ± 0.08 c	6.03 ± 0.13 c	193.73 ± 10.19 b
M_1	3.0111 ± 0.13 bc	6.66 ± 0.16 b	204.20 ± 6.44 b
M_2	3.2333 ± 0.15 b	7.14 ± 0.14 b	249.31 ± 9.44 a
M_3	3.7667 ± 0.14 a	7.70± 0.21 a	270.84 ± 8.46 a
Significant level	***	***	***

Interaction effect of cultivar and vermicompost on fresh wt. of knob with leaf

A significant variation was observed in fresh wt. of the knob with leaf with interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table: 11 and Appendix XXIV). Different treatment combination viewed different fresh wt. of the knob with leaf. It was observed that the maximum fresh wt. of the knob with leaf (295.46g) was observed with V_2M_3. On the other hand, the minimum fresh wt. of the knob with leaf (194.0g) was observed with a V_3M_0 treatment combination, which was statistically identical with the V_3M_1 treatment combination.

Table11: Interaction effect of Cultivar and different levels of Vermicompost on Fresh wt. of root, Root length and Knob weight with leaf

Treatment combinations	Fresh weight of root	Root Length	Knob weight with leaf
$V_1 M_0$	2.76 ± 0.18 ef	6.06 ± 0.31 e	205.26 ± 24.74
$V_1 M_1$	3.13 ± 0.17 cde	6.38 ± 0.17 cde	189.20 ± 5.02 ef
$V_1 M_2$	3.13 ± 0.07 cde	7.03 ± 0.17 bc	261.13 ± 19.20 abc
$V_1 M_3$	3.53 ± 0.07 bc	7.46 ± 0.48 b	272.40 ± 9.20 ab
$V_2 M_0$	2.87 ± 0.13 def	6.20 ± 0.17 de	181.93 ± 22.03 f
$V_2 M_1$	3.27 ± 0.29 cd	7.26 ± 0.14 b	228.93 ± 1.22 cde
$V_2 M_2$	3.76 ± 0.21 b	7.53 ± 0.20 b	266.40 ± 5.92 abc
$V_2 M_3$	4.30 ± 0.10 a	8.33 ± 0.17 a	295.46 ± 6.37 a
$V_3 M_0$	2.50 ± 0.05 f	5.83 ± 0.21 e	194.00 ± 3.62 ef
$V_3 M_1$	2.63 ± 0.08 f	6.33 ± 0.12 cde	194.46 ± 2.48 ef
$V_3 M_2$	2.80 ± 0.00 def	6.87 ± 0.23 bcd	220.40 ± 5.68 def
$V_3 M_3$	3.46 ± 0.13 bc	7.3 ± 0.10 b	244.67 ± 9.36 bcd
Significant level	***	***	***

4.12 Dry wt. of root, shoot and leaf

Effect of cultivar on dry weight of root, shoot and leaf

Under the present study, dry wt. of the root, shoot, and leaf was significantly influenced by different varieties of Kohlrabi (Table 12 and Appendix XXV). Results showed that the cultivar White Vienna (V_2) was evident for maximum dry wt. of root shoot and leaf. Dry wt. of root shoot and leaf was recorded after harvesting the crops by weight machine. Dry wt. of the root, shoot, and leaf varied significantly in different cultivars. Maximum Dry wt. of root shoot and leaf (11.25 g) was observed in cultivar White Vienna (V_2) while the minimum (10.58 g) was obtained from Early 005 (V_3) and in Quick star (V_1) dry wt. of the root, shoot, and leaf was found (10.67g).

Effect of vermicompost on dry wt. of root, shoot and leaf

Different levels of vermicompost application showed a significant variation on dry wt. of the root, shoot, and leaf. Dry wt. of the root, shoot, and leaf was significantly affected by different levels of vermicompost under the present study (Table 13 and Appendix XXV). Dry wt. of the root, shoot, and leaf was the maximum with a dose of vermicompost (M_3) treatment. Maximum dry wt. of the root, shoot, and leaf (12.56 g) was observed in vermicompost treatment (M_3) while the minimum dry wt. of the root, shoot, and leaf (9.67 g) was obtained from the control treatment (M_0).

Interaction effect of cultivar and vermicompost on dry wt. of root, shoot and leaf:

Significant variation was observed in dry wt. of the root, shoot, and leaf with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table 14 and Appendix XXV). Different treatment combination viewed different dry wt. of the root, shoot, and leaf.It was observed that the maximum dry wt. of root shoot and leaf (13.67g) was observed with V_2M_3. On the other hand, the minimum dry wt. of the root, shoot, and leaf (9.33g) was observed with the V_1M_0 treatment combination, which was statistically identical with the V_3M_0 treatment combination.

4.13 Yield per plot

Effect of cultivar on yield per plot:

Cultivar is an important factor considering yield per plot. Under the present study, yield per plots was significantly influenced by different varieties of Kohlrabi (Table 12). Results showed that the cultivar of White Vienna (V_2) was evident for maximum yield per plot. Yield per plots was recorded after harvesting the crops. Yield per plot varied significantly in different cultivars. Maximum Yield per plot (2.17 kg) was observed in cultivar White Vienna (V_2) while the minimum (1.69 kg) was obtained from Early 005 (V_3) and in Quick star (V_1) yield per plot was found (1.84 kg).

Table 12: Effect of cultivars on Dry wt. of root, shot and leaf, yield per hacter and yield per plot

Treatment	Dry weight of root, shot and leaf	Yield per hectare	Yield per plot
V_1	10.67 ± 0.35 b	9.59 ± 0.59	1.84 ± 0.11
V_2	11.25 ± 0.47 ab	11.31 ± 1.03	2.17 ± 0.19
V_3	10.58 ± 0.31a	8.80 ± 0.56	1.68 ± 0.10
Significant level	Non-significant	Non-significant	Non-significant

Effect of vermicompost on yield per plot

Different levels of vermicompost application showed a significant variation on yield per plot. Yield per plot was significantly affected by different levels of vermicompost under the present study (Table 13). Yield per plot was the maximum with a dose of vermicompost (M_3) treatment. The maximum yield per plot (2.52 kg) was observed in vermicompost treatment (M_3) while the minimum yield per plot (1.34 kg) was obtained from the control treatment (M_0).

Table 13: Effect of vermicompost on dry wt. of root, shot and leaf, yield per Hectare, and yield per plot

TREATMENT	Dry Wt. of root, shot α leaf	Yield per hectare	Yield per plot
M_0	9.67 ± 0.16 c	7.00 ± 0.41 d	1.34 ± 0.08 d
M_1	10.0 ± 0 .00 c	8.82 ± 0.45 c	1.69 ± 0.08 c
M_2	11.11 ± 0.35 b	10.65 ± 0.37 b	2.04 ± 0.07 b
M_3	12.55 ± 0.29 a	13.12 ± 0.80 a	2.52 ± 0.15 a
Significant level	***	***	***

Interaction effect of cultivar and vermicompost on yield per plot

Significant variation was observed in yield per plot with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table 14). Different treatment combination viewed different yield per plot. It was observed that the maximum yield per plot (3.13kg) was observed with V_2M_3.

On the other hand, the minimum yield per plot (1.24kg) was observed with the V_3M_0 treatment combination.

4.15 Yield per hectare

Effect of cultivar on yield per hectare

Cultivar is an important factor considering yield per hectare. Under the present study, yield per hectares was significantly influenced by different varieties of Kohlrabi (Table 12 and Appendix XXVI). Results showed that the cultivar of White Vienna (V_2) was evident for maximum yield per hectare. Yield per hectares was recorded after harvesting the crops. Yield per hectare varied significantly in different cultivars. Maximum Yield per hectare (11.31t) was observed in cultivar White Vienna (V_2) while the minimum (8.80 t) was obtained from Early 005 (V_3) and in Quick star (V_1) yield per hectare was found (9.59 t). The variation in yield among Kohlrabi varieties might be due to congenial environment to express the dominant genes in the genotypes and different genetic makeup of the varieties.

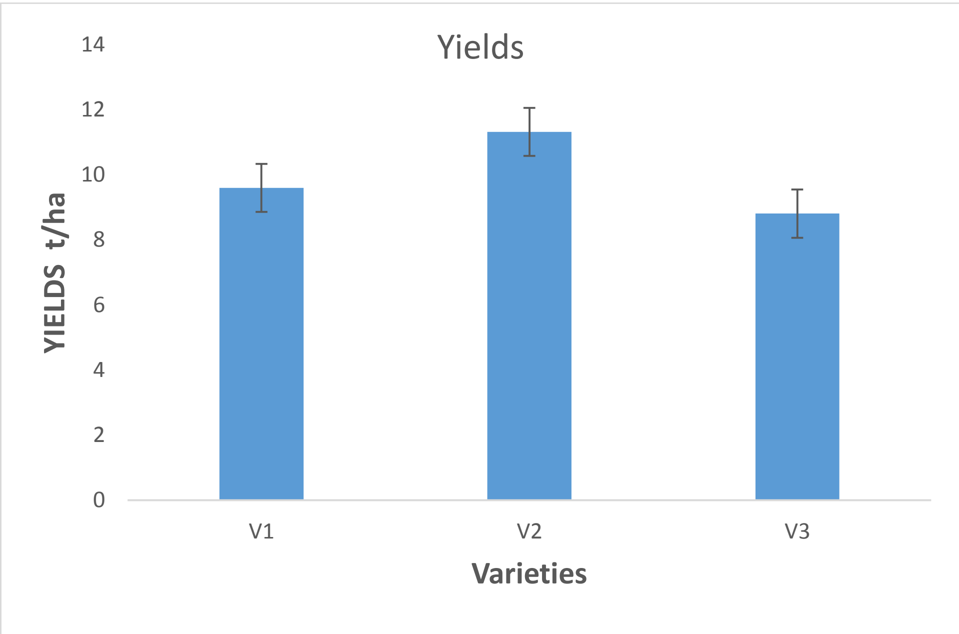


Figure 12: Effect of Kohlrabi Cultivars on Yields.
(V_1 = Quick star, V_2 = White vienna, V_3 = Early 005)

Effect of vermicompost on yield per hectare:

Different levels of vermicompost application showed a significant variation in yield per hectare. Yield per hectare was significantly affected by different levels of vermicompost under the present study (Table 13 and Appendix XXVI). The yield per hectare was the maximum with a dose of vermicompost (M_3) treatment. Maximum yield per hectare (13.12 t) was observed in vermicompost treatment (M_3) while the minimum yield per hectare (7.00 t) was obtained from the control treatment (M_0).

All the treatments recorded more yield with higher doses of vermicompost as compared to the control because Vermicompost contains a higher percentage of available nutrients (Edwards and Burrows 1988), humic acid (Senesi et al. 1992), substances that encourage plant growth such as auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah 1986), bacteria, enzymes, and vitamins that solubilize N-fixing and P (Ismail 1997). Vermicompost is a rich source of both macro and micronutrients, vitamins, growth hormones, and enzymes, and derived from earthworms (Bhavalkar 1991).

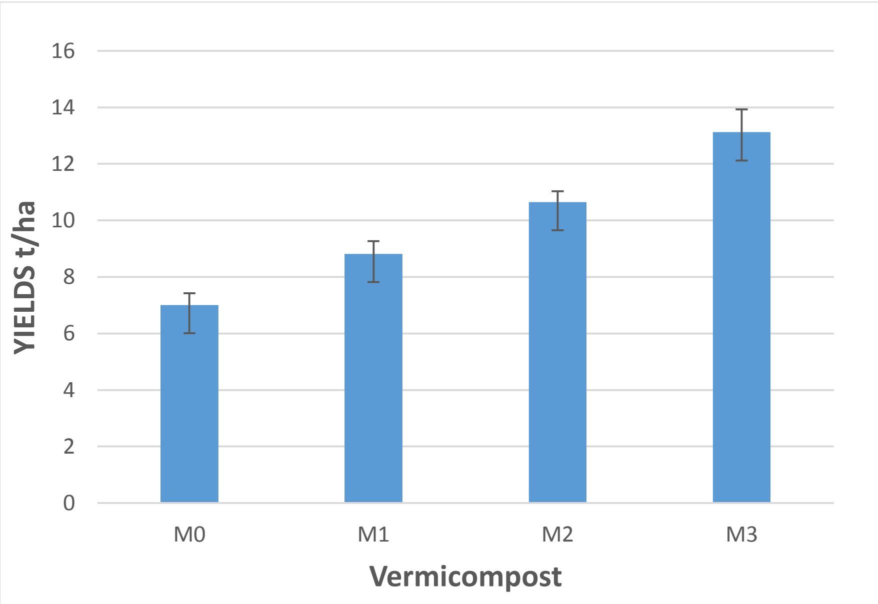


Figure 13: Effect of Vermicompost on Yield.

Here. M_0 = Control, M_1= 6 t/ha, M_2 = 8 t/ha, M_3 =10 t/ha

Interaction effect of cultivar and vermicompost on yield per hectare:

Significant variation was observed in yield per hectare with the interaction effect of kohlrabi varieties and different levels of vermicompost under the present study (Table 14 and Appendix XXVI). Different treatment combination viewed different yield per hectare. It was observed that the maximum yield per hectare (16.29 t) was observed with V_2M_3. On the other hand, the minimum yield per hectare (6.48 t) was observed with the V_3M_0 treatment combination.

Table 14:Interaction effect of Cultivar and different levels of Vermicompost on dry weight of root, shoot and leaf, yield per hectare and yield per plot.

Treatment combinations	Dry Wt. of root, shoot and leaf	Yield per hectare	Yield per plot(kg)
$V_1 M_0$	9.33 ± 0.33 e	7.03 ± 0.12 fg	1.34 ± 0.02 fg
$V_1 M_1$	10.00 ± 0.00 de	8.40 ± 0.17 def	1.610 ± 0.03 def
$V_1 M_2$	11.33 ± 0.67 de	11.13 ± 0.09 bc	2.13 ± 0.01 bc
$V_1 M_3$	12.00 ± 0.00 b	11.80 ± 0.18 b	2.26 ± 0.03 b
$V_2 M_0$	10.00 ± 0.00 de	7.50 ± 1.19 efg	1.44 ± 0.23 efg
V_2M_1	10.00 ± 0.00 bc	9.90 ± 1.04 cd	1.90 ± 0.20 cd
$V_2 M_2$	11.33 ± 0.67 bc	11.54 ± 0.52 bc	2.21 ± 0.10 bc
$V_2 M_3$	13.67 ± 0.33 a	16.29 ± 0.35 a	3.13 ± 0.06 a
$V_3 M_0$	9.67 ± 0.33 de	6.48 ± 0.60 g	1.24 ± 0.11 g
$V_3 M_1$	10.00 ± 0.00 de	8.16 ± 0.72 dg	1.56 ± 0.13 dg
$V_3 M_2$	10.67 ± 0.67 cd	9.29 ± 0.11 de	1.78 ± 0.02 de
$V_3 M_3$	12.00 ± 0.00 b	11.27 ± 0.32 bc	2.16 ± 0.02 bc
Significant level	***	***	***

CHAPTER -V

SUMMARY AND CONCLUSIONS

The experiment was conducted at the Horticultural farm of Sher-e-Bangla Agricultural University to study the influence of vermicompost on the growth and yield of kohlrabi from October 2018 to January 2019. The experiment consisted of two factors. One factor was three kinds of cultivar viz; Quick star (V_1), White Vienna (V_2), Early 005 (V_3), and another factor was four levels of vermicompost viz; control (M_0), 6t/ha(M_1), 8 t/ha (M_2) and 10 t/ha (M_3). The experiment was laid in Randomized Complete Block Design (RCBD) with three replication. There was twelve treatment combination in this experiment. Data on growth and yield parameter were collected and analyzed statistically.

The tallest plant was recorded in cultivar White Vienna (V_2) and that was (24.55 cm, 26.05 cm, and 27.57cm) at 25, 35, and 45 DAT respectively. On the other hand, the shortest plant was founded in the V_3 cultivar (22.9 cm, 24.68 cm, and 26.23cm at 25, 35, and 45 DAT respectively). During the period of plant growth the tallest plant was observed in vermicompost treatment (M_3) (25.6 cm, 27.84 cm, and 29.67 cm at 25, 35, and 45 DAT respectively). The shortest plant was observed in vermicompost treatment (M_0) (21.15 cm, 23.07 cm, and 24.49 cm at 25, 35, and 45 DAT, respectively). In the case of interaction effect at 25, 35, and 45 DAT the tallest plant (26.93 cm, 28.87 cm, and 31.07 cm respectively) was obtained from V_2M_3. While the shortest plant 20.73 cm, 22.6 cm, and 23.87cm respectively was obtained from the V_3M_0

The maximum number of leaves was recorded in White Vienna (V_2) cultivar (8.75, 9.67, and 11. 00) and the minimum number of leaves founded in V_3 cultivar (8.5, 9.41, and 10.50 at 25, 35, and 45 DAT respectively). During the period of plant growth maximum number of leaves was observed in vermicompost treatment (M_3) (9.78, 10.44, and 11.89) and the minimum number of leaves was observed in vermicompost treatment (M_0) (7.67, 8.67, and 9.67) at

25, 35 and 45 DAT respectively). In the case of interaction effect at 25, 35, and 45 DAT maximum number of leaves (10, 11, and 13.33 respectively) was obtained from V_2M_3, while the minimum number of leaves (7.67, 8.67 and 9.67 respectively) was obtained from the V_3M_0. The maximum length of the leaf was recorded in White Vienna (V_2) cultivar (23.33 cm, 24.94 cm and 26.43 cm) and the minimum length of leaf recorded in Early 005 (V_3) (22.82 cm, 24.20 cm, and 25.97 cm) at 25, 35, and 45 DAT respectively. The maximum length of the leaf was recorded in vermicompost treatment (M_3) (25.64 cm, 27.27 cm, and 29.15 cm) and the minimum length of the leaf was recorded in vermicompost M_1 (20.42 cm, 22.41 cm and 24.00 cm) at 25, 35, and 45 DAT respectively. In the case of the interaction effect maximum leaf length (26.2 cm, 28.53 cm and 31.07 cm) was obtained from V_2M_3, while minimum leaf length (20.4 cm, 21.73 cm, and 22.87 cm) was obtained from the V_3M_0 at 25, 35, and 45 DAT.

The maximum breadth of the leaf was recorded in White Vienna (V_2) cultivar (10.17 cm, 13.67 cm and 14.85 cm) and minimum breadth of leaf recorded in Early 005 (V_3) (8.39 cm, 12.23 cm and 13.72 cm) at 25, 35, and 45 DAT respectively. The maximum breadth of the leaf was recorded in vermicompost treatment (M_3) (10.49 cm, 14.53 cm, and 15.84 cm) and the minimum breadth of leaf was recorded in vermicompost M_0 (7.89 cm, 11.18 cm and 12.18 cm) at 25, 35, and 45 DAT respectively. In case of the interaction effect, maximum leaf breadth (12.00 cm, 16.07 cm, and 17.73 cm) was obtained from V_2M_3, while minimum leaf breadth (7.13 cm, 10.87 cm, and 11.60 cm) was obtained from the V_3M_0 at 25, 35, and 45 DAT.

The maximum canopy of the plant was recorded in White Vienna (V_2) cultivar (43.73 cm, 46.28 cm and 48.33 cm) and the Minimum canopy of the plant recorded in Early 005 (V_3) (40.05 cm, 43.13 cm, and 45.33 cm) at 25, 35, and 45 DAT respectively. The maximum canopy of the plant was recorded in vermicompost treatment (M_3) (44.17 cm, 46.53 cm, and 49.75 cm) and the minimum canopy of the plant was recorded in vermicompost M_0 (37.31 cm, 41.22 cm, and 42.87 cm) at 25, 35, and 45 DAT respectively). In the case of interaction effect maximum canopy (47.0 cm, 50.0 cm, and 53.33 cm) was obtained from V_2M_3, while minimum (35.33 cm, 39.6 cm and 41.8 cm) was obtained from the V_3M_0 at 25, 35, and 45 DAT respectively.

The fresh weight of the knob was recorded as maximum (209.98g) in White Vienna (V_2) and minimum (140.80 g) in Early 005 (V_3). With applying vermicompost fresh weight of knob was found maximum (209.98 g) in White Vienna (V_2) and minimum (112.07 g) in Early 005 (V_3). In case of interaction effect maximum fresh wt. of the knob (260.67 g) was obtained from V_2M_3, while minimum (103.60 g) was obtained from the V_3M_0.

The dry weight of the knob was recorded as maximum (6.1g) in Quick star (V_1) and minimum (5.67g) in Early 005 (V_3) and White Vienna (V_2). With applying vermicompost dry weight of knob was found maximum (6.44g) in White Vienna (V_2) and minimum (4.89g) in Early 005 (V_3). In case of interaction effect maximum dry wt. of the knob was (6.67g) obtained from V_2M_3, while minimum (4.67g) was obtained from the V_3M_0.

The diameter of the knob was recorded as maximum (7.53 cm) in White Vienna (V_1) and minimum (6.73 cm) in Early 005 (V_3). Applying the vermicompost Diameter of the knob was found maximum (7.78 cm) in White Vienna (V_2) and minimum (6.41 cm) in Early 005 (V_3). In the case of interaction effect maximum Diameter of the knob was (8.49 cm) obtained from V_2M_3, while a minimum (6.03 cm) was obtained from the V_3M_0.
The fresh weight of root was recorded maximum (2.85g) in White Vienna (V_2) and minimum (2.85g) in Early 005 (V_3). With applying vermicompost fresh weight of root was found maximum (3.77g) in White Vienna (V_2) and minimum (2.71g) in Early 005 (V_3). In case of interaction effect maximum fresh wt. of the root (4.3g) was obtained from V_2M_3, while minimum (2.5g) was obtained from the V_3M_0.

Root length was recorded maximum (7.33 cm) in White Vienna (V_2) and minimum (6.58 cm) in Early 005 (V_3). With applying vermicompost Root length was found maximum (7.7 cm) in White Vienna (V_2) and minimum (6.0 cm) in Early 005 (V_3). In the case of an interaction effect, the maximum length of root (8.33 cm) was obtained from V_2M_3, while minimum (5.83 cm) was obtained from the V_3M_0.

Knob weight with leaf was recorded maximum (243.18g) in White Vienna (V_2) and minimum (213.38g) in Early 005 (V_3). With applying vermicompost Knob weight with leaf was found maximum (270.84g) in White Vienna (V_2) and minimum (193.73g) in Early 005 (V_3). In the case of an interaction effect, maximum Knob weight with leaf (295.46 g) was obtained from V_2M_3, while minimum (194.00 g) was obtained from the V_3M_0.

Dry wt. of the root, shoot and leaf was recorded maximum (11.25 g) in White Vienna (V_2) and minimum (10.58 g) in Early 005 (V_3). By applying vermicompost dry wt. of the root, shoot, and leaf was found maximum (12.55 g) in White Vienna (V_2) and minimum (9.67 g) in Early 005 (V_3). In case of interaction effect maximum dry wt. of the root, shoot, and leaf (13.67 g) was obtained from V_2M_3, while minimum (9.67g) was obtained from the V_3M_0.

Yield per plot was recorded maximum (2.17 kg) in White Vienna (V_2) and minimum (1.68 kg) in Early 005 (V_3). With applying vermicompost yield per plot was found maximum (2.52 kg) in White Vienna (V_2) and minimum (1.34 kg) in Early 005 (V_3). In the case of interaction effect maximum yield per plot (3.13 kg) was obtained from V_2M_3, while minimum (1.24 kg) was obtained from the V_3M_0.

Yield per hectare was recorded maximum (11.31t) in White Vienna (V2) and minimum (8.80 t) in Early 005 (V_3). With applying vermicompost yield per hectare was found maximum (13.12 t) in White Vienna (V_2) and minimum (7.00 t) in Early 005 (V_3). In case of interaction effect maximum yield per hectare (16.29 t) was obtained from V_2M_3, while minimum (6.48 t) was obtained from the V_3M_0.

Conclusion: From the present study it may be concluded that in the case of cultivar White Vienna gave the highest (11.31 t/ha) yield/ha. In the case of vermicompost levels M_3 (10 t/ha) gave the highest (13.12 t/ha) yield/ha. In the case of interaction V_2M_3 (White Vienna × vermicompost @ 10 t/ha) performed the highest 16.29 t/ha than other treatments comprised of other cultivar and vermicompost applications.

Recommendation:

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 trials, the best kohlrabi cultivar could be proposed for commercial cultivation all over the country.

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

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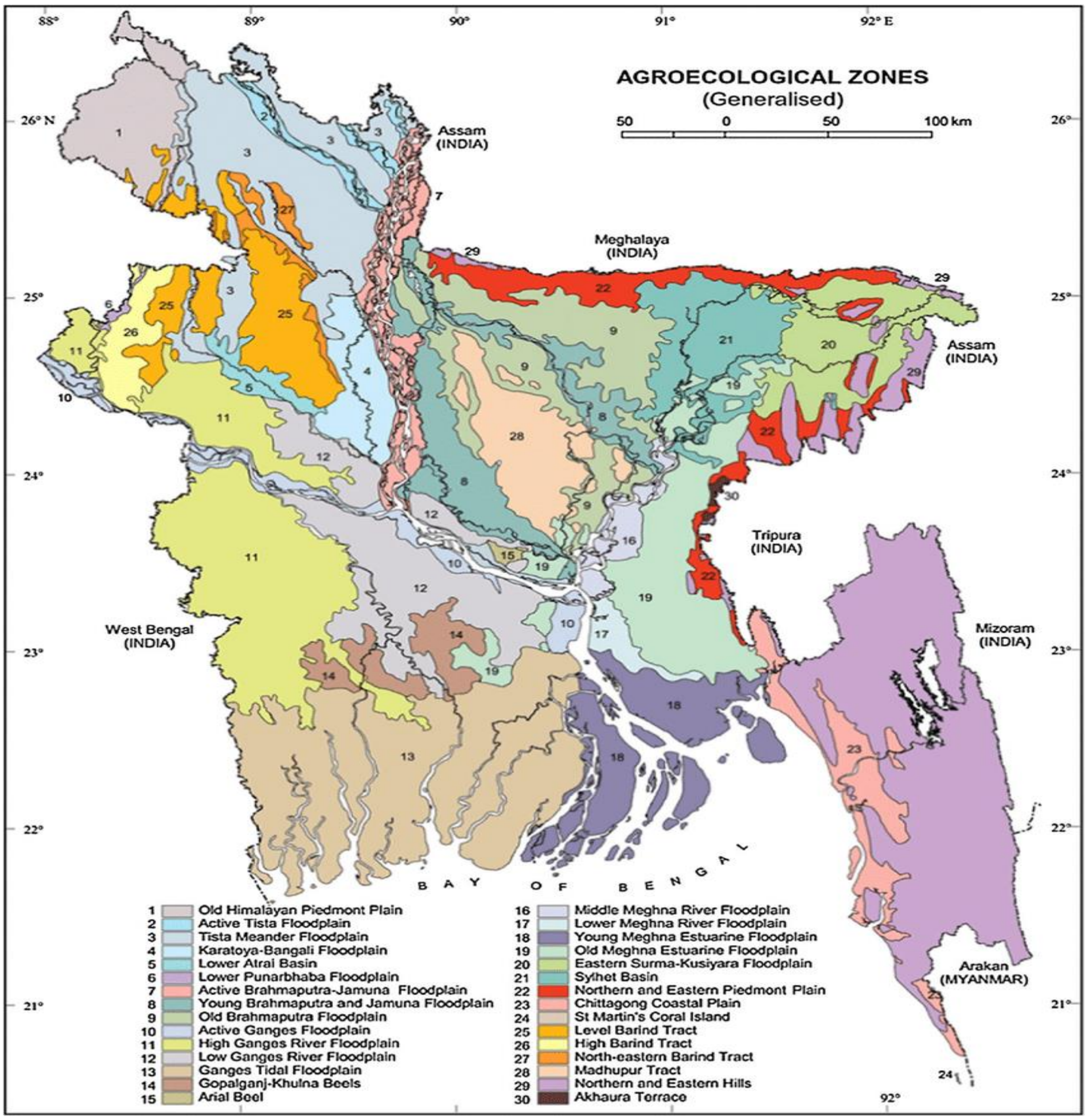
APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location



Appendix ii: Monthly records of air tempertature, relative humidity and rainfall during the period of 2018-2019.

Year	Month	Air temperature (°C)			Relative humidity (%)	Rainfall (mm)
		Max.	Min	Mean		
2018	October	30.42	16.24	23.33	68.48	52.60
2018	November	28.60	8.52	18.56	56.75	14.40
2018	December	25.50	6.70	16.10	54.80	0.0
2019	January	23.80	11.70	17.75	46.20	0.0

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III: Morphological feature ,Physical characteristics and chemical composition of soil of the experimental plot

Morphological features	Characteristics
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur 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
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	Value
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix IV: Analysis of variance of plant height at 25 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	65.769	32.884	8.231	0.001
Vermicompost (M)	3	25.262	8.421	1.563	0.217
Combination (V×M)	11	106.596	9.691	2.555	0.026

Appendix V: Analysis of variance of plant height at 35 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	1.824	0.912	0.169	0.845
Vermicompost (M)	3	57.983	19.328	5.008	0.005
Combination (V×M)	11	64.376	5.852	1.220	0.327

Appendix VI: Analysis of variance of plant height at 45 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	9.376	4.688	0.957	0.394
Vermicompost (M)	3	39.106	13.035	3.162	0.038
Combination (V×M)	11	56.946	5.177	1.089	0.410

Appendix VII: Analysis of variance of Number of leaf at 25 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	8.240	4.120	9.802	0.000
Vermicompost (M)	3	1.212	0.404	0.691	0.608
Combination (V×M)	11	11.283	1.026	2.274	0.045

Appendix VIII: Analysis of variance of Number of leaf at 35 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	7.727	3.863	5.584	0.008
Vermicompost (M)	3	1.724	.575	0 .638	0.596
Combination (V×M)	11	12.720	1.156	1.556	0.176

Appendix IX: Analysis of variance of Number of leaf at 45 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	3.380	1.690	3.794	0.033
Vermicompost (M)	3	1.662	.554	1.080	0.327
Combination (V×M)	11	9.787	0.890	2.575	0.028

Appendix X: Analysis of variance of Leaf Length at 25 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	28.127	14.063	3.050	0.061
Vermicompost (M)	3	45.470	15.157	3.598	0.024
Combination (V×M)	11	82.297	7.4821	1 .833	0.104

Appendix XI: Analysis of variance of Leaf Length at 35 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	5.135	2.568	0.425	0.658
Vermicompost (M)	3	56.860	18.953	4.104	0.014
Combination (V×M)	11	80.300	7.300	1.409	0.232

Appendix XII: Analysis of variance of Leaf Length at 45 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	22.460	11.230	1.683	0.201
Vermicompost (M)	3	66.573	22.191	4.032	0.015
Combination (V×M)	11	102.840	9.349	1.605	0.161

Appendix XIII: Analysis of variance of Leaf Breadth at 25 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	16.676	8.338	6.595	0.004
Vermicompost (M)	3	2.502	0.834	0.478	0.700
Combination (V×M)	11	23.249	2.114	1.443	0.218

Appendix XIV: Analysis of variance of Leaf Breadth at 35 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	67076.062	33538.031	0.997	0.380
Vermicompost (M)	3	102460.981	34153.660	1.017	0.398
Combination (V×M)	11	370975.426	33725.039	1.004	0.471

Appendix XV: Analysis of variance of Leaf Breadth at 45 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	10.349	5.174	3.947	0.029
Vermicompost (M)	3	10.919	3.640	2.728	0.060
Combination (V×M)	11	27.559	2.505	2.308	0.042

Appendix XVI: Analysis of variance of Canopy at 25 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	51.896	25.948	1.135	0.334
Vermicompost (M)	3	258.156	86.052	5.021	0.006
Combination (V×M)	11	419.436	38.131	2.364	0.038

Appendix XVII: Analysis of variance of Canopy at 35 DAT

Source of variance	**Degree of freedom**	**Sum of Square (SS)**	**Mean of Square (MS)**	**F-value**	**P-value**
Varieties (V)	2	111.202	55.601	2.390	0.107
Vermicompost (M)	3	151.594	50.531	2.224	0.104
Combination (V×M)	11	358.492	32.590	1.503	0.194

Appendix XVIII: Analysis of variance of Canopy at 45 DAT

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	230.087	115.043	3.534	0.0412
Vermicompost (M)	3	455.097	151.699	5.716	0.003
Combination (V×M)	11	929.683	84.517	5.414	0.000

Appendix XIX: Analysis of variance of Fresh Weight of Knob

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	1590.394	795.197	1.000	0.379
Vermicompost (M)	3	18511.214	6170.405	21.207	0.000
Combination (V×M)	11	22566.896	2051.536	9.370	0.000

Appendix XX: Analysis of variance of Dry Weight of Knob

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	2.000	1.000	1.000	0.379
Vermicompost (M)	3	12.778	4.259	6.133	0.002
Combination (V×M)	11	16.333	1.485	1.909	0.090

Appendix XXI: Analysis of variance of Diameter Knob

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	5.067	2.533	6.982	0.003
Vermicompost (M)	3	8.225	2.742	9.952	0.000
Combination (V×M)	11	14.212	1.292	10.960	0.000

Appendix XXII: Analysis of variance of Fresh Weight of Root

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	5.387	2.694	14.119	0.000
Vermicompost (M)	3	4.063	1.354	5.688	0.003
Combination (V×M)	11	9.863	0.897	11.824	0.00

Appendix XXIII: Analysis of variance of Root Length

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	8.564	4.282	5.419	0.009
Vermicompost (M)	3	5.270	1.757	1.914	0.147
Combination (V×M)	11	18.961	1.724	2.638	0.023

Appendix XXIV: Analysis of variance of Knob with leaf

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	16743.860	8371.930	2.984	0.064
Vermicompost (M)	3	58311.827	19437.276	12.191	0.000
Combination (V×M)	11	81781.187	7434.653	6.476	0.00

Appendix XXV: Analysis of variance of Dry weight of Shoot, Root and leaf

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	6.000	3.000	2.605	0.089
Vermicompost (M)	3	4.000	1.333	1.067	0.377
Combination (V×M)	11	17.333	1.576	1.418	0.228

Appendix XXVI: Analysis of variance of Yield per hectare

Source of variance	Degree of freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Varieties (V)	2	10539154023	5269577011	2.227	0.124
Vermicompost (M)	3	19454390561	6484796854	2.999	0.045
Combination (V×M)	11	59429424019	5402674911	4.439	0.01