EFFECT OF ORGANIC NUTRIENT SOURCES ON THE GROWTH AND YIELD OF KOHLRABI (*Brassica oleracea* var. *gongylodes*)

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CERTIFICATE

This is to certify that the thesis entitled, **"EFFECT OF ORGANIC NUTRIENT SOURCES ON THE GROWTH AND YIELD OF KOHLRABI (*Brassica oleracea var. gongylodes*)"** 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 **NANDITA DASH DISHA; Registration No. 19-10265,** under my supervision and guidance. No part of this thesis has been submitted for anyother 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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The Author

EFFECT OF ORGANIC NUTRIENT SOURCES ON THE GROWTH AND YIELD OF KOHLRABI (*Brassica oleracea* var. *gongylodes*)

By

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ABSTRACT

The present study was undertaken with an aim to investigate the "Effect of organic nutrient sources on growth and yield of kohlrabi plants". The experiment was conducted during the period from November 2020 to February 2021 at Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka. The experiment was laid out in Complete Randomized Design (CRD). The experiment consisted of nine treatments viz., N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (4 t/ha) (50%) + Biochar (4 t/ha) (50%), N_4: Vermicompost (4 t/ha) (70%) + Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%) + Vermicompost (4 t/ha) (20%) + Trichoderma (5 t/ha) (30%), N_6: Mushroom Compost (5 t/ha) (50%) + Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha). Total numbers of unit plots were twenty seven. The unit plot size was 1.2 m x 0.9 m. The results indicate that plant height, number of leaf, leaf length, leaf breadth and yield were influenced significantly among the treatments. With application of organic nutrient sources the maximum yield per plot was obtained from N_5 treatment (3.86 kg) while the minimum yield per plot (2.26 kg) was obtained from the control treatment N_0 and likewise maximum yield per hectare (35.77 t) was observed in treatment (N_5) while the minimum yield per hectare (20.95 t) was obtained from the control treatment (N_0). Therefore, it can be concluded that applying N_5 treatment was best for kohlrabi production.

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LIST OF ACRONYMS

Acronym		Full meanings
AEZ	=	Agro-Ecological Zone
ANOVA	=	Analysis of Variance
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
BCR	=	Benefit Cost Ratio
Cm	=	Centimeter
CRD	=	Complete Randomized Design
DAT	=	Days After Transplanting
^{0}C	=	Degree Celsius
et al.	=	And others
FAO	=	Food and Agriculture Organization
G	=	Gram(s)
ha^{-1}	=	Per Hectare
Kg	=	Kilogram
Kg ha^{-1}	=	Kilogram Per Hectare
LSD	=	Least Significant Difference
MoP	=	Muriate of Potash
M	=	Meter
Max	=	Maximum
Min	=	Minimum
No.	=	Number
Plant^{-1}	=	Per Plant
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
T	=	Ton
TSP	=	Triple Super Phosphate
%	=	Percent
CV%	=	Percentage of Coefficient of Variance
Viz.	=	Namely
Wt.	=	Weight

CHAPTER I

INTRODUCTION

Kohlrabi (*Brassica oleraceae* var. *gongylodes*) is a member of the botanical family Brassicaceae and considered as a Cole crop. Its edible portion is enlarged stem (knob). It is well known that, kohlrabi has massive nutritional and medicinal values due to its high contents vitamins (A, B1, B2, B5, B6 and E), minerals (Ca, Mg, Zn and Fe) and antioxidant substances which prevent the formation of cancer causing agents (Beecher, 1994). Kohlrabi is widely cultivated in European and American countries. Kohlrabi can be an alternative crop for vegetable growers due to its similarity to other Cruciferae members, having a short growing season and its export possibility. In Bangladesh, still it is grown in a very limited scattered areas and total cultivated area is not exactly known.

The fleshy enlargement of the stem develops entirely above the ground, called knob and is used as a vegetable. It is an excellent vegetable if it is used before it becomes tough and fibrous. It is a member of the cole crops. It is high in minerals and vitamins A and C. It contains adequate amount of water (90.3 g), calories (29.0 g), protein (2.0 g), carbohydrate (6.6 g), fiber (1.0 g) and ash (l.0 g) per 100 g of edible stem The crop has tremendous medicinal properties like, acidosis, asthma, cancer, cholesterol level, heart problems, indigestion, muscle and nerve functions, prostate and colon cancer, skin problems, weight loss etc.

Production of kohlrabi depends on many factors such as quality of seed, variety, plant spacing, fertilizer and proper management practices. The production of kohlrabi has not been extended much beyond the agricultural farms in Bangladesh (BBS, 2020). Kohlrabi responds greatly to major essential nutrients, like N, P, K and organic fertilizer in respect of growth and yield. In 2018-2019, Bangladesh produces 38 thousand tons of kohlrabi per year from 7.56 thousand hectares of land with an average yield of 4.80 t ha^{-1} which is very low against the potential yield (BBS, 2020).

Kohlrabi is planted in the winter season in Bangladesh. The temperature in Bangladesh remains fairly high up to mid-October and gradually goes down in mid-December. This cool period extends up to mid-February. The temperature increases sharply thereafter. Planting dates for each region is one of the factors that have a significant role in the performance of this product. Proper planting makes all the environmental factors occurring at the time of emergence, and seedling establishment of appropriate. Each stage of growth coincide with environmental conditions is desired. Due to the climatic conditions of each region are different varieties of the same species also having different reactions. The proper planting time for any amount due to climatic conditions, characteristics of cultivars and planting should be determined (Kochki *et al*., 1995).

Organic matter is a source of food for the innumerable number of micro-organisms and creatures like earthworm who breaks down these to micronutrients, which are easily absorbed by the plants. Organic manure plays a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization, improving the physical and physiological properties of soils. Organic manures such as cow dung, poultry manure and vermicompost improve the soil structure, aeration, release the nutrients slowly thus support root development leading to higher growth and yield of kohlrabi plants (Abou El- Magd *et al*. 2005).

Moreover, organic fertilizers is easily available to the farmers, and its cost is relatively lower than the inorganic fertilizers. The crop production cost is more or less similar to organic and inorganic fertilizer (Haque, 2000). The readily available organic sources of nutrients should therefore, be used to maximize the economic return. Organic manures such as compost improves the soil structure, aeration, slow release nutrient which support root development leading to higher growth and yield of kohlrabi plants (Uddin *et al*., 2009). Organic fertilizers can therefore be used to reduce the amount of toxic compounds (such as nitrates) produced by conventional fertilizers in vegetables like kohlrabi and improving the quality of salad vegetables produced. Increased consumer awareness of food safety issues and environmental concerns has contributed to the development of organic farming over the last few years (Relf *et al.*, 2002). Thus, it may be possible to lessen the escalating effects of human diseases such as cancer and boost immunity. Farm income will also improve when farmers use less money for fertilizers and pesticides for growing crops, (Vernon, 1999).

To attaining significant production and quality yield for any crops it is necessary to proper management including ensuring the availability of essential nutrient components. In Bangladesh population is increasing day by day. On the other hand, area under crops production is decreasing, because of the inadequacy of land. By the proper management of fertilizer especially organic fertilizer management, it will be easy to grow vegetable to meet up the requirement of food of the nation. Organic fertilizers provide nutrients uniformly throughout the season and mulch keeps the soil more evenly moist and the nutrients more uniformly available (Sam and Frank, 2006).

Biologically active soils with adequate organic matter usually supply necessary nutrients required for the better crop production. Kohlrabi cultivation in Bangladesh has not extended due to the lack of awareness regarding its nutritive value and appropriate method of manure application.

Considering the above situation, the present study was undertaken with the following objectives:

- to find out the effect of organic nutrient sources on growth and yield of kohlrabi.
- to find out the optimum nutrient sources that give higher yield.
- to study nutritive value of kohlrabi and appropriate method of organic nutrient application.

CHAPTER II

REVIEW OF LITERATURE

Kohlrabi is one of the most widely grown vegetables in the temperate zones and is a biennial and herbaceous "Cole" crops in Bangladesh It is a thermo sensitive crop and grown in Bangladesh. Vegetative growth and yield of kohlrabi have been studied in various parts of the world, but a little study has been done on this crop under the agro ecological condition of Bangladesh. However, available information pertaining to this study has been reviewed and presented in this chapter under the following heads.

2.1 Effect of different organic nutrients on the growth and yield of kohlrabi crops

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 which were supplied with 100% cattle manure. However, the highest total yield and quality of broccoli were recorded by adding poultry manure in the two seasons.

Adediran *et al*. (2003) compared poultry manure, household, market and farm waste and found that poultry manure at 20 t/ha had highest nutrient contents and mostly increased yield of tomato and soil macro and micronutrients content.

Adeli *et al*. (2009) said that addition of poultry manure has been shown to improve the fertility of the cultivated soil by increasing the organic matter content, water holding capacity, oxygen diffusion rate and the aggregate stability of the soils.

Akanbi *et al*. (2005) observed that 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.

Akande and Adediran (2004) found that poultry manure at 5 t/ha significantly increased tomato and dry matter yield, soil pH, N, P, K, Ca and Mg and nutrient uptakes.

Akanni and Ojeniyi (2007) observed that application of different levels (0, 10, 20, 40, 50 t/ha) of poultry manure on tomato, the 20 t/ha poultry manure gave highest value of number and weight of fruits and increase height, number of branches, leaf area and tap root length. Utilization of poultry manure in tomato production in Nigeria, and information about effects on soil physical properties and nutrient uptake, and sustainability of tomato production systems is scarce.

Akter *et al*. (1996) carried out an experiment at Joydebpur to find out the effects of poultry manure (PM) and cow dung (CD) in presence and absence of chemical fertilizer on growth and yield of broccoli and reported that 10 ton/ha of poultry manure with recommended dose of nutrients produced the highest curd yield of broccoli. The application of only PM and CD caused yield depression even at higher doses. The highest curd yield of 20.70 and 16.75 tons per hectare were obtained with PM and CD against 9.0 tons per hectare in the control treatment.

Aluko and Oyedele (2005) found that little information on the effects of organic waste on soil physical properties and they observed that poultry manure incorporation had no significant effect on soil density and porosity. The work being reported studied the effect of different levels of poultry manure on soil bulk density, moisture content, nutrient status, growth and fruit yield of tomato.

Antonova *et al*. (2014) stated that, a new Bulgarian kohlrabi variety Niki was studied in two systems of organic crop production: organic system without fertilizer and without pesticide treatment of the plants and organic system by use of biological fertilizer and plant protection with biological insecticides and bio fungicides. The morphological characteristics: size of leaf rosette, number and weight of rosette leaves and weight, height and diameter of the kohlrabi (knob) were investigated. It was established that the new kohlrabi variety demonstrates relatively good biological potential for realization in organic crop production systems although the values recorded for almost all studied characters of the morphological characteristics were lower compared to those recorded in the conditions of conventional crop production. The phenotypical manifestations of the variety were better in organic system production with use of bio products for fertilization and plant protection where the values of the characters from the morphological characteristics were with 6 % to 23 % lower than those recorded in conventional production system. The values of the studied characters of kohlrabi grown in organic production without application of products for fertilization and plant protection were with 15 % to 34 % lower compared to the recorded in the conventional production. The average weight of the kohlrabi (knob) was 1.110 kg in organic system production with use of bio products for fertilization and 0.897 kg by growing in organic production without application of products for fertilization and plant protection which were smaller compared to the registered knob weight in conventional production 1.256 kg.

Ayeni *et al*. (2008) observed that N, P and K 20, 30 and 40 t/ha poultry manure performed better than 300 kg/ha NPK 15:15:15 fertilizers. This work showed that increase in poultry manure up to 30 t/ha maximizes yield than 20 t/ha of poultry manure earlier recommended as, optimum level for the production of tomato in the rain forest zone of southwest Nigeria.

Boari *et al.* (2010) investigated the effects of fertilization and cultivar on yield and quality of broccoli in organic farming. Three levels of organic manure 0, 40 and 80 kg/ha of amino sprint, respectively indicated with F1, F2 and F3 on 4 cultivars of broccoli, were compared. Any effects of fertilization levels were observed on broccoli yield and quality, because of low quantity of main nutritional elements contained in the amino sprint.

Duncan (2005) observed that application of chicken manure acts as a good soil amendment and/or fertilizer (e.g. provides N, P and K) and can also increase the soil and leaf N, P, K, Ca and Mg concentrations. These soil chemical properties provide information on the chemical reactions, processes controlling availability of nutrients and ways of replenishing them in soils.

EI-Bassiony *et al*. (2014) reported that, two cultivars of Kohlrabi plants Delikatess weisser and Burble Vina were grown in a sandy soil at the Experimental Station of the National Research Centre in El- Nubaria region, Behira Governorate on the two successive seasons of 2010/2011 and 2011/2012, to study the effect of two varieties and foliar spray of yeast, amino acid and chitosan on growth, yield and chemical content of Kohlrabi plants.Obtained results show that the highest plant height was found by cv. Delikatess weisser with foliar spray of chitosan. Meanwhile, the highest values of dry weight of leaves and tubers were found by Delikatess weisser with foliar spray of yeast. Furthermore, the highest values of leaves number, tuber height and diameter and fresh weight of tubers as well as total yield of tubers of Kohlrabi plants were recorded by cv. Burble Vina with foliar spray of chitosan. Furthermore, the highest amount of N, P and K% in leaves and N% in tubers of Kohlrabi were found by cv. Burble Vina with foliar spray of chitosan

Ekandjo and Ruppel (2015) stated that, Biological Nitrogen Fixation (BNF) is a process of great importance in crop production systems, as it provides additional natural sources of mineral nitrogen. BNF is catalyzed by diazotrophs that are identified by the nif operon presence comprising the nifH gene that encodes for enzyme nitrogenase synthesis. Thoroughly understanding of factors that influence diazotrophic abundance is crucial for their utilization to enhance sustainability and prevent land degradation in modern agriculture. In this study the impacts of nitrogen fertilization on diazotrophic abundance in Brassica oleracea roots and leaves was investigated in greenhouse experiments by real-time qPCR. Increased nitrogen fertilization significantly increased the nitrogen content in leaves but not in roots. No significant changes in nifH gene copy numbers nor in proportion of nifH gene copy numbers were detectable. This indicates no effect of mineral N fertilization on the abundance of total native diazotrophic bacterial numbers in kohlrabi (*Brassica oleracea*) plants.

Ewulo (2005) said that Poultry manure contains high percentage of nitrogen and phosphorus for the healthy growth of plants Nitrogen is equally said to be the motor of plant growth.

Ewulo *et al*. (2008) said that Manure applications increased leaf N, P, K, Ca and Mg concentrations of tomato, plant height, and number of branches, root length, number and weight of fruits. The 25 t/ha poultry manure gave highest leaf P, K, Ca and Mg.

IFA (2000) observed that Organic matter is the ultimate determinant of the soil fertility in most tropical soils and this account for its use to raise seedling in tropical areas, the fertility of the soil could be sustained with the addition of poultry manure.

Maurya *et al.* (2008) conducted a field experiment in Pantnagar, Uttaranchal, India to study the effects of the recommended fertilizer and farmyard manure on broccoli (cv. Fiesta): recommended fertilizers (RF; 120:60:60 kg NPK/ha), farmyard manure (FYM) at 20 t/ha, FYM at 10 t/ha + 50% FR, neem cake at 5 quintal/ha, neem cake at 2.5 quintal/ha + 50% RF, vermicompost at 5 t/ha, vermicompost at 2.5 t/ha + 50% RF, poultry manure at 5 t/ha, and poultry manure at 2.5 t/ha + 50% RF. Poultry manure + 50% RF and FYM + 50% RF resulted in the greatest plant height in 2005-06. In 2006-07, poultry manure + 50% RF, vermicompost + 50% RF, RF and poultry manure gave the tallest plants, the number of fully opened leaves in both years was highest for poultry manure + 50% RF. Leaf length was greatest for poultry manure + 50% RF and vermicompost + 50% RF. The greatest leaf weight per plant was recorded for poultry manure + 50% RF, FYM + 50% RF and vermicompost + 50% RF in 2005-06, and for poultry manure + 50% RF, RF, FYM + 50% RF and vermicompost + 50% RF in 2006-07. Poultry manure + 50%RF, FYM + 50% RF and vermicompost + 50% RF registered the greatest head weight in 2005- 06, whereas poultry manure + 50% RF was superior for this trait in 2006-07. The highest yields were obtained with poultry manure + 50% RF.

Mehdizadeh *et al.* (2013) observed that addition of organic fertilizers at rate of 20 ton/ha significantly (at $P<0.05$) increased tomato growth and yield compared to control (no fertilizer application). Also obtained results proved that tested treatments could be arranged in decreasing order as follows: municipal waste compost > poultry manure> cow manure> sheep manure > no fertilizer. Compost and poultry manure had a synergistic effect on both fresh and dry weights of tomato shoots and roots Application of poultry manure and 300 kg/ha NPK fertilizer significantly ($P<0.05$) increased plant N, P and K. Poultry manure at 20, 30 and 40 t/ha and NPK 15:15:15 fertilizer significantly ($P<0.05$) increased plant leaf, area height, number of leaves, branches fruits and fruit yield. Application of 10 t/ha poultry manure gave similar values of plant N, P and K and yield components compared with 300 kg/ha NPK fertilizer.

Olaniyi and Ajibola (2008) observed that the combined application of the two types of fertilizers resulted in the highest marketable fruit yield. The content of essential nutrient elements increased and was also influenced by fertilizer treatments, except K in all the treatments Plant height, number of leaves, leaf area, number of fruits and tomato yield as well as N, P and K were increased with the increase in the level of poultry manure up to 30 t/ha. The soil treated with 30 t/ha poultry manure gave highest plant K with corresponding increase in yields. The yield and growth parameters were found to decrease at 40 t/ha compare to 30 t/ha poultry manure indicating nutrient imbalance at the highest rate of application. The better performance of 30 t/ha poultry manure might be as a result of higher nutrient uptake especially N, P and K. It was indicated in the result that 40 t/ha PM reduced plant P, K, Ca and Mg compared to 20 t/ha of poultry manure. The least plant N, P and K contents recorded for tomato without poultry manure agrees with the observation that poultry manure supplied.

Palm *et al.* (1997) recommended that 9-18 tons/acre of manure for good tomato yield.

Pane *et al*. (2014) reported that, the use of compost tea (CT) is becoming interesting for applications in organic agriculture. CTs are oxygenated extracts of compost that give positive effects on the crops because contain bioactive molecules and microorganisms that improve plant growth and health. This study was carried out to evaluate the effects of CTs applied as foliar spray and drenching, respectively, on kohlrabi and lettuce cultivation. The CT tested here was originated by an aerated water-extraction of two artichoke and fennel composts. CT treatments considerably improved crop yields. CT, in fact, increased lettuce and kohlrabi commercial yields higher 24% and 32%, respectively. Due to CT, the physiological and nutritional status of the plants increased, as noticed by foliar chlorophyll content assessment measured during crop cycles. The results provided encouraging indications about the practical application of CT in horticultural organic farming system.

Perin *et al.* (2004) conducted a field experiment to study the residual effects of sunn hemp and millet (*Pennisetum americanum* [P. *glaucum*]), singly or in combination, on the N uptake and yield of broccoli grown after maize were studied in Brazil. Broccoli was supplied with 0 or 150 kg N/ha. The green manures were cultivated from 26 September to

3 December 2001, whereas maize was grown from 4 December 2001 to 28 May 2002. Broccoli was cultivated after maize (5 June to 10 August 2002) under zero tillage and in the presence of maize residues. The green manures had no significant residual effects on the diameter, dry weight of flower buds, and dry matter yield of broccoli. Sunn hemp monocrop increased the content and accumulation of N in the leaves and flower buds of broccoli. Sunn hemp-millet intercropping was more effective in the enhancement of the N content and uptake in leaves and flower buds of broccoli than millet monocropping. The diameter of broccoli buds did not significantly vary in plots without N fertilizer but with sunn hemp and plots supplied with 150 kg N/ha only. However, broccoli yield, and N content and uptake in buds were greater in plots supplied with 150 kg N/ha only than in plots with green manures but without 150 kg N/ha. The utilization of N by broccoli through biological fixation reached 9.15% under sunn hemp monocropping and 8.48% under sunn hemp-millet intercropping.

Premsekhar and Rajashree (2009) observed that poultry manure application could be attributed to easy solubilisation effect of released plant nutrient leading to improved nutrient status of the soil the results obtained were in agreement with the findings in which they reported that higher yield response of crop due to organic manure application.

Saleh *et al*. (2013) stated that, two field experiments were carried out in newly reclaimed land at El-Nobaria, Northern Egypt during the two successive seasons of 2009/2010 and 2010/2011 to study the response of Kohlrabi plants (*Brassica oleracea var. Gongylodes* L.) to different fertilizer sources and application rates of Nitrogen (N). The experiments were carried out in a split plot design with three replicates. Three fertilizer sources, i.e., mineral-N fertilizer (control) as ammonium nitrate (33.5% N), organic-N as chicken manure (3.4% N) and combined application of 50% mineral-N (ammonium nitrate) + 50% organic-N (chicken manure) were assigned to the main-plots, while three N rates, i.e., 50, 75 and 100 kg N/feddan (4200 m^2) were randomized and occupied the sub-plots. Plant growth characters (plant height, number of leaves per plant and plant fresh weight), chlorophyll content and tuber yield as well as chemical composition of edible part (tuber) were evaluated. The data showed that applying of mineral-N source ranked the first in increasing Kohlrabi yield followed by the combined application of 50% organic-N with

50% mineral-N and lastly coming organic-N source. Organically fertilized plants resulted in 83-87% yield containing less nitrate (75-68%) compared to the mineral -N source. The productivity of Kohlrabi plants fertilized by 50% mineral -N in combination with 50% organic -N was similar (approx. 95-96%) to those fertilized by 100% mineral -N. Moreover, the edible part (tuber) had much vitamin C and TSS as well as less nitrate content. On the other hand, increasing the application rate of N within the range of 50 up to 100 kg N/fed. Increased all studied plant growth characters, chlorophyll content and tuber yield, but the differences within application rate of 75 and 100 were not great enough to be significant. It could be concluded that, the economical and useful fertilizer source and application rate of N for the best growth, productivity and tuber quality of Kohlrabi plants is the combined source of 50% organic -N with 50% mineral -N at application rate of 75 kg N/feddan (4200 m^2).

Sanjay and Chaudhary (2002) conducted a field experiment to study the effects of molybdenum (0.5 and 1 kg sodium molybdate/ha) and boron (10 and 20 kg borax/ha), applied alone or in combination with 25 t farmyard manure (FYM)/ha, on the yield and yield components of cauliflower cv. Pusa Snowball-1 were determined in a field experiment conducted in Kullu, Himachal Pradesh, India from October to March of 1995-97. Molybdenum and boron application significantly increased curd diameter, weight and yield in the absence of FYM. Boron at 10 kg/ha and molybdenum at 0.5 kg/ha increased the yield by 32 and 14%, respectively. Application of FYM in addition to 100% recommended NPK enhanced the yield of cauliflower by about 27% compared to application of NPK alone.

Shams (2012) reported that, field experiments were carried out on Kohlrabi (*Brassica oleracea var. gongylodes*) ‘Purple Vienna cv.’ at the Experimental Farm of the Faculty of Agriculture, Moshtohor, Benha University, Egypt, during the winter seasons of 2009 and 2010 under drip irrigation system. This study aimed to investigate the effect of organic manure and/or mineral N fertilizer with or without biofertilizer inoculation on growth, yield and quality of kohlrabi knobs. Results show that using 50% mineral-N + 50% organic-N combined with biofertilizer, improved plant growth, yield and knob quality compared to other N-fertilizer systems. Inoculation of kohlrabi transplants with biofertilizer gave good results in this respect. Therefore, this treatment gave the best growth and increased total yield with the best knob quality as compared with uninoculated one. The highest content of nitrate in knobs (803.84 mg kg-1 DW) was recorded by using 100% mineral-N treatment (average in both seasons). Whereas, adding 100% organic-N recorded the lowest content of nitrate in knobs (387.75 mg kg-1 DW) average of both seasons. It is worthy to mention that nitrate concentration in tested kohlrabi knobs is still in the safe border for human consumption. Finally, kohlrabi plant contains good amounts of antioxidants substances positioned to be at the forefront of salad plants.

Sultana *et al*. (2012) stated that, an experiment was carried out at the Horticulture Farm of the Bangladesh Agricultural University, Mymensingh during the period from November 2010 to January 2011 to study the effects of cowdung and potassium on growth and yield of Kohlrabi. The experiment consisted of three levels of cowdung (0, 20 and 40 t/ha) and four levels of potassium (0, 20, 50, 80 kg /ha). The experiment was laid out in randomized complete block design with three replications. All the parameters were significantly influenced by application of cowdung and potassium. The highest plant height (44.65 cm), number of leaves per plant (12.11), length of largest leaf (37.54 cm), and breadth of largest leaf (18.66 cm) were obtained from the highest dose of cowdung and potassium applied (40 t cowdung + 80 kg K/ha) while the lowest plant height (33.64 cm), number of leaves (9.01), length of largest leaf (27.94 cm), and breadth of largest leaf (11.00 cm) were obtained from control treatment combination. 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 (22.11 g), fresh weight of knob (136.00 g) and fresh weight of roots (23.33 g) 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 C0K0. The marketable yields of knob per plot (7.86 kg) and per hectare (39.58 t) were also the highest under the treatment combination 40 t cowdung/ha and 80 kg potassium per hectare.

Uddin *et al*. (2009) reported that, an experiment was conducted at Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during October-December, 2007 to study the effect of different organic manures on growth and yield of kohlrabi plant. Three types of organic manures viz., were compared with control (no manure) in the experiment. The maximum plant height (36.50 cm), plant canopy (63.50 cm), leaf length (30.42 cm), leaf breadth (14.25 cm), fresh leaves weight per plant (131.10g), diameter of knob (8.23cm), Knob weight (366.60 g), yield per hectare (22.90 t/ha) were found in poultry manure application. Only the maximum number of leaves (20.00) was 1 found in control treatment. On the other hand, 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), diameter of knob (7.95 cm), Knob weight (177.50 g), yield per hectare (15.40 t/ha) were found in control treatment. Minimum number of leaves (14.33) was found with cowdung application.

Warman (1986) said that the potential impacts of chicken manure on soil chemical properties and crop yield and in particular evaluating the critical application levels. Moreover, the need and utilization of chicken manure has overtaken the use of other animal manure (e.g. pig manure, kraal manure) because of its high content of nitrogen, phosphorus and potassium.

CHAPTER III

MATERIALS AND METHOD

This chapter includes the information regarding methodology that was used in execution of the experiment. It contains a short description of location of the experimental site, climatic condition, materials used for the experiment, treatments of the experiment, data collection procedure and statistical analysis.

3.1 Location of the site

The experiment was conducted at the Horticultural Farm of the Sher-e-Bangla Agricultural University, Dhaka during the period from November, 2020 to February, 2021. The site is 23.5^0N and 90.2^0E Latitude and at an altitude of 8.2 m from the sea level (FAO, 1988).

3.2 Characteristics of soil

The soil of the experiment was non-calcareous, dark gray, medium high land. The soil texture was silty loam with a pH 6.7. Soil samples of the experimental plot were collected from a depth of 0 to 30 cm before conducting the experiment. Soil was analyzed in the Soil Resources Development Institute (SRDI) Farm gate, Dhaka. The experimental site was a medium high land (Appendix I)

3.3 Climatic condition

The experimental area was under the sub-tropical monsoon climate, which is characterized by heavy rainfall during Kharif season and scanty in the Rabi season (October to March). There was no rainfall during the month of November, December and January. The average maximum temperature during the period of experiment was 26.82^0C and the average minimum temperature was 17.14^0C. Details of the meteorological data in respect of temperature, rainfall and relative humidity during the period of the experiment were collected from Weather Station of Agargaon, Dhaka (Appendix II).

3.4 Agro-ecological region

The experimental field belongs to the agro-ecological region of the Modhupur Tract (AEZ-28). The landscape comprises level upland, closely or broadly dissected terraces associated with either shallow or broad, deep valleys.

3.5 Experimental materials

"Quick Star" a variety of kohlrabi has been used as experimental material. The seeds of kohlrabi had been collected from Siddik Bazar, Dhaka.

3.6 Treatment of the experiment

i. N_0: Control

ii. N_1: Cowdung (10 t/ha)

iii. N_2: Vermicompost (4 t/ha)

iv. N_3: Vermicompost (4t/ha) (50%) + Biochar (4 t/ha) (50%)

v. N_4: Vermicompost (4t/ha) (70%) + Biochar (4 t/ha) (30%)

vi. N_5: Kitchen compost (5 t/ha) (50%) + Vermicompost (4 t/ha) (20%) + Trichoderma (5 t/ha) (30%)

vii. N_6: Mushroom Spent Compost (5 t/ha) (50%) + Trichoderma (5 t/ha) (50%)

viii. N_7: Kitchen compost (5 t/ha)

ix. N_8: Mushroom Compost (5 t/ha)

3.7 Design and layout of the experiment

The experiment was laid out in Completely Randomized Design (CRD) with three replications. The experimental plot was divided into 27 plots where 9 treatments combination were allotted at random. The size of each plot was 1.2 m × 0.9 m.

3.8 Seed sowing

Seeds were sown on November, 2020 in the seedbed. Sowing was done thinly in lines spaced at 5 cm distance. Seeds were sown at a depth of 2 cm and covered with a fine layer of soil followed by light watering by water can. Thereafter the beds were covered with dry straw to maintain required temperature and moisture. The cover of dry straw was removed immediately after emergence of seed sprout. When the seeds were germinated, shade by white polythene was provided to protect the young seedlings from scorching sunshine and rain.

3.9 Raising of seedlings

Light watering and weeding were done several times. No chemical fertilizers were applied for raising of seedlings. Seedlings were not attacked by any kind of insect or disease. Healthy and 25 days old seedlings were transplanted into the experimental field on December 2020.

3.10 Preparation of the main field

The selected plot of the experiment was opened in the 1st week of November, 2020 with a power tiller, and left exposed to the sun for a week. Subsequently cross ploughing was done five times with a country plough followed by laddering to make the land suitable for transplanting the seedlings. All weeds, stubbles and residues were eliminated from the field. Finally, a good tilth was achieved. The soil was treated with insecticides (cinocarb 3G @ 4 kg/ha) at the time of final land preparation to protect young plants from the attack of soil inhibiting insects such as cutworm and mole cricket.

3.10.1 Application of nutrient sources

Organic nutrient sources were applied as per the treatment. Organic nutrient sources such as cowdung, vermicompost, kitchen compost and mushroom compost etc. were used as the source of nitrogen, phosphorus and potassium. Total amount of organic nutrient sources were applied during final land preparation as per treatment.

3.10.2 Transplanting of seedlings

Healthy and uniform seedlings of 25 days old seedlings were transplanting in the experimental plots on 19 December, 2020. The seedlings were uprooted carefully from the seed bed to avoid damage to the root system. To minimize the damage to the roots of seedlings, the seed beds were watered on hour before uprooting the seedlings. Transplanting was done in the afternoon. The seedlings were watered immediately after transplanting. Seedlings were sown in the plot with maintaining distance between row to row and plant to plant was 30 cm and 30 cm, respectively. The young transplants were shaded by banana leaf sheath during daytime to protect them from scorching sunshine up to 7 days until they were set in the soil. They (transplants) were kept open at night to allow them receiving dew. A few seedlings were also planted in the border if the experimental plots for gap filling.

3.10.3 Intercultural operation

After raising seedlings, various intercultural operations such as gap filling, weeding, earthing up, irrigation pest and disease control etc. were accomplished for better growth and development of the kohlrabi seedlings.

3.10.4 Gap filling

The transplanted seedlings in the experimental plot were kept under careful observation. Very few seedlings were damaged after transplanting and such seedling were replaced by new seedlings from the same stock. The transplants were given shading and watering for 7 days for their proper establishment.

3.10.5 Weeding

The hand weeding was done at 15, 30, 45 and 60 days after transplanting (DAT) to keep the plots free from weeds.

3.10.6 Earthing up

Earthing up was done at 20 and 40 days after transplanting on both sides of rows by taking the soil from the space between the rows by a small spade.

3.10.7 Irrigation

Light watering was given by a watering cane at every morning and afternoon. Following transplanting and it was continued for a week for rapid and well establishment of the transplanted seedlings.

3.10.8 Insects and diseases management

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

3.10.9 Harvesting

Only the compact mature knobs were harvested with 15 cm long fleshy stalk by using as sharp knife. To prevent the rotting of steam the cut portion were slanted, so that rain water could not stay. The knobs were harvested in compact condition before the flower buds opened (Thomson and Kelly, 1985). Before harvesting of the kohlrabi knob, compactness of the knob was tested by pressing with thumbs.

3.11 Collection of data

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

1. Plant height (cm)
2. Individual plant weight(g)
3. Number of leaves per plant
4. Leaf length (cm)
5. Leaf breadth (cm)
6. Fresh weight of leaves (g)
7. Root length (cm)
8. Root weight(g)
9. Knob length(cm)
10. Knob weight(g)
11. Knob diameter (cm)
12. Dry weight of leaves (g)
13. Dry weight of knob (g)
14. Yield per plot (kg)
15. Yield per hectare (ton)

3.12 Data collection procedure

3.12.1 Plant height (cm)

Plant height was measured from sample plants in centimeter from the ground level to the tip of the longest leaf and mean value was calculated. Plant height was also recorded at 15 days interval starting from 30 days after Transplanting (DAT) upto 60 days and at harvest to observe the growth rate of plants.

3.12.2 Individual Plant weight (g)

The weight of kohlrabi plant was recorded from the average of five (5) selected plants in gram (g) with a beam balance.

3.12.3 Number of leaves per plant

Total number of leaves produced by each plant was counted at 30, 45 DAT and at harvest time. The time of main knob harvesting excluding the small leaves.

3.12.4 Leaf length (cm)

The length of the leaf was measured from the base of the petiole to the tip at 30, 45 DAT and at harvest time. A meter scale was used to measure the length of the leaves and expressed in centimeter (cm)

3.12.5 Leaf breadth (cm)

The large leaf breadth was measured on 30, 45 DAT and at harvest time. A meter scale was used to measure the large breadth of the leaves and expressed in centimeter (cm)

3.12.6 Leaf weight (g)

The fresh weight of leaves was recorded from the average of five (5) selected plants in gram (g) with a beam balance.

3.12.7 Root length (cm)

Root of kohlrabi plant was measured using the measuring tape and express as centimeter (cm).

3.12.8 Root weight (g)

Per plant weight of roots was recorded by weighting the total roots and was recorded in gram (g).

3.12.9 Knob length (cm)

The length of knob was measured in centimeter (cm) with a meter scale or with a measuring tape.

3.12.10 Knob weight (g)

The weight of knob per plant was recorded in gram (g) by a beam balance.

3.12.11 Knob diameter (cm)

The diameter of knob was measured in several directions with meter scale and the average of all directions was finally recorded and expressed in centimeter (cm).

3.12.12 Dry weight of leaves (g)

At first 100 g leaves of selected plant was collected, cut into pieces and was dried under sunshine for a few days and then dried in an oven at 70^0c for 72 hours before taking dry weight till it was constant. The dry weight was recorded in gram (g) with a beam balance.

3.12.13 Dry weight of knob (g)

100 g knob was taken, cut into pieces and was dried under direct sunshine for 3 days and then was dried in an oven at 70^0c for 72 hours before taking the dry weight till it was constant. The dry weight was recorded in gram (g) with a beam balance.

3.12.14 Yield per plot (kg)

The yield per unit plot was calculated by adding the weight of all the central curds and secondary curds produced in the respective plot. The yield of all plants in each unit plot was recorded and was expressed in kilogram (kg).

3.12.15 Yield per hectare (t ha^{-1})

The yield per hectare was calculated by converting from the per plot yield data to per hectare and was expressed in ton (t).

3.13 Statistical analysis

The data obtained for different characters were statistically analyzed by using SPSS computer package program to find out the significance of the different organic nutrients on growth and yield contributing characters of kohlrabi. The mean values of all the recorded characters were evaluated and analysis of variance was performed by the “F” (variance ratio) test. The significance of the difference among the treatment combinations of means was estimated by Duncan’s Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

3.14 Economic Analysis

The cost of production was analyzed in order to find out the most economic combination of organic nutrients. All input cost included the cost for lease of land and interests on running capital in computing the cost of production. The interests were calculated @ 12% in simple rate. The market price of kohlrabi was considered for estimating the cost and return. Analyses were done according to the procedure of Alam et al. (1989). The benefit cost ratio (BCR) was calculated as follows:

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

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to observe "Effect of organic nutrient sources on the growth and yield of kohlrabi plants" 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-XXV. 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)

With the application of organic nutrients, plant height of kohlrabi showed increasing trend up to the harvest. Data showed that positively significant plant height of kohlrabi was found (Figure 1 and Appendix III, IV, V).

The tallest plant of kohlrabi was recorded in the N_5 (33.67, 37.68 and 39.63 cm at 30 DAT, 45 DAT and 60 DAT, respectively) treatment and the shortest plant was found in the N_0 (23.25, 27.25 and 29.20 cm at 30 DAT, 45 DAT and 60 DAT, respectively) treatment.

Different organic nutrients have different effect on production of vegetables. Trichoderma produces plant growth hormones and volatile compounds which enhances plant growth. Efficiency of nitrogen uptake enhanced vegetative growth of Kohlrabi plants through poultry manure. Mishra and Indulkarl (1993); Sharma *et al*. (2002), Singh (2004) and Reddy and Padmaja (2005) found the same results in the present investigation.

Vermicompost contains a higher percentage of available nutrients (Ali *et al*. 2018), 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).

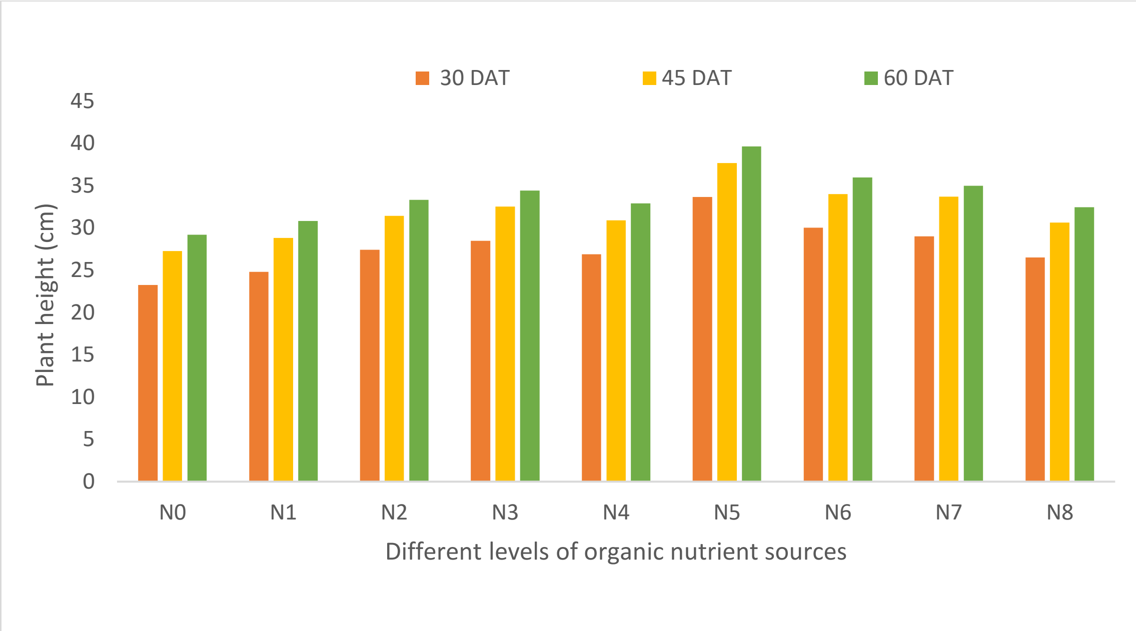

Figure 1: Effect of organic nutrient sources on plant height (cm)

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

4.2 Number of Leaves Plant^{-1}

Organic nutrient sources had a significant influence on the number of leaves per kohlrabi plants at 30 DAT, 45 DAT and harvesting time (60 DAT) (Fig. 2, Appendix VI, VII, VIII). Data showed that positively significant leaf number of kohlrabi was found. The highest leaf number of kohlrabi was recorded in the N_5 (9.10, 12.20 and 13.00 cm at 30 DAT, 45 DAT and 60 DAT, respectively) treatment and the lowest leaf number was found in the N_0 (5.33, 8.40 and 9.36 cm at 30 DAT, 45 DAT and 60 DAT, respectively) treatment.

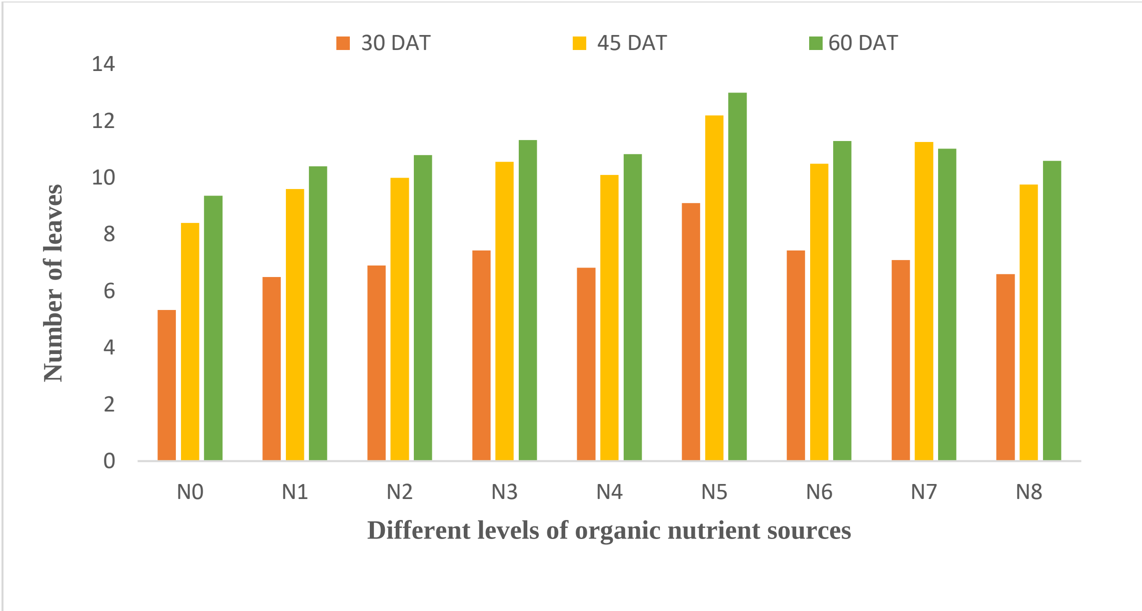

Figure 2: Effect of organic nutrient sources on number of leaves plant^{-1}

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

4.3 Leaf Length (cm)

Organic nutrient sources had a significant influence on the length of leaves of Kohlrabi plants at 30 DAT, 45 DAT and harvesting time (60 DAT) (Fig. 3, Appendix IX, X, XI). Data showed that positively significant leaf length of kohlrabi was found. The longest leaf length of kohlrabi was recorded in the N_5 (34.73, 37.53 and 38.86 cm at 30 DAT, 45 DAT and 60 DAT, respectively) treatment and the shortest leaf length was found in the N_0 (23.50, 26.20 and 27.43 cm at 30 DAT, 45 DAT and 60 DAT, respectively) treatment.

Trichoderma produces plant growth hormones and volatile compounds which enhances leaf length. Poultry manure is rich in its nitrogen and nutrient content. This favorable condition creates better nutrient absorption and favors for vegetative growth. Similar result was obtained by other investigator such as Abou *et al*. (2006).

Vermicompost is a rich source of both macro and micronutrients, vitamins, growth hormones, and enzymes, and derived from earthworms (Bhavalkar 1991).

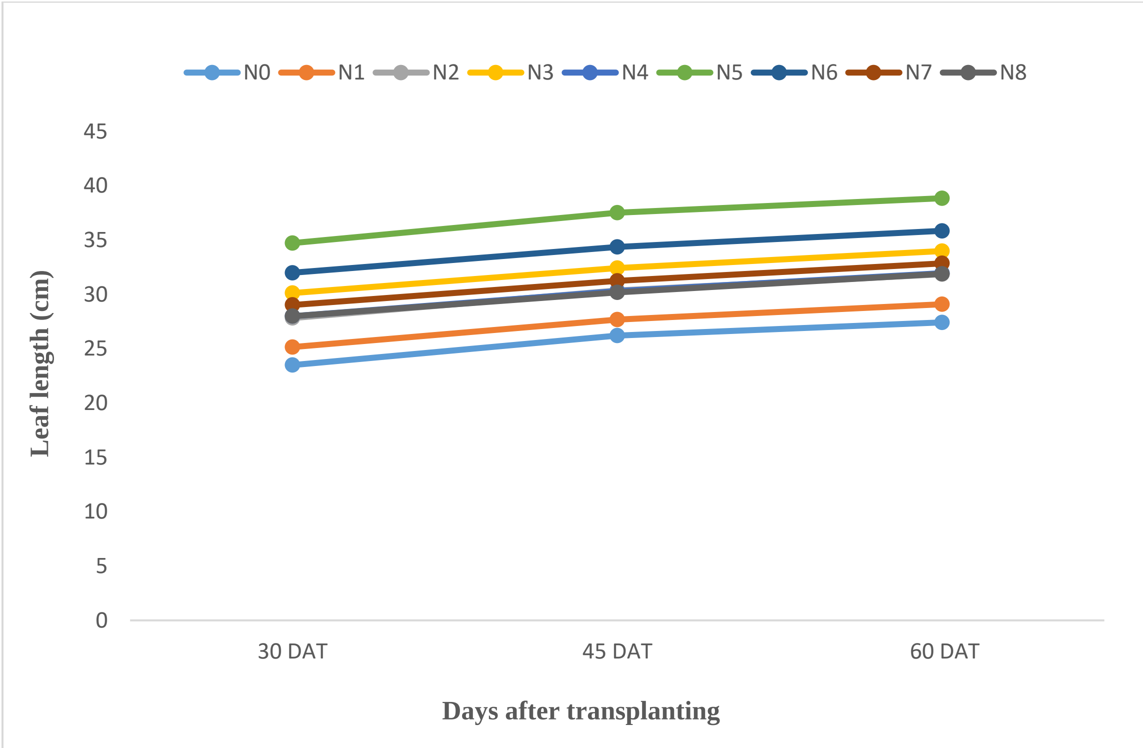

Figure 3: Effect of organic nutrient sources on leaf length (cm)

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

4.4 Leaf Breadth (cm)

Organic nutrient sources had a significant influence on the breadth of leaves of kohlrabi plants at 30 DAT, 45 DAT and harvesting time (60 DAT) (Fig. 4, Appendix XII, XIII, XIV). Data showed that positively significant leaf breadth of kohlrabi was found (Figure 1 and Appendix III, IV, V). The maximum leaf breadth of kohlrabi was recorded in the N_5 (10.43, 12.90 and 14.33 cm at 30 DAT, 45 DAT and 60 DAT, respectively) treatment and the minimum leaf breadth was found in the N_0 (5.33, 8.16 and 9.30 cm at 30 DAT, 45 DAT and 60 DAT, respectively) treatment.

Poultry manure is rich in its nitrogen and nutrient content which enhance vegetative growth and photosynthetic activity of Kohlrabi plants. Trichoderma produces plant growth hormones and volatile compounds which enhances leaf breadth.

Vermicompost contains a higher percentage of available nutrients (Edwards and Burrows 1988), humic acid (Ali *et al*. 2018) and substances that encourage plant growth such as auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah 1986).

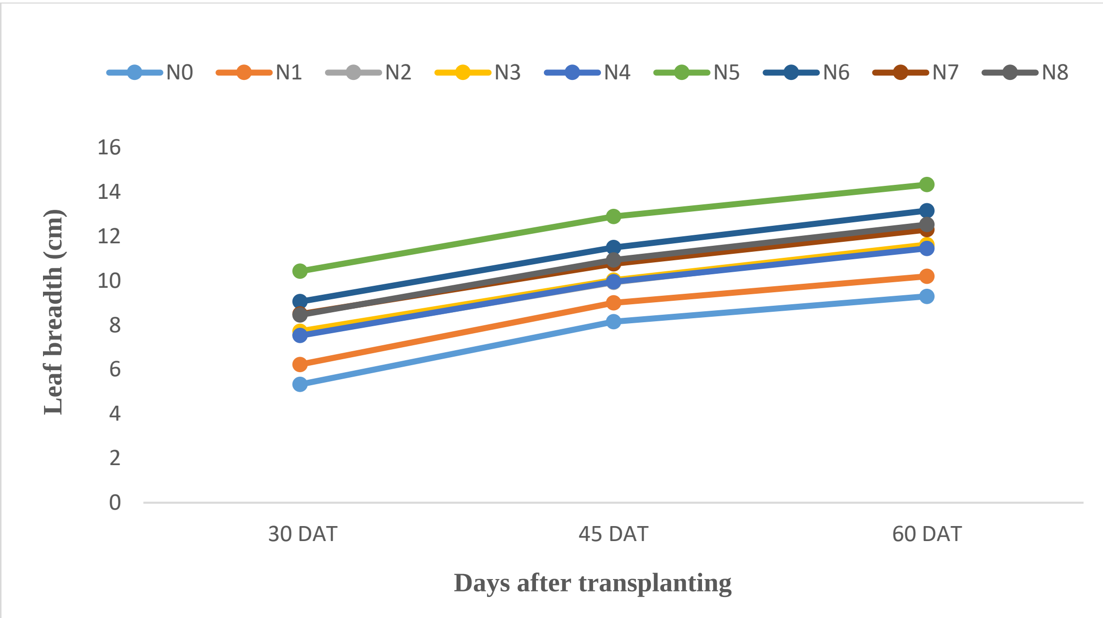

Figure 4: Effect of organic nutrient sources on leaf breadth (cm)

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

4.5 Individual Plant Weight (g)

With the application of different level of organic nutrients, individual plant weight showed positively significant variation (Table 1 and Appendix XV). The highest individual plant weight of kohlrabi was recorded in the N_5 (439.13 g) treatment that contained kitchen compost (50%) (5 t/ha), vermicompost (20%) and trichoderma (30%). The lowest plant weight was found in the control N_0 (212.45 g) treatment.

Tanwar *et al*. (2013) also noted a significant increase in the weight and size of broccoli curds as a response to inoculation with *Trichoderma viride*.

4.6 Fresh Weight of Leaves (g)

With the application of different level of organic nutrients, individual leaf weight showed positively significant variation (Table 1 and Appendix XXII). The highest individual leaf weight of kohlrabi was recorded in the N_5 (135.33 g) treatment that contained kitchen compost (50%) (5 t/ha), vermicompost (20%) (4 t/ha) and trichoderma (30%) (5 t/ha). The lowest leaf weight was found in the control N_0 (87.36 g) treatment.

Trichoderma harzianum releases volatile organic antibiotic compounds against pathogenic fungi, and it also stimulates plant size, weight and growth. (Vinale et al., 2008).

4.7 Dry Weight of Leaves (g)

Significant effect of different organic nutrients was observed on the dry weight of 100 g of leaves of kohlrabi (Table 1 and Appendix XXIII). The highest value of the dry weight of 100 g of leaves (26.00 g) was recorded in N_5 treatment while the lowest dry weight of 100 g of leaves (14.07 g) was found in N_0 treatment.

Table 1: Effect of different organic nutrients on Plant weight (g), Fresh weight of leaves (g) and Dry weight of leaves (g) of Kohlrabi

Treatment	Individual Plant weight (g)	Fresh weight of leaves (g)	Dry weight of leaves (g)
N_0	212.45 ± 11.01e	87.36 ± 2.72e	14.07 ± 0.09f
N_1	242.10 ± 7.03de	93.43 ± 1.78de	15.93 ± 0.06e
N_2	287.86 ± 22.83cde	108.40 ± 2.70c	14.76 ± 0.27f
N_3	315.20 ± 64.94bcd	111.76 ± 5.26bc	22.84 ± 1.02b
N_4	293.80 ± 18.31bcde	101.10 ± 3.38cd	17.20 ± 0.10d
N_5	439.13 ± 22.26a	135.33 ± 5.98a	26.00 ± 0.11a
N_6	383.00 ± 23.43ab	120.76 ± 1.00b	19.44 ± 0.33c
N_7	363.16 ± 11.56abc	107.46 ± 3.24c	19.64 ± 0.12c
N_8	312.13 ± 20.74bcd	108.10 ± 1.64c	17.83 ± 0.12d

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

4.8 Diameter of Knob (cm)

Organic nutrient sources showed significant variation on diameter of knob of kohlrabi (Table 2 and Appendix XIX). The highest diameter of knob (8.40cm) was recorded from N_5 (Kitchen Compost (50%) (5ton/ha) + Vermicompost (20%) + Trichoderma 30%), whereas the lowest diameter (6.96 cm) was recorded from N_1 (Cowdung 10 ton/ha).

Trichoderma concentration showed significant variation among the growth and yield characteristics of tomato reported by Uddin *et al.* (2015).

4.9 Knob Length (cm)

With the application of different levels of organic nutrients, individual knob length showed positively significant variation (Table 2 and Appendix XVIII). The highest individual knob length without leaves of kohlrabi was recorded in the N_5 (6.20 cm) treatment that contained kitchen compost (50%) (5 t/ha), vermicompost (20%) and trichoderma (30%). The lowest individual knob length was found in the control treatment N_0 (4.80 cm). The present finding is agreed with the findings of EI-Bassiony *et al*. (2014).

4.10 Fresh Weight of Knob (g)

Significant variation was recorded in terms of weight of knob for different organic nutrients (Appendix XX). The highest weight of knob (322.0 g) was recorded from N_5 (Kitchen Compost (50%) (5 t/ha) + Vermicompost (20%) + Trichoderma (30%), while the lowest weight (188.63 g) was recorded from N_0 (control) which was statistically similar with N_1 (202.76 g) (Cowdung 10 t/ha) (Table 2). Weight of knob of kohlrabi varied significantly for different organic nutrients (Appendix XX). Organic fertilizer released all type of micro and macro nutrients that improved soil physical properties for higher weight of knob. Hossain *et al*. (2011) reveled that, trichoderma had additional and promoting effects on vegetative and qualitative traits of tulip bulbs.

4.11 Dry Weight of Knob (g)

Significant effect of different organic nutrients was observed on the dry weight of 100 g knobs of kohlrabi (Table 2 and Appendix XXI). The highest value of the dry weight of 100 g of the knobs (29.46 g) was recorded in N_3 treatment while the lowest dry weight of 100 g of the knob (22.40 g) was found in N_0 control treatment.

Table 2: Effect of different organic nutrients on Knob diameter (cm), Knob length (cm), Knob weight (g) and Knob dry weight (g) of Kohlrabi

Treatment	Diameter of knob (cm)	Knob length (cm)	Weight of Knob (g)	Knob dry weight (g)
N_0	7.03 ± 0.31cd	4.80 ± 0.26d	188.63 ± 6.84d	22.40 ± 0.05f
N_1	6.96 ± 0.43d	5.11 ± 0.14cd	202.76 ± 7.61d	23.93 ± 0.36ef
N_2	7.53 ± 0.03bcd	5.43 ± 0.24abcd	240.86 ± 19.78c	23.86 ± 0.37ef
N_3	7.76 ± 0.26abc	5.60 ± 0.30abc	292.53 ± 22.99ab	28.26 ± 0.33ab
N_4	7.76 ± 0.13abc	5.56 ± 0.17abc	237.93 ± 3.37c	24.03 ± 0.18e
N_5	8.40 ± 0.17a	6.20 ± 0.25a	322.00 ± 7.09a	29.46 ± 0.35a
N_6	7.94 ± 0.08ab	5.63 ± 0.88abc	293.66 ± 10.47ab	26.76 ± 0.61bc
N_7	7.96 ± 0.12ab	5.96 ± 0.23ab	251.96 ± 1.35c	25.93 ± 0.20cd
N_8	7.80 ± 0.20ab	5.41 ± 0.28bcd	270.40 ± 2.10bc	25.10 ± 1.15de

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

4.12 Root Length (cm)

With the application of different organic nutrients, root length showed positively significant variation (Table 3 and Appendix XVI). The highest root length of kohlrabi (13.53 cm) was recorded in the N_5. The lowest root length (8.43 cm) was found in the N_0 treatment. Vermicompost contains N and P which induces the root length. The present finding is agreed with the findings of Sultana et al. (2012). Kitchen compost ensures the optimum soil moisture for proper root development, and these conditions enhance root development as well as increase root length.

Harman et al. (2012) and Hermosa *et al.* (2012) report that *Trichoderma* strains colonize plant roots, establishing chemical communication and systemically altering the expression of numerous plant genes that alter plant physiology and may result in the improvement of abiotic stress resistance, nitrogen fertiliser uptake, and photosynthetic efficiency.

4.13 Root Weight (g)

With the application of different levels of organic nutrients, individual root weight showed positively significant variation (Table 3 and Appendix XVII). The highest root weight of kohlrabi was recorded in the N_5 (12.36 g) treatment that contained kitchen compost (50%) (5 t/ha), vermicompost (20%) and trichoderma (30%). The lowest individual root weight was found in the N_0 application (9.10 g) which was cowdung (10 t/ha). Trichoderma produces auxins that are able to stimulate plant growth and root development (Contreras-Cornejo *et al*., 2009)

Table 3: Effect of different organic nutrients on Root length (cm) and Root weight (g) of Kohlrabi

Treatment	Root length (cm)	Root weight (g)
N_0	8.43 ± 0.29d	9.33 ± 1.24bc
N_1	9.53 ± 0.23cd	9.10 ± 1.00c
N_2	10.33 ± 0.14bc	9.96 ± 0.36bc
N_3	11.60 ± 1.31b	10.43 ± 0.29bc
N_4	10.53 ± 0.23bc	9.90 ± 0.25bc
N_5	13.53 ± 0.78a	12.36 ± 0.33a
N_6	11.73 ± 0.13b	10.73 ± 0.13bc
N_7	10.86 ± 0.29bc	10.80 ± 0.46b
N_8	10.50 ± 0.10bc	9.86 ± 0.21bc

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

4.14 Yield per Plot (kg)

Different levels of organic nutrient application showed a significant variation on yield per plot. Yield per plot was significantly affected by different levels of organic nutrients under the present study (Table 4 and Appendix XXIV). Yield per plot was the maximum with a dose of kitchen Compost (50%) (5 t/ha), vermicompost (20%) and trichoderma (30%). The maximum yield per plot was obtained from N_5 treatment (3.86 kg) while the minimum yield per plot (2.26 kg) was obtained from the control treatment N_0 which was statistically similar with cowdung (10 ton/ha) treatment N_1 (2.43 kg).

Porras *et al.* (2007) reported that the significant positive correlations found in between Trichoderma and strawberry yield. Additionally, increased yields in cucumber, bell pepper and strawberry had been also reported with (Altintas and Bal, 2008; Poldma *et al.*, 2002).

4.15 Yield per Hectare (t ha^{-1})

Different levels of organic nutrient application showed a significant variation in yield per hectare. Yield per hectare was significantly affected by different levels of organic nutrient under the present study (Table 4 and Appendix XXV). The yield per hectare was the maximum with a dose of kitchen Compost (50%) (5 t/ha), vermicompost (20%) and trichoderma (30%) treatment. Maximum yield per hectare (35.77 t) was observed in treatment (N_5) while the minimum yield per hectare (20.95 t) was obtained from the control treatment (N_0) which was statistically similar with cowdung (10 t/ha) treatment N1 (22.52 t). All the treatments recorded more yield with higher doses of vermicompost as compared to the control.

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).

Abd Alla and El-Shoraky (2017) found a significant increase in the yields of white cabbage and cauliflower after Trichoderma harzianum inoculation.

Table 4: Effect of different organic nutrients on Yield per plot (kg) and yield per hectare (t ha^{-1}) of Kohlrabi

Treatment	Yield per plot (kg)	Yield per hectare (t ha^{-1})
N_0	2.26 ± 0.08d	20.95 ± 0.76d
N_1	2.43 ± 0.09d	22.52 ± 0.84d
N_2	2.89 ± 0.23c	26.76 ± 2.19c
N_3	3.51 ± 0.27ab	32.50 ± 2.55ab
N_4	2.85 ± 0.04c	26.43 ± 0.37c
N_5	3.86 ± 0.08a	35.77 ± 0.78a
N_6	3.52 ± 0.12ab	32.62 ± 1.16ab
N_7	3.02 ± 0.01c	27.99 ± 0.15c
N_8	3.24 ± 0.02bc	30.04 ± 0.23bc

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

4.16 Economic Analysis

Input costs for land preparation, organic fertilizer, irrigation and manpower required for all the operations from seed sowing to harvesting of kohlrabi were recorded as per experimental plot and converted into cost per hectare. Price of kohlrabi was considered as per market rate. The economic analysis presented under the following headings-

4.16.1 Gross Return

The combination of different organic nutrients showed different value in terms of gross return under the trial (Table 5). The highest gross return (Tk. 715400) was obtained from the treatment combination N_5 and the lowest gross return (Tk. 419000) was obtained from treatment N_0.

4.16.2 Net Return

The combination of different organic nutrients showed different value in terms of net return under the trial (Table 5). The highest net return (Tk. 551090) was obtained from the treatment combination N_5 and the lowest net return (Tk. 294360) was obtained from treatment N_4.

4.16.3 Benefit Cost Ratio

The highest benefit cost ratio (4.35) was noted from the combination of N_5 and the lowest benefit cost ratio (2.11) was obtained from N_6 (Table 5). From economic point of view, it is apparent from the above results that it was more profitable treatment combination than rest of the combinations.

Table 5. Economic analysis of kohlrabi production as influenced by different levels of organic fertilizer application

Treatments	Yield ($t\ ha^{-1}$)	Total cost of production (tk)	Gross return/ha (tk)	Net return/ha (tk)	Benefit Cost Ratio (BCR)
N_0	20.95	97710	209500	111790	2.14
N_1	22.52	131010	225200	94190	1.72
N_2	26.76	186510	267600	81090	1.43
N_3	32.50	230910	325000	94090	1.41
N_4	26.43	213150	264300	51150	1.24
N_5	35.77	165420	357700	192280	2.16
N_6	32.62	264210	326200	61990	1.23
N_7	27.99	153210	279900	126690	1.83
N_8	30.04	153210	300400	147190	1.96

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

CHAPTER: V

SUMMARY AND CONCLUSION

The investigation was conducted at the Horticultural farm of Sher-e-Bangla Agricultural University to study the plant characters, growth and yield of kohlrabi as influenced by different organic nutrients during the period from November 2020 to February 2021. The experimental site was located under the Modhupur Tract (AEZ-28) and it was medium high land with adequate irrigation facilities. The soil was having a texture was silty clay loam with pH 5.8, ECE-25.28. The experiment was laid out in Complete Randomized Design (CRD). There were nine treatments with three replications. Total numbers of unit plots were twenty seven. The unit plot size was 1.2 m x 0.9 m, treatment dose was vermicompost 4 t/ha, cowdung 10 t/ha, biochar 4 t/ha, kitchen compost 5 t/ha, mushroom spent compost 5 t/ha and trichoderma 5 t/ha. After transplanting of seedlings, various intercultural operations were accomplished for better growth and development of the plant.

The parameters recorded were plant height, number of leaf, leaf length, leaf breadth, plant weight, leaf weight, leaf dry weight, diameter of knob, knob length, knob weight, knob dry weight, root length, root weight, yield per plot, and yield per hectare.

Application of organic manure exhibited a significant influence on the plant height, number of leaf, leaf length, and leaf breadth of Kohlrabi plants at 30 DAT, 45 DAT and 60 DAT (Appendix III-XIV).

By the treatment combinations at 30 DAT, 45 DAT and 60 DAT, the plant height, number of leaf, leaf breadth, and leaf length of Kohlrabi plants were significantly influenced. In all the cases treatment combination of N_5 was found significant.

The tallest plant of kohlrabi was recorded in the treatment N_5 (33.67, 37.68 and 39.63 cm at 30 DAT, 45 DAT and harvesting time, respectively) and the shortest plant was found in the treatment N_0 (23.25, 27.25 and 29.20 cm at 30 DAT, 45 DAT and 60 DAT respectively).

The maximum leaf length of kohlrabi was recorded in the N_5 (34.73, 37.53 and 38.86 cm at 30 DAT, 45 DAT and 60 DAT respectively) treatment and the minimum leaf length was found in the N_0 (23.50, 26.20 and 27.43 cm at 30 DAT, 45 DAT and 60 DAT respectively) treatment.

The maximum leaf breadth of kohlrabi was recorded in the N_5 (10.43, 12.90 and 14.33 cm at 30 DAT, 45 DAT and 60 DAT respectively) treatment and the minimum leaf breadth was found in the N_0 (5.33, 8.16 and 9.30 cm at 30 DAT, 45 DAT and 60 DAT respectively) treatment.

The highest leaf number of kohlrabi was recorded in the N_5 (9.10, 12.20 and 13.00 cm at 30 DAT, 45 DAT and 60 DAT respectively) treatment and the lowest leaf number was found in the N_0 (5.33, 8.40 and 9.36 cm at 30 DAT, 45 DAT and 60 DAT respectively) treatment.

The maximum individual plant weight of kohlrabi was recorded in the N_5 (439.13 g) and the lowest plant weight was found in the control N_0 (212.45 g) treatment. The maximum individual leaf weight of kohlrabi was recorded in the N_5 (135.33 g) treatment and the minimum leaf weight was found in the control N_0 (87.36 g) treatment. The highest value of the dry weight of 100 g of leaves (26.00 g) was recorded in N_5 treatment while the lowest dry weight of 100 g of leaves (14.07 g) was found in N_0 treatment.

The highest diameter of knob (8.40cm) was recorded from N_5 (Kitchen Compost (50%) (5ton/ha) + Vermicompost (20%) + Trichoderma 30%), whereas the lowest diameter (6.96 cm) was recorded from N_1 (Cowdung 10 ton/ha). The highest individual knob length without leaves of kohlrabi was recorded in the N_5 (6.20 cm) treatment that contained kitchen compost (50%) (5ton/ha), vermicompost (20%) and trichoderma (30%). The lowest individual knob length was found in the control treatment N_0 (4.80 cm). The maximum weight of knob (322.0 g) was recorded from N_5, while the minimum weight (188.63 g) was recorded from N_0 (control) which was statistically similar with N_1 (202.76 g).

The highest value of the dry weight of 100 g of the knobs (29.46 g) was recorded in N_3 treatment while the lowest dry weight of 100 g of the knob (22.40 g) was found in N_0 control treatment.

The longest root of kohlrabi (13.53 cm) was recorded in the treatment N_5. The shortest root (8.43 cm) was found in the N_0 treatment. The highest root weight of kohlrabi (12.36 g) was recorded in the N_5 treatment and the lowest individual root weight (9.10 g) was found in the N_0 application.

Yield parameters like yield per plot, yield per hector varied significantly due to different organic manure treatment combination. Application of organic manure exhibited a significant influence on yield per plot. The maximum yield per plot was obtained from N_5 treatment (3.86 kg) while the minimum yield per plot (2.26 kg) was obtained from the control treatment N_0 which was statistically similar treatment N_1 (2.43 kg). Maximum yield per hectare (35.77 t) was observed in treatment (N_5) while the minimum yield per hectare (20.95 t) was obtained from the control treatment (N_0) which was statistically similar with treatment N_1 (22.52 t).

By considering the results of the present experiment, further studies in the following areas are suggested below:

I. Studies of similar nature could be carried out in different agro ecological zones (AEZ) in different seasons of Bangladesh for the evaluation of zonal adaptability.
II. Different level of organic manure may be used for further study.
III. Another experiment may be carried out with another variety.

REFERENCES

Abd Alla, M. A., El-Shoraky, F. S. (2017): Impact of biological agents and plant essential oils on growth, quality and productivity of cabbage and cauliflower plants correlated to some diseases control. – Journal of Sustainable Agricultural Sciences 43(1): 27-38. DOI:10.21608/jsas.2017.3493.

Abou, M.M., El- Magd, A.M., El-Bassiony and Fawzy, Z.F. (2006). Effect of organic manure with or without chemical fertilizers on growth, yield and quality of some varieties of broccoli plants. *J. App. Sci.* Res, **2**(10): 791-798.

Abou, El-Magd, M.M., Hoda A. Mohamed and Z.F. Fawzy., 2005. Relationship growth, yield of broccoli with increasing N, P or K ratio in a mixture of NPK fertilizers (*Brassica oleracea var italica* plenck)

Adediran JA, Taiwo LB, Sobulo RA (2003). Organic wastes and their effect on tomato (*Lycopersicon esculentum*) yield. *African Soils* **33**: 99-116.

AdeliA, Tewolde H, Sistani KR and Rowe DE (2009). Broiler litter fertilization and cropping system impacts on soil properties. *Agron. J.* **110**: 1304-1310.

A.F.M. Jamal Uddin, M.S. Hussain, Sk. S. Rahman, H. Ahmad and M.Z.K. Roni (2015). Effect of Trichoderma Concentrations on Growth and Yield of Tomato. Bangladesh Res. Pub. J. 11(3): 228-232.

Akanbi WB, Akande MO, Adediran JA, (2005). Suitability of composted maize straw and mineral N fertilizer for tomato production. *J. Veg. Sci*. **11**(1): 57-65.

Akande MO, Adediran JA (2004). Effects of terralyt plus fertilizer on growth nutrients uptake and dry matter yield of two vegetable crops. *Moor J.Agric*. Res. **5**:12-107.

Aknni DI and Ojeniyi SO, (2007). Effect of different levels of poultry manure on soil physical properties, nutrients status, growth and yield of tomato (*Lycopersicon esculentum*). Res. *J. Agron*. **1**:((1-4).

Akter, S., Noor. S., Rahman, M., Sultana S. and Nandi, S.K. (1996). Effect of organic manure and chemical fertilizer on the yield of broccoli. *Bangladesh Hort*., **24** (1&2): 59-64.

Alam, M.S., Iqbal, T.M.T, Amin, M.S. and Gaffer, M.A. (1989). Production and Improvement of Agronomic Crop. T.M. Jubair Bin Iqbal, Manik Potal, Meghai, Serajgonj. pp. 231-239.

Ali S, Kashem MA, Sarker MMH. 2018. Effect of vermicompost on the growth and yield of cauliflower in acid soil of Bangladesh. Journal of Sylhet Agricultural University 5:37–43.

Aluko, O.B., Oyedele, D.J. (2005). Influence of organic incorporation on changes in selected soil physical properties during drying of a Nigerian alfisols. *J. Applied Sci.* **5**:357-362.

Antonova, G., Neykov, S., Krasteva, L. and Chavdarov, P. (2014). Evaluation of Morphological Manifestations of New Bulgarian Kohlrabi Variety Grown in The Conditions of Organic Crop Production. *Türk Tarım ve Doğa Bilimleri*, 7(7): 1579-1583.

Altintas, S. and Bal, U. 2008. Effects of the commercial product based on Trichoderma harzianum on plant, bulb and yield characteristics of onion. *Scientia Horticulturae*, 116(2): 219-222.

Ayeni L.S., Adetunji, M.T., Ojeniyi.S.O., Ewulo, B.S. and Adeyemo, A.J. (2008). Comparative and cumulative effect of cocoa pod husk ash and poultry manure on soil and nutrient contents and yield of maize. *American-Eurasian J. of sustain. Agric.* **2**(1): 92 -97.

Bal, U., Altintas, S. (2006): A positive side effect from *Trichoderma harzianum*, the biological control agent: Increased yield in vegetable crops. – Journal of Environmental Protection and Ecology 7: 383-387.

BBS (Bangladesh Bureau of Statistics). (2020). Statistical Yearbook of Bangladesh. Bangladesh Bur. of Stat., Stat. Div. Minis. Plan. Govt. People's repub. Bangladesh.

Beecher, C. (1994). Cancer preventive properties of varieties of Brassica oleracea: a review. The American Journal of clinical Nutrition 59, 1166-1170.

Bhavalkar US. (1991). Vermiculture biotechnology for LEISA. Seminar on Low External Input Sustainable Agriculture, Amsterdam, Netherlands, 1-6.

Boari, F., Bianco, V.V., Cefola, M., Pace, B., Vanadia, S and Cantore, V. (2010). Characteristics of broccoli in organic farming related to cultivar and biofertilizer amount. *Italus Hortus*., **17**(2): 39-41

Contreras-Cornejo, H. A., L. Macías-Rodríguez, C. Cortés-Penagos and J. López-Bucio. 2009. Trichoderma virens, a plant beneficial fungus, enhances biomass production and promotes lateral root growth through an auxin-dependent mechanism in Arabidopsis. *Plant Physiology,* 149:1579–1592.

Duncan J (2005). Composting chicken manure. WSU Cooperative Extension, King County Master Gardener and Cooperative Extension Livestock Advisor.

Edwards, C.A. and Burrows, I. (1988). The potential of earthworms composts as plant growth media. In: Edward, C.A. and Neuhauser, E.F. Eds., 'Earthworms in Waste and Environmental Management', SPB Academic Publishing, The Hague, 2132.

EI-Bassiony, A. M., Fawzy, Z. F., EI-Nemr, M. A. and Li, Y. (2014). Improvement of growth, yield and quality of two varieties of kohlrabi plants as affected by application of some bio stimulants. *East J. Agric. Res.*, **3**(3): 491-498

Ekandjo, L. K., and Ruppel, S. (2015). The impact of mineral nitrogen fertilization on the occurrence of native diazotrophic bacteria in Kohlrabi (Brassica oleracea) shoots and roots. *J. Agric. Sci.*, **7**(2): 1.

Ewulo BS, OjeniyiSO and Akanni DA, (2008). Effect of poultry manure on selected soil physical and chemical properties, growth, yield and nutrient status of tomato. *African J. Agril*. Res. **3** (9): 612-616.

Ewulo, B.S. (2005). Effect of poultry and cattle manure on sandy clay loam soil. *J. Anim. Vet.Sci.*, **4**: 839-841.

Gomez, K.A. and A.A. Gomez, 1984. Statistical procedures for Agricultural Research. 2 Edn. *Willey Inter Science Publ*., pp: 357- 423.

Haque, M.O. (2000). Effect of different fertilizer management practices on the growth and yield of main and ratoon crop of cabbage. An MS Thesis, Department of Horticulture., Bangladesh Agricultural University, Mymensingh.

Harman, G. E., Herrera-Estrella, A. H., Horwitz, B. A., Lorito, M. (2012): *Trichoderma* – from basic biology to biotechnology. – Microbiology 158(Special Issue): 1-2. DOI: 10.1099/mic.0.056424-0.

Hermosa, R., Viterbo, A., Chet, I., Monte, E. (2012): Plant-beneficial effects of *Trichoderma* and of its genes. – Microbiology 158: 17-25.

Hussain M. A., T. Mukhtar and M. Z. Kayani. 2011. Efficacy evaluation of Azadirachta indica, Calotropis procera, Datura stramonium and Tagetes erecta against rootknot nematodes Meloidogyne incognita. *Pakistan Journal of Botany*, 43:197– 204.

IFA/FAO (2000). Fertilizer and their use. FAO Rome Italy.

Ismail, S.A. (1997) Vermicology: The biology of Earthworms. Orient Longman Limited, Chennai, 1997, 92.

Kochki A., Hosseini M., Nasiri-Mahallati M. (1995). Crops in relation to soil and water. Publications Jahad. Mashhad. Iran, pp. 20-30.

Krishnamoorthy, R.V. and Vajranabhaiah, S.N. (1986). Biological activity of earthworm casts: An assessment of plant growth promoter levels in the casts. Proceedings of Indian Academy of Sciences (Animal Science), 95(3), 341-351

Maurya, A.K., Singh, M.P., Srivastava, B. and Singh, K. (2008). Effect of organic manures and inorganic fertilizers on growth characters, yield and economics of sprouting broccoli cv. *Fiesta Indian J. Hort*., **65**(1): 116- 118.

Mehdizadeh M, Ebrahim ID, Naseri-Rad H and Tobeh A, (2013). Growth and yield of tomato (*Lycopersicon esculentum Mill*.) as influenced by different organic fertilizers. *Intl J. Agron. and Plant Production*. **4** (4):734-738

Olaniyi, J.O. and Ajibola, A.T. (2008). Effects of inorganic and organic fertilizers application on the growth, fruit yield and quality of tomato (*Lycopersicon lycopersicum*). *J. Veg. Crop Production* **1**(1): 53-62.

Palm, C.A., Myers, J.K., Nandwa, S.M. (1997). Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment. Soil Science Society of America Special Publication **51**: 193-217

Pane, C., Palese, A. M., Celano, G. and Zaccardelli, M. (2014). Effects of compost tea treatments on productivity of lettuce and kohlrabi systems under organic cropping management. *Italian J. Agron.*, **9**(3): 153-156.

Perin, A., Santos, R. H. S., Urquiaga, S., Guerra, J. G. M. and Cecon, P. R. 2004. Residual effect of green manures on broccoli (*Brassica oleraceae* var. *italica*) yield cultivated in succession to corn (*Zea mays* L.). *Ciencia Rural*, **34**(6): 1739-1745.

Poldma, P., Albrecht, A., and Merivee, A., 2002. Influence of fungus Trichoderma viride on the yield of cucumber in greenhouse conditions. In: Proceedings of the Conference on Scientific Aspects ofOrganic Farming, Jelgava, Latvia 21–22 March 2002, pp. 176–180.

Porras, M., C. Barrau and F. Romero. 2007. Effects of soil solarization and on strawberry production. *Crop Protection.* 26(5): 782-787.

Premsekhar, M. and Rajashree, V. (2009).Influence of organic manures on growth, yield and quality of okra. *American-Eurasian J. Sustain. Agric.*, **3**: 6-8

Relf, D., A. McDoniel and V. Tech 2002. Fertilising the vegetable garden. fertilizers.htm (21/08/2008)

Saleh, S. A. and Zaki, M. F. Nagwa; Hassan, M. K. and Ezzo, M. I. (2013). Optimizing nitrogen sources and doses for optimum kohlrabi production in new reclaimed lands. *J. Appl. Sci. Res.*, *9*(3): 1642-1650.

Sam, C. and Franks J. D. (2006). Texas Home Gardening Guide. Texas Agricultural Extension Service. The Texas A&M University System, College Station, Texas, pp. 6-18.

Sanjay, K. and Chaudhary, D. R. 2002. Effect of FYM, molybdenum and boron application on yield attributes and yield of cauliflower. *Crop Res. Hisar*, **24**(3): 494-496.

Senesi, N., C. Saiz-Jimenez and T.M. Miano. (1992). Spectroscopic characterization of metal humic acid-like complexes of earthworm- composted organic wastes. The Science of the Total Environment, 117/118: 111-120.

Shams, A. S. (2012). Effect of mineral, organic and bio-fertilizers on growth, yield, quality and sensory evaluation of Kohlrabi. *Research J. Agric. Biol. Sci.*, **8**(2): 305-314.

Sharma, S. K., Rajendrer, S. and Korla, B. N. 2002. Effect of nitrogen and phosphorus on the growth and seed yield of sprouting broccoli cv. Green head. Hort. J., 15(2): 87-90.

Singh, A. K. 2004. Effect of nitrogen and phosphorus on growth and curd yield of cauliflower var. snowball -16 under cold arid region of Ladakh Haryana J. Hort. Sci., 33(1&2): 127-129.

Sultana, J., Siddique, M. A., and Rashid, M. H. A. (2012). Effects of cowdung and potassium on growth and yield of Kohlrabi. *J. Bangladesh Agric. Univ.*, **10**(1): 27-32.

Tanwar, A., Aggarwal, A., Kaushish, S., Chauhan, S. (2013): Interactive effect of AM fungi with *Trichoderma viride* and *Pseudomonas fluorescens* on growth and yield of broccoli. – Plant Protection Science 49(3): 137-45. DOI: 10.17221/54/2012.

Uddin, J., Solaiman, A. H. M. and Hasanuzzaman, M. (2009). Plant Characters and Yield of Kohlrabi (*Brassica oleraceae* var. *gongylodes*) as Affected by Different Organic Manures. *J. Hortic. Sci. Ornamental Plants*, **1**(1): 01-04.

Warman PR (1986). The effect of fertilizer, chicken manure and dairy manure on Timothyyield, tissue composition and soil fertility. *Agric.Wastes* **18**: 289-298.

Vernon, G. 1999. Sustainable vegetable production. Ithca Inc. New York. USA

Vinale, F., Sivasithamparam, K., Ghisalberti, E. L., Marra, R., Barbetti, M. J., Li, H., Woo, S. L., Lorito, M. (2008): A novel role for *Trichoderma* secondary metabolites in the interactions with plants. – Physiological and Molecular Plant Pathology 72: 80-86.

APPENDICES

Appendix I. Morphological characteristics and results of mechanical & chemical analysis of soil of the experimental plot

A. Morphological Characteristics

Morphological Features	**Characteristics**
Location	Horticulture Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General soil type	Shallow redbrown terrace soil
Land type	Medium high land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

Source: Soil Resource Development Institute (SRDI)

B. Mechanical Analysis

Constituents	**Percent**
Sand	27
Silt	43
Clay	30

Source: Soil Resource Development Institute (SRDI)

C. Chemical Analysis

Soil Properties	Amount
Soil pH	5.8
Organic carbon (%)	0.45
Total nitrogen (%)	0.03
Available P (ppm)	20
Exchangeable K (%)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix II. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from November, 2020 to February, 2021

Month	Air Temperature (0C)		R. H. (%)	Total Rainfall (mm)
	Maximum	Minimum		
November’20	29.2	20.5	67	9
December’20	26.4	17	60	9
January’21	26	15.3	53	10
February’21	29.8	17.4	45	25

Source: Bangladesh Metrological Department (Climate and Weather Division) Agargaon, Dhaka.

Appendix III: Analysis of Variance of Plant Height at 30 DAT

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	220.314	27.539	7.970	.000
Error	18	62.197	3.455		
Total	26	282.512			

Appendix IV: 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
Treatment	8	226.387	28.298	7.733	.000
Error	18	65.871	3.660		
Total	26	292.258			

Appendix V: Analysis of Variance of Plant Height at 60 DAT

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	220.311	27.539	8.058	.000
Error	18	61.518	3.418		
Total	26	281.828			

Appendix VI: Analysis of Variance of Number of Leaf at 30 DAT

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	24.045	3.006	6.592	.000
Error	18	8.207	.456		
Total	26	32.252			

Appendix VII: 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
Treatment	8	27.480	3.435	7.886	.000
Error	18	7.840	.436		
Total	26	35.320			

Appendix VIII: Analysis of Variance of Number of Leaf at 60 DAT

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	22.336	2.792	6.389	.001
Error	18	7.867	.437		
Total	26	30.203			

Appendix IX: Analysis of Variance of Leaf Length at 30 DAT

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	272.133	34.017	24.736	.000
Error	18	24.753	1.375		
Total	26	296.887			

Appendix X: 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
Treatment	8	274.194	34.274	21.471	.000
Error	18	28.733	1.596		
Total	26	302.927			

Appendix XI: Analysis of Variance of Leaf Length at 60 DAT

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	276.967	34.621	24.710	.000
Error	18	25.220	1.401		
Total	26	302.187			

Appendix XII: Analysis of Variance of Leaf Breadth at 30 DAT

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	54.279	6.785	19.847	.000
Error	18	6.153	.342		
Total	26	60.432			

Appendix XIII: 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
Treatment	8	46.047	5.756	16.088	.000
Error	18	6.440	.358		
Total	26	52.487			

Appendix XIV: Analysis of Variance of Leaf Breadth at 60 DAT

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	54.200	6.775	20.257	.000
Error	18	6.020	.334		
Total	26	60.220			

Appendix XV: Analysis of Variance of Plant Weight at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	118065.717	14758.215	6.459	.001
Error	18	41125.620	2284.757		
Total	26	159191.336			

Appendix XVI: Analysis of Variance of Root Length at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	49.707	6.213	6.970	.000
Error	18	16.047	.891		
Total	26	65.754			

Appendix XVII: Analysis of Variance of Root Weight at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	22.667	2.833	3.789	.009
Error	18	13.460	.748		
Total	26	36.127			

Appendix XVIII: Analysis of Variance of Knob Length at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	4.168	.521	3.232	.018
Error	18	2.902	.161		
Total	26	7.070			

Appendix XIX: Analysis of Variance of Knob Diameter at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	4.943	.618	3.945	.007
Error	18	2.819	.157		
Total	26	7.762			

Appendix XX: Analysis of Variance of Knob Fresh Weight at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	45778.219	5722.277	14.275	.000
Error	18	7215.367	400.854		
Total	26	52993.585			

Appendix XXI: Analysis of Variance of Knob dry weight at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	126.650	15.831	20.669	.000
Error	18	13.787	.766		
Total	26	140.436			

Appendix XXII: Analysis of Variance of Leaf Fresh weight at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	4829.819	603.727	16.897	.000
Error	18	643.140	35.730		
Total	26	5472.959			

Appendix XXIII: Analysis of Variance of Leaf Dry Weight at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	358.100	44.763	103.099	.000
Error	18	7.815	.434		
Total	26	365.915			

Appendix XXIV: Analysis of Variance of Yield per Plot at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	6.592	.824	14.275	.000
Error	18	1.039	.058		
Total	26	7.631			

Appendix XXV: Analysis of Variance of Yield per hectare at Harvest

Source of Variance	Degree of Freedom	Sum of Square (SS)	Mean of Square (MS)	F-value	P-value
Treatment	8	565.163	70.645	14.275	.000
Error	18	89.079	4.949		
Total	26	654.242			

Appendix XXVI: Per hectare cost of production of kohlrabi as influenced by different organic manure application

A. Input cost

Cost of production of Kohlrabi per hectare Input cost

Treatments	Labour	Ploughing	Seed	Irrigation	Pesticides	Organic fertilizer cost	Subtotal input cost(A)
N_0	30000	10000	5000	10000	6000	0	61000
N_1	30000	10000	5000	10000	6000	30000	91000
N_2	30000	10000	5000	10000	6000	80000	141000
N_3	30000	10000	5000	10000	6000	120000	181000
N_4	30000	10000	5000	10000	6000	104000	165000
N_5	30000	10000	5000	10000	6000	61000	122000
N_6	30000	10000	5000	10000	6000	150000	211000
N_7	30000	10000	5000	10000	6000	50000	111000
N_8	30000	10000	5000	10000	6000	50000	111000

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

B. Overhead cost

Treatments	Miscellaneous cost (Tk. 5% of the input cost)	Cost of lease for 6 months land rent	Interest on running capital for 6 months (Tk. 12% of cost/year)	Subtotal Overhead cost (B)
N_0	3050	30000	3660	36710
N_1	4550	30000	5460	40010
N_2	7050	30000	8460	45510
N_3	9050	30000	10860	49910
N_4	8250	30000	9900	48150
N_5	6100	30000	7320	43420
N_6	10550	30000	12660	53210
N_7	5550	30000	6660	42210
N_8	5550	30000	6660	42210

Here, N_0: Control, N_1: Cowdung (10 t/ha), N_2: Vermicompost (4 t/ha), N_3: Vermicompost (50%)+ Biochar (50%), N_4: Vermicompost (70%)+ Biochar (4 t/ha) (30%), N_5: Kitchen compost (5 t/ha) (50%)+ Vermicompost (20%)+ Trichoderma (30%), N_6: Mushroom Spent Compost (50%)+ Trichoderma (5 t/ha) (50%), N_7: Kitchen compost (5 t/ha), N_8: Mushroom Compost (5 t/ha)

C. Treatment cost

Cowdung @ Tk. 3/kg

Vermicompost @ Tk. 20/kg

Kitchen compost @ Tk. 10/kg

Mushroom Spent Compost @ Tk. 10/kg

Trichoderma @ Tk. 20/kg and

Biochar @ Tk. 40/kg

Plate 1: Seedling grown in seedbed

Plate 2: Field preparation with layout design

Plate 3: Field preparation with application of different organic nutrients

Plate 4: Transplantation of seedlings

Plate 5: Irrigation

Plate 6: Data collection

Plate 7: Growing knob of Kohlrabi

Plate 8: Pictorial representation of the experimental field

Plate 9: Harvest of Kohlrabi

Plate 10: Measurement of knob weight