# INFLUENCE OF VERMICOMPOST ON GROWTH AND YIELD OF CARROT (*Daucus carota*) CULTIVARS

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# INFLUENCE OF VERMICOMPOST ON GROWTH AND YIELD OF CARROT (*Daucus carota*) CULTIVARS

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# *CERTIFICATE*

*This is to certify that the thesis entitled,* ***"Influence of vermicompost on growth and yield of carrot cultivars (Daucus carota)*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE IN HORTICULTURE*** *embodies the result of a piece of bona fide research work carried out by* ***JANNATUL FERDAUSE; Registration No. 13-5268*** *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.*

***Dated: June, 2020***
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Dedicated to

My Beloved Mother

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***The Author***

# Influence of vermicompost on growth and yield of carrot (*Daucus carota* L.) cultivars

By

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## Abstract

The experiment was carried out at Horticultural Farm, Sher-e-Bangla Agricultural University, during the period from November 2018 to April 2019 to study the application of vermicompost interaction with carrot cultivars for higher growth and yield of carrot. The experiment consists of two factors. Factor A:Three carrot cultivar, CRS-016, New kuroda and Sangal. Factor B: four levels of vermicompost, $V_0$: 0 t/ha, $V_1$: 6 t/ha, $V_2$: 10 t/ha and $V_3$:14 t/ha were used for the present study. The experiment was laid out in RCBD with three replications. Results showed that highest yield of carrot (19.84 t/ha) was found from Sangal cultivar and lowest yield (16.52 t/ha) was found from CRS-016 . For different levels of vermicompost, the highest yield of carrot (25.35 t/ha) was found from $V_2$ (10 t/ha) treatment and the lowest yield (12.55 t/ha) was found from $V_0$ (control) treatment. In case of combined effect, the highest yield of carrot (29.60 t/ha) was produced from $C_3V_2$ (Sangal and 10 t/ha) treatment combination and the lowest yield (11.46 t/ha) was found from $C_1V_0$ (CRS-016 and control) treatment combination. From the treatment combination of Sangal with 10 t/ha vermicompost appeared to be the best for cultivation of carrot under Sher-e-Bangla Agricultural University Farm condition.

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# LISTS OF ABBREVIATIONS

| | | |
|---|---|---|
| cm | = | Centimeter |
| $^0C$ | = | Degree Centigrade |
| DAS | = | Days after sowing |
| *et al.* | = | and others *(at elli)* |
| Kg | = | Kilogram |
| t | = | ton |
| Kg/ha | = | Kilogram/hectare |
| g | = | gram (s) |
| m | = | Meter |
| $P^H$ | = | Hydrogen ion conc. |
| RCBD | = | Randomized Complete Block Design |
| t/ha | = | ton/hectare |
| % | = | Percent |

# CHAPTER 1

## INTRODUCTION

Carrot (*Daucus carota* L.), is one of the world's most common vegetable crops, and the Apiaceous family member crop (formerly Umbelliferae). It is known as being Mediterranean native (Pierce, 1987). It is well distributed in the world's temperate, tropical, and subtropical regions (Bose and Som, 1990), and is widely cultivated in Europe, Asia, North Africa, North and South America (Thompson and Kelly, 1957). Throughout the Rabi season, carrot grows successfully in Bangladesh, and mid-November to early December is the best time for its cultivation to yield satisfactorily. (Rashid, 1993).

Vegetables are one of the most essential components of human food providing proteins, carbohydrates, fats, vitamins, and minerals Per capita vegetable production in Bangladesh is much less than its requirement. Carrot contains higher concentrations of carotene (l0mg / l00 g), thiamine (0.04mg/100 g), riboflavin (0.05mg/100 g), and is often used as a carbohydrate source, protein, fat, minerals, vitamin - C and calories (Yawalkcr,1985). The two main components of carrot flavor are sugar and volatile terpenoids; glucose, fructose, and sucrose, which make up more than 95 percent of free sugars and 40 percent to 60 percent of carrot carbohydrates contained in the core. The ratio of sucrose to sugar reduction increases with root ripeness but decreases after harvest and during cold storage (Freman and Simon, 1983).

In some countries, blindness in children due to serving vitamin-A deficiency is a public health problem, especially in rice-dependent Asian countries (Woolfe, 1988). So carrot (rich in vitamin-A) will contribute a lot of vitamin-A to overcoming this situation. The popularity of carrots in Bangladesh is growing day by day, particularly among the urban population due to its high nutritive value and possible diversified use in making palatable foods.

In Bangladesh, carrot can be eaten raw or by making halua, a sweet preparation. Carrot root is also used in the preparation of soups as a vegetable, and curries and grated roots are used as salads. But large-scale carrot production has yet to begin to satisfy its demand. In Bangladesh, carrot production statistics are not available, and even before the year 2000 are not included in the BBS report.

The field under cultivation of carrots was 1125805 hectares worldwide, total production of 40,316,041 metric tons (FAO, 2017). Carrot development figures aren't available in Bangladesh. Bangladesh grows 16306 MT of carrots in 4533 acres of cultivation in 2016-2017. (BBS, 2017). Rashid (1999) reported an average carrot yield of 25 tones per hectare. This amount production is relatively low compared to other carrot-producing Countries like Switzerland, Denmark, Sweden, UK, Australia, and Israel, where the average per hectare yield is reported to be 36.46, 64.16, 65.42, 49.06, 67.99 tons respectively (FAO, 2017).

The production of carrots can be increased in two ways, either by expanding the area under cultivation or by increasing the yield per hectare with population growth. Land area for vegetable production is not growing due to land limitation as per requirement. So, carrot production can only be increased by increasing the yield per unit area.

Carrot growth and yield largely depend on variety, climatic conditions, and various cultivation practices. In our country, we don't have enough available varieties. But carrots are being cultivated throughout the world with huge productivity of different colors such as yellow, orange, purple, etc. Varietal differences affect production greatly. In tropical and sub-tropical regions different varieties are available.

Vermicompost, which is produced by earthworms, is a rich source of both macronutrients NKP (Nitrogen 2-3%, Potassium 1.85-2.25% and Phosphorus 1.55-2.25%) and micronutrients. Growers typically use chemical fertilizer. Vermicompost application will increase the yield of root crops. Vermicompost contains a higher percentage of available nutrients, humic acids (Senesi et al. 1992), plant growth-promoting substances such as auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah 1986), N-fixing and P solubilizing bacteria, enzymes and vitamins (Ismail 1997). Carrot cultivation requires an ample supply of plant nutrients. This huge amount of otherwise unused vegetable waste and other farm wastage may be utilized for the production of valuable vermicompost. This is essential for the replenishment of plant nutrients, sustaining soil health, reducing the pollution problem, and creating employment opportunities, which is being increasingly recognized as a strategy for sustainable organic farming. Inorganic cultivation leaves a residual effect in crops that are thought to cause public health and environmental threats.

The experiment was conducted with the following objectives in light of the above facts:

- To identify the suitable carrot cultivar for growth and yield of carrot
- To find out the optimum level of vermicompost for growth and yield of carrot.
- To determine the combined effect of variety and vermicompost level for growth and yield of carrot.

# CHAPTER 2

# REVIEW OF LITERATURE

Carrot (*Daucus carota* L.) is the world's largest carotene-rich root vegetables as well as Bangladesh and forms the nutritional point of view in particular; carrot draws much attention to the advancement of its production technology by researchers worldwide.

Like many other root and tuber crops, the growth and yield of carrot vary with different cultivar and organic nutrients. Different factors like different cultivar, source of nutrient, type of soil, temperature, soil moisture, etc. are also influence the growth and yield of carrot. Carrot is also known to be a heavy absorber of nutrient which should be ensured through the proper supply of fertilizer or manure. The Application of vermicompost could also be suitable for successful crop production. The yield and quality of carrot also vary with different cultivars. Nutrient content and storage quality are also influenced by the characteristics of different cultivars. But there is a little combined research work was done to know the influence of cultivar and vermicompost on growth and yield of carrot in Bangladesh. The literature related to the present study is reviewed in this chapter.

## 2.1 Review related to vermicompost

There is no work was done on the effect of the only vermicompost on the growth and yield of carrot. Carrot is closely related to root crops and vegetable crops. Therefore, reports related to the effect of vermicompost to the related crops are reviewed here.

Blouinl (2019) found that vermicompost brought about average increases of 26% in commercial yield, 13% in total biomass, 78% in shoot biomass, and 57% in root biomass. The positive effect of vermicompost on plant growth reached a maximum when vermicompost represented 30 to 50% of the soil volume.

Durukan (2019) conducted an experiment to investigate the effects of solid and liquid vermicompost on yield and nutrient uptake of tomato plant. it was determined that the solid vermicompost showed higher effect on the yield and nutrient uptake of tomato plant than liquid vermicompost.

Chaichit *et al.* (2018) investigated to know the effect of vermicompost tea (VCT) in faba bean. The VCT Treated plants were larger and had more flowers per clump, as well as more clumps and pods per plant than the control. Moreover, treated plants reached the flowering stage at least 3 weeks earlier than the control. This could be explained by the presence of nutrients, humic acid, and probable hormones in VCT, which may positively affect growth, reproduction, and yield. Treatment at 10% VCT presented better values than 20% VCT. The latter contained more humic acid, which probably limited growth and flowering. The soluble sugar and protein contents were higher in treated plants, and the highest values coincided with the flowering and reproductive stages.

Chaichit *et al.* (2018) also found that seeds produced by treated plants were richer in protein than control seeds. These results indicate that 10% of VCT is a useful fertilizer to improve growth in faba bean. This study highlights the possibility of using VCT to increase growth in faba bean.

Kumari *et al*. (2017) conducted a field experiment to identify the "Effect of organic, inorganic fertilizers and plant densities on performance of radish (Raphanus sativas L.)". The experiment consisted three treatment of organic manures (control, VC @ 5 t/ha and FYM @ 15 t/ha) and two treatment of plant densities (20 x 10 cm and 30 x 10 cm). Results indicated that application of vermicompost @ 5 t/ha significantly higher yield attributes, yield and quality of radish over control.

Alper *et al.* (2017) studied the effects of vermicompost on yield and some growth parameters of lettuce were investigated. For this purpose, a random block designed experiment with 5 different applications was conducted in 3 replicates. The applications were control, vermicompost applications of 100 kg, 200 kg, and 300 kg per decare, and conventional fertilization. According to the results obtained, yield and growth parameters were improved by vermicompost application when compared to control and conventional fertilization. As a result of this study, it was concluded that 300 kg vermicompost/da is a promising application in lettuce production for optimal yield and soil improvement.

Wang *et al.* (2017) conducted a greenhouse pot test to study the impacts of replacing mineral fertilizer with organic fertilizers for one full growing period on soil fertility, tomato yield, and quality, it was observed that vermicompost improved fruit quality in each type of soil, and increased the sugar/acid ratio, and decreased nitrate concentration in fresh fruit compared with the CK treatment; vermicompost led to greater improvements in fruit yield (74%), vitamin C (47%), and soluble sugar (71%) in soils with no tomato planting history compared with those in soils with long tomato planting history; and vermicompost led to greater improvements in soil quality than chicken manure compost, including higher pH (averaged 7.37 vs. averaged 7.23) and lower soil electrical conductivity (averaged 204.1 vs. averaged 234.6 μS/cm) at the end of the experiment in each type of soil. We conclude that vermicompost can be recommended as a fertilizer to improve tomato fruit quality and yield and soil quality, particularly for soils with no tomato planting history.

Beykkhormizi *et al.* (2016) stated that Vermicompost can play an effective role in plant growth and development and also in reducing harmful effects of various environmental stresses on plants due to its porous structure, high water storage capacity, having hormone-like substances and plant growth regulators and also high levels of macro and micronutrients.

Kumar *et al.* (2014) conducted a field experiment to study the influence of organic source of nutrients on growth and yield of radish cv. Japanese White. The experiment consisted 5 of 11 treatments laid out in randomized block design with three replications. It was seen that the plant height was significantly increased by the application of organic manures and it was maximum under treatment of vermicompost + poultry manure (50% each). Similarly, vermicompost+poultry manure 50% each recorded highest number of leaves. Root length and root diameter were significantly influenced by organics at harvest. Highest root length (18.91 cm) and better fresh and dry weight of plant was recorded with vermicompost (50%) + poultry manure (50%). The study suggested that application of poultry manure (50%) + vermicompost (50%) was found more beneficial and significantly improved growth and yield of radish var. Japanese White grown under Lucknow condition.

Hossein (2013) experimented on peppermint at the University of Guilan reveals that vermicompost increases electrical conductivity in soil due to increased salinity associated with continued usage. Plants treated with vermicompost, vermiwash , or leachate vermicompost + vermiwash were the tallest and had the highest levels of chlorophyll a, chlorophyll b, total chlorophyll, and carotenoids. Plants treated with vermicompost or vermiwash had the highest total plant fresh weight, leaf fresh weight, and total fresh yield. The leachate vermicompost, vermiwash, and vermicompost can be used as organic fertilizers for sustainable peppermint cultivation.

Kezia and David (2013) conducted a field experiment to study the effect of various compositions of organic, inorganic fertilizers, and their interactions on the growth of white radish plant. Four unique combinations of organic and inorganic fertilizers were applied. The parameters measured to study the growth are weight, the number of leaves, and the length of the bulb. The study reveals that inorganic fertilizer had a significant impact on the weight and number of leaves but not on the length of the root of the radish plant. The individual and interaction of the organic and inorganic fertilizers had a significant effect on the length of the root of the radish plant. Among different combinations of FYM (10, 15, and 20 t $ha^{-1}$), vermicompost (0.5 and 1.0 t $ha^{-1}$), and neem cake (0.5 and 1.0 t $ha^{-1}$), Umesha et al. (2012) recorded the maximum plant height, total dry matter, fresh and dry herbage yield with the application of FYM ® 20 t $ha^{-1}$ + vermicompost ®1.0 t $ha^{-1}$+ neem cake @ 1.0 t $ha^{-1}$ in Solanum nigrum. Ranuma et al. (2012) recorded the highest plant height and leaf yield in mulberry with vermicompost application.

Cristina (2011) observed from the experiment on sweet corn plants were grown under (i) a conventional fertilization regime with inorganic fertilizer, and integrated fertilization regimes in which 75% of the nutrients were supplied by the inorganic fertilizer and 25% of the nutrients were supplied by either (ii) rabbit manure, or (iii) vermicompost the integrated regimes yielded the same productivity levels as the conventional treatment. Moreover, both vermicompost and manure produced significant increases in plant growth and marketable yield.
Cristina (2011) observed that the use of organic fertilizers such as vermicompost has a positive effect on crop yield and quality.

Padmavathiamma *et al.* (2008) opined that the addition of vermicompost improved soil environment and encouraged the proliferation of roots that drew more water and nutrients from a larger area.

Ansari (2005) studied the effect of organic farming on soil nutrients and quality of carrot. Composted cow dung, poultry manure, vermicompost, rice straw compost, recommended fertilizer were used. Among the treatment performance, poultry manure was superior to other organic treatments for soil moisture, organic matter, total N, and available S in soil. Poultry manure and composted cow dung, poultry manure + vermicompost was superior for enrichment in the nutritional quality of carrot.

Kale *et al.* (1991) observed that the use of vermicompost helps reduce the basal dose of fertilizer to 25 percent in tomato, radish, carrot, and brinjal.

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

Bakthavathsalam *et al.* (2004) observed the vegetative growth of radish using vermicomposts obtained from the culture study of earthworm (Lampito mauritii) using 7 paddy chaff and weed plants. The results revealed a different effect on the height and weight of the radish plant cultivated in fresh organic manure and vermicompost. Plants that were grown in PSR media of fresh organic manures showed relatively lesser growth values than the plants raised in vermicompost. The results proved that the application of vermicompost had a positive role in the growth parameters of radish.

Arancon *et al.* (2004) pointed out that The positive response of vermicompost on plant growth and yield was probably not only due to the available nutrients but also due to the availability of plant growth influencing materials, such as growth regulators, humic acids produced by the microbial population resulting from earthworm activity

Oliveira *et al.* (2001) studied the effect of earthworm compost and mineral fertilizer on root production in carrot and found that the different levels (0, 15, 20, 25 and 30 t/ha) of earthworm compost, in the presence or absence of mineral fertilizers, on the production (cv. *Brasilla Nova Selocoa*) roots was evaluated in a field experiment conducted in Areia (Praibaj), Brazil during July-October 1997. Earthworm compost at 25 t/ha produced the highest total (70.1 t/ha) and marketable (31.1 t/ha) yields and the lowest non-marketable yield of roots (39.0 t/ha). The presence of mineral fertilizers increased root yields and increased the production of Extra-A and Extra grade, special and first grade roots by 4.9, 5.6, 1.7 and 19.4 t/ha, respectively compared to its absence.

Ndegwa and Thompson (2001) observed that Vermicompost carried high levels of soil enzymes and plant growth hormones which enhanced microbial populations and held more nutrients over longer periods.

Anonymous (1977) reported that the application of compost to the soil increases water holding capacity, reduces soil erosion, and improves the physio-chemical and biological condition of the soil, besides providing with plant nutrients.

## 2.2 Review related to carrot cultivars

Lucian *et al.* (2019) conducted this experiment to identify some healthy technological solutions for carrot production in the agricultural area, for three carrot varieties: Royal Chantenay, Atomic Red and Purple Haze F1, especially in the actual conditions of climate warming and aridity (risk situations and areas strongly affecting the carrot production potential). It has been observed that after fertilization by zeolite increased the production of carrot cultivars by 27.1%, while the chemical fertilization increased the harvest only with 14.9%.

Nadezhda *et al*. Experiment on studying the carrots cultivars was carried in 2017-2019. The object of research was 17 types of carrots from the world Vavilov collection. Based on three-year studies on yield, we can distinguish the following cultivars: Berlanda F1 (Netherlands), Nantes (Italy), and Imperator Type 9-11 (USA) with a yield of 68.4 to 75.2 t/ha. The coefficient adaptability was higher than 1, in the varieties Berlanda F1 (Netherlands), Nantes (Italy), F1 Eagle (Canada), Imperator Type 9-11 (USA), Wav-88 (Germany), Surazhevskaya-1 (Russia). They have the ability to adapt to difficult growing conditions and produce consistently high yields. The samples selected can be used in the future to create new cultivars and hybrids.

Gabriela *et al*. (2017) the experimental material was represented by five carrot cultivars: 3 varieties (Berlikum, Flakkee, and Chantenay Red Cored) and two hybrids (Warmia F1and Fidra F1). Depending on the cultivar, the root length varied between 10.8 cm (Flakkee) and 14.1 cm (Chantenay Red Cored), the root diameter between 2.4 cm (Flakkee) and 3.9 cm (Chantenay Red Cored), and the average weight of roots between 84.5 g (Flakkee) and 130.2 g (Chantenay Red Cored). The yield was between 38.8 t/ha (Flakkee) and 60.2 t/ha (Chantenay Red Cored). Also, Berlikum carrot variety had a high yield (57.6 t / ha). In the climate conditions of Vidra area, variety Chantenay Red Cored recorded the highest values for all studied parameters (root length, root diameter, average root weight, and yield).

Resende *et al*. (2014) evaluated the behavior of cultivars and populations of carrot under organic cropping system, under the climatic conditions of the Submiddle Sao Francisco Valley, Pernambuco state, Brazil, during the period of mild temperatures (June to September 2008). The experiment was carried out to evaluate 13 cultivars (Brasilia, Alvorada, Karine, Brazlandia, Nantes, Suprema, Redonda de Nice, Nancy, Kuronan, Esplanada, Danvers, Tropical, Nova Kuroda) and three populations (Alvorada POP, Brasilia POP, and Esplanada POP). Plant height ranged from 48.0 to 64.1 cm, with an emphasis on Brasilia (64.1 cm). The total root yield ranged from 65.2 to 98.9 t ha-1 being greater for Brasilia POP (98.9 t ha-1), followed by Brasilia (96.3 t ha-1) and Danvers (94.7 t ha-1). The yield of roots ranged from 0.0 to 84.5 t ha-1, highlighting the genotypes Brasilia POP (84.5 t ha-1), Brasilia (81.7 t ha-1), and Danvers (78.1 t ha-1). The cv. Esplanada excelled with higher fresh root weight (123.2 g root-1), followed by cv. Danvers (122.8 g root-1) and genotype Esplanada POP (119.1 g root-1) the former and the latter presenting no higher marketable yields.

Malek (2012) studied different varieties of carrot and growing conditions of stecklings showed highly significant influence all most all the parameters studied. The highest seed yield (1321.53 kg/ha) was recorded from Brasilia Agroflora and the quality of seed (germination 83.20% and seed vigor index 12.21) was produced from the same variety, while the lowest seed yield (1193.70 kg/ha) and germination (79.42%) were obtained from New Kuroda.

Byung Sup Kim (2011) was carried out this research to select desirable cultivar for organic cultivation of carrot in Korea. ``PI 223360`` was resistant against powdery mildew. Ten cultivars including ``Oxheart Carrot Heirloom`` were moderately resistant, 22 cultivars including ``Long Imperator #58`` were susceptible to powdery mildew. Although there was no resistant cultivar against black rot and leaf blight, our results showed that several cultivars have moderate resistance. Thirteen cultivars including ``Oxheart Carrot Heirloom`` were having insect (Erythroplusia pyropia) tolerance and ``SA 102`` and ``Scarlet Keeper Carrot Rare`` were susceptible. According to the investigation of bolting, 6 cultivars including ``Hongsim Ouchon Carrot`` were early bolting and 4 cultivars including ``Japanese Imperial Long Carrot`` were moderate bolting. Other cultivars were identified as late bolting. From the above results, we confirmed that ``Oxheart Carrot Heirloom`` was a suitable cultivar for organic cultivation among 32 genetic resources of carrot.

Anagnoste *et al.* (2010) studied 10 variants presented in of the 10 variants, nine are new hybrid cultivars, as a witness was elected a traditional variety Nantes improved recently. New carrot cultivars Biometric determinations reveal that the entire experimental range shows values very close. Napoli F1 is remarkable that the early production, harvested at 90 days after the mass emergence was 27. 70t/ha; The group is distinguished Bangor F1 mid-early cultivars with a production of 71.43 t/ha and late cultivars Kamaran F1 group with 78.24 t/ha; Washers are suitable for freezing as nearly the entire range except for Chantanay type cultivars or Flakke useful for freezing of carrot cubes.

Schuch *et al.* (1999) studied the effect of organic manure on yield and quality of carrot cultivar Names Forto, Flakkese, Fuyumaki Names Superior and harumaki Kimko, in 1993 and 1995. Manure was applied at 4.5. 6.5 and 15 t/ha in 1993 followed by 2.1, 2.6 and 15 t/ha in 1995. In the 1995 experience Names, Forto produced the highest root yield. Root number, weight. diameter and length varied with the amount of organic manure application. The Application of organic manure generally increased all factors evaluated.

Jaiswal *et al.* (1996) found that carrot cultivars New Kuroda and Early Names performed well during the off-season. The use of mulching in carrot was found to be useful at most locations in terms of conserving soil moisture and for preventing the crop from moisture stress although yield effects were not significant.

Otani (1974) conducted an experiment with 3 carrot cultivars and different doses of nitrogen as (NH4)2SO4. It was reported that, plant height increased with the increase in nitrogen supply varied with cultivars.

# CHAPTER 3

## MTERIALS AND METHOD

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka from November 2018 to April 2019 to study the growth, yield and quality of carrot as influenced by variety and vermicompost. This chapter deals with the materials and methods that were used in carrying out the experiment.

### 3.1 Location of the experiment field

The experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207. The location of the experimental site was at 23°75' N latitude and 90°34' E longitude with an elevation of 8.2 meters from the sea level (Anon., 1989).

### 3.2 Climate of the experimental area

The experimental area is characterized by subtropical rainfall from May to September throughout the month and intermittent rainfall during the rest of the year. Information on average monthly soil temperature as reported during the study period by the Bangladesh Meteorological Department (Climate Division) Agargoan, Dhaka, was given in Appendix II.

### 3.3 Soil of the experimental field

The soil of the experimental area belongs to silty clay loam series in the Modhupur Tract (UNDP, 1988) under AEZ No. 28 (Appendix I), pH 6.5. It had shallow red brown terrace soil. The selected plot was medium high land and the soil series was Tejgaon (FAO, 1988). The analytical data of the soil sample collected from the experimental area were determined in the soil Resource Development Institute (SRDI), Soil Testing Laboratory, Khamarbari, Dhaka and have been presented in Appendix III.

### 3.4 Planting materials

The seeds of carrot cultivars New Kuroda (a Japanese variety), Sangal, CRS-016 (chantenay type) were used in the experiment. The seeds were collected from afroza Seed Store, Siddique Bazar, Dhaka.

### 3.5 Treatments of the experiment

The experiment was a two-factorial designed to study the effect of different levels of vermicompost on the growth and yield of different carrot cultivars. The experiment consisted of the following treatments:

**Factor A:** It comprised three(3) carrot cultivars

I. $C_1$ = CRS-016

II. $C_2$ = New kuroda

III. $C_3$= Sangal

**Factor B:** It comprised four(4) different dose of vermicompost

I. $V_0$= 0 t/ha

II. $V_1$ =6 t/ha

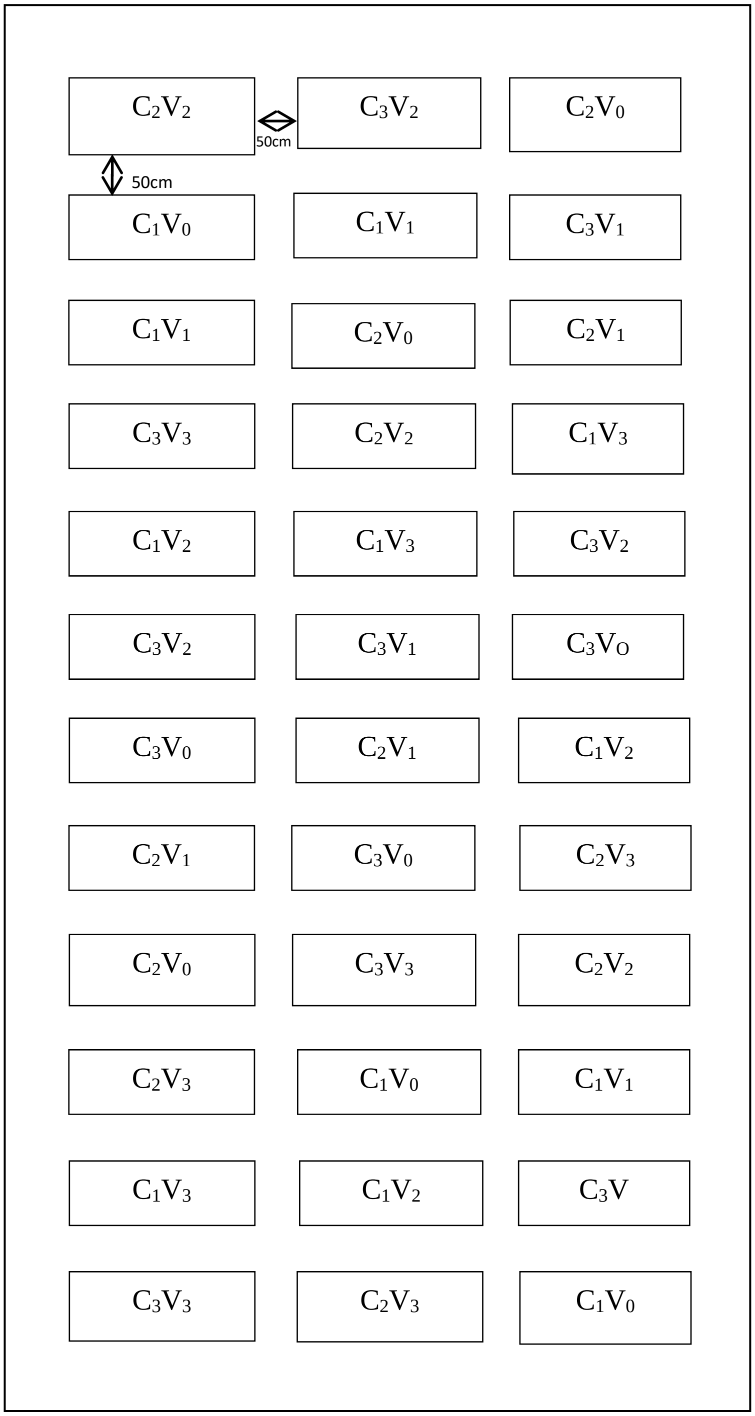
III. $V_2$ =10 t/ha

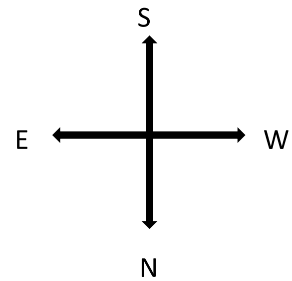
IV. $V_3$=14 t/ha

There were 12 (3x4) treatments combination such as $C_1V_0$,$C_1V_1$,$C_1V_2$,$C_1V_3$,$C_2V_0$,$C_2V_1$,$C_2V_2$, $C_2V_3$,$C_3V_0$,$C_3V_1$,$C_3V_2$,$C_3V_3$.

### 3.6 Experimental design and layout

The experiment was conducted in Randomized Complete Block Design (RCBD) having two factors with three replications. The total area of the experimental plot was divided into three equal blocks and each block was divided into 12 unit plots. The size of each plot was 1.25m x 1m. Thus, there were 36 (12 x 3) unit plots altogether in the experiment. The distance between blocks was 0.5 m and 0.5 m wide drain was made between the plot, to facilities different intercultural operations.




**Legend:**
Plot size: 1.25mx1m
Plant-plant distance: 20cm
Row-row distance: 25cm
Block-block distance: 50cm
Plot-plot distance: 50cm

**Factor A: Different Carrot Cultivars**
$C_1$: CR-016
$C_2$: New Kuroda
$C_3$: Sangal

**Factor B: Levels of Vermicompost**
$V_0$: 0 t/ha
$V_1$: 6 t/ha
$V_2$: 10 t/ha
$V_3$: 14 t/ha

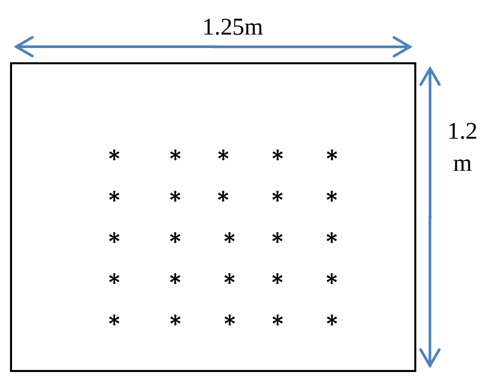



**Fig.1 Layout of the experimental field**

**Figure: Layout of a unit plot*plant**

## 3.7 Cultivation procedure

The soil was well-grounded and strong tilth for commercial crop growth was assured. The experimental field was plowed with a power tiller. the land was plowed and laddering three times, later on, proceeded to gain desirable tilth. The land's corners were spaded, and larger clods were broken into smaller pieces. All the stubbles, roots and uproots we had were removed after plowing and laddering.

### 3.7.1. Application of manure and fertilizers

The Only vermicompost was applied to the field to supply nutrients to the plants. But vermicompost was recorded as a factor of this experiment. No other fertilizer was incorporated into the soil.

| Nutrient element | Vermicompost (%) |
|---|---|
| Organic Carbon | 9.8-13.4 |
| Nitrogen | 0.51-1.61 |
| Phosphorus | 0.19-1.02 |
| Potassium | 0.15-0.73 |
| Calcium | 1.18-7.61 |
| Magnesium | 0.093-0.568 |
| Sodium | 0.058-0.158 |
| Zinc | 0.0042-0.11 |
| Copper | 0.0026-0.0048 |
| Iron | 0.2050-1.3313 |
| Manganese | 0.0105-0.2038 |

## 3.8 Seed soaking

Before sowing, the seed was soaked in water for 24 hours and then covered with a piece of thin cloth prior to planting. Then the moistened seeds were spread over the polythene sheet for two hours to dry out the surface water, this operation was to facilitate for rapid germination of seeds.

## 3.9 Sowing of seeds

The soaked seeds @ 3 Kg/ha (Rikabdar, 2000) were sown on 10 November 2018. Shallow furrows with 1.5 cm depth were made at a distance of 25 cm along the rows and plant to plant spaced at a distance of 20 cm. There were 25 holes in each unit plots and four to ten seeds were placed in each hole and immediately after sowing, covered with loose soil.

## 3.10 Intercultural operations

### 3.10.1 Thinning

The Emergence of seedlings started after 2 weeks from the date of sowing. Seedlings were thinned out two times. First thinning was done after 25 days of sowing (DAS), leaving four seedlings in each hill. The second thinning was done after 20 days from the first thinning, keeping one healthy seedling in each hill.

### 3.10.2. Weeding

Weeding was done as necessary to keep the crop free from weeds, for better soil aeration and to break the crust and to achieve a good quality of carrot roots. Generally, weeding was done four to five times.

### 3.10.3 Irrigation

The field was irrigated 10 times during the whole period of plant growth. Just after sowing light watering was done with a fine watering cane for the first time. After germination, irrigation was given at every alternate day for the proper establishment of seedlings. The surface crust was broken after each irrigation, The rest watering was done at 20, 35, 55, 65 and 75 days after sowing of seeds respectively

## 3.11 Plant protection

### 3.11.1 Insect pest and diseases

The crop was a very little infested with ant , mole cricket, field cricket during the early stage of growth of seedlings. No insecticide was sprayed as infestation was a little amount and it was an organic carrot production experiment.

## 3.12 Harvesting

The crop was harvested on 15 February 2019 after 97 days from seed sowing when the foliage turned pale yellow (Bose and Som, 1990). Rikabdar (2000) suggested that carrots should be harvested in Bangladesh within 90-105 days after sowing for maximum yield and quality. The crop was harvested plot-wise carefully by hand. The soil and fibrous roots and hearing to the roots were cleaned with a cloth. Ten plants were selected at random and uprooted very carefully from each unit plot at the time of harvest and mean data on the following parameters were recorded

## 3.13 Parameters assessed

**Growth stage**

1. Plant height (cm)
2. Number of leaves per plant

**Maturity stage**

1. Length of root per plant (cm)
2. Diameter of root per plant (cm)
3. Fresh weight of leaves per plant
4. Fresh weight of root per plant
5. Dry matter content of roots (%)
6. Dry matter content of leaves (%)
7. Deformed root

8. Rotten roots per plot

9. Total yield of roots per plot (Kg)

10. Total yield of roots per hectare (tone)

11. Marketable yield of roots per plot (Kg)

12. Marketable yield of roots per hectare (tone)

## 3.14 Collection of data

Ten plants per plot were sampled in the middle rows and marked by a bamboo stick for collection of per plant data while the crop of the whole plot was harvested to record per plant data. The plants in the outer rows and the extreme end of the middle rows were omitted from the random sampling to avoid the border effect.

### 3.14.1 Plant height

In order to measure the plant height, a centimeter (cm) by a meter scale at 40,60,80 and 108 days after sowing (DAS) from the point of the attachment of the leaves to the root (ground level) up to the tip of the longest leaf.

### 3.14.2 Number of leaves per plant

The number of leaves per plant of 10 sampled hills was counted at 40, 60, 80 and 108 DAS. All the leaves of the plants were counted separately. Only the smallest young leaves at the growing point of the plant were omitted from the counting.

### 3.14.3 Length of root per plant (g)

The average length of the root was recorded in cm by a meter scale from the point of attachment of the leaves (proximal end) to the last point of the root (distal end) in each treatment combination.

### 3.14.4 Diameter of root per plant (cm)

The average diameter of the root was measured at the thickest portion of the root at harvest with the help of a slide caliper.

**314.5 Fresh weight of leaves per plant (100 g)**

Leaves were detached by a sharp knife and 100 gm fresh weight was recorded in gram (g).

**3.14.6 Fresh weight of root per plant (100 g)**

Underground modified roots were detached by a sharp knife from the attachment of leaves and after cleaning the soil and thin roots, the 100gm fresh weight was taken in gram (g) by a triple beam balance.

**3.14.7 Dry matter content of roots (%)**

Immediately after harvesting, roots were cleaned thoroughly with water and air-dried. Then from several roots, a sample of 100g was taken and cut into small pieces were sun-dried for 4 days and then oven-dried for 72 hours at 70°-80°c temperature. After oven drying, the samples were weighted by an electrical balance and dry matter content was calculated by using the following formula—

$$\text{\% Dry matter of root} = \frac{\text{Constant dry weight of root}}{\text{Fresh weight of root}} \times 100$$

**3.14.8 Dry matter content of leaves (%)**

Fresh leaves of l00g as per treatment sample were weighed and cut into small pieces. After sun drying for 3 days the samples were oven-dried at 72 hours. Then the samples were weighted by an electrical balance and the weight of dry leaves were calculated by using the following formula—

$$\text{\%Dry matter of leaves} = \frac{\text{the Constant dry weight of leaves (g)}}{\text{Fresh weight of leaves (g)}} \times 100$$

### 3.14.9 Deformed roots per plot

At the time of harvest, the number of cracked roots was counted. Cracked root percentage was calculated by using the following formula—

$$\text{Deformed root (\%)} = \frac{\text{Number of Deformed roots}}{\text{Number of total roots}} \times 100$$

### 3.14.10 Rotten roots per plot

At, harvest the number of rotten roots were counted and the result was calculated on a percentage basis as per the following formula

$$\text{Rotten roots (\%)} = \frac{\text{Number of rotten roots}}{\text{Number of total roots}} \times 100$$

### 3.14.11 Total yield of roots per plot (kg)

After the removal of cracked roots, branched root and rotten root, the fresh weight of roots per plot was taken and recorded in kilogram (kg).

### 3.14.12 Total yield of roots per hectare (tone)

The yield of roots per hectare was computed from the per plot yield and was recorded in tonnes.

### 3.14.13 Marketable yield of roots per plot (kg)

The marketable yield of roots per plot has consisted of only good quality roots other than branched, racked and rotten roots. The marketable roots were weighed and expressed in kg.

Marketable yield = Gross yield - Non-marketable yield of cracked, branched and rotten roots.

### 3.14.114 Marketable yield of roots per hectare (tone)

The marketable yield per hectare was computed from the per plot marketable yield data and was recorded in tones

**3.14.15 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 4

# RESULTS AND DISCUSSION

The experiment was conducted to assess the effects of vermicompost on the growth and yield of carrot cultivars. Data on different parameters were analyzed statistically and results have been presented in tables 1 to 11 and figures 2 to 6. The result of the present study have been presented and discussed in this chapter under the following headings

## 4.1. Plant height

### 4.1.1 Effect of cultivar on plant height

Variety is an important factor considering plant height. Under the present study, plant height was significantly influenced by different carrot cultivars at different days after sowing (DAS). The plant height was recorded at different stages of growth i.e. 40, 60, 80 and at harvest after sowing (DAS). The plant height varied significantly in different cultivars (Fig.2 & Appendix III). During the period of plant growth the tallest plant (20.25 cm) was observed in $C_1$ while the shortest plant (16.91 cm) was obtained from $C_3$ at 40 days. At 60 days, the tallest plant (30.87 cm) was obtained from $C_2$ while the shortest plant (23.10 cm) was obtained from $C_3$. At 80 days, the tallest plant height (37.59 cm) was obtained from $C_2$ while the shortest plant (29.07cm) was obtained from the $C_3$. During harvest , the tallest plant (39.58 cm) was obtained from $C_2$ while the shortest plant (28.65cm) was obtained from the $C_{3.}$ Here, findings indicate that C3 is a short variety compared to two others. This result indicates that the plant heights of different carrot cultivars were not the same and this character might be genetically controlled.

**4.1.2 Effect of vermicompost on plant height**

Fertilizer is the most important factor for achieving best yield of crop. Plant height was significantly affected by application of vermicompost at different levels under the present study (Fig.3 & Appendix IV). During the period of plant growth, the tallest plant (21.78 cm) was observed in vermicompost treatment ($V_2$) while the shortest plant (16.17 cm) was obtained from the control treatment ($V_0$) at 40 days. At 60 days, the tallest plant (31.23 cm) was obtained from $V_2$ while the shortest plant (24.03 cm) was obtained from $V_0$. At 80 days, at, the tallest plant (37.73 cm,) was obtained from $V_2$ while the shortest plant (30.03 cm, cm) was obtained from the control ($V_0$). At harvest, the tallest plant (39.66 cm) was obtained from $V_2$ while the shortest plant (31.82 cm) was obtained from the control treatment ($V_0$).The result may be for the optimum dose of vermicompost. when vermicompost provided maximum P and K and reasonable concentration of nitrogen and supplied the elements throughout the growth phases of the plant that might have fulfilled the demand of the crop and encouraged better plant growth .(Rekha *et al.* 2018).

### 4.1.3 Combined effect of on plant height

Interaction effect of cultivar and different level of vermicompost affected plant height significantly under the present study (Table 1 & Appendix V). Different treatment combination viewed different plant height at different days after sowing (DAs). It was observed that highest plant height was achieved with $C_2V_2$ and that was 23.40, 34.93, 42.00 and 43.33 cm at 40, 60, 80 DAS and at harvest respectively which was closely followed by $C_2V_3$ at 40 and 60 DAS, $C_1V_2$ at 80 DAS and at harvest. On the other hand the lowest plant height; 12.80, 19.26, 24.23 and 26.93 cm at 40, 60 and 80 DAS respectively was obtained with $C_3V_0$.

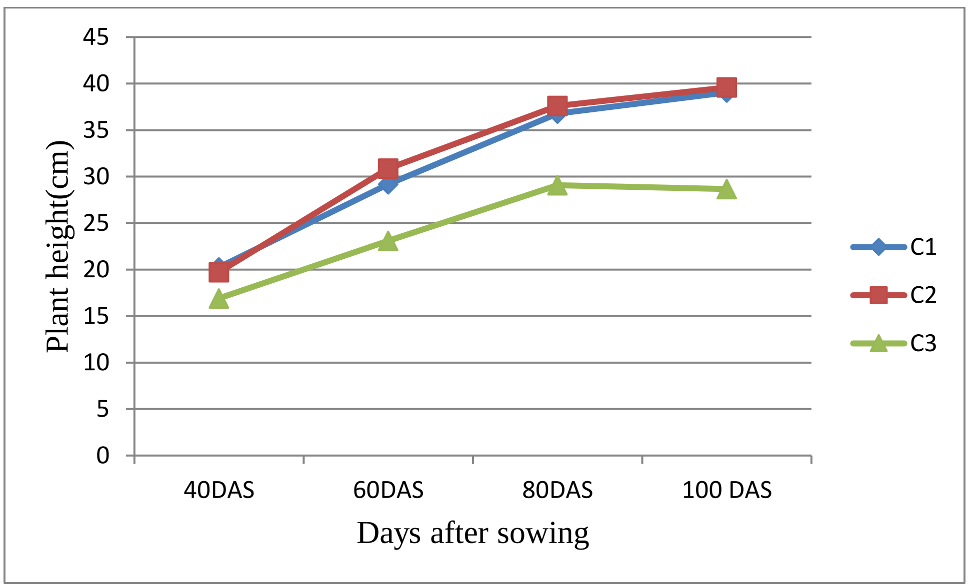



Fig 2: Effect of carrot cultivars on plant height

$C_1$= CRS-016, $C_2$= New kuroda ,$C_3$= Sangal

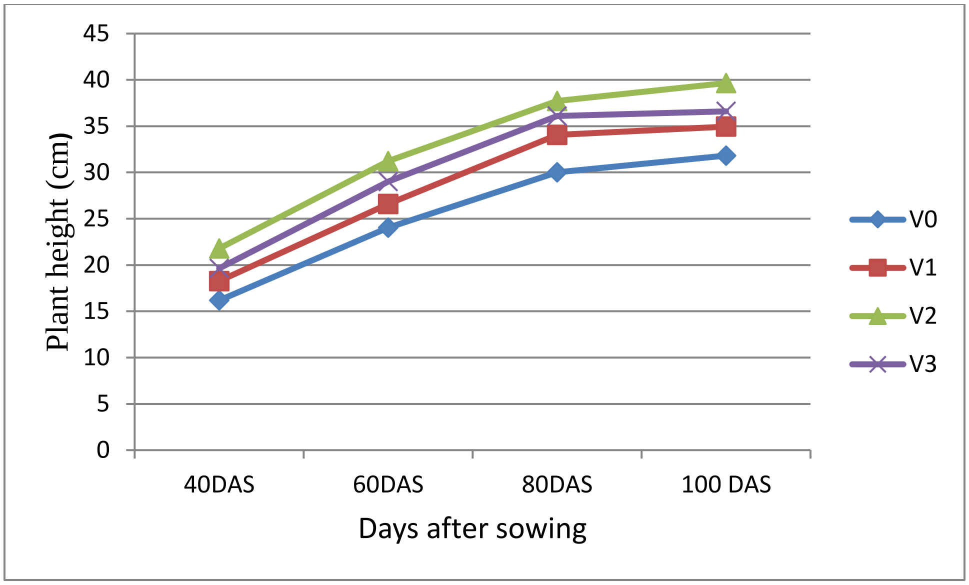



Fig 3 : Effect of vermicompost on plant height

$V_0$= 0t/ha, $V_1$= 6t/ha, $V_2$= 10t/ha $V_3$= 14t/ha

**Table1: Combined effect of carrot cultivars and vermicompost on plant height**

| Treatment | Plant height after sowing(Days) | | | |
|---|---|---|---|---|
| | **40** | **60** | **80** | **Harvest** |
| $C_1V_0$ | 19.06 ± 0.72 bcd | 26.53±0.24 ef | 34.06±1.24 cd | 34.80±1.67 ef |
| $C_1V_1$ | 19.53 ± 0.74 bcd | 28.93±0.92cde | 35.80±1.40 bc | 38.13±0.53 cd |
| $C_1V_2$ | 22.03 ± 1.23 ab | 31.60±1.00 bc | 39.66±0.85 ab | 42.60±0.80 ab |
| $C_1V_3$ | 20.36 ± 0.86 abc | 29.66±1.16 cd | 37.60±1.24 bc | 40.66±0.46 bc |
| $C_2V_0$ | 16.66 ± 0.89 d | 26.30±1.60 ef | 31.80±2.08 de | 37.00±0.57 de |
| $C_2V_1$ | 18.53 ± 0.83 cd | 29.20±0.23cde | 37.53±0.37 bc | 38.93±0.06 cd |
| $C_2V_2$ | 23.40 ± 1.33 a | 34.93±0.93 a | 42.00±1.62 a | 43.33±0.66 a |
| $C_2V_3$ | 20.33 ± 1.50 abc | 33.06±1.10 ab | 39.03±0.50 ab | 39.06±0.52 cd |
| $C_3V_0$ | 12.80 ± 0.70 e | 19.26±0.78 h | 24.23 ± 0.72 f | 26.66 ± 0.81 h |
| $C_3V_1$ | 16.73 ± 1.22 d | 21.66 ± 0.46gh | 28.86 ± 1.32 e | 27.80 ± 0.86 g |
| $C_3V_2$ | 19.93±0.99 bcd | 27.16± 0.73def | 31.53 ± 1.26 de | 33.06 ±1.16 f |
| $C_3V_3$ | 18.20 ± 0.72 cd | 24.33 ±.081 fg | 31.66±1.32 de | 30.06 ±1.04 g |
| Significant level | *** | *** | *** | *** |

## 4.2 Number of leaves per plant

### 4.2 .1 Effect of cultivar on number of leaves

Number of leaves per plant is an important parameter considering the highest performance of carrot yield The number of leaves per plant was recorded at different stages of growth recorded i.e.40, 60 ,80, and at harvest after sowing. The number of leaves per plant significantly varied with cultivars (Fig.4 & Appendix VII). The maximum number of leaves per plant (6.65) was observed from ($C_1$) and the minimum number of leaves per plant (5.41) was found from the $C_2$ cultivar at 40 DAS. At 60 DAS, the maximum number of leaves per plant (7.33) was observed $C_1$ while the minimum number of leaves per plant (6.50 ) was found under $C_3$. At 80 DAS, the maximum number of leaves per plant (9.9) was found from $C_1$. Number of leaves per plant of carrot varies with cultivars. These results might be due to cause of genetical characters of cultivars that caused higher and lower number of leaves per plant.

**4.2 .2 Effect of vermicompost on number of leaves**

Significant variation was observed in the case of number of leaves/plant at different days after sowing (DAS) (Fig.5 & Appendix VIII). At 40 DAS, the maximum number of leaves per plant (6.16) was observed from in vermicompost treatment ($V_2$) and the minimum number of leaves per plant (5.41) was found under the control treatment ($V_0$). At 60 DAS, the maximum number of leaves per plant (7.51) was observed $V_2$ while the minimum number of leaves per plant (6.24) was found under $V_0$. At 80 DAS, the maximum number of leaves per plant (10.28) was observed from $V_2$ and the minimum number of leaves per plant (8.2) was found under the control treatment ($V_0$). At harvest, the maximum number of leaves (12.65) was observed from $V_2$ while the minimum number of leaves (10.46) was recorded under $V_0$ . As, vermicompost is rich in NKP micronutrients, and also contain plant growth hormones & enzymes which may influence the number of leaves largely.

**4.2 .3 Combined effect of on number of leaves**

Interaction effect of carrot cultivars and vermicompost affected number of leaves per plant significantly under the present study (Table 2 & Appendix IX). Different treatment combination viewed different number of leaves per plant according to the treatment at different days after sowing (DAS).The combined effects of cultivar and vermicompost treatment had significantly influenced the number of leaves per plant at different DAS of observation (Table2). It was observed that the highest (7.23) number of leaves was obtained from the treatment combination of $C_1V_2$ and the lowest (5.06) was found from $C_2V_0$ at 45 DAS. At 60 DAS, the highest (8.06 ) number of leaves was obtained in $C_1V_2$ whereas the lowest (5.60) was obtained from the treatment combination of $C_3V_0$ . The highest (11.53) number of leaves was obtained from the treatment combination of $C_2V_2$ and the treatment combination of $C_1V_0$ contributed the lowest (7.60 ) number of leaves at 80 DAS. The highest number of leaves per plant (14.23) was counted with $C_2V_2$ (New kuroda and 10 t/ha) treatment combination at harvest, whereas the lowest number of leaves per plant (9.06) was obtained in $C_1V_0$ (CRS-016 and 0 t/ha) treatment. The number of leaf increased with different combined treatments at different days. It may be mentioned here that, the number of leaves increased more rapidly during early period of crop growth and leaf number decreased at later stage. The results also agreed with the findings of Sediyama *et al*. (1998).

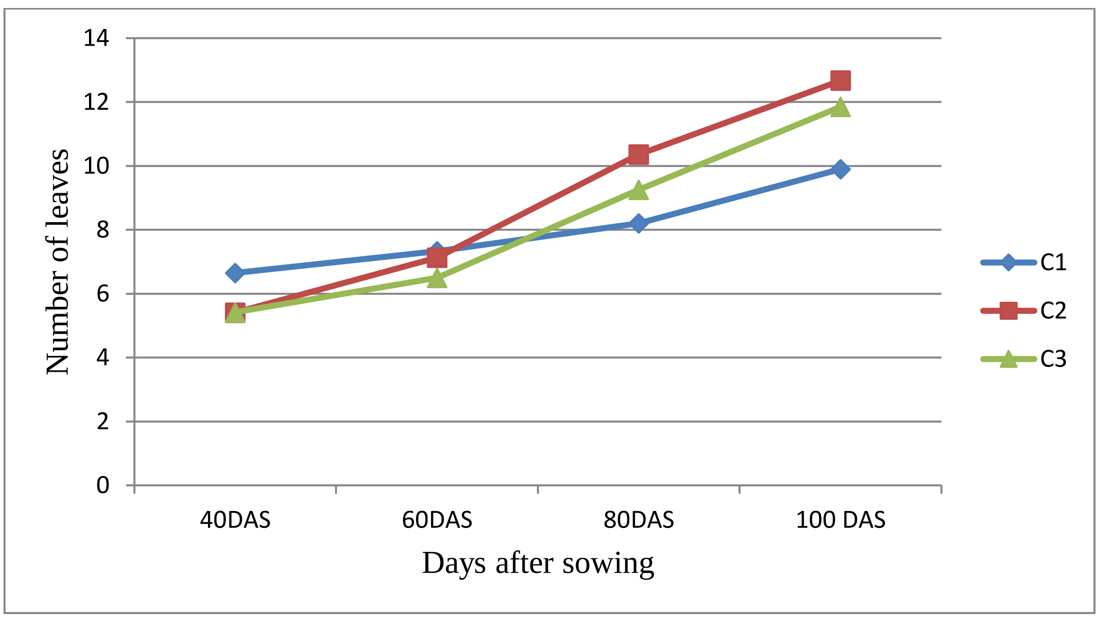



Fig 4: Effect of carrot cultivars on number of leaves

$C_1$= CRS-016, $C_2$= New kuroda, $C_3$= Sangal

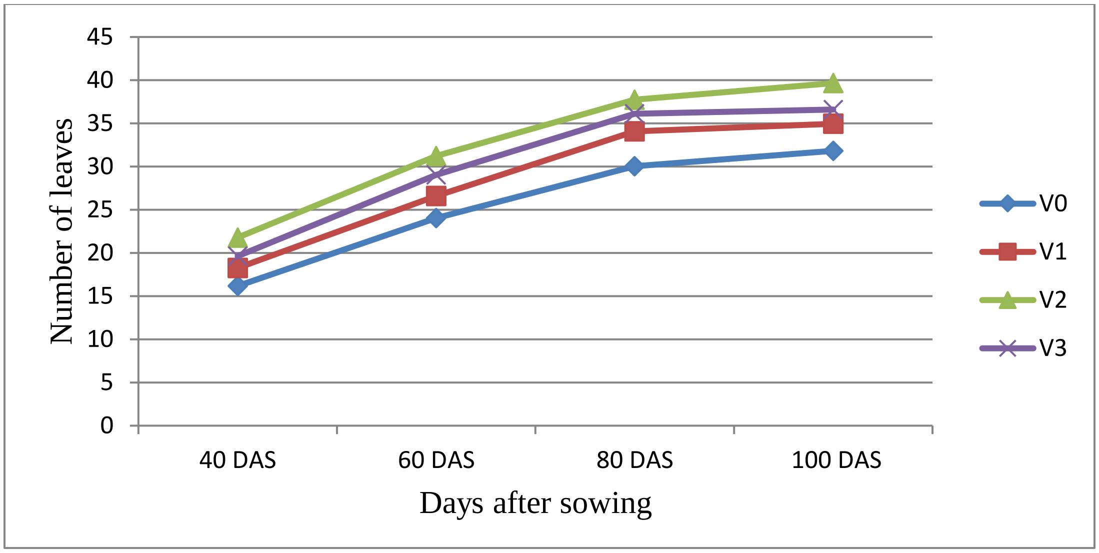



Fig 5: Effect of vermicompost on number of leaves

$V_0$= 0 t/ha, $V_1$= 6 t/ha, $V_2$= 10 t/ha, $V_3$= 14 t/ha

**Table 2: Combined effect of vermicompost and carrot cultivars on the number of leaves**

| Treatment | Number of leaf after sowing (days) | | | |
|---|---|---|---|---|
| | **40** | **60** | **80** | **Harvest** |
| $C_1V_0$ | 6.06±0.37 bc | 6.53±0.37 bc | 7.60±0.20 f | 9.06±0.37 e |
| $C_1V_1$ | 6.60±0.46 ab | 7.26±0.40ab | 8.13±0.17 ef | 9.66±0.24 de |
| $C_1V_2$ | 7.23±0.29 a | 8.06±0.81 a | 8.80±0.52 def | 10.60±0.11cde |
| $C_1V_3$ | 6.73±0.40 ab | 7.46±0.63 ab | 8.26±0.29 ef | 10.26±0.06cde |
| $C_2V_0$ | 5.06±0.24 d | 6.60±0.30 bc | 9.00±0.75 cde | 11.43±0.81bcd |
| $C_2V_1$ | 5.60±0.11 cd | 7.33±0.06 ab | 10.06±0.43bc | 11.73±0.56 bc |
| $C_2V_2$ | 5.66±0.17 cd | 7.46±0.06 ab | 11.53±0.17 a | 14.23±0.12 a |
| $C_2V_3$ | 5.33±0.29 cd | 7.13±0.17 ab | 10.86±0.35 ab | 13.30±0.37 ab |
| $C_3V_0$ | 5.10±0.10 d | 5.60±0.52 c | 8.00±0.23 ef | 10.90±1.04cde |
| $C_3V_1$ | 5.46±0.13 cd | 6.53±0.29 bc | 8.73±0.26 def | 11.40±0.83bcd |
| $C_3V_2$ | 5.60±0.11 cd | 7.00±0.30 ab | 10.53±0.33 ab | 13.13±0.88ab |
| $C_3V_3$ | 5.53±0.06 cd | 6.86±0.37abc | 9.80±0.20bcd | 12.00±0.52 bc |
| Significant level | *** | ** | *** | *** |

### 4.3 Length of root per plant

#### 4.3.1 Effect of cultivar on length of root per plant

Root length per plant is one of the most important parameter for measuring yield performance of carrot cultivars. Under the present study, root length per plant was significantly influenced by different carrot cultivars.(Table 3 & Appendix IX). Different cultivars showed different root length at the time of harvest. (Table 3). The highest root length per plant was produced the highest (18.96 cm) from $C_1$ (CRS-016) cultivar and the lowest (15.93 cm) was obtained in $C_3$ (Sangal) cultivar. The results obtained from the experiment on root length perplant with petiole might be due to cause of varietal effect, soil type, nutrient availability etc.

#### 4.3.2 Effect of vermicompost on length of root per plant

The length of the underground modified root of carrot was significantly influenced by vermicompost treatment. (Table 4 & Appendix IX) The root length was observed to be gradually increased with increasing the dose of vermicompost. The root length per plant was produced the highest (18.77 cm) in vermicompost treatment $V_2$ (10 t/ha). However, control treatment $V_0$ (0 t/ha) showed the lowest root length (16.81cm) (Table 4). The results also agreed with the findings of Ali, (1998).Vermicompost stimulates to increases the availability of oxygen, maintains normal soil temperature, increases soil porosity and infiltration of water, improves nutrient content (Arora *et al*. 2011) that may contribute to the higher root length.

#### 4.3.3 Combined effect of on length of root per plant

It was observed that the combined effects of length of the underground modified root of the carrot was significantly influenced by the cultivars and vermicompost treatment (Table 5 & Appendix XI). Different treatment combination viewed different Root length per plant at the time of harvesting.The root length per plant ranged from 14.73 to 19.4 cm. The root length per plant was produced the highest (19.4 cm) in $C_1V_3$ the treatment combination of CRS-016 cultivar and vermicompost $V_3$ (14 t/ha), whereas the lowest root length (14.73 cm) was observed in $C_3V_0$, $C_3$ (Sangal) with vermicompost $V_0$ (0 t/ha).

## 4.4 Root diameter

### 4.4.1 Effect of cultivar on diameter of root per plant

Root diameter per plant is also another important parameter for measuring yield performance of carrot cultivar. Under the present study, root length per plant was significantly influenced by different carrot cultivars C Different varieties showed different root diameter at the time of harvesting. It was observed that the highest (3.82 cm) diameter of the root was recorded from $C_3$ (Sangal) cultivar and the lowest (3.41 cm) was obtained in $C_1$ (CRS-016) cultivar.

### 4.4.2 Effect of vermicompost on diameter of root per plant

The length of the underground modified root of carrot was significantly influenced by vermicompost treatment (Table 4 & Appendix XII)). The highest (4.12 cm) diameter of the root was recorded in $V_2$ (10 t/ha) which is significantly higher than the others. The minimum (3.31 cm) in this regard was found in control treatment $V_0$ (0 t/ha). In the case of $V_2$ , the plant got sufficient nutrients which might have encouraged more photosynthesis resulting in higher photosynthetic production and translocation of the same to the storage organ (root) which ultimately increased the root diameter compared to others. The results also agreed with the findings of Boulin *et al*. (1998).

### 4.4.3 Combined effect of on diameter of root

The combined effect was also found significant variation due to the cultivars and vermicompost treatment (Table 5 & Appendix XII)**.** it was observed that the root diameter ranged from 2.97 to 4.48 cm. The highest (12.53 cm) diameter of the root was recorded from the treatment combination of ($C_3V_2$) (Sangal) with vermicompost $V_2$ (10 t/ha), whereas the lowest (2.97 cm) root diameter was observed in $C_1V_0$ (CRS-016 with vermicompost 0 t/ha).

## 4.5. Fresh weight of root per plant

### 4.5.1 Effect of cultivar on Fresh weight of root

Determination of fresh weight of root is an important measurement for comparing yield performance among the carrot cultivars under the present study. The fresh weight of root per plant significantly varied with cultivars (Table 3 & Appendix XIII) **.** The maximum (99.24 g) fresh weight of root per plant was obtained in $C_3$(sangal) while the minimum (82.63g) was noted from $C_1$ (CRs-016) (Table 3).

### 4.5.2 Effect of vermicompost on Fresh weight of root

There was a significant result of the fresh weight of root per plant due to vermicompost treatment (Table 4 & Appendix XIII)). The maximum (126.75 g) fresh weight of root per plant was noted in $V_2$ (10 t/ha) whereas the treatment $V_0$ showed the minimum (62.77 g) fresh weight of root per plant (Table 4).

### 4.5.3 Combined effect on Fresh weight of root

The combined effect was also found significant variation due to cultivars and vermicompost treatment(Table 5 & Appendix XIII). The highest (148.02 g) fresh weight of root per plant was noted in $C_3V_2$ while the lowest (57.33g) was obtained from the treatment combination $C_3V_0$**.**

## 4.6. Dry matter content of root

### 4.6.1 Effect of cultivar on Dry matter content of root

The dry matter content of root was also varied significantly with cultivars (Table 3 & Appendix XIV) The maximum (14.50%) dry weight of root was obtained at $C_3$ (Sangal), while the minimum (10.0 %) dry matter content of root was obtained in $C_1$ cultivar (Table3).

### 4.6.2 Effect of vermicompost on Dry matter content of root

The dry matter content of the root was increased gradually with vermicompost treatment. The dry matter content of the root was varied significantly with the vermicompost treatment (Table 4 & Appendix XIV). The maximum (13.33 %) dry matter content of root was recorded when $V_2$ (10t/ha) and the minimum (12.00%) in this regard was found in control treatment $V_0$ (Table 4). The dry matter content of root obtained from $V_0$,$V_1$,$V_3$ treatment was not statistically different.

**4.6.3 Combined effect of on Dry matter content of root**

The combined effect of cultivar and different levels of vermicompost showed a significant variation on dry matter content of root (Table 5 & Appendix XIV). The highest (16.00 %) dry matter content of root was recorded from the treatment combination of $C_3V_2$(Sangal and 10 t/ha), while the lowest (10.00 %) dry weight of root was observed from $C_1V_0$ (CR-016) (Table 5).

## Table 3: Main effect of carrot cultivars on growth and yield parameters of carrot

| Treatment | Root Length (cm) | Root Diameter (cm) | Root wt(Fresh) (g) | Root wt(Dry) (%) |
|---|---|---|---|---|
| $C_1$ | 18.96±0.47 a | 3.41±0.11 b | 82.63±6.58 a | 10.00±0.00c |
| $C_2$ | 18.09±0.32 a | 3.74±0.06 a | 87.97±7.38 a | 12.50±0 .26 b |
| $C_3$ | 15.93±0.27 b | 3.82±0.11 a | 99.24±9.52 a | 14.50±0.26a |
| Significant level | *** | ** | Non significant | *** |

**Table 4: Main effect of vermicompost on growth and yield parameters of carrot**

| Treatment | Root Length (cm) | Root Diameter (cm) | Root wt(Fresh) (g) | Root wt(Dry) (%) |
|---|---|---|---|---|
| $V_0$ | 16.81±0.53 b | 3.31±0.09 c | 62.77±3.85c | 12.00±0.57a |
| $V_1$ | 17.60±0.56 ab | 3.5±0.07 bc | 78.70±4.36b | 12.00±0.57a |
| $V_2$ | 18.77±0.62 a | 4.12±0.11 a | 126.75±6.8a | 13.33±0.88a |
| $V_3$ | 17.45±0.55 ab | 3.68±0.05 b | 91.57±3.35b | 12.00±0.5 a |
| Significant level | Non significant | *** | *** | Non significant |

**Table 5: Combined effect of vermicompost and cultivars on growth and yield parameters of carrot**

| Treatment | Root Length (cm) | Root Diameter (cm) | Root wt(Fresh) (g) | Root wt(Dry) (%) |
|---|---|---|---|---|
| $C_1V_0$ | 17.59±0.11cde | 2.97±0.14 g | 57.33±3.44 e | 10.00±0.00 |
| $C_1V_1$ | 18.33±0.54bcd | 3.23±0.01 fg | 73.54±9.52 de | 10.00±0.00 |
| $C_1V_2$ | 20.53±1.15 a | 3.86±0.20 bc | 109.92±7.70bc | 10.00±0.00 |
| $C_1V_3$ | 19.40±0.87 ab | 3.56±0.16cde | 89.73±5.63 cd | 10.00±0.00 |
| $C_2V_0$ | 18.13±0.17bcd | 3.52±0.06 de | 59.76±5.01 e | 12.00±0.00 |
| $C_2V_1$ | 19.00±0.11 bc | 3.63±0.06 cde | 78.90±6.76 de | 12.00±0.00 |
| $C_2V_2$ | 18.73±0.58 bc | 4.02±0.05 b | 122.32±7.32 b | 14.00±0.00 |
| $C_2V_3$ | 16.50±0.28 ef | 3.78±0.03bcd | 90.90±6.37 cd | 12.00±0.00 |
| $C_3V_0$ | 14.73±0.06 g | 3.44±0.04 ef | 71.22±9.27 de | 14.00±0.00 |
| $C_3V_1$ | 15.46±0.08 fg | 3.67±0.01 cde | 83.65±8.145 d | 14.00±0.00 |
| $C_3V_2$ | 17.06±0.14 de | 4.48±0.01 a | 148.02 ±8.37 a | 16.00±0.00 |
| $C_3V_3$ | 16.46±0.24 ef | 3.70±0.03cde | 94.08±7.60cd | 14.00±0.00 |
| Significant level | *** | *** | *** | Non significant |

## 4.7. Fresh weight of leaves per plant

### 4.7.1 Effect of cultivar on Fresh weight of leaves

The fresh weight of leaves per plant was significantly varied with cultivars (Table 6 & Appendix XV). The highest (80.01 g) fresh weight of leaves per plant was recorded in $C_2$ (New kuroda ) and the lowest (53.12 g) was found in $C_1$ (CRS-016).

### 4.7.2 Effect of vermicompost on Fresh weight of leaves

The fresh weight of leaves per plant was significantly influenced by vermicompost treatment (Table 7 & Appendix XV). The maximum (79.12 g) fresh weight of leaves was obtained in $V_2$ (10t/ha) whereas the minimum (51.46 g) was recorded in $V_0$ (control treatment) (Table 7 ).

### 4.7.2 Combined effect on Fresh weight of leaves

The combined effect was also found significant variation due to the cultivars and vermicompost treatment on fresh weight of leaves per plant (Table 8 & Appendix XV) .The highest (89.80 g) fresh weight of leaves per plant was recorded from the treatment combination of $C_2V_2$ (New kuroda with 10t/ha vermicompost ) and the treatment combination of $C_1V_0$ performed the lowest (35.56 g) fresh weight of leaves per plant (Table 8 & Appendix XV).

## 4.8. Dry matter content of leaves

### 4.8.1 Effect of cultivar on Dry matter content of leaves

Dry matter content of leaves per plant was significantly varied with cultivars (Table 6 & Appendix XVI). The maximum dry matter content of leaf (17.5 %) was obtained at $C_3$ (Sangal), while the minimum dry matter content of leaves (14.66 %) was obtained in $C_1$ (CRS-016**)** (Table 6).

### 4.8.2 Effect of vermicompost on Dry matter content of leaves

The dry matter content of leaves was significantly influenced by vermicompost treatment (Table 7 & Appendix XVI). The maximum dry matter content of leaves (17.33 %) was recorded in $V_2$ (10 t/ha). The minimum (14.88 %) was found in the $V_3$ treatment (14 t/ha) (Table 7).

### 4.8.3 Combined effect of on Dry matter content of leaves

The combined effect between the cultivars and vermicompost treatment was observed significant variation on dry matter content of leaves (Table 9 & Appendix XVI**).** The dry matter content of leaves ranged from 14.0 % to 20.0%. The highest (20.0 %) dry matter content of leaves was recorded in the treatment combination of $C_3V_2$ (Sangal and 10t/ha), while the lowest (14.0 %) dry matter content of leaves was observed from $C_2V_0$ (New kuroda and 0t/ha) , $C_1V_0$ (CR-016 and 0 t/ha).

## 4.9 Percentage of Deformed root

### 4.9.1 Effect of cultivar on Percentage of Deformed root

There was a significant variation in the percentage of deformed root due to cultivar (Table 6 & Appendix XVII). The highest (5.66%) percentage of the deformed root was produced in $C_3$ and the lowest (3.33 %) was found in $C_2$ (New kuroda).

### 4.9.2 Effect of vermicompost on Percentage of Deformed root

A significant variation in the percentage of the deformed root was not found due to different levels of vermicompost (Table 7 & Appendix XVII). The maximum (9.77 %) deformed percentage of the root was recorded when $V_0$ (0 t/ha), which significantly differs from the remaining treatment. The minimum (1.33 %) in this regard was found in the $V_2$ (10 t/ha) treatment.

### 4.9.2 Combined effect of on Percentage of Deformed root

The combined effect of cultivar and levels of vermicompost treatment on the deformed percentage of the root was significant (Table 8 & Appendix XVII). The highest (14.66 %) deformed percentage of the root was recorded from the treatment combination of $C_3V_0$ (Sangal and 0 t/ha), while the lowest (1.33%) deformed percentage of the root was observed from $C_1V_2$, $C_2V_2$, $C_3V_2$.

## 4.10 Rotten root

### 4.10.1 Effect of cultivar on Percentage of Rotten root

There was a variation in the percentage of Rotten root due to different cultivar (Table 6 & Appendix XVIII). However, the highest (0.66%) percentage of Rotten root was obtained from $C_1$ and the lowest (0.33%) was obtained from $C_2$ and $C_3$.

### 4.10.2 Effect of vermicompost on Percentage of Rotten root

The number of different levels of vermicompost had an effect on the percentage of Rotten root in the carrot (Table 7 & Appendix XVIII). It was observed that the Rotten percentage of the root was decreased with increasing levels of vermicompost. The highest (0.88%) Rotten percentage was recorded in $V_0$ (0 t/ha) while the lowest (0.0%) was in $V_3$ (14 t/ha) treatment .

### 4.10.3 Combined effect on Percentage of Rotten root

The combined effect of the number of cultivar and different levels of vermicompost had significant differences in the Rotten percentage of roots (Table 8 & Appendix XVIII). The highest (2.66 %) Rotten percentage of roots was recorded from the treatment combination of $C_1V_0$ (CRS-016), while the lowest (0.0%) Rotten percentage of roots was observed from $C_1V_2$,$C_2V_2$,$C_3V_3$ (Table 8 & Appendix XVIII).

**Table 6: Effect of carrot cultivars on the yield parameters of carrot**

| Treatment | Leaf wt(Fresh) (g) | Leaf wt(Dry) (%) | Deformed root (%) | Rotten root (%) |
|---|---|---|---|---|
| $C_1$ | 53.12±3.64b | 14.66±0.28b | 4.66±1.37 a | 0.66±0.44 a |
| $C_2$ | 80.01±2.33 a | 15.50±0.26b | 3.33±1.28 a | 0.33±0.33 a |
| $C_3$ | 60.58±3.88b | 17.50±0.65 a | 5.66±1.80 a | 0.33±0.33 a |
| Significant level | *** | *** | Non significant | Non significant |

**Table 7: Effect of vermicompost on the yield parameters of carrot**

| Treatment | Leaf wt(Fresh) (g) | Leaf wt(Dry) (%)) | Deformed root (%) | Rotten root (%) |
|---|---|---|---|---|
| $V_0$ | 51.46±5.16 c | 15.33±0.66b | 9.77±2.11a | 0.88±0.58 a |
| $V_1$ | 60.21±4.05bc | 16.00±.57 ab | 4.88±1.11b | 0.44±0.44 a |
| $V_2$ | 79.12±3.58 a | 17.33±.66 a | 1.33±.66 b | 0.44±0.44 a |
| $V_3$ | 67.50±4.34 ab | 14.88±.35 b | 2.22±1.17b | 0.00±0.00 a |
| Significant level | *** | ** | *** | Non significant |

**Table 8: Combined effect of vermicompost and carrot cultivars on the yield parameters of carrot**

| Treatment | Leaf wt(Fresh) (g) | Leaf wt(Dry) (%) | Deformed root (%) | Rotten root (%) |
|---|---|---|---|---|
| $C_1V_0$ | 35.56±3.62 j | 14.00±0.00 e | 10.66±2.6 ab | 2.66±1.33 a |
| $C_1V_1$ | 53.00±2.91 hi | 14.00±0.00 e | 5.33±1.33 bc | 0.00±0.00 b |
| $C_1V_2$ | 66.90±2.93 ef | 16.00±0.00 c | 1.33±1.33 c | 0.00±0.00 b |
| $C_1V_3$ | 57.03±2.18 gh | 14.66±0.66 d | 1.33±1.33 c | 0.00±0.00 b |
| $C_2V_0$ | 70.16±1.12 be | 14.00±0.00 e | 4.00±4.00 bc | 0.00±0.00 b |
| $C_2V_1$ | 75.96±1.49 cd | 16.00±0.00 c | 5.33±2.66 bc | 1.33±1.33 ab |
| $C_2V_2$ | 89.80±1.33 a | 16.00±0.00 c | 1.33±1.33 c | 0.00±0.00 b |
| $C_2V_3$ | 84.13±1.27 ab | 16.00±0.00 c | 2.6±2.66 c | 0.00±0.00 b |
| $C_3V_0$ | 48.66±0.33 i | 18.00±0.00 b | 14.66±1.33 a | 0.00±0.00 b |
| $C_3V_1$ | 51.66±0.33 hi | 18.00±0.00 b | 4.00±2.30 bc | 0.00±0.00 b |
| $C_3V_2$ | 80.66±3.28 bc | 20.00±0.00 a | 1.33±1.33 c | 1.33±1.33 ab |
| $C_3V_3$ | 61.33±2.84 fg | 14.00±0.00 e | 2.66±2.66 c | 0.00±0.00 b |
| Significant level | *** | *** | Non significant | Non significant |

## 4.11. Root yield per plot

### 4.11.1 Effect of cultivar on Root yield

Per pot yield of root was significantly varied due to cultivars of carrot (Table 9 & Appendix XIX). The highest (2.48 kg/plot) yield per plot was obtained in $C_3$ (Sangal) where the lowest (2.06 kg/plot) was obtained from $C_1$ (CRS-016).

### 4.11.2 Effect of vermicompost on Root yield

Per plot yield of root was significantly varied due to different levels of vermicompost (Table 10 & Appendix XIX). The yield of carrot per plot was the highest (3.16 kg/plot) was obtained when vermicompost applied at $V_2$ (10 t/ha), which significantly different from the remaining treatment. The lowest yield (1.56 kg/plot) was found when vermicompost applied at $V_0$ (0 t/ha )

### 4.11.3 Combined effect on Root yield

The combined effect of cultivar and different levels of vermicompost showed significant variation on root yield per plot (Table 11 & Appendix XIX). The highest (3.70 kg/plot) root yield per plot was recorded from the treatment combination of $C_3V_2$ (Sangal and 10 t/ha), while the lowest (1.43 kg/plot) root yield per plot was observed from $C_1V_0$ (CRS-016 and 0 t/ha)

**Table 9: Effect of carrot cultivars on yield parameters of carrot**

| Treatment | Gross yield/plot (kg) | Gross yield/ha (ton) | Marketable yield/plot (kg) | Marketable yield/ha (ton) |
|---|---|---|---|---|
| $C_1$ | 2.06±0.16 a | 16.52±1.31 a | 1.97±0.17 a | 16.43±1.32 a |
| $C_2$ | 2.19±0.18 a | 17.59±1.47 a | 2.11±0.19 a | 17.50±1.48 a |
| $C_3$ | 2.48±0.23 a | 19.84±1.90 a | 2.34±0.24 a | 19.71±1.90a |
| Significant level | Non significant | Non significant | Non significant | Non significant |

**Table 10: Effect of vermicompost on yield parameter of carrot**

| Treatment | Gross yield/plot (kg) | Gross yield/ha (ton) | Marketable yield/plot (kg) | Marketable yield/ha (ton) |
|---|---|---|---|---|
| $V_0$ | 1.56 ±0.09 c | 12.55±0.77 c | 1.37±0.06 d | 12.35±0.74 c |
| $V_1$ | 1.96 ±0.10 b | 15.74±0.87 b | 1.85±0.09 c | 15.63±0.85 b |
| $V_2$ | 3.16 ± 0.17 a | 25.35±1.36 a | 3.10±0.15 a | 25.28±1.35 a |
| $V_3$ | 2.28 ± 0.08 b | 18.31±0.67 b | 2.23±0.08 b | 18.26±0.67 b |
| Significant level | *** | *** | *** | *** |

## 4.12 Root yield per hectare

### 4.12 .1 Effect of cultivar on Root yield per hectare

Per hectare yield of root was significantly varied due to different cultivars of carrot ( Fig. 6 & Table 9 ). The highest (19.84 t) root yield of carrot per hectare was obtained in $C_3$ (Sangal) while the lowest (16.52 t) produced in $C_1$ (CRS-016) cultivar .

### 4.12 .2 Effect of vermicompost on Root yield per hectare

Per hectare yield of root was significantly varied due to different levels of vermicompost ( Fig. 7 & Table 10 ). The yield was found to increase with increasing levels of vermicompost. The yield of carrot per plot was the highest (25.35 t/ha) was obtained when vermicompost applied at $V_2$ (10 t/ha), which significantly different from the remaining. The lowest yield (12.55 t/ha) was found when when vermicompost applied at $V_0$ (0 t/ha).

### 4.12 .3 Combined effect on Root yield per hectare

The combined effect of cultivar and different levels of vermicompost on root yield per hectare was significant (Table 11 & Appendix XX).). The highest (29.60 t/ha) root yield per hectare was recorded from $C_3V_2$ the treatment combination of

Sangal and 10 t/ha, while the lowest (11.46 t) root yield per hectare was observed from $C_1V_0$ (CRS-016 and 0t/ha)

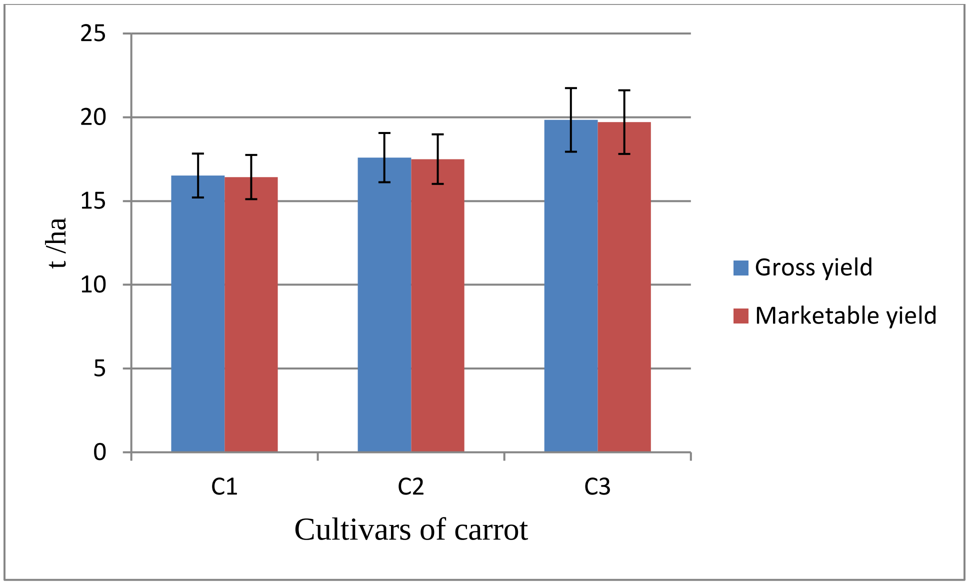



Fig 6: Effect of carrot cultivars on the gross yield and marketable yield of carrot

$C_1$= CRS-016, $C_2$=New kuroda , $C_3$=Sangal

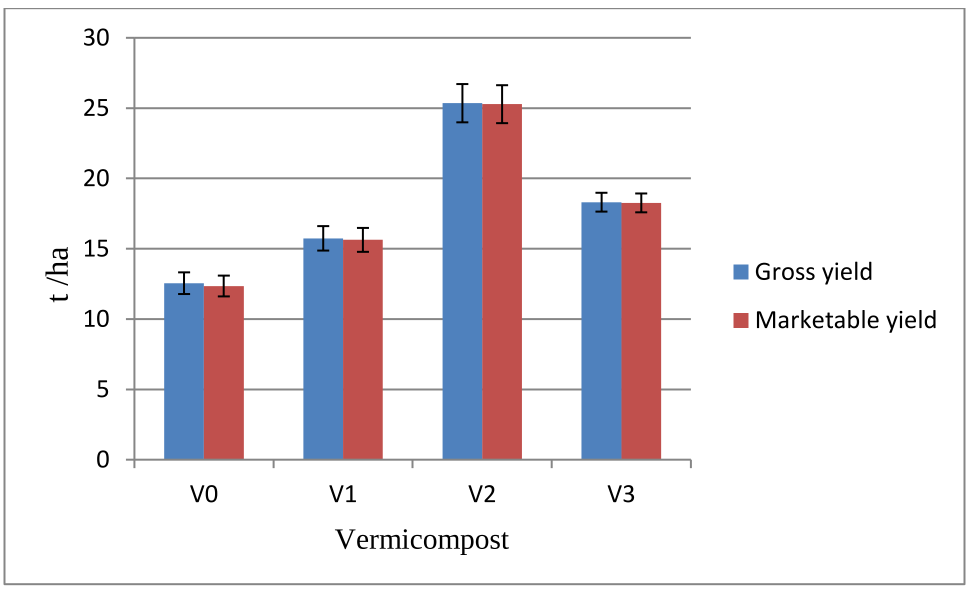



Fig 7: Effect of vermicompost on the gross yield and marketable yield of carrot

$V_0$=0 t/ha, V1= 6 t/ha, $V_2$=10 t/ha $V_3$=14 t/ha

**Table 11: Combined effect of carrot cultivars and vermicompost on yield parameters of carrot**

| Treatment | Gross yield/plot (kg) | Gross yield/ha (ton) | Marketable yield/plot (kg) | Marketable yield/ha (ton) |
|---|---|---|---|---|
| $C_1V_0$ | 1.43±0.08 e | 11.46±0.68 e | 1.23±0.03 h | 11.26±.63 f |
| $C_1V_1$ | 1.83±0.23 de | 14.70±1.90de | 1.73±0.22 eh | 14.61±1.89def |
| $C_1V_2$ | 2.74±0.19 bc | 21.98±1.54bc | 2.70±0.15 bc | 21.94±1.50bc |
| $C_1V_3$ | 2.24±0.14 cd | 17.94±1.12cd | 2.21±0.16 cde | 17.92±1.15cde |
| $C_2V_0$ | 1.49±0.12 e | 11.95±1.00 e | 1.36±0.06 gh | 11.82 ±0.94 f |
| $C_2V_1$ | 1.97±0.16 de | 15.78±1.35de | 1.83±0.16 dg | 15.64±1.32def |
| $C_2V_2$ | 3.05±0.18 b | 24.46±1.46 b | 3.02±0.21 b | 24.42±1.49 b |
| $C_2V_3$ | 2.27±0.15 cd | 18.18±1.27cd | 2.22±0.20 cde | 18.12±1.32cde |
| $C_3V_0$ | 1.78±0.23 de | 14.24±1.85de | 1.51±0.17 fgh | 13.97±1.80 ef |
| $C_3V_1$ | 2.09±0.20 d | 16.73 ±1.62 d | 1.99±0.15 def | 16.63±1.57d e |
| $C_3V_2$ | 3.70±0.20 a | 29.60±1.67 a | 3.59±0.15 a | 29.49±1.60 a |
| $C_3V_3$ | 2.35±0.19 cd | 18.81±1.52cd | 2.28±0.14 cd | 18.74±1.46cd |
| Significant level | *** | *** | *** | *** |

## 4.13. Marketable yield of roots per plot

### 4.13.1 Effect of cultivar on marketable yield of roots

The yield of carrot root per plot was found statistically significant due to the variation among cultivars (Table 9 & Fig.6).Cultivar Sangal ($C_3$) produced the highest yield (2.34 kg) while CRS-016 ($C_1$) treatment produced the lowest root yield (1.97 kg) per plot.

### 4.13.2 Effect of vermicompost on marketable yield of roots

Statistically, significant variation was found due to the effect of vermicompost on the marketable yield of roots per plot (Table 10 & Fig.6).The maximum marketable yield per plot (3.10kg) was obtained from the application of vermicompost ($V_2$) while the control ($V_0$) treatment produced the minimum (1.37 kg).

### 4.13.3 Combined effect on marketable yield of roots

The combined effect of different vermicompost and cultivars were found significant on the marketable yield of root per plot **(**Table 11**).** The maximum marketable yield per plot (3.59 kg) was found from the Sangal with vermicompost ($C_3V_2$) followed by the second highest (3.02 kg) was found from the treatment of the New kuroda with vermicompost ($C_2V_2$). On the other hand, the minimum marketable yield of the root (1.20 kg/plot) was recorded from the control condition of the CRS-016 cultivar ($C_1V_0$).

## 4.14. Marketable yield of carrot per hectare

### 4.14.1 Effect of cultivar on marketable yield of roots per hectare

The marketable yield of roots varied significantly due to different cultivar **(**Table 9). The maximum marketable yield (19.71 t/ha) was obtained from Sangal cultivar ($C_3$), while the minimum yield (16.43 t/ha) was found from the control treatment ($C_1$) ( Fig. 5 ).

### 4.14.2 Effect of vermicompost on marketable yield of carrots per hectare

The marketable yield of carrot per hectare was found statistically significant due to the application of vermicompost **(**Table 10) .The highest yield (25.28 t/ha) was obtained from vermicompost ($V_2$) and the lowest (12.35 t/ha) from no vermicompost application. (Fig. 6).

### 4.14.3 Combined effect on marketable yield of roots per hectare

A significant combined effect of vermicompost and different cultivar was observed on the marketable yield of root per hectare (Table 11). The highest marketable yield of root per hectare (29.49 t/ha) was recorded from cultivar Sangal with vermicompost ($C_3V_0$) while the lowest marketable yield of carrot root per hectare (11.26 t/ha) was found from the treatment combination of $C_1V_0$.

# CHAPTER V

## SUMMARY AND CONCLUSION

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka to evaluate the growth and yield of carrot as influenced by vermicompost on different carrot cultivars during the period from November 2018 to March 2020. The experiment consisted of three different cultivars (viz. CRS-016, New Kuroda and Sangal) and four levels of vermicompost (viz. 0, 6, 10,14 t/ha).

The two-factor experiment was laid out in Randomized Complete Block Design with three replications. There were altogether 12 treatment combinations in this experiment. There were 25 hills in a single plot maintaining a spacing of 25 cm x 20 cm.

Different carrot cultivars significantly influenced all the parameters. The tallest plant (39.58 cm) after 100 days of sowing, highest (3.82 cm) diameter of root , The maximum (99.24 g) fresh weight of root, maximum (14.50%) dry weight of root, highest (2.48 kg/plot) yield per plot , the highest (2.48 kg/plot) yield per plot, the highest (19.84 t) root yield of carrot per hectare, The maximum marketable yield (19.71t/ha) was obtained from $C_3$ (sangal) and the maximum number of leaves per plant (12.67) was observed from $C_2$ at 100 DAS. The highest root length per plant was produced the highest (18.96 cm) from $C_1$ cultivar. But the highest (5.66%) percentage of the deformed root was produced in $C_3$ and the highest (0.66%) percentage of Rotten root was obtained from $C_1$(CRS-016).

Vermicompost showed a significant effect on all the parameters. At the maximum vegetative growth of 100 DAS, the tallest plant (39.66 cm), the maximum number of leaves (12.65) per plant, the highest root length per plant (18.77 cm), maximum diameter (4.12 cm) of root, maximum fresh weight (126.75 g) of root per plant, maximum (79.12 g) fresh weight of leaves per plant, maximum dry matter content of leaves (17.33 %), the maximum (13.33 %) dry matter content of root, the highest yield of carrot per plot was the (3.16 kg/plot), the highest marketable yield of carrot per plot(3.10kg/plot), was obtained from $V_2$ and shortest plant (31.82 cm), the minimum number of leaves (10.46), lowest root length (16.81cm), minimum (3.3 cm) root diameter, the minimum (62.77 g) fresh weight of root per plant, minimum fresh weight (51.46 g) of the leaf, minimum lowest dry weight (12.00%) of the root, minimum dry weight(14.88 %) of the leaf was obtained from the control treatment ($V_0$).

Due to the interaction effect of different types of treatment showed a significant variation on all the parameters. At harvest, The highest root yield (3.70 kg/plot) per plot, maximum marketable yield per plot (3.59 kg), the highest (12.53 cm) diameter of the root, the highest (148.02 g) fresh weight of root per plant, the highest (16.00 %) dry matter content of root, the highest (20.0 %) dry matter content of leaves, was found from the Sangal with vermicompost ($C_3V_2$) and On the other hand, the minimum marketable yield of the root (1.20 kg/plot), the lowest number of leaves per plant (9.06), the lowest (2.97 cm) root diameter per plant, the lowest (35.56 g) fresh weight of leaves per plant, the lowest (10.00 %) dry weight of root, the lowest (11.46 t) root yield per hectare was recorded from the control condition of CRS-016 cultivar ($C_1V_0$), the lowest root length (14.73cm) was observed in $C_3V_0$.

The highest number of leaves per plant (14.23), highest (89.80 g) fresh weight of leaves per plant was recorded from the treatment combination of $C_2V_2$ (New kuroda with 10t/ha vermicompost) treatment combination. The highest root length(19.4 cm) per plant was produced in $C_1V_3$ the treatment combination of CRS-016 cultivar and vermicompost $V_3$ .

Considering the present experiment, such type of study may be carried out in other agro-ecological zones of Bangladesh before the final recommendation. Different cultivars of carrot with different level of vermicompost combination can be practiced for obtaining better yield..

Therefore, from the present study, it may be suggested that the higher yield of carrot could be obtained by cultivating cultivar of carrot (Sangal) along with vermicompost (10 t/ha). Different doses of vermicompost may be included for further study.

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# APPENDICES

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

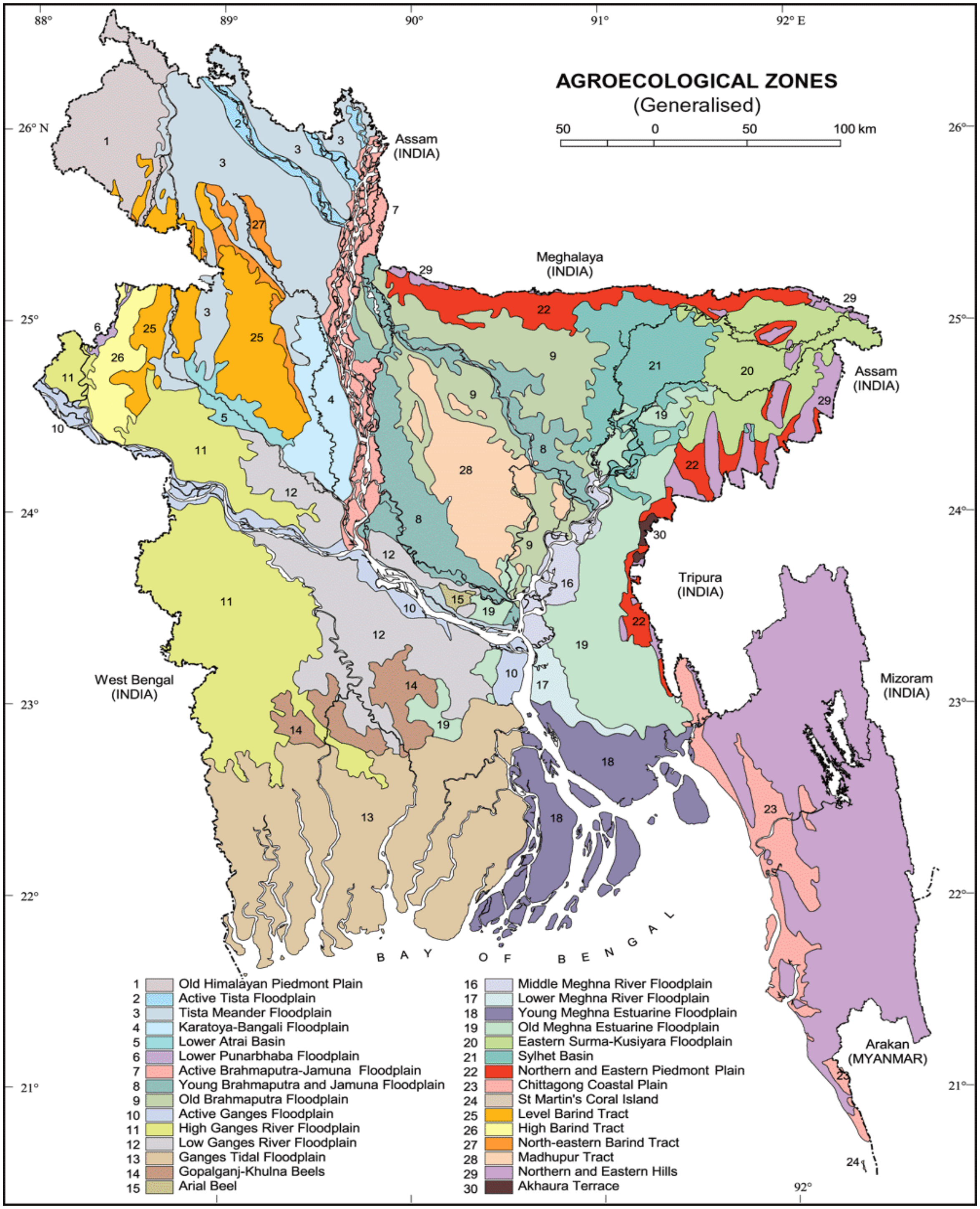


Fig. 8. Experimental site

Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from October 2018 to January 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. Characteristics of soil from Sher-e-Bangla Agricultural University is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka.

**A. Morphological Characteristics of the experimental field**

| **Morphological Features** | **Characteristics** |
|---|---|
| Location | Sher-E-Bangla Agricultural University |
| ALZ | Madhupur Tract (28 |
| General Soil Type | Shallow Red Brown Terrace Soil |
| Land Type | high Land |
| Soil Series | Tejgoan * |
| Topography | Fairly Leveled |
| Flood Level | Above Flood Level |
| Drainage | Well Drained |
| Cropping Pattern | Fellow-Carrot |
| **B. Physical and Chemical properties of initial soil** | |
| Characteristics | Value |
| Particle size analysis | |
| % Sand | 28 |
| % Silt | 42 |
| % Clay | 30 |
| textural class | 5.6 |
| PH | 0.46 |
| Organic carbon (%) | 0.08 |
| Organic Matter Total N | 0.05 |
| Available P | 20.00 |

Source: Soil Resource Development Institute (SRDI)

Appendix III. Analysis of variance of plant height at 40 DAS of carrot as influenced by carrot cultivars and different levels of vermicompost

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 77.247 | 38.623 | 5.162 | .011 |
| Factor B: Levels of vermicompost | 3 | 150.096 | 50.032 | 9.198 | .000 |
| Interaction (A x B) | 11 | 249.700 | 22.700 | 7.317 | .000 |

Appendix IV. Analysis of variance of plant height at 60 DAS of carrot as influenced by carrot cultivars and different levels of vermicompost.

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 400.354 | 200.177 | 19.467 | .000 |
| Factor B: Levels of vermicompost | 3 | 259.967 | 86.656 | 5.780 | .003 |
| Interaction: (A x B) | 11 | 679.282 | 61.753 | 24.538 | .000 |

Appendix V. Analysis of variance of plant height at 80 DAS of carrot as influenced by carrot cultivars and different levels of vermicompost.

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 530.422 | 265.211 | 19.942 | .000 |
| Factor B: Levels of vermicompost | 3 | 298.370 | 99.457 | 4.744 | .008 |
| Interaction: (A x B) | 11 | 856.317 | 77.847 | 16.538 | .000 |

Appendix VI. Analysis of variance of plant height at harvest of carrot as influenced by carrot cultivars and different levels of vermicompost .

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 911.929 | 455.964 | 41.677 | .000 |
| Factor B: Levels of vermicompost | 3 | 289.088 | 96.363 | 3.134 | .039 |
| Interaction: (A x B) | 11 | 1219.772 | 110.888 | 50.031 | .000 |

Appendix VII. Analysis of variance of Number of leaves 40 DAS of carrot as influenced by carrot cultivars and different levels of vermicompost.

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 12.252 | 6.126 | 24.628 | .000 |
| Factor B: Levels of vermicompost | 3 | 2.642 | .881 | 1.582 | .213 |
| Interaction: (A x B) | 11 | 15.447 | 1.404 | 6.722 | .000 |

Appendix VIII. Analysis of variance of Number of leaves 60 DAS of carrot as influenced by carrot cultivars and different levels of vermicompost.

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 4.542 | 2.271 | 3.546 | .040 |
| Factor B: Levels of vermicompost | 3 | 7.720 | 2.573 | 4.586 | .009 |
| Interaction: (A x B) | 11 | 13.036 | 1.185 | 2.250 | .047 |

Appendix IX. Analysis of variance of Number of leaves at 80 DAS of carrot as influenced by carrot cultivars and different levels of vermicompost

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 28.169 | 14.084 | 13.665 | .000 |
| Factor B: Levels of vermicompost | 3 | 21.676 | 7.225 | 5.708 | .003 |
| Interaction: (A x B) | 11 | 52.396 | 4.763 | 11.681 | .000 |

Appendix X. Analysis of variance of Number of leaves at the time harvest of carrot as influenced by carrot cultivars and different levels of vermicompost

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 48.811 | 24.405 | 15.090 | .000 |
| Factor B: Levels of vermicompost | 3 | 25.638 | 8.546 | 3.573 | .025 |
| Interaction: (A x B) | 11 | 76.996 | 7.000 | 6.670 | .000 |

Appendix XI :Analysis of variance of root length of carrot as influenced by carrot cultivars and different levels of vermicompost

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 58.422 | 29.211 | 17.983 | .000 |
| Factor B: Levels of vermicompost | 3 | 18.020 | 6.007 | 2.045 | .127 |
| Interaction: (A x B) | 11 | 94.234 | 8.567 | 11.555 | .000 |

Appendix XII: Analysis of variance of root diameter of carrot as influenced by carrot cultivars and different levels of vermicompost .

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 1.147 | .573 | 4.416 | .020 |
| Factor B: Levels of vermicompost | 3 | 3.239 | 1.080 | 15.753 | .000 |
| Interaction: (A x B) | 11 | 4.804 | .437 | 16.710 | .000 |

Appendix XIII: Analysis of variance of root weight (fresh) of carrot as influenced by carrot cultivars and different levels of vermicompost.

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 1726.426 | 863.213 | 1.144 | .331 |
| Factor B: Levels of vermicompost | 3 | 20001.311 | 6667.104 | 32.248 | .000 |
| Interaction: (A x B) | 11 | 22782.165 | 2071.106 | 12.961 | .000 |

Appendix XIV. Analysis of variance of root weight (dry) of carrot as influenced by carrot cultivars and different levels of vermicompost

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 122.000 | 61.000 | 111.833 | .000 |
| Factor B: Levels of vermicompost | 3 | 12.000 | 4.000 | 1.000 | .405 |
| Interaction: (A x B) | 11 | 140.000 | 12.727 | . | . |

Appendix XV: Analysis of variance of leaf weight (fresh) of carrot as influenced by carrot cultivars and different levels of vermicompost.

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 4625.772 | 2312.886 | 17.111 | .000 |
| Factor B: Levels of vermicompost | 3 | 3699.443 | 1233.148 | 7.325 | .001 |
| Interaction: (A x B) | 11 | 8720.288 | 792.753 | 51.964 | .000 |

Appendix XVI. Analysis of variance of leaf weight (dry) of carrot as influenced by carrot cultivars and different levels of vermicompost.

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 50.889 | 25.444 | 10.952 | .000 |
| Factor B: Levels of vermicompost | 3 | 30.667 | 10.222 | 3.376 | .030 |
| Interaction: (A x B) | 11 | 124.889 | 11.354 | 102.182 | .000 |

Appendix XVII. Analysis of variance of deformed root of carrot as influenced by carrot cultivars and different levels of vermicompost.

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 32.889 | 16.444 | .603 | .553 |
| Factor B: Levels of vermicompost | 3 | 388.889 | 129.630 | 7.625 | .001 |
| Interaction: (A x B) | 11 | 570.222 | 51.838 | 3.430 | .006 |

Appendix XVIII. Analysis of variance of rotten root of carrot as influenced by carrot cultivars and different levels of vermicompost

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | .889 | .444 | .262 | .771 |
| Factor B: Levels of vermicompost | 3 | 3.556 | 1.185 | .711 | .553 |
| Interaction: (A x B) | 11 | 24.889 | 2.263 | 1.697 | .135 |

Appendix XIX. Analysis of variance of total weight of root of carrot per plot as influenced by carrot cultivars and different levels of vermicompost

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 1.079 | .540 | 1.144 | .331 |
| Factor B: Levels of vermicompost | 3 | 12.501 | 4.167 | 32.248 | .000 |
| Interaction: (A x B) | 11 | 14.239 | 1.294 | 12.961 | .000 |

Appendix XX. Analysis of variance of total weight of root of carrot per hactare as influenced by carrot cultivars and different levels of vermicompost

| Source of variation | df | Sum of square | Mean square | F-value | P-value |
|---|---|---|---|---|---|
| Factor A: Carrot cultivars | 2 | 69.057 | 34.529 | 1.144 | .331 |
| Factor B: Levels of vermicompost | 3 | 800.052 | 266.684 | 32.248 | .000 |
| Interaction: (A x B) | 11 | 911.287 | 82.844 | 12.961 | .000 |

Plate 1: seedbed prepared

Plate 2: Seedling germinated

Plate 3: Germinated seedlings on a plot

Plate 4: Growing carrot plant in a plot

Plate 5: carrot plant in the field

Plate 6: Carrot plant in the field

Plate 7: Collection of data

Plate 8: Collection of data


Plate 9: Fully grown experiment field

Plate 10: Whole experiment field

Plate 11: Carrot initiated in the experiment field

Plate 12: Harvested carrot root

Plate 13: Sliced carrot root for oven dry

Plate 14: Sliced carrot root and leaf for oven dry