INFLUENCE OF ORGANIC MANURES AND NEEM PRODUCTS ON GROWTH AND YIELD OF CARROT

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Dedicated to
My
Beloved Parents

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Memo no… Dated…..

CERTIFICATE

This is to certify that the thesis entitled, "**INFLUENCE OF ORGANIC MANURES AND NEEM PRODUCTS ON GROWTH AND YIELD OF CARROT**" submitted to the Department of Horticulture, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka. In partial fulfilment 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 **ABU SALEH MOHAMMAD YOUSUF ALI**, Registration No.06-01956, under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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ABSTRACT

An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2011 to February 2012 to evaluate growth and yield of carrot as influenced by different types of organic manures (O_0: no organic manure, $O_{c:}$ cowdung and $O_{v:}$ vermicompost) and neem products ($N_{0:}$ no neem products, $N_{1:}$ neem leaf powder and $N_{2:}$ neem oil cake) . The experiment was conducted in Randomized Complete Block Design with three replications. Application of organic manures and neem products significantly influenced the growth and yield contributing parameters. For organic manures, O_v gave the highest gross yield (33.33 t/ha) and marketable yield (32.20 t/ha) whereas, O_0 produced the lowest gross yield (15.84 t/ha) and marketable (12.50t/ha) yield. The highest gross yield (27.89 t/ha) and marketable (25.60 t/ha) yield was obtained from N_1 and the lowest from N_0. For combind effect N_1O_v produced the highest marketable yield (29 t/ha) whereas, the lowest (09.00 t/ha) from N_0O_0. The maximum benefit cost ratio (3.37) was obtained from O_cN_1 and minimum (1.42) from N_0O_0 . So, it may be concluded that cowdung with neem leaf powder was found suitable for growth and yield of carrot.

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ABBREVIATIONS AND ACRONYMS

%	:	Percentage
@	:	At the Rate of
Abstr.	:	Abstract
AEZ	:	Agro-ecological Zone
Agric.	:	Agriculture
BARC	:	Bangladesh Agricultural Research Council
BARI	:	Bangladesh Agricultural Research Institute
BAU	:	Bangladesh Agricultural University
BBS	:	Bangladesh Bureau of Statistics
BCR	:	Benefit Cost Ration
cv.	:	Cultivar
DAS	:	Day After Sowing
DM	:	Dry mater
DW	:	Dry weight
EC	:	Emulsifiable Concentrate
et al.	:	and others
FAO	:	Food and Agriculture Organization of United Nations
FW	:	Fresh weight
FYM		Farm Yard Manure

Hort.	:	Horticulture
i.e.	:	That is
J.	:	Journal
LSD	:	Least Significant Difference
^{O}C	:	Degree Celsius
RCBD	:	Randomized Complete Block Design
Sci.	:	Science
Soc.	:	Society
Tk.	:	*Taka*
UK	:	United Kingdom
UNDP	:	United Nations Development Program
Viz.	:	Namely

CHAPTER I

INTRODUCTION

Carrot (*Daucus carota L.*) is an important vegetable root crops belongs to the family Apiaceae. It is ranked third among the succulent vegetables in the world production (Yamaguchi, 1983). It is mainly a temperate crop grown during spring through autumn in temperate countries and during winter in tropical and subtropical countries of the world (Bose and Som, 1990). Carrot grows successfully in Bangladesh during rabi season when temperature ranges from 11.17 to 28.9 ^{0}C (Alim, 1974) and mid November to early December is the best time for its cultivation to get satisfactory yield (Rashid, 1993). In the year 2009-2010, the area under carrot cultivation was 1215 hectares and total production of 14000 metric tons in Bangladesh (BBS, 2010). Rashid (1999) mentioned an average yield of 25 t/ha of carrot. This production is relatively low compared to other carrot producing countries like, Israel, Australia, Sweden and Switzerland where the yield are reported to be 58.66, 56.37, 50.56 and 57.60 t/ha, respectively (FAO, 2004).

Carrot contains appreciable amount of carotene, thiamin and riboflavin (Sharfuddin and Siddique, 1985). It contains carotene (10 mg/100 g), thiamin (0.04 mg/100 g), riboflabin (0.05 mg/100 g) and also serves as a source of carbohydrate, protein, fat, minerals, vitamin-C and calories (Yawalker, 1985).The edible roots are nutritious and contain water, protein, ash, vitamins and mineral (Norman, 1992). Blindness in children for the severe vitamin-A deficiency is a problem of public health in some countries, particularly in the rice dependent countries of Asia (Woolfe, 1989). So, carrot (rich in vitamin-A) may contribute a lot of vitamin-A to overcome this situation in Bangladesh. Furthermore, carrot has some important medicinal values (Razzak and Ahmed, 1973, Bose and Som, 1990). Carrot roots are used as salad, vegetable and halua preparation. The popularity of organic carrot is increasing day by day in Bangladesh especially among the urban people because of its

high nutritive value and possible diversified use in making different palatable foods. Carrot can be eaten either raw or by soups and curries and grated roots are used as salad. The area under carrot cultivation was 899 thousand hectares with total production of 193740 thousand tones in the world (FAO, 2004)

Vermicompost, which is produced by earthworms, is a rich source of both macro and micro nutrients, vitamins, growth hormones, and enzymes (Bhavalkar, 1991). Among the neem oil cakes, neem and castor cakes are quick acting though insoluble in water and they provide slow and steady nourishment and protection from nematodes and improve yield and quality of produce (Gaur *et al*., 1992).

Insects controlled by neem products include migratory locust, army worms, whitefly and even head lice. The pathogen it controls include Meloidogyne root-knot nematode, Rhizoctonia root-rot fungus and rice stunt virus (Anonymous, 1992; Anjorin *et al*., 2004) and it is found to be safe to beneficial organisms such as earthworms. Khalid and Shad (2002) specifically reported that their toxic effect is normally of an ephemeral nature disappearing within 14-21 days. The addition of organic amendments that stimulate growth of antagonistic micro-organisms, or release toxins during decomposition (Badra *et al*., 1979).

Organic manures as well as neem products improves soil structure as well as increases its water holding capacity. Neem oil cake and seed extracts are known to possess germicidal and anti bacterial properties which are useful to protect the plants from different kinds of pests. Neem products play a vital role in pest management, do not harm micro organisms except bacteria fungus and widely have been used in Agriculture. Neem pesticide has been an evident shift all over the world from synthetic pesticides to non-synthetic ones.

Neem pesticides based on neem leaf and neem seed are being manufactured and exported to various countries as a lot of research has been conducted to test

the safety and efficacy of neem for use as a pesticide (Anis joseph et al., 2010). Neem leaf powder has 2.5, 1.0 and 1.4 per cent N, P_2O_5 and K_2O, respectively (Yawalkar *et al.*,1996). De-oiled neem cake is a byproduct of the oil production and is being used as manure (Yawalkar *et al.*,1996). Neem cake contain azadiractin, miliantriol, etc. having insecticidal and nematicidal properties (Anon., 2001). Moreover, it facilitates aeration in soil. Recently organic farming is appreciated by vegetable consumers as it enhances quality of the produce.

Inorganic cultivation leaves residual effect in crops which is believed to cause hazard to public health and environment.

Considering the above facts, the experiment was undertaken with the following objectives:

i) To find out the effect of organic manures on carrot production
ii) To investigate the effect of neem products on carrot production
iii) To find out the interaction effect of organic manures and neem products on carrot producion

CHAPTER II

REVIEW OF LITERATURE

Carrot is a plant which is an important high value vegetables of the world as well as Bangladesh. It received much attention to the researchers of different countries including Bangladesh. Like many other root and tuber crops, the growth and yield of carrot are influenced by organic nutrients and neem products. Different factors like type of soil, temperature, soil moisture are involved with organic nutrients and neem products which ultimately influence the growth and yield of a crop. Carrot is also known to be a heavy absorber of soil moisture which should be ensured through proper soil moisture management such as irrigation and organic manures. But irrigation is a costly practice and organic manure may be an alternative proposition for successful carrot production. There is a little combined research work to the influence of organic manures and neem products on growth and yield of carrot in Bangladesh. The literature related to the present study is reviewed in this chapter.

2.1 The literature related to organic manures

Optimum organic manure is one of the most important and uncontroversial factors for maximizing the yield of a crop. The results of the researchers relating to organic manure of carrot are reviewed below:

Akand (2003) conducted an experiment with mulching and organic manure trial on carrot in BAU, Bangladesh and observed that black polythene mulch and organic manure (cowdung) significantly resulted the highest yield of carrotof his experiment.

Mesquita *et al.* (2002) conducted an experiment on a clayey yellow Red Oxisol to evaluate the residual effect of the application of phosphorus and urban waste compost of the previous two years on the root production of carrot cv.

Brasilia in Brazil. Carrot plants were harvested 90 days after planting. After the harvest a linear and quadratic effect for phosphorus and urban waste compost ($P<0.01$) was observed. The linear interaction P and quadratic urban compost was highly significant. The maximum root production was 26.5 t/ha corresponding to 18.5 t/ha of P_2O_5 and 53.2 t/ha of urban waste compost.

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 production of Extra-A and Extra grade roots increased linearly as earthworm compost rates increased. Production of Extra-A and Extra grade roots increased by approximately 0.6 and 0.16 t/ha for each of tonne of earthworm compost added in the soil. 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.

Maity *et al.* (2001) worked on growth and sporulation of *Alternaria radicina* under various carbon and nitrogen sources and found that carrot black rot pathogen Alternaria radicina grew best on a liquid medium containing xylose and potassium nitrateas the carbon and nitrogen sources, respectively. starch, sucrose and dextrose also supported mycelia growth. Ammonium salts as in organic nitrogen sources were poorly utilized. Among the organic nitrogen sources, case in hydrolysate produced good growth, followed by glycine. Maximum vegetable growth was observed in medium containing a carbon nitrogen ratio of 16:1.

Salminen *et al.* (2001) showed the effect of plant growth in carrot with the application of digested poultry slaughterhouse waste as nitrogen source, gave the higher yield.

At the Horticulture Farm, Bangladesh Agricultural University, Mymensingh, Rahman (2000) carried out an experiment and found that plant height of TPS seedlings was significantly influenced by the application of cowdung. The highest plant height (75.28 cm.) at 100 days was obtained from the highest dose of cowdung (100 t/ha).

In Brazil, Schuch *et al.* (1999) worked on the effect of organic manure (chicken and quail) on yield and quality of carrot cv. 'Nantes Forto', 'Flakkese', 'Fuyumaki', 'Nantes Superior' and 'Harumaki Kinko' were studied in 1993 and 1995. In 1995, cv. 'Nantes superior' and 'Harumaki Kinko' were replaced by Brasillia and Tin Ton. 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 1993 experiment, 'Nantes' for to produce the highest root yield. Root number, weight, diameter and length varied different amount of manure applied. Application of organic manure generally increased all the parameters evaluated.

Vieira *et al*. (1998) studied on a clayey Dusky Red Latosol in Dourados, Brazil, to evaluate the response of *Arracacia xanthorrhiza*to P fertilizer application at 4.3, 25.8, 43.0, 60.2 or 81.7 kg/ha as triple supper phosphate as well as the response to application of poultry house litter at 1, 6, 10, 14 or 19 t/ha. Treatments were defined by the plane puebla III experimental matrix, resulting in the following P (kg/ha) and poultry house litter (t/ha) combination: 4.3 x 6; 25.8 x 1; 25.6 x 6; 25.8 x 14; 43.0 x 10; 60.2 x 6; 60.2 x 14; 60.2 x 19 and 81.7 x 14. Each plot was 3.5 m^2 with 10 plants grouped in double rows with 0.50 m between plants, 0.60 m between paired rows and o.80m between double rows. During the vegetative cycle, plant height was measured every 15 days.

Harvesting was carried out 9 month after planting. Plant height presented little variation due to treatment and maximum heights were between 31cm (4.3 kg P/ha + 6 t litter/ha) and 37cm (60.2 kg P/ha +19 t litter /ha), 234 and 260 days after planting, respectively. Dry manure production of marketable root was independent of poultry house litter level, but increased linearly with P dose ranging from 0.42 t/ha (4.3 kg P/ha) to 1.3 t/ha (81.7 kg/ha). Marketable root yield increased linearly with P and poultry house litter rates, averaging 10 t/ha.

Sediyama *et al.* (1998) carried out an experiment to assess the plant nutritional status, root quality and yield of carrot cv. Brasilla, influenced by the following treatments: seven types of organic compounds which were produced from liquid swine manure and straw materials, crushed sugarcane, napier grass (*Pennisetum purpureum*) and coffee straw and crushed sugarcane with four replications, from 3 May to 23 August 1994 in Ponte Nova county, Minas Gerais State, Brazil. Generally, both a greater plant height and aerial part yield were obtained from treatments with organic compounds and dry swine manure. The organic compounds produced from coffee straw plus liquid swine manure, crushed sugarcane plus triple super phosphate and napier grass plus liquid swine manure provided yields of total roots higher than 50 t/ha. The organic compound produced form coffee straw and liquid swine manure provided a greater yield of total and commercial roots. Enrichment of the organic compound crushed sugarcane plus liquid swine manure with gypsum or triple super phosphate did not affect root yield, neither Ca and P contents in leaves and roots. The carrot roots that received organic or mineral fertilization presented superior P and K contents and similar Ca content, when compared to those contents considered as standard for human diets

Datta and Chakrabarty (1995) conducted a field experiment in 1991-93 at Sriniketan, West Bengal with 0, 50 and 100 kg/ha each of N, P_2O_5 and K_2O and manure with 5 t/ha rice husk ash, 0.5 t/ha mustard oil cake or 10 t/ha FYM. The highest tuber yield (27.6 t/ha) was obtained from the highest NPK rate used.

Among the manures, the highest tuber yields were obtained from FYM followed by rice husk ash and mustard oil cake.

Kale *et al.* (1991) observed that use of vermicompost is helpful reducing basal dose of fertilizer to 25 per cent in tomato, radish, carrot and brinjal.

Bohec (1990) studied the use of urban compost and sewage sludge compost for vegetable crops in 1980-86. Various vegetable crops were grown in rotation on land with annual application of composted FYM, composted urban waste or composted sewage sludge. In 1981, the highest total yield of celery and yield trimmed to 40 cm. were given by compost Hydromer or by composted FYM while other composts gave lower yields. In 1982, the yield of leeks was similar in all treatments except the control without added organic manureand composted household waste from Auray. Yields of celery in 1986 were the highest with FYM than that of any other treatments. Lettuce and celery showed accumulation of Cd while carrot and celery leaves accumulation Pb. In all treatments, including the control, soil Cu and Cd increased from 1980 to 1986.

Lang (1984) found that organic manures increased the yield of potato (31.14-32.5 t/ha) compared with control (23.2-32.6 t/ha).Hochmuth and Howell (1983) reported that, leaf area, leaf number, total dry weight and the highest marketable yield (18.6 t/ha) was obtained from organic cowdung raised beds with 'New Kuroda' where non-organic mulched bed gave the lowest yield (7.0 t/ha).Sans *et al.* (1974) stated that organic compound reduced soil temperature on the soil surface, and a depth of 10 cm soil temperature disappeared.

2.2 The literature related to neem products

Marcic *et al.* (2009) in an experiment to determine the effectiveness of azadirachtin (NeemAzal-T/S) in controlling pear psylla (*Cacopsylla pyri*) and European red mite *(Panony chusulmi*) reported that *azadirachtin* and *abamectin* achieved 100% efficacy, while the effectiveness of mineral oil was 97.4% and that of diflubenzuron a mere 59%.

All four insecticides significantly reduced the number of older yellow eggs and larvae, the efficacy being 80.5-92.6% (yellow eggs), 69.8-79.3% (larvae I-III instar) and 94.3-100% (larvae IV-V instar). *Azadirachtin, abamectin* and mineral oil achieved 100% efficacy against white and yellow eggs in evaluation while diflubenzuron achieved 93% and 86.9% efficacy. All four insecticides were found to demonstrate high efficacy against I-III instar larvae (99.2-100%), but mineral oil treatment alone achieved high efficacy against IV-V instar larvae (92.4%) as well. They reported that neem-based products have considerable oviposition deterrence against winterform pear psylla females.

Tukur *et al*. (2009) determined the efficacy of neem oils in the control of okra leaf beetle and reported that ripe neem seed oil extract controlled the pest from damaging the okra leaves. The population of flea beetle in plots treated with ripe neem seed oil extract was drastically reduced. This was due to the efficacy of the active ingredients azadirachtin, meleantriols and salannin contained in the neem plant. They said that the efficacy may have to do with the repelling activities of the active ingredients when sprayed on crops. Spraying neem seed oil on okra recorded lower leaf damage and higher yield of okra green pods. They attributed this to the inhibitory activities of the ingredients azadirachtin which deter flea beetles from causing damage to okra leaves and flowers.

Singh and Vinod Kumar (1995) in an experiment to determine Effect of carbofuran and neem cake on *Meloidogyne incognita* infecting Japanese mint reported that Neem cake at the rate of 2 per cent w/w was very effective in reducing the populationof *Miloidogyne incognita* as well as significantly increasing growth parameters (i.e., shootlength, shoot dry weight, root fresh weight, number of leaves) of Japanese mint. Treatment ofneem cane was also better than that of inoculated control and carbofuran @ 2 kg a.i./haincreasing some growth parameters of mint plants .

CHAPTER III
MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in execution of the experiment.

3.1 Experimental site

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2011 to February 2012. The site is situated between 23 ^{0} 41$^{/}$ N latitude and 90 ^{o} 22$^{/}$ E longitude and at a altitude of 8.6 m from sea level.

3.2 Climate

The experimental area is situated in the subtropical zone, characterized by heavy rainfall during Kharif season (April to September), and scanty in Rabi season (October to March). Rabi season is characterized by plenty of sunshine. Information regarding average monthly maximum and minimum temperature, rainfall, relative humidity and soil temperature as recorded by the Bangladesh Meterological Department (climate division) Agargaon, Dhaka, during the period of study have been presented in Appendix I.

3.3 Soil

The soil of the experimental area was medium high land type and belongs to the Modhupur Tract and AEZ No. 28 (UNDP and FAO, 1988). The analytical data of the soil sample collected from the experimental area were determined from the Soil Resource Development Institute (SRDI), Farmgate, Dhaka,have been presented in Appendix II. The experimental site was a medium high land and the pH of the soil was 6.7. The morphological characters of soil of the experimental plots as indicated by FAO (1998) have been presented in Appendix III.

3.4 Treatments of the experiment

The experiment was designed to study the effect of different types of organic manure and neem extracts on growth and yield of carrot. The experiment consisted of two factors which are as follows:

Factor A: Three levels of organic manures

O_o = Control (no organic manure)

O_C = Cowdung (10 t/ha)

O_V = Vermicompost (3.5 t/ha)

Factor B: Three levels of neem product

N_o = Control (no neem products)

N_1 = Neem leaf powder (250 kg/ha)

N_2 = Neem oil cake (250 kg/ha)

There were altogether 9 treatment combinations such as: N_oO_o, N_oO_c,N_oO_v, N_1O_o, N_1O_c, N_1O_v,N_2O_o,N_2O_c and N_2O_v

3.5 Experimental materials

"New kuroda" variety of carrot was used for the experiment. The seeds of this variety were collected from Dhaka Seed Store", Siddique Bazar,Dhaka.

3.6 Experimental design and layout

The two-factor experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. An area of 114 m^2 was divided into three equal blocks. Each block was divided in to 9 plots where 9 treatments were allotted at random. Thus, there were 27 (9 × 3) unit plots altogether in the experiment. The size of each plot was 1.8 ×1 m. The distance between blocks and between plots were kept respectively 1 and 0.5 m. A layout of the experiment is shown in Appendix IV.

3.7 Land preparation

The land which was selected to conduct the experiment was opened on 6 November, 2011 with the help of a power tiller and then it was kept open to sun for 7 days prior to further ploughing. Afterwards it was prepared by ploughing and cross ploughing followed by laddering. Deep ploughing was done to have a good tilth, which was necessary for getting better yield of this crop. The weeds and stubbles were removed after each laddering. Simultaneously the clods were broken and the soil was made into good tilth.

3.8 Manuring

The following doses of manures and fertilizers were applied for carrot production.

Manures/fertilizer	N (kg/ha)	P (kg/ha)	K (kg/ha)	Dose
Cowdung	45	15	50	10 t/ha
Vermicompost	70	44	91	3.5t/ha

Neem products	N (kg/ha)	P (kg/ha)	K (kg/ha)	Dose
Neemleafpowder	6.25	1	3.5	250kg/ha
Neem oil cake	2	1.20	3	250kg/ha

Source: Krishi Diary, 2012, BARC-2005, Neem Foundation, 2010.

The total amount of cowdung, vermicompost, neem leaf powder and neem oil cake were applied during land preparation.

3. 9 Collection and sowing of seeds

The seeds of carrot ‘New Kuroda’was used in the experiment. The seeds were in a sealed container, and procured by the Dhaka Seed Store. The seeds were soaked in water for 24 hours and then wrapped with piece of thin cloth. The socked seed were then spreaded over polythene sheet for 2 hours to dry out the surface water. This treatment was given to help quick germination of seeds.

The treated seeds were sown is field on 15 November 2011. Small holes of about 1.5 cm depth were made at a distance of 15 cm. along the row spaced at a distance of 25 cm. Three or four seeds were placed in each hole and covered with loose soil.

3.10 Intercultural operations

3.10.1 Thinning out

Seedlings emergence was completed within ten days and when the attained a height about 20 cm were thinned out two times. First thinning was done after 20 days of sowing, leaving two seedlings in each hill. The second thinning was done ten days after first thinning, keeping only one seedling in each hill.

3.10.2. Weeding

Weeding was done four or five times in plots to keep plots free from weeds.

3.10.3.Pest management

Soil of each plot was treated by sevin 85 WP @ 0.2% at 15 days interval for two times to protect the young plants from the attack of field cricket, mole cricket, cutworm and ants.

3.10.4 Diseases management

The crop was healthy and fungicide was used when and as necessary.

3.11 Harvesting

The crop was harvested on 23 February 2012 i.e. after 100 days after sowing (DAS). Harvesting of the crop was done plot wise. It was done by uprooting the plants by hand carefully. The soil and fibrous roots adhering to the conical roots were removed and cleaned.

3.12 Data collection

Data were recorded from the sample plants on the following parameters during the course of experiment. Ten plants were sampled randomly from each unit plot. The whole plot was harvested to record per plot data.

Data were collected on different growth and yield contributing character and yield. The plants in the outer rows and at the extreme end of the middle rows were excluded from the random selection to avoid the border effect. The following observations were made regarding plant growth, yield and yield attributes as affected by different types of organic manure and Neem product. The following parameters were recorded:

3.12.1 Plant height

Plant height was recorded in centimeter (cm) by a meter scale at 40, 55, 70, 85 and 100 DAS from the point of attachment of the leaves to the root (ground level) up to the tip of the longest leaf.

3.12.2 Number of leaves per plant

Number of leaves per plant was recorded from ten random selected plants at 40, 55, 70, 85 and 100 DAS. All the leaves of each plant were counted separately. Only the smallest young leaves at the growing point of the plant were excluded from the counting and the average number was recorded.

3.12.3 Fresh weight of leaves per plant

Leaves were detached by a sharp knife and fresh weight of the leaves was taken by a triple beam balance at harvest (100DAS) and was recorded.

3.12.4 Percent dry matter of leaves

100 g leaves were collected from the random samples and cut into small pieces and then sun dried for two days. Sun dried samples are then put in paper packets and oven dried for 72 hours at 70 to 80^0C in an oven. After oven drying, leaves were weighed. An electric balance was used to record the dry weight of leaf and it was calculated on percentage basis. The percentage of dry matter of leaves was calculated by the following formula.

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

3.12.5 Length of root

The length of the conical roots was measured in centimeter with the help of a meter scale from the proximal end of the conical root to the last point of the tapered end of the root (distal end) in each treatment.

3.12.6 Diameter of root

To measure the diameter of the root a slide callipers was used. The diameter of the roots were measured in centimeter after harvest at the thickened portion of the root.

3.12.7 Fresh weight of root per plant

Carrot roots of ten selected plants were made detached by a knife from the attachment of the stem and after cleaning the soil and fibrous root fresh weight was taken by the triple beam balance in gram and then the average value was calculated.

3.12.8 Percent dry matter of root

Immediately after harvest, the roots were cleaned thoroughly by washing with water. Then from the roots, a sample of 100 g was taken randomly and cut into small pieces. The small pieces were sun dried for 3 days, and then oven dried for 72 hours at 70 to 80^0C. Immediately after oven drying, the dried root pieces were weighed and the dry matter content of the roots was calculated by the following, formula.

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

3.12.9 Percentage of deformed roots

At harvest, among the carrot roots the number of cracked roots was counted. Then percentage of crack roots was calculated according to the following formula.

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

3.12.10 Percentage of rotten roots

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

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

3.12.11 Gross yield of roots per plot

A balance was used to record the gross weight of the harvested roots. All leaves were removed from the plant by a sharp knife and weight of the roots was taken in kilogram (kg) from each unit plot.

3.12.12 Marketable yield of roots per plot

It consisted of only good quality roots per plot other than cracked and rotten roots. The marketable roots were weighed and expressed in kilogram(kg).

3.12.13 Gross yield of roots per hectare

The yield of roots per hectare was calculated in tonne by converting the total yield of roots per plot.

3.12.14 Marketable yield of root per hectare

Marketable yield of roots per hectare was calculated by conversion of the marketable root yield per plot and recorded in tonne.

3.13 Economic analysis

Cost benefit ratio or Economic analysis in details was done according to the procedure of Alam *et al.* (1989). Materials, non-materials and overhead cost were recorded from all the treatments for unit plots and calculated per hectare basis (marketable yield). The price of carrot roots was noted at the market rate of Kawranbazer, Dhaka.

3.14 Statistical analysis

The collected data on aforementioned paramerets were statistically analyzed. The mean value for all the treatments was calculated and the analysis of variance for most of the characters was accomplished by F variance test. The significance of difference between pair of means was tested by the Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to investigate the growth and yield of carrot as influenced by different organic manures and neem products. The analysis of variances for different characters have been presented in Appendices V. The results of the present study have been presented and discussed in this chapter under the following headings.

4.1 Effect of organic manures and neem products on growth and yield of carrot.

4.1.1 Plant height

The plant height was recorded at different stages of growth i.e. 40, 55, 70, 85 and 100 days after sowing (DAS). The plant height varied significantly due to the application of organic manures (Fig. 1). During the period of plant growth the tallest plant (18 cm) was observed in vermicompost treatment (O_v) whilethe shortest plant (10.5 cm) was obtained from the control treatment (O_0) at 40 days. At 55 days, the tallest plant (24.5 cm) was obtained from vermicompost (O_v) while the shortest plant (16 cm) was obtained from the control treatment (O_0). At 70 days, 85days, the tallest plant height (30 cm, 33.5 cm) was obtained from vermicompost (O_v) while the shortest plant (19 cm, 20.5 cm) was obtained from the control treatment (O_0). At 100 days, the tallest plant (36 cm) was obtained from O_v while the shortest plant (22 cm) was obtained from the control treatment (O_0).

The plant height varied significantly due to the application of neem products (Fig.2). During the period of plant growth the tallest plant (16 cm) was observed in neem leaf powder treatment (N_1) whilethe shortest plant (11.5 cm) was obtained from the control treatment (N_0) at 40 days.

At 55 days, the tallest plant (22.73 cm) was obtained from N_1 while the shortest plant (15.44 cm) was obtained from N_0. At 70 days, 85days, the tallest plant (27.23 cm, 30 cm) was obtained from N_1 while the shortest plant (18.5 cm, 20.5 cm) was obtained from the control (N_0). At 100 days, the tallest plant (31.80 cm) was obtained from N_1 while the shortest plant (21.5 cm) was obtained from the control treatment (O_0).

In case of interaction effect (Table 1), at 40, 55, 70, 85 and 100 days, the tallest plant 17, 23.62, 28.62, 31.75, and 33.9 respectively was obtained from neem leaf powder (N_1) and vermicompost (O_v) while the shortest plant 11, 15.68, 18.75, 20.5, and 21.75cm respectively was obtained from the control treatment (O_0).

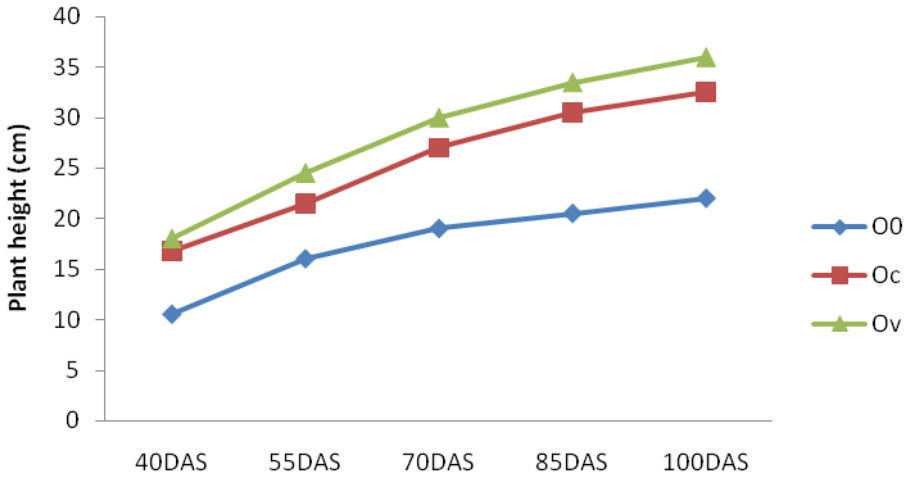

Fig. 1. Effect of organic manures on plant height of carrot

0_0=No organic manure (Control) , 0_c= Cowdung , 0_v= vermiCompost

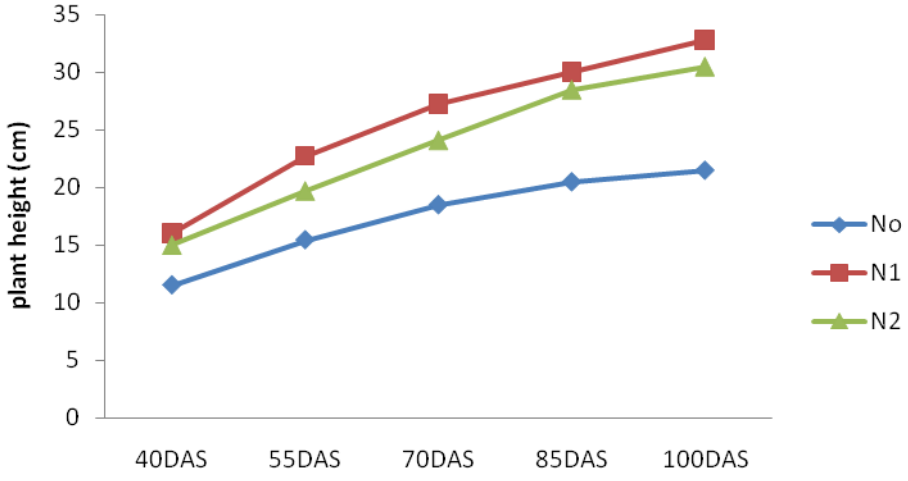

Fig. 2. Effect of neem products on plant height of carrot

N_o= No neem products (control) , N_1=Neem leaf powder , N_2= Neem oil cake

Table 1. Combined effect of organic manures and neem products on plant height of carrot.

Treatments combination	Plant height (cm) at different days after sowing (DAS)				
	40	**55**	**70**	**85**	**100**
N_o0_o	11.00f	15.68g	18.75g	20.50f	21.75h
N_o0_v	14.75c	19.97d	24.25d	27.00d	28.75e
N_0O_c	14.15cd	18.47e	22.75e	25.50e	27.00f
N_1O_o	13.25de	19.37d	23.12e	25.25e	26.90f
N_1O_v	17.00a	23.62a	28.62a	31.75a	33.90a
N_1O_c	16.40ab	22.12b	26.79b	30.25bc	32.15c
N_2O_o	12.75e	17.85f	21.55f	24.50e	26.25g
N_2O_v	16.50ab	22.10b	27.05b	31.00ab	33.25b
N_2O_c	15.90b	20.60c	25.55c	29.5c	31.50d
$LSD_{(0.05)}$	1.09	0.62	0.65	1.02	0.60
Level of Significance	*	**	**	**	*
CV (%)	4.31	1.80	1.53	2.16	1.17

0_0=No organic manure (Control)
0_c= Cowdung
0_v= vermiCompost

N_o= No neem products (control)
N_1=Neem leaf powder
N_2= Neem oil cake

* = Significant at 5% level
** = Significant at 1% level

4.1.2 Number of leaves per plant

The number of leaves per plant was recorded at different stages of growth i.e.40, 55, 70, 85 and 100 days after sowing. Application of organic manures increased the number of leaves per plant significantly (Fig. 4). The maximum number of leaves per plant (6.5) was observed from vermicompost (O_v) and the minimum number of leaves per plant (5.05) was found under the control treatment (O_0) at 40 DAS. At 55 DAS, the maximum number of leaves per plant (9.35) was observed O_v while the minimum number of leaves per plant (8.07) was found under O_0. The maximum number of leaves per plant (11.55) was observed from vermicompost (O_v) and the minimum number of leaves per plant (8.50) was found under the control treatment (O_0) at 70 DAS. At 85 DAS, the maximum number of leaves per plant (13.65) was observed from O_v while the minimum number of leaves per plant (9.15) was found under O_0. At 100 DAS, the maximum number of leaves (12.50) was observed from vermicompost (O_v) while minimum number of leaves (8.40) was recorded under control treatment (O_0).

Application of neem products increased the number of leaves per plant significantly (Fig. 5). The maximum number of leaves per plant (5.95) was observed from in neem leaf powder treatment (N_1) and the minimum number of leaves per plant (5.05) was found under the control treatment (N_0) at 40 DAS. At 55 DAS, the maximum number of leaves per plant (9.2) was observed N_1 while the minimum number of leaves per plant (8.2) was found under N_0. The maximum number of leaves per plant (10.38) was observed from N_1 and the minimum number of leaves per plant (9.0) was found under the control treatment (O_0) at 70 DAS. At 85 DAS, the maximum number of leaves per plant (11.67) was observed from N_1 while the minimum number of leaves per plant (9.2) was found under O_0.

At 100 DAS, the maximum number of leaves (10.65) was observed from N_1 while minimum number of leaves (8.40) was recorded under N_0.

The comparison showed that the number of leaves was greater at 85 DAS than that of 100 DAS. 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 due to senescence phase of plant. The results also agreed with the findings of Sediyama*et al*. (1998).

At 40, 55, 70, 85 and 100 days, the maximum number of leaves per plant 6.34, 9.57, 12.34, 13.85 and 12.60 respectively was obtained from neem leaf powder (N_1) and vermicompost (O_v) which was closely followed by neem 0il cake (N_2) and vermicompost (O_v) while the minimum number of leaves per plant 5, 7.67, 8.26, 9 and 8.16 respectively was obtained from the control treatment (N_oO_0).

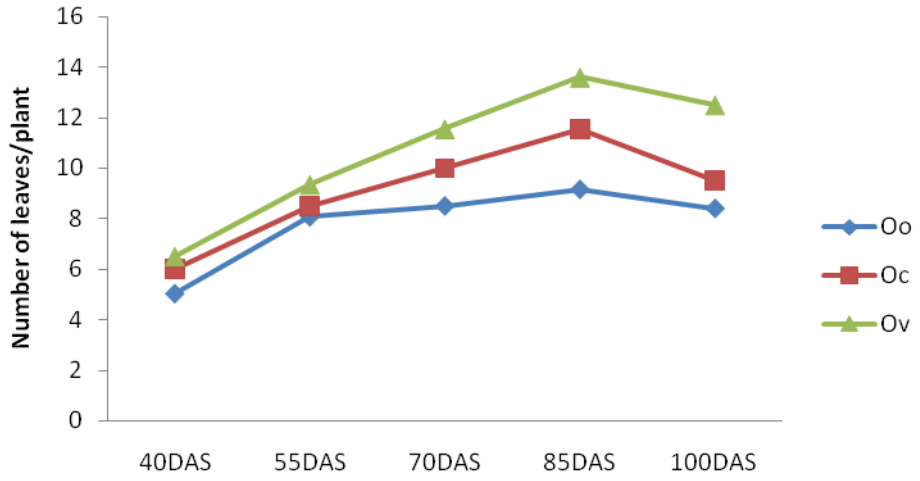

Fig. 4. Effect of organic manures on number of leaves of carrot

0_0 = No organic manure (Control) , 0_c = Cowdung , 0_v = vermicompost

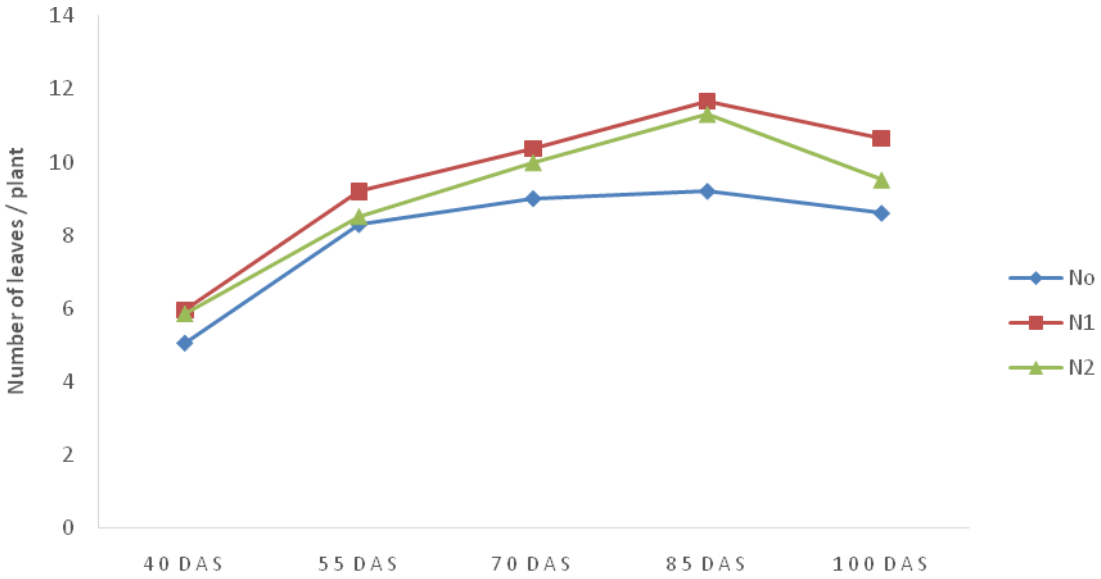

Fig. 5. Effect of neem products on number of leaves of carrot

N_o = No neem products (Control) ,
N_1= Neem leaf powder ,
N_2 = Neem oil cake

Table 2. Interaction effect of organic manures and neem products on number of leaves of carrot.

Treatments combination	Number of leaves per plant at different days after sowing (DAS)				
	40	55	70	85	100
N_o0_o	5.00c	7.67d	8.27g	9.00g	8.17d
N_o0_c	5.54bc	7.87d	9.74e	10.73	9.67c
N_0O_v	6.10ab	9.34ab	11.27b	13.43b	12.34a
N_1O_o	5.37c	8.60c	9.07f	9.40f	8.54d
N_1O_c	6.00ab	8.90bc	10.80c	11.80c	10.80b
N_1O_v	6.34a	9.57a	12.34a	13.85a	12.60a
N_2O_o	5.10c	7.97d	8.80f	9.10fg	8.50d
N_2O_c	6.10ab	8.47c	10.20d	11.20d	9.90c
N_2O_v	6.37a	9.07b	10.93c	13.60ab	12.54a
$LSD_{(0.05)}$	0.65	0.45	0.30	0.38	0.55
Level of Significance	*	**	**	**	*
CV(%)	6.25	2.96	1.55	1.80	3.05

0_0 = No organic manure (Control)
0_c = Cowdung
0_v = vermicompost

N_o = No neem products (control)
N_1 = Neem leaf powder
N_2 = Neem oil cake

** = Significant at 1% level
* = Significant at 5% level

4.1.3 Fresh weight of leaves per plant

A significant variation was observed on the fresh weight of leaves per plant due to organic manures (Table 3). The fresh weight of leaves per plant increased significantly with the application of vermicompost. The maximum fresh weight of leaves (102.89 g) per plant was recorded from the vermicompost treatment (O_v) while the minimum (64.89 g) was from the control (O_0).

The fresh weight of leaves per plant differed significantly by different neem products (Table 4). Neem leaf powder (N_1) gave the maximum fresh weight of leaves (90g/plant). However, control (N_0) showed the minimum fresh weight of leaves (67.56 g/plant).

In case of combind effect, neem leaf powder and vermicompost ($N_1O_{v)}$ gave the maximum fresh weight of leaves (96.5g/plant) while the minimum fresh weight of leaves (66.23g/plant) was obtained from the control (N_0O_0) treatment (Table 5). The increased fresh weight of leaf under vermicompost and neem leaf powder treatment may be attributed to the availability of more soil moisture that possibly increased the rate of cell division and elongation producing more leaves and their development leading to increased fresh weight of leaf. The result is consistent with that of Hochmuth and Howell (1983) in sweet potato, and Sutater (1987) in potato crop.

4.1.4 Percent dry matter of leaves

Organic manures had significant effect on dry matter content of leaves per plant. The highest dry matter of leaves (12.2%) was recorded from vermicompost (O_v) and the lowest dry matter (7.1%) was recorded from the control (O_0) treatment (Table 3).

Dry matter of leaves was also significantly influenced by different neem products (Table 4). The highest dry matter of leaves (10%) was recorded from neem leaf powder (N_1) while the lowest dry matter of leaves (7%) was found in control (N_0).

The combined effect of different organic manures and neem products on percentage of dry matter of leaves was significant (Table 5). The highest dry matter (11.1%) was obtained from vermicompost with neem leaf powder (N_1O_v) which was closely followed by vermicompost with neem oil cake while the treatment combination of control (O_0N_0) produced the lowest (7.05%) dry matter of leaves .

4.1.5 Length of root

A significant variation was observed on the length of root due to the effect of organic manures. The longest root (16.20 cm) was obtained from the application of vermicompost (O_c) and the shortest (10.50 cm) was from control (O_0) treatment (Table 3).

Significant influence was observed due to the effect of different neem products on the length of root (Table 4). The longest root (14 cm) was obtained from neem leaf powder (N_1). However, control (N_0) treatment showed the lowest root length (10 cm).

The combined effect of organic manures and neem products was significant (Table 5). The combined effect of vermicompost with neem leaf powder (N_1O_v) gave the longest (15.10 cm) root which was closely followed by vermicompost with neem oil cake (N_2O_v) and the shortest (10.25 cm) length of root was obtained from the control treatment (N_0O_0).

4.1.6 Diameter of root

Diameter of carrot root was significantly influenced by the application of organic manures . The highest diameter (4.77 cm) was obtained from vermicompost (O_v). while the control treatment (O_0) gave the lowest (3.21 cm) from table 3.

Diameter of carrot roots was significantly influenced by different neem products. The maximum root diameter (4.18 cm) was obtained from neem leaf powder (N_1) and the lowest root diameter (3.24 cm) was produced from control (N_0) treatment (Table 4).

Root diameter varied significantly due to combined effect of organic manures and neem products. The maximum diameter of root (4.5 cm) was found from vermicompost with neem leaf powder (N_1O_v) which was closely followed by neem oil cake with vermicompost while the minimum (3.23 cm) was recorded from control (N_0O_0) treatment (Table 5).

4.1.7 Fresh weight of root per plant

The fresh weight of root per plant significantly differed with organic manures (Table 6). The maximum fresh weight of root (170 g) was recorded from vermicompost (O_v). However, the control treatment (O_0) gave the lowest fresh weight of root (90 g).

The fresh weight of root per plant significantly differed with neem products (Table 7). The highest fresh weight of root (147 g) was recorded from (N_1). However, the control (N_0) gave the lowest fresh weight of root (85 g).

The combined effect of organic manures and neem products showed significant variation on fresh weight of root per plant (Table 8). The maximum (158.5 g) fresh weight of root was recorded from plant grown over the neem leaf powder with vermicompost (N_1O_v) and the second maximum (150 g) fresh weight of root was recorded from the neem oil cake with vermicompost. whereas, the minimum (87.5 g) was found from the control (N_0O_0). The present findinds disagreed with the results of Viera *et al.* (1998).

4.1.8 Percent dry matter of root

The percent dry matter of root also varied significantly by organic manures (Table 3). The dry matter of roots was recorded to be the highest (17%) in plant grown by the application of vermicompost. The lowest root dry matter (10.6%) was obtained from control treatment (O_0).

Use of different neem products showed significant influence on the percent dry matter of root (Table 4). The highest dry matter of root (14.9%) was found from the neem leaf powder and the lowest (10.2%) from the control treatment (N_0).

Significant variation was observed on dry matter percentage of roots due to combined effect of organic manures and different neem products (Table 5). However, the highest dry matter of root (15.95%) was observed in the treatment combination of vermicompost application with neem leaf powder (N_1O_v) which was closely followed by the treatment combination neem oil cake with vermicompost (N_2O_v) and the lowest dry matter (10.4%) was recorded from control treatment (N_0O_0).

Table 3. Main effect of organic manures on growth and yield parameters of carrot

Organic nutrient sources	Fresh weight of leaves (g)	Dry Matter of leaves (%)	Root Length per plant (cm)	Diameter of root per plant (cm)	Dry matter of root (%)
0_0	64.89c	7.10c	10.50c	3.21c	10.60c
0_c	92b	10.50b	14.10b	4.20b	15b
0_v	102.89a	12.20a	16.20a	4.77a	17a
$LSD_{(0.05)}$	1.56	0.35	0.32	0.20	0.42
CV (%)	1.94	2.64	2.24	4.30	3.46
Level of Significance	**	**	**	**	**

0_0 = No organic manure (Control), 0_v= VermiCompost , ** = Significant at 1% level
0_c= Cowdung ,

Table 4. Main effect of neem products on growth and yield parameters of carrot

Neem products	**Fresh weight of leaves (g)**	**Dry Matter of leaves (%)**	**Root Length per plant (cm)**	**Diameter of root per plant (cm)**	**Dry matter of root (%)**
N_o	67.56c	7c	10.00c	3.24c	10.2c
N_1	90a	10a	14.20a	4.18a	14.9a
N_2	80.70b	8.5b	13.30b	4.07b	14b
$LSD_{(0.05)}$	1.60	0.40	0.32	0.20	0.35
CV (%)	1.94	2.64	2.24	4.30	3.46
Level of Significance	**	**	**	**	**

N_o = No neem products (control), N_1 = Neem leaf powder , N_2 = Neem oil cake, ** = Significant at 1% level

Table 5. Interaction effect of organic manures and neem products treatment on growth and yield parameters of carrot

Treatment combinations	Freshwt. of leaves (g)	Dry matter of leaves (%)	Root length (cm)	Diameter of root (cm)	Dry matter of root (%)
N_o0_o	66.23h	7.05f	10.25g	3.23e	10.40e
N_o0_c	79.80e	8.75cd	12.05f	3.40de	12.60dc
N_0O_v	85.30d	9.6bc	13.10de	4.01bc	13.60c
N_1O_o	77.45f	8.55d	12.25ef	3.70cd	12.75d
N_1O_c	91b	10.25b	14.05bc	4.19ab	14.95c
N_1O_v	96.50a	11.10a	15.20a	4.50a	15.95a
N_2O_o	72.80g	7.80e	11.90f	3.60de	12.30e
N_2O_c	86.35c	9.50bc	13.70cd	4.13ab	14.50c
N_2O_v	92b	10.35ab	14.93b	4.42a	15.50b
$LSD_{(0.05)}$	0.89	0.75	0.91	0.40	0.50
Level of Significance	**	**	**	*	**
CV (%)	0.65	3.25	5.68	4.01	2.90

0_0 = No organic manure (Control)
0_c = Cowdung
0_v = vermiCompost

N_o = No neem products (control)
N_1 = Neem leaf powder
N_2 = Neem oil cake

** = Significant at 1% level
* = Significant at 5% level

Table 6. Main effect of organic manures on the yield of carrot

Organic nutrients sources	**Fresh weight of root / plant (g)**	**Gross yield of root / plot (kg)**	**Gross yield / ha (ton)**	**Marketable yield of root / plot (kg)**	**Marketable yield / ha (ton)**	**Deformed Root (%)**	**Root rotting (%)**
0_0	90c	2.85c	15.84 c	2.25c	12.50c	22.23a	8.33a
0_c	155b	5.20b	28.90 b	4.81b	26.70b	8.33b	5.56b
0_v	170a	6a	33.33 a	5.77a	32.20a	5.56c	4.16b
LSD $_{(0.05)}$	4.30	0.16	0.58	0.45	0.87	1.66	1.47
Level of Significance	**	**	**	**	**	**	**
CV (%)	3.40	2.65	3.72	2.56	5.62	22.51	32.41

0_0 = No organic manure (Control) , 0_c = Cowdung , 0_v = vermiCompost , ** = Significant at 1% level

Table 7. Main effect of neem products on the yield of carrot

Neem products	**Fresh weight of root / plant (g)**	**Gross yield of root / plot (kg)**	**Gross yield of root /ha (ton)**	**Marketable yield of root / plot (kg)**	**Marketable yield /ha (ton)**	**deformed root (%)**	**Root rotting (%)**
N_o	85c	2.67c	14.83c	2.04c	11.34c	25a	11.12a
N_1	147a	5.02a	27.89a	4.60a	25.60a	11.12b	2.78b
N_2	130b	4.40b	24.45b	4.01b	22.27b	8.33c	3.47b
$LSD_{(0.05)}$	4.29	0.16	1.02	0.15	1.23	1.66	1.47
Level of Significance	**	**	**	**	**	**	**
CV (%)	3.40	2.65	3.45	2.56	4.67	22.51	52.41

N_o = No neem products (control), N_1 = Neem leaf powder, N_2 = Neem oil cake ** = Significant at 1% level

Table 8. Combined effect of organic manures and neem products on yield of carrot

Treatment combinations	Fresh wt. of root (g)	Gross yield of root/plot (kg)	Gross yield of root (t/ha)	Marketable yield of root /plot (kg)	Marketable yield of root (t/ha)	deformed root (%)	Root rotting (%)
N_o0_o	87.17g	2.71e	12.34g	2.15f	09.00g	23.62a	9.73a
N_o0_v	127.5d	4.27c	23.70d	3.91d	21.72d	15.28c	7.64b
N_0O_c	120.7e	3.94cd	21.86e	3.43de	19.15e	16.67b	8.34b
N_1O_o	118.5e	3.90cd	21.80e	3.42e	19.00e	16 68b	5.56cd
N_1O_v	158.5a	5.50a	30.23a	5.22a	29.00a	8.34e	3.47e
N_1O_c	151b	5.11b	28.40b	4.70bc	26.15b	9.73d	4.17e
N_2O_o	110f	3.63d	20.15f	3.20e	17.38f	15.28c	5.90c
N_2O_v	150b	5.13b	28.52b	4.90b	27.30b	6.95f	3.82e
N_2O_c	142.5c	4.80bc	26.66c	4.41c	24.50c	8.33e	4.52de
$LSD_{(0.05)}$	3.21	0.43	1.19	0.49	1.25	1.07	1.27
Level of Significance	**	**	**	**	**	**	*
CV (%)	3.40	2.65	2.56	2.65	2.55	22.21	52.41

0_0 = No organic manures (Control)
0_c = Cowdung
0_v = vermiCompost
N_o =No neem products (Control)
N_1 = Neem leaf powder
N_2 = Neem oil cake
** = Significant at 1% level
* = Significant at 5% level

4.1.9 Percentage of deformed roots

Organic manures had significant effect on the deformed percentage of roots (Table 6). The highest percentage of deformed root (22.23%) was observed from the control treatment (O_0) and the lowest percentage of deformed root was found from vermicompost (5.56%).

The percentage of deformed roots production of carrot was significantly influenced by the different neem products (Table 7). The highest (25%) percentage of deformed root recorded from control treatment (N_0) whereas, the lowest (8.33%) was found from the neem oil cake.

Deformed root varied significantly due to combined effect of organic nutrients and neem products (Table 8). The highest deformed root (23.62%) was recorded from the control (N_0O_0) while the lowest (6.95%) was observed from vermicompost with neem oil cake.

4.1.10 Percentage of rotting roots

The percentage of rotting of roots was significantly affected by the organic manures treatment (Table 6). However, the highest rotting percentage of roots (8.33%) was recorded in control treatment (O_0) whereas the lowest rotting percentage (4.16%) was observed in vermicompost (O_v).

The percentage of rotting roots of carrot was significantly affected by the neem products (Table 7). The highest rotting percentage of roots (11.12%) was recorded from no neem products (N_0) and the lowest (2.78%) rotting percentage was observed in neem leaf powder (N_1) .

The combined effect of organic manures and neem products was observed significant on rotting percentage of roots (Table 8). The highest percentage of rotten root (9.73%) was recorded from no organic nutrients with no neem products (N_0O_0) followed by second highest (5.20%) was found from cowdung with no neem extracts (N_0O_c) and the lowest (3.47%) was obtained from the vermicompost with neem leaf powder (N_1O_v).

4.1.11 Gross yield of roots per plot

Statistically significant variation was found due to effect of organic manures on gross yield of roots per plot (Table 6). The maximum gross yield per plot (6 kg) was obtained from the application of vermicompost (O_v) while the control (O_0) treatment produced the minimum (2.85 kg).

The yield of carrot root per plot was found statistically significant due to the effect of neem products (Table 7). Neem leaf powder (N_1) produced the highest yield (5.02 kg) while control (N_0) treatment produced the lowest root yield (2.67 kg) per plot.

The combined effect of different organic manures and neem products were found significant on gross yield of root per plot (Table 8). The maximum gross yield per plot (5.5 kg) was found from the vermicompost with neem leaf powder (N_1O_v) while the minimum gross yield of root (2.71 kg/plot) was recorded from the control condition (N_0O_0).

4.1.12 Marketable yield of roots per plot

Statistically significant variation was found due to effect of organic manures on gross yield of roots per plot (Table 6). The maximum gross yield per plot (5.77 kg) was obtained from the application of vermicompost (O_v) while the control (O_0) treatment produced the minimum (2.25 kg).

The yield of carrot root per plot was found statistically significant due to the effect of neem products (Table 7). Neem leaf powder (N_1) produced the highest yield (4.6kg) while control (N_0) treatment produced the lowest root yield (2.04 kg) per plot.

The combined effect of different organic manures and neem products were found significant on gross yield of root per plot (Table 8). The maximum gross yield per plot (5.22 kg) was found from the vermicompost with neem leaf powder (N_1O_v) followed by second highest (4.9kg) was found from the treatment of the vermicompost with neem oil cake (N_2O_c). On the other hand, the minimum marketable yield of root (2.15 kg/plot) was recorded from the control condition (N_0O_0).

4.1.13 Gross yield of roots per hectare

Gross yield of carrot roots per hectare was influenced significantly by organic manures (Fig. 6). The maximum gross yield of carrot (32.56 t/ha) was obtained from vermicompost treatment (O_v) while the minimum (15.84 t/ha) was observed from the control (no organic manure).

Gross yield of roots per hectare was significantly influenced by different neem products (Fig.7). The highest yield (27.89 t/ha) was obtained from neem leaf powder and the lowest (14.83 t/ha) from control (N_0).

The combined effect of different organic manures and neem products was also found to be significant on gross yield of carrot root per hectare (Table 8). The highest gross yield of root per hectare (30.23 t/ha) was found from neem leaf powder with vermicompost (N_1O_v)) which was followed by (28.52 t/ha) neem oil cake with vermicompost (N_2O_v). On the other hand, the lowest gross yield of carrot root (12.34 t/ha) was recorded from N_0O_0 .

4.1.14 Marketable yield of roots per hectare

Marketable yield of roots varied significantly due to different organic nutrient sources. The maximum marketable yield (32.20 t/ha) was obtained from vermicompost treatment (O_v), while the minimum yield (09.00 t/ha) was found from control treatment (O_0) (Fig. 6).

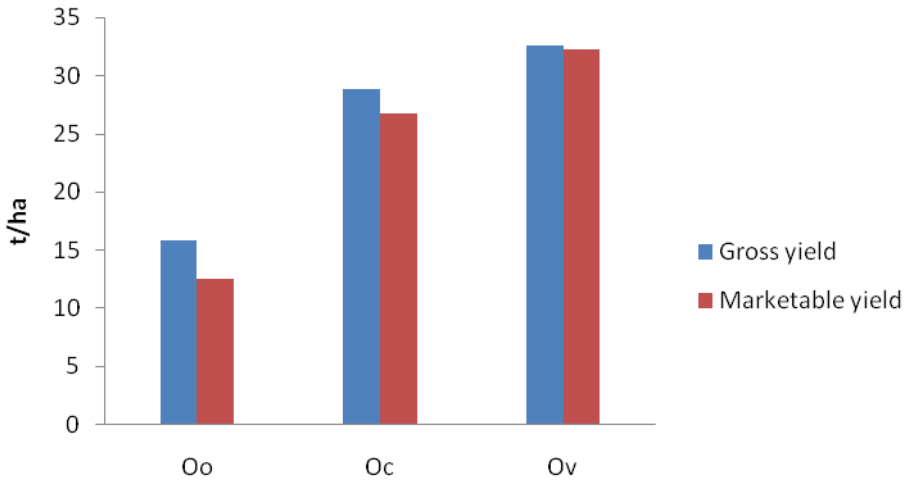

Fig. 6. Effect of organic manures on gross and marketable yield of carrot

0_0 = Control (no organic manures),
0_c = Cowdung ,
0_v = vermiCompost

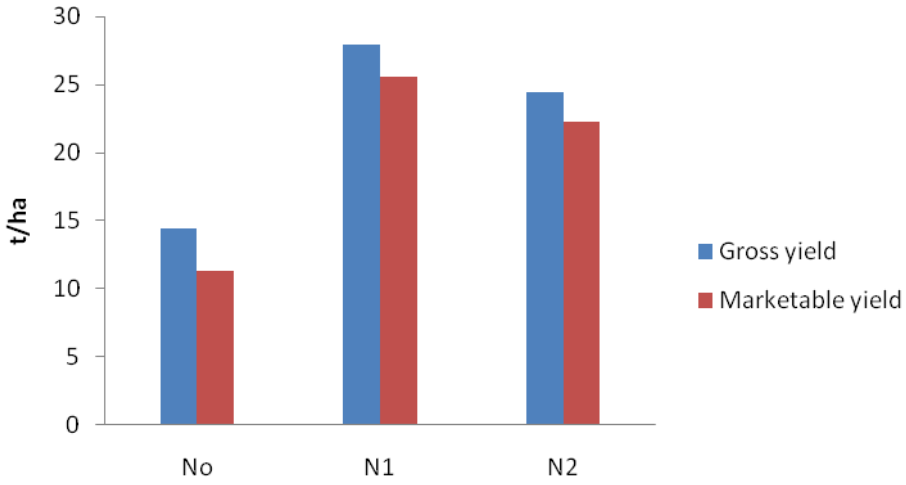

Fig. 7. Effect of neem products on gross and marketable yield of carrot

N_o = Control (no neem products) ,
N_1 = Neem leaf powder ,
N_2 = Neem oil cake

The marketable yield of carrot per hectare was found statistically significant due to neem products (Fig. 7). The highest yield (25.60t/ha) was obtained from neem leaf powder (N_1) and the lowest (11.34 t/ha) from no neem products.

A significant combined effect of organic manures and neem products was observed on marketable yield of root per hectare (Table 8). The highest marketable yield of root per hectare (29 t/ha) was recorded from neem leaf powder with vermicompost (N_1O_v) while the lowest marketable yield of carrot root per hectare (11.92 t/ha) was found from the treatment combination of N_0O_0.

4.2 Cost and return analysis

The cost and return analysis were done and have been presented in Table 9 and in Appendix VI.

The total cost of production ranged between Tk. 167361.00 to Tk. 93772.00 per hectare among the different treatment combinations. The variation was due to different cost of neem products and different types of organic manures. The highest cost of production Tk. 167361.00 per hectare was involved in the treatment combinations of neem leaf powder with vermicompost (N_1O_v) while the lowest cost of production Tk 93772.00 per hectare was involved in the combination of no organic manure with no neem products (N_0O_0). The gross return from the different treatment combinations ranged between Tk 435000.00 and Tk. 135000.00 /ha. The return was the total income through sale of harvested carrot root (marketable yield) @ Tk. 15000 per tonne.

Among the different treatment combinations, neem leaf powder with cowdung (N_1O_c) gave the highest net return Tk 275621.00 while the lowest net return Tk. 85028.00 /ha was obtained from the treatment combination of no neem products and vermicompost. (N_0O_0).

The benefit cost ratio (BCR) was found to be the highest (3.37) in the treatment combination N_1O_c (cowdung with neem leaf powder). The lowest BCR (1.42) was recorded from N_0O_v (no neem products with vermicompost) combination. Thus, it was apparent that neem leaf powder with vermicompost (N_1O_v) gave the highest marketable yield (29 t/ha) and the highest gross return (TK. 435000.00) but N_1O_c gave highest net returt (TK. 275621.00) due to low price of cowdung compare to vermicompost.

Table 9. Cost and return of carrot grown with organic manures and neem products.

Treatment combination	Marketable yield (t/ha)	Gross return (Tk./ha)	Total cost of production (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio (BCR)
N_o0_o	09.00	135000	93772	85028	1.42
N_o0_c	19.15	287250	106594	180656	2.70
N_0O_v	21.72	325800	157327	168473	2.07
N_1O_o	19.00	285000	105479	179521	2.70
N_1O_c	26.15	392250	116629	275621	3.37
N_1O_v	29.00	435000	167361	267639	2.59
N_2O_o	17.38	260700	105479	155221	2.47
N_2O_c	24.50	367500	116629	250871	3.10
N_2O_v	27.30	409500	167361	242139	2.45

0_0 =No organic manures

0_c = Cowdung

0_v = vermiCompost

N_o = No neem products

N_1 = Neem leaf powder

N_2 = Neem oil cake

Note: Sale of carrot @TK.15000.00/t

Total income = Marketable yield (t/ha) x Tk.15000.00 ;

BCR= $\frac{\text{Gross return/Gross income}}{\text{total cost of production}}$

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka toevaluate growth and yield of carrot as influenced by organic manures and neem products during the period from November 2011 to February 2012. The experiment consisted of three different types of organic manures, viz.control, cowdung and vermicompost and three neem products treatments viz. control, neem leaf powder and neem oil cake.

The two-factor experiment was laid out in Randomized Complete Block Design with three replications. There were altogether 9 treatment combinations in this experiment. A unit plot size was 1.8 × 1.0 m keeping 1.0 m and 0.5 m gap between the row and plots, respectively. Data on growth and yield parameters were collected from 10 randomly selected plants of each plot and analyzed statistically. The mean differences were adjudged by Least Significant Different (LSD) test.

Organic manuress significantly influenced all the parameters. vermicompost gave the maximum plant height (36 cm) at 100 days after sowing and the maximum number of leaves (13.65/plant) at 85 DAS. The maximum length of root (16.20 cm), diameter of root (4.77 cm), fresh weight of root (170 g/plant), dry matter root (17%), gross yield of root per plot (6 kg), marketable yield of root per plot (5.77 kg), gross yield of roots per hectare (33.33 t/ha) and marketable yield of roots per hectare (32.20 t/ha) was recorded from the vermicompost treatment which was significantly superior to all other treatments but deformed roots (22.23%) and rotting of roots (8.33%) was found higher in control treatment.

Neem products treatments showed a significant effect onall the parameters. At the maximum vegetative growth of 100 DAS, the highest plant height (31.80 cm) was obtained from neem leaf powder and the lowest (21.50 cm) from control. The maximum number of leaves (11.67), the highest length of root (14 cm), diameter of root (4.18cm) were obtained from neem leaf powder and control gave the lowest number of leaf (9.20), the minimum length of root (10cm), diameter of root (3.24) respectively.

The highest gross yield of roots (5.02 kg /plot, 27.89 t/ha) was recorded from neem leaf powder and the lowest (2.67 kg/plot, 14.83t/ha) were observed from control. The highest marketable yield of roots (4.60 kg/plot, 25.60 t/ha) was recorded from neem leaf powder and the lowest (2.04 kg/plot, 11.34 t/ha) was obtained from control.

Due to interaction effect of different types of teratments showed significant variation on all the parameters. Vermicompost with neem leaf powder showed the tallest plant (33.9 cm) at 100 DAS while the shortest plant (21.75 cm) was observed from the control condition with no neem products at 100 DAS. The maximum dry matter percentage of leaves (11.10%) were found from vermicompost with neem leaf powder while the minimum dry mater percentage (7.05 %) were obtained fromO_0N_0. The maximum root length and its diameter were 15.20 cm and 4.50 cm, respectively by the application of O_vN_1, while the minimum root length was obtained 10.25 cm and root diameter was 3.23 cm from the control with no neem products.

The maximum fresh weight of root and dry matter percentage were obtained from vermicompost with neem leaf powder, they were 158.5 g and 15.95%, respectively. The minimum fresh weight 87.5 g and minimum dry matter percentage (10.40%) were found from control with no neem products. The highest gross yield of carrot root (5.5 kg/plot, 30.23 t/ha) was recorded from vermicompost with neem leaf powder and the lowest gross yield (2.71 kg/plot, 12.34 t/ha) was observed from no organic nutrients with no neem products.

The highest marketable yield (5.22 kg/plot, 29 t/ha) was found from the treatment combination of N_1O_v. The cost and return analysis indicated the highest BCR (3.37) was obtained from cowdung with neem leaf powder due to low cost of cowdung and the lowest BCR (1.42) was recorded $N_oO_{o.}$

Considering the present experiment, such type of study may be carried out in other agro-ecological zones of Bangladesh before final recommendation. Different levels of organic manuress with other neem products combination can be practiced for obtaining better yield but the price of vermicompost is high compare to other organic manures while cowdung is low price and also more effective.

Therefore, from the present study it may be suggested that the higher yield and economic return of carrot could be obtained by cultivating of carrot along with neem leaf powder with cowdung. Different doses of neem products may be included for further study. Some other organic manures should be added for further recommendation.

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APPENDICES

Appendix I. Monthly records of air temperature, relative humidity, rainfall and sunshine during the period from November 2011 to February 2012

Year	Month	** Air temperature (^{0}C)			** Soil temp. at different depth			**Relative humidity (%)	*Rainfall (mm)	**Sunshine (Hours)
		Max.	Min.	Mean	5 cm	10 cm	20 cm			
2011	November	29.21	19.50	24.36	24.5	24.9	25.4	80.63	86.2	230.0
	December	24.32	15.40	19.86	20.1	20.5	20.9	83.76	0.00	192.6
2012	January	22.67	13.17	17.92	17.5	16.9	18.3	84.05	0.00	161.6
	February	26.56	17.49	22.03	20.8	21.7	21.4	77.25	25.60	219.9

*Monthly total, ** Monthly average

Source: Bangladesh Metrological Department (Climate division), Agargaon, Dhaka.

Appendix II. Soil analysis data of the experimental plot.

Mechanical analysis

Constituents	**Percentage (%)**
Sand	32.5
Silt	61.5
Clay	6.0
Textural classification	Silty loam

Chemical analysis

Soil properties/constituents	**Values**
pH	6.5
Organic carbon	1.02%
Total nitrogen	0.079%
Available P	19 ppm
Available K	40 ppm
Available S	7.5 ppm

Source : SRDI, 2011

Appendix III. The morphological characters of soil of the experimental plots

AEZ No. 28
Soil Series : Tejgaon
General soil: Non-calcareous dark grey flood plain soil
Land type : Medium high land
Topography: Upland
Field level : Above flood level
Drainage : Fairly good
Firmness : Compact to friable when dry

Source : FAO.1998

Appendix IV. Experimental design and layout.

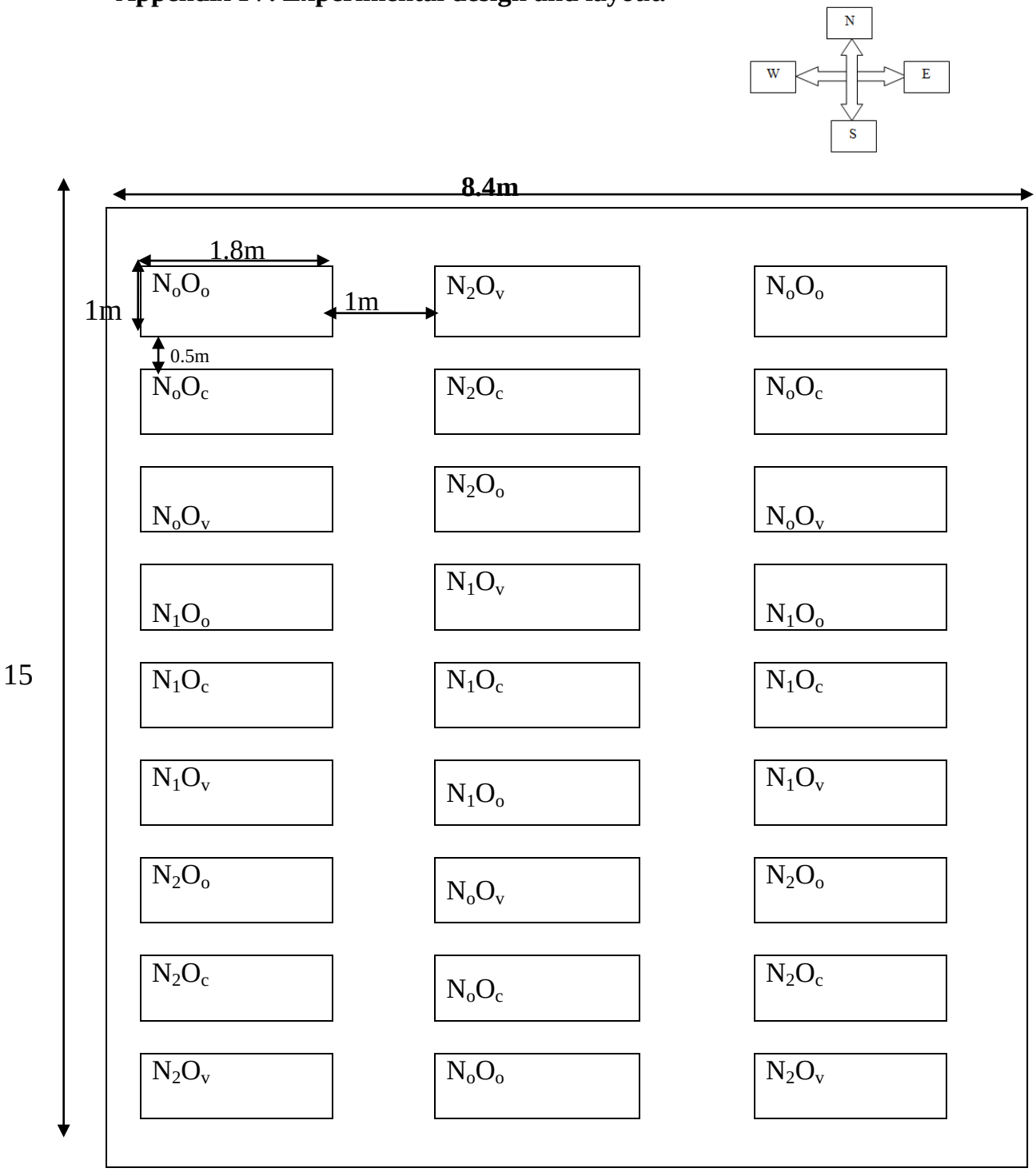

Fig 1. Field layout of the two-factor experiment in Randomized Complete Block Design (RCBD)

Number of treatment combinations = 9, Unit plot size = 1.8 ×1 m
Plot spacing: = 0.5 m
Between replication = 1.0 m

Appendix V. Analysis of variance of different characters of carrot

Sources of variation	**Degree of freedom**	Mean of sum of square				
		Plant height				
		40 DAS	55 DAS	70 DAS	85 DAS	100 DAS
Replication	2	0.73	0.06	1.65	2.46	0.41
Factor-A (organic manure)	2	167.19**	135.33**	131.82**	133.36**	99.60**
Factor-B (neem extracts)	2	27.86**	67.23**	160.84**	167.18**	229.92**
Interaction (A × B)	4	0.65**	1.57*	0.65**	0.47**	4.78**
Error	16	0.84	0.98	1.98	2.27	2.87

** = Significant at 1% level

* = Significant at 5% level

Appendix V. Cont'd.

Sources of variation	Degree of freedom	Mean of sum of square				
		Number of leaves				
		40 DAS	55 DAS	70 DAS	85 DAS	100 DAS
Replication	2	2.20	0.40	0.64	0.40	4.834
Factor-A(organic manure)	2	0.32**	1.30**	0.38**	0.85**	14.618**
Factor-B (neem extracts)	2	2.84**	3.74**	17.69**	44.96**	9.742**
Interaction (A × B)	4	0.05**	0.20**	1.30*	0.12**	0.225^{NS}
Error	16	0.13	0.065	0.024	0.05	0.13bk

** = Significant at 1% level

* = Significant at 5% level

NS = Non significant

Appendix V. Cont'd.

Sources of variation	***Degree of freedom***	Means square					
		Fresh weight of Leaves per plant (g)	Dry manureof leaves (%)	Root length (cm)	Diameter of root (cm)	Fresh weight of Root per plant (g)	Dry manureof root (%)
Replication	***2***	1.037	0.39	0.068	0.011	0.349	0.034
Factor-A (Organic manure)	2	708.04**	15.85**	5.564**	8.509**	1182.025**	4.213**
Factor-B (Variety)	2	1625.04**	22.38**	22.65**	22.978**	749.135**	4.834**
Interaction (A × B)	4	113.65**	0.493**	0.489*	0.593**	58.615**	0.358**
Error	16	2.42	0.122	0.102	0.116	0.334	0.029

** = Significant at 1% level

* = Significant at 5% level

Appendix V. Cont'd.

Sources of variation	***Degree of freedom***	Means square					
		Deformed root (%)	Root rotting (%)	Gross yield of root per plot(kg)	Marketable yield of root per plot (kg)	Gross yield of root (t/ha)	Marketable yield of root (t/ha)
Replication	2	5.205	3.184	0.066	0.077	2.026	2.381
Factor-A (Organic manure)	2	57.549**	43.837**	3.494**	3.556**	107.683**	109.729**
Factor-B (Variety)	2	100.979**	13.556**	4.435**	4.794**	136.693**	148.012**
Interaction (A × B)	4	18.054**	0.754*	0.013**	0.029**	0.405**	0.891**
Error	16	2.747	2.154	0.025	0.020	0.759	0.627

** = Significant at 1% level

* = Significant at 5% level

Appendix VI. Production cost of carrot per hectare

(A) Material cost (Tk.)

Treatment combination	Seed (3kg/ha)	Organic manures		Neem products		Pesticide	Sub total1(A)
		Cowdung (5.00 t/ha)	VermiCompost (3.50 t/ha)	Neem leaf powder	Neem oil cake		
N_o0_o	18600	-	-			9000	27600
N_o0_c	18600	10000	-			9000	37600
N_0O_v	18600	-	55500			9000	83100
N_1O_o	18600	-	-	15000		3000	36600
N_1O_c	18600	10000	-	15000		3000	46600
N_1O_v	18600		55500	15000		3000	92100
N_2O_o	18600		-		15000	3000	36600
N_2O_c	18600	10000	-		15000	3000	46600
N_2O_v	18600	-	55500		15000	3000	92100

Neem leaf powder @ Tk. 60/kg
Variety = New Kuroda @ 6200 Tk/kg
Neem oil cake @ Tk. 60/kg
Cowdung @ Tk. 2/kg
VermiCompost @ Tk. 15.85/kg

Appendix VI. (Cont'd.)

(B) Non-Material cost (Tk.)

Treatment Combination	Land preparation	Organic manures,neem products application	Seed sowing	Intercultural operation	Harvesting	Sub-total 1 (B)	Total input cost 1(A)+ 1(B)
N_o0_o	18000	-	2500	10000	6000	36500	64100
N_o0_c	18000	1500	2500	10000	6000	38000	75600
N_0O_v	18000	1500	2500	10000	6000	38000	121100
N_1O_o	18000	1500	2500	10000	6000	38000	74600
N_1O_c	18000	1500	2500	10000	6000	38000	84600
N_1O_v	18000	1500	2500	10000	6000	38000	130100
N_2O_o	18000	1500	2500	10000	6000	38000	74600
N_2O_c	18000	1500	2500	10000	6000	38000	84600
N_2O_v	18000	1500	2500	10000	6000	38000	130100

Lobour cost @ Tk. 250/day

N_o = No neem products (control)
N_1 = Neem leaf powder
N_2 = Neem oil cake

0_0 = No organic manure (Control)
0_c = Cowdung
0_v = vermiCompost

Appendix VI. (Cont'd.)

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

Treatment Combination	Cost of lease of land	Miscellaneous cost (5% of input cost)	Interest on running capital for 6 months (13% of total input cost)	Total	Total cost of production (Input cost + interest on running capital) (Tk./ha)
N_o0_o	20000	4205	5467	29672	93772
N_o0_c	20000	4780	6214	30994	106594
N_0O_v	20000	7055	9172	36227	157327
N_1O_o	20000	4730	6149	30879	105479
N_1O_c	20000	5230	6799	32029	116629
N_1O_v	20000	7505	9756	37261	167361
N_2O_o	20000	4730	6149	30879	105479
N_2O_c	20000	5230	6799	32029	116629
N_2O_v	20000	7505	9756	37261	167361

N_o = No neem products (control)
N_1 = Neem leaf powder
N_2 = Neem oil cake

0_0 = No organic manure (Control)
0_c = Cowdung
0_v = vermiCompost