EFFECT OF DIFFERENT SOURCES OF ORGANIC MANURE AND SOWING TIME ON THE GROWTH AND YIELD OF CARROT

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BY

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ABSTRACT

An experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka during the period from October 2010 to March 2011. The experiment consisted of two factors, Factor A four levels of organic manure, O_0: Control (0 t/ha), O_1: Cowdung (20 t/ha), O_2: Poultry litter (12 t/ha), O_3: Vermicompost (10 t/ha) and Factor B: three sowing time, S_1=1st sowing (November 01); S_2=2nd sowing (November 15) and S_3= 3rd sowing (November 30) respectively. The experiment was laid out in Randomized Complete Block Design with three replications. The maximum plant height (47.42 cm) root length (21.50 cm), yield (22.53 t/ha) were recorded from O_1. For sowing time, maximum plant height (46.83 cm) root length (22.46 cm), yield (22.63 t/ha) was found in S_2. In case of combined effect highest yield (28.65 t/ha) was obtained from S_2O_1 and lowest (14.82 t/ha) from S_1O_0. So, it can be concluded that, 20 t/ha cowdung with 15th November sowing was best for carrot cultivation.

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CERTIFICATE

This is to certify that thesis entitled, **"EFFECT OF DIFFERENT SOURCES OF ORGANIC MANURE AND SOWING TIME ON GROWTH AND YIELD OF CARROT"** 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 **NAJIM UR ROUF KHAN,** Registration No. **04-1467** 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.

Dated: June, 2011
Place: Dhaka, Bangladesh

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

ABBREVIATIONS	ELABORATIONS
%	Percent
@	At the rate
°C	Degree centigrade
ADB	Asian Development Bank
AEZ	Agro-Ecological Zone
Anon.	Anonymous
ANOVA	Analysis of Variance
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BSMRAU	Bangabandhu Sheikh Mujibur Rahman Agricultural University
CV	Coefficient of Variation
df	Degrees of Freedom
e.g.	Example
et al.	And others
etc.	Etcetera
FAO	Food and Agriculture Organization
HRC	Horticulture Research Centre
J.	Journal

MoP	Muriate of Potash
ns	Non Significant
OM	Organic manure
pH	Hydrogen ion concentration
Res.	Research
RH	Relative humidity
SAU	Sher-e-Bangla Agricultural University
SPSS	Statistical Package for Social Studies

CHAPTER I

INTRODUCTION

Carrot (*Daucuscarota* L.) is herbaceous biennial plant belong to the genus *Daucus*, species *carota* and the member of Apiaceae family (Peirce, 1987). Carrot is one of the important and major root vegetables used as salad and cooked vegetable.It is a rich source of beta carotene, which is a precursor of vitamin A (Chadha, 2003). It is said to be originated in Mediterranean region (Banga,1976). It produces an enlarge fleshy tap root that is edible and possesses high nutritive value (Shanmugavelu,1989).

Carrot 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). According to Barnes (1936) 15.6 °C to 21.1 °C temperature is the ideal for its growth and development. Higher and lower temperatures reduce the rate of growth and adversely affect the quality of the roots. Carrot grows successfully in Bangladesh during Rabi season when temperature ranges from 11.17 °C to 28.9 °C (Alim, 1974) and the best time is from mid November to early December to get satisfactory yield (Rashid, 1993).

Carrots are also a good source of vitamin A (carotene) B_1, B_2 and C (Leclerc *et al*.1991; Warman and Harvard, 1996 a and b). Sugar and volatile terpenoids are the two major components of carrot flavor, glucose, fructose and sucrose

have made up more than 95% of the free sugars and 40% to 60% of the stored carbohydrates in the carrot root. The ratio of sucrose to reducing sugar increases with root maturity but decreases following harvest and during cold storage (Freman and Simon ,1983). Blindness in children for the rice dependent countries of Asia may contribute a lot to overcome this problem in Bangladesh (Woolfe, 1989).

Organic manure improves soil structure as well as increases its water holding capacity. Moreover, it facilitates aeration in soil. Recently organic farming is appreciated by vegetable consumers as it enhances quality of the production. Inorganic cultivation leaves residual effect in crops which is believed to cause hazard to public health and environment. Carrot is a heavy feeder of nutrients and absorbs 100 kg N, 50 kg P_2O_5 and 180 kg K_2O/ha. Therefore, judicious and proper use of organic manures and fertilizers is very essential not only for obtaining higher yield and quality production but also to maintain soil health and sustainability for longer period. Among the oil cakes, neem and castor cakes are quick insoluble in water and they provide slow and steady nourishment and protection from nematodes and improve yield and quality of production (Gaur*et al.*1992). Vermicompost, which is produced by earthworms, is a rich source of both micro and macro nutrients, vitamins, growth hormones and enzymes (Bhavalkar,1991).

Sowing time is also an important factor for increasing yield of carrot (Rashid and Shakur, 1986). The different sowing time of carrot have a significant effect on growth and yield due to environmental factor like temperature and light intensity. Mack, (1977) suggested that carrot should be harvested at proper stage of maturity otherwise, it will become fluffy and unfit for consumption. Moreover, the percent of root splitting, firmness, the contents of dry matter, carotene and sucrose are increased during the growth of carrot, whereas the contents of glucose and fructose and respiration quotient are decreased. The contents of total sugar remained almost constant from the beginning of the harvesting period but increased at low temperature.

To extend the availability of carrot during the early and late season; sowing time may play a critical role. Keeping the importance of organic manures in view, the present experiment was undertaken to study the effect of different organic manures in combination with sowing time on growth and yield of carrot.

Objectives:

1. To find out optimum sowing time for better yield

2. To study the effect of different sources of organic manure on the growth and yield of carrot.

3. To find out the suitable combination of organic manure and sowing time for carrot cultivation in Bangladesh.

CHAPTER II

REVIEW OF LITERATURE

Carrot (*Daucus carota*) is one of the most important vegetable crops of the world. From the nutritional point of view, it received much attention to the researches throughout the world to develop its production technology. Many Research works have been carried out in relation to the effect of sowing dates and different spacing for the production of marketable size, maximizing the yield and quality of carrot in different countries. Yet, a few studies were found to have made in this regard in Bangladesh. However, literatures available in this respect at home and abroad are presented here.

2.1 Effect of organic manure on the growth and yield of carrot.

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.

Mesquta *et al.* (2002) conducted an experiment on clay 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 planting. After the harvest a linear and quadratic effect for phosphorus and urban waste compost ($P<0.01$) was observed. The linear interaction P X quadratic urban compost was highly significant. The maximum root production was 26.5 t/ha corresponding to 18.5t/ha of P_2O_5 and 53.2t/ha of urban waste compost.

Akand (2003) conducted an experiment with mulching and organic manure trial on carrot in BAU. He reported that black polythene mulch and organic manure (cow dung) significantly resulted the highest yield of carrot.

Oliveira *et al.* (2001) studied the effect of earthworm compost and mineral fertilizer on root production of carrot. Earthworm compost @ 25 t/ha produced the highest total (70.1 t/ha) and marketable (31.1 t/ha) yields. The production of high quality roots of carrot increased for each of ton of earthworm compost added in the soil. The presence of mineral fertilizers increased super grade root yields.

Salminen *et al.* (2001) reported that the application of digested poultry slaughter house waste as nitrogen source gave the higher yield carrot roots.
Rahman (2000) carried out an experiment and reported that height of carrot seedling was significantly influenced by the application of cowdung. The highest plant height (75.28 cm) at 100 days was reported from the dose of cowdung (100t/ha).
Sehuch *et al.* (1999) studied on the effect of organic manure (chicken and quail) on yield and quality of carrot and reported that Nantes produced the height root yield, root number, weight, diameter and length when applied different amount of manure applied.
Levedeva *et al. (*1998) observed the effect of limning and organic fertilization on the lead content in agricultural crop and dernopodzolic soils contaminated with lead (up to 500 mg/kg soil). The soil P^H and content of organic manure was determined which would enable the safe production of red beet and carrot.
Sediyama *et al.* (1998) assessed the plant nutritional status, root quality and yield of carrot cv. Brasilia, influenced by seven types of organic compounds produced from liquid swine manure and straw materials, crushed sugarcane, Napier grass (*Pennisetum purpureum*) and coffee straw and crushed sugarcane, They reported that a greater plant height and aerial part yield obtained from treatments with organic compounds and dry swine manure, crushed sugarcane plus triple super phosphate and Napier grass plus liquid swine manure. The organic compound produced from coffee straw and liquid swine manure provided a greater yield of total and commercial roots.
Roe (1998) carried out an experiment by using compost, obtained from dairy manure and municipal solid waste to find out the beneficial effects on Broccoli. He found beneficial effects on growth, yield and nutrient component compost application in the Broccoli production.

Vieira *et al.* (1998) studied on a clayey Dusky Red Latosol in Dourados, Brazil, to evaluate the response of *Arracacia xanthorrhiza* to P fertilizer as well as the response to application of poultry house litter. They noted that plant

height variation due to treatment and maximum heights were recorded 31 cm (4.3 kg P/ha + 6 t litter/ha) and (60.2kg P/ha + 19 t litter/ha), 234, 260 days after planting respectively. Dry manure production of marketable root increased linearly with P dose ranging from 0.42 t/ha to 1.3 t/ha. Marketable root yield increased linearly with P and poultry house litter rates, averaging 10 t/ha.

Nielsen *et al.* (1998) studied to test the essential of various organic wastes as soil amendments in horticultural production, in British Columbia, Canada. They were grown Swiss chard *(Beta vulgaris)* and carrot during 1993-1995 under irrigation in a coarse textured soil. British Columbia soil to which annual application of 45 t/ha of various organic amendments plus NPK fertilizers were applied. The amendments included bio solids, bio wastes and peat. Yield of both chart and carrot was increased for some organic treatments plus fertilizer relative to lots receiving commercially recommended rates of NPK fertilizer only. The evidence suggested that many locally produced bio solids and bio wastes might improve soil quality and the growth of high value horticultural crops, especially carrot.

Damagala *et al*. (1998) conducted on 3 sites near Rzeszow, Poland with carrot cultivars Joba and Flacore. Ammonium sulfate was applied at seed sowing. On all sites Carrot yield harvested from placements treatments were significantly higher than that from broadcast treatments of Ammonium sulfate. Irrespective of fertilizer application method, the lowest contents of nitrates were detected in roots cultivated in heavy soil containing 1.8% organic manure.

Zarate *et al*. (1997) evaluated rates and methods of application of poultry manure on Lettuce. They found in the absence of incorporated manure, surface application of manure 14 t/ha gave significantly higher yield (17.8 ton fresh manure per hectare) than other nutrients. When 7 t/ha incorporated, the rate of surface application had no significant effect on yield (13.3-17t/ha), whereas

when 14 t/ha was incorporated, surface application of 7 t/ha manure gave the significantly highest yield (20 t/ha fresh matter).

Geweda *et al*. (1995) grew Lettuce (cultivars Syrens and Debata) and Carrot (cultivars Karo F_1 and Kama F_1) seedlings in soil containing 0, 3 or 8% organic manure (peat) and 0, 300 or 600 mg Pb dm^3(as lead acetate). The inclusion of organic manure in the soil reduced the Pb content of lettuce leaves and carrot roots in the Pb treatments. In the investigation, no external symptoms of the Pb toxicity were observed but difference in the mineral and organic composition of lettuce leaves and Carrot roots retarded Pb contamination, particularly in the soil without organic manure.

Datta and Chakrabarty (1995) conducted a field experiment in 1991-1993 at Sriniketan , West Bengal with 5 t/ha rise husk ash, 0.5 t/ha Mustard oil cake or 10 t/ha FYM . The highest potato 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.

Flynn *et al*. (1995) carried out an experiment to evaluate the suitability of reposted broiler chicken manure as a potting substrate using lettuce plants. They mentioned that the broiler manure containing peanut hulls as FYM material was composted and then combined with a commercially available potting substrate. The highest fresh weight yield was obtained when broiler chicken litter compost was mixed with commercially available potting substrate at 3:1 ratio. There was no evidence of physiological disorders from excessive nutrient concentrations.

Kipkin *et al*. (1994) made investigation using poultry manure , a mixture of poultry manure plus hydrolysis lignin, and a compost of poultry manure plus hydrolysis lignin as organic fertilizers for Potatoes, Carrot, Cabbage etc and without irrigation. The result should that these organic fertilizers proved the yield and quality of crop, especially on soil having a low content of nitrate N.

Almazov and Kholuyako (1990) worked with the application of organic manures and mineral fertilizers in productivity of a vegetable crop in 1982-86 and found that the effects of application of the NPK rates for each crop and/or 2peat (organic manures) rates on yields and quality of 4 vegetable crops, Peat (organic manures) gave the highest yields in the all crops. Peat increased dry manure and sugar content in tomato fruits, carotene in carrot roots and vitamin C in cucumber and decreased dry matter, sugar and vitamin C and cabbage for vegetable crops in 1980-86.

Koddus and Morgan (1986) worked on Spent Mushroom Compost (SMC) and deep litter fowl manure (FM) as a soil ameliorant for vegetable. Spent Mushroom compost and litter fowl manure were applied at 0, 10, 20, 40 and 80 t/ha prior to showing or transplanting Celery, Lettuce, Cauliflower and Carrot in a rotation. The thermal conductance and bulk density of soil decreased and its water stable aggregates (>0.25 mm) hydraulic conductivity, water retention, N, P, K and organic C increased with increasing rates of Spent mushroom compost and litter fowl manure . Neither material increased soil salinity to a harmful level. Spent mushroom compost was superior to deep litter fowl manure in increasing soil P^H and organic carbon. Both materials decreased the yields of the first three crops but not the fourth crop. Concentration of N, P , K in the plant tissue increased as the rates of spent mushroom compost and deep litter fowl manure increased. Deep litter fowl manure significantly increased the levels of Zn and Mn in the plant tissue.

Dumitrescu (1965) from his experiment on “compost as organic manures of high fertilizing value” reported that application of FYM at the rate of 20 t/ha gave higher total yield.

2.2. Effect of sowing dates on the growth and yield of carrot

Pariari and Maity (1992) were conducted an experiment on three Carrot cultivars (PusaMeghali, PusaKesar and Half Long Nantes) evaluated for growth and yield related traits when grown under 4 sowing dates (14 October to 28 November) at Mondouri, West Bengal during 1988. Significant

differences were observed both cultivars and sowing dates. PusaKesar was superior to the other cultivars having larger roots of increased weight and producing a mean yield of 1.7 t/ha. Top weight, root weight and root yield were significantly higher after sowing on 29 October. The greatest yield (2.8 t/ha) was obtained when PusaKesar was sown on 29 October.

Jaiswal *et al*. (2003) conducted an experiment on sowing date (20 July, 10 August. 30 August. 20 September or 9 October) and spacing (45x15, 45x20, 45x30or 45x45 cm) of Carrot (cv. PusaKesar) at Akola, Maharashtra, in India; during kharif 1998/99. Early sowing (20 July) obtained the tallest plant height (156.25 cm) at 150 days after sowing and maximum number of leaves per plant (34.66) at 150 DAS plant height at 150 DAS, which increased with the reduction in spacing , was greatest(147.42 cm) at a spacing of 45x15 cm; this spacing also gave the lowest number of days to (131.26) flowering.

Mason and Tong (1971) conducted an experiment in Hong Kong and compared twelve carrot cultivars with two sowing time, October and January. They recorded highest yield from the best Dande crop, Market King, Hawkes when planted in early October.

Shantha *et al.* (1998) carried out an experiment and reported that carrot cv, PusaKesar seeds both the sowing environment and umbel order affected field emergence and vigor. The first environment i.e. September sowing (mean maximum and minimum temperatures of 32.0 and 22.6^{0}C, respectively) combined with seeds from primary umbels gave the best performance.

Ilic, Z. (1997) conducted an experiment on the influence of sowing time and growing space on the possibility of producing carrot seeds through the “seed-seed” system. Total seed yields were highest (2948kg/ha) from sowing on 28 July at a spacing of 25 X 10 cm. Seed germination was>90%.

Berry *et al.* (1997) conducted an experiment on the effects of Sowing and harvest dates on carrot. The proportion of damaged carrots resulting from late sowings (mid November-late December) and harvested before the third carrot rust fly generation was lower than those sown earlier (early-late October). However, a reduction in growing time for later sowing dates resulted in roots,

which were not of a marketable size. There were low numbers of first-generation flies caught from late March to late June. An early sowing (October) in combination with a harvest before the peak of third- generation flight activity (mid April-early May) resulted in a higher proportion of marketable Carrots.

Pashine *et al.* (1993) conducted an Experiment on the effect of sowing time on the yirld of carrot (*Daucus carota. L*) In Punjab Krishi Vidyapeeth, Seeds of PusaKesar, Nantes and local cultivars were sown on 7 different dates from 5 Nov. 1988 to 5 Feb. 1989, at fortnightly intervals. Maximum yield (155.18 q/ha) was obtained by early sowing on 5 November followed by sowing in 20 November (144.81 q/ha).Yield decreased with delayed sowing. The local cultivar produced the highest root yield (152.40 1/ha), followed by Pusa Kesar (102.96 q/ha)

CHAPTER III
MATERIALS AND METHODS

3.1. Experimental site

The experiment was conducted at the Horticulture Farm of the Sher-e-Bangla Agricultural University, Dhaka during October, 2010 to March, 2011. Laboratory works were done both at Horticulture Laboratory and Soil Science Laboratory in Sher-e-Bangla Agricultural University, Dhaka-1207.

3.2 Climate

The experimental area was situated in Sub-tropical Climatic Zone as characterized by heavy rainfall during the month of October February rainfall during the rest period of the year (Anon, 1960). Information regarding monthly maximum and minimum temperature (^{0}C), rainfall (mm) and relative humidity

(%) were recorded from the Weather Yard Station, Agargaon, Dhaka during the study period.

3.3. Soil

The experiment area was belonged to the Modhupur Tract and AEZ 28. The soil was sandy loam with a pH value 6.6. Soil samples were collected randomly from a depth up to 30 cm of the experimental plot and analyses were done and showed nitrogen 0.075%, phosphorus 13 ppm, exchangeable potassium 0.20 me/ 100 g soil and organic carbon 0.82%.

3.4. Experimental materials

New Caroda, variety of Carrot, was used for the experiment. The seeds of this variety were collected from “Hamid Seed Store”, Siddique Bazar, Dhaka.

3.5 Experimental Treatments

The experiment was conducted to study the effect of four levels of organic manure and three levels of sowing time .Different levels of two factors were as follows:

Factor A: Different types of organic manure

O_0 = Control (No manure)

O_1= Cowdung (20 t/ha)

O_2= Poultry litter (12t/ha)

O_3=Vermicompost (10 t/ha)

Factor B: Different sowing times

S_1 = 1stsowing , November 01, 2010

S_2=2ndsowing ,November 15, 2010

S_3= 3rdsowing , November30, 2010

Table 1. Two factors consist of twelve (4×3=12) treatments combination. These are as follows :

Treatment combination	**Description**	
	Organic manure	**Sowing time**
S_1O_0	Control (No manure)	November 01, 2010
S_1O_1	Cowdung	November 01, 2010
S_1O_2	Poultry litter	November 01, 2010
S_1O_3	Vermicompost	November 01, 2010

S_2O_0	Control (No manure)	November 15, 2010
S_2O_1	Cowdung	November 15, 2010
S_2O_2	Poultry litter	November 15, 2010
S_2O_3	Vermicompost	November 15, 2010
S_3O_0	Control (No manure)	November 30, 2010
S_3O_1	Cowdung	November 30, 2010
S_3O_2	Poultry litter	November 30, 2010
S_3O_3	Vermicompost	November 30, 2010

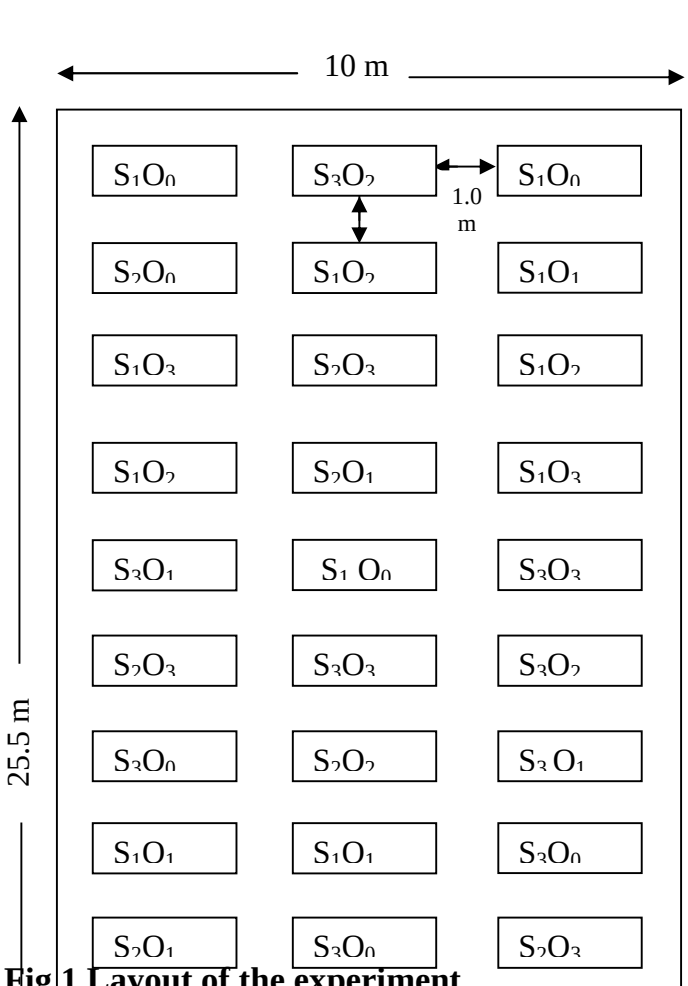

Fig 1.Layout of the experiment

Whole plot size: 25.5m×10 m

Unit of plot size: 2m×1.5m

Plot to plot distance: 0.5m

Factor A: Different types of organic manure

O_0 = Control (No manure)

O_1= Cowdung (20 t/ha)

Factor B: Different sowing time

S_1 = 1st sowing , November 01, 2010

S_2=2nd sowing ,November 15, 2010

S_3= 3rd sowing , November30, 2010

3.6. Design of the experiment

The two factor experiment was laid out in a RCB design with three replications. The whole experimental area was 25.5m x 10m which was divided into three blocks. Each block was again divided into 12 plots and hence there were 36 (12 x 3) unit plots. The treatments were assigned randomly in each block separately. The size of unit plot was 2.0m x 1.5m. The distance between two adjacent blocks and plots were 1.0 m and 0.5 m respectively.

3.7. Seed Soaking and Treatment

Carrot seeds were soaked into water for 12 hours and then wrapped with a piece of thin cloth prior to sowing. Then they were spread over polythene sheet in sun for two hours to dry. The seeds were treated with Vitavex-200@3g/100g seed.

3.8. Land preparation

The selected land for the experiment was first opened on October 15, 2010 by disc plough and it was exposed to sun for seven days prior to next ploughing. The land was ploughed six times by tractor to obtain goodtilth. Laddering to break the soil clods and pieces was followed with each ploughing. All weeds and stubbles were removed and the land was finally prepared through addition of the basal doses of manure and fertilizers. Plots were prepared according to design and layout. Finally soil of each plot was treated by Sevin 80 WP @ 2kg/ha to protect the young plant from the attack of mole cricket, cutworm and ants, Irrigation channels were made around each block.

3.9 Manure and fertilizer

The sources of applied N, P_2O_5, K_2O were as urea, TSP and MP, respectively. The entire amounts of TSP and MP were applied during the final land preparation. Urea was applied in the three equal installments at 15, 30 and 45 days after seed sowing as indicated by Rashid (1993).

3.10. Seed Rate and Seed sowing

Seeds were used at the rate of 3 Kg/ha as narrated by Rashid (1993), consequently 60 g of seeds were used for the experimental area. Seeds were sown on different times as per treatments. The seeds were sown at a distance of 20 cm × 25 cm by making a shallow furrow at a depth 1.5 cm in each plot.

3.11. Intercultural Operation

When the plants establishing in the plots they were always kept under careful observation. Various intercultural operations were accomplished for better growth and development of germinated plants.

i. Thinning

Emergence of seedlings started about six days after sowing. Different number of plants per plot was found due to different sowing. Thinning was done at two stages like 15 and 30 days after sowing in order to keep a healthy plant in each hill.

ii. Weeding

Weeding was done at two times. First weeding was done after 15 days of sowing when seedlings were thinned. Second weeding was done after 30 days of sowing before application of second dose of fertilizer.

iii. Irrigation

The field was irrigated five times during the whole period of plant growth. Just after sowing light watering was done with fine watering can. Surface rust was broken after each irrigation. The second, third, fourth and fifth watering were done at 20, 35, 55 and 75 days after sowing of seeds respectively.

iv. Insects and diseases Management

Precautionary measure against Fusarium rot was taken by spraying Dithane M-45 @ 2g /litter water. The crop was ingested by cutworms (*Agrotisypsilon*) during the early stage of growth of seedlings in the month of February. This insect was controlled initially by beating and hooking, afterwards by spraying Dieldrin 20 EC @ 0.1%.

v. Fertilizer as top dressing

Recommended Urea was top dressed after four weeks of sowing followed by light irrigation.

3.12. Collection of data

i. Plant height:

The plant height was measured with the help of a meter scale from the ground level of the root up to the tip of leaf at 30, 60 and 90 days after sowing**.**

ii. Number of leaves per plant

Number of leaves was counted 30 days interval and was started from 30 days after sowing and continued to harvest, i.e. 30, 60 and 90 DAS. Ten plants in each plot were used to count number of leaves per plant.

iii. Foliage length per plant

The length of the largest leaf was considered as the foliage length. It was measured by using a meter scale and recorded in centimeter (cm). Ten plants in each plot were used to measure foliage length per plant.

iv. Fresh weight of leaves per plant

Leaves of ten fresh plants in each plot were detached by sharp knife and fresh weight was taken by using a balance and recorded in gram (g).

v. Dry matter content of leaves (%)

Leaves were detached from the root and kept in an oven at 70-80^{0}C for 72 hours until reached constant weight. After drying, the leaves were kept in a desiccators containing blur silica gel. Fifteen minutes later the samples were weighed by using electric balance and recorded in gram (g).

$$\text{Dry matter content of leaves (\%)} = \frac{\text{Dry weight of leaves} \times 100}{\text{Fresh weight of leaves}}$$

vi. Length of root per plant

Ten plants are uprooted and detached from foliage parts. Then the length of modified roots was measured by scale and recorded in centimeter.

vii. Diameter of root per plant

Ten selected plants are used to determine root diameter. Root diameter was measured at the time of harvesting from the middle portion with slide calipers and recorded in centimeter (cm).

viii. Fresh weight of root per plant

Ten selected carrot roots were used to determine the fresh weight of root. Modified roots were detached by knife from the foliage part and fresh weight was taken by using balance and recorded in gram (g).

ix. Root dry matter per plant (%)

Ten selected carrot roots were used to determine root dry weight. Immediate after harvesting roots were weighed initially, then chopped and kept it in an oven at 70-80^{0}C for 48 hours in order to get constant weight. (AOAC, 2965). The dry weight of root was measured byelectric balance and was considered as dry weight and recorded in gram (g).

$$\% \text{ of dry meter} = \frac{\text{Dry weight of root} \times 100}{\text{Dry weight of root}}$$

x. Cracking root per plot (%)

The percentage of cracking root was estimated by using the following formula-

$$\% \text{ of cracking root} = \frac{\text{Number of cracked root} \times 100}{\text{Total number of root}}$$

xi. Branched root per plot

After harvest the branched roots are counted and the percentage was calculated by the following formula-

$$\% \text{ of branched root} = \frac{\text{Number of branched root} \times 100}{\text{Total number of root}}$$

xii. Gross yield of roots per plot

Gross yield of roots per plot was calculated by using the following formula-

$$\text{Gross yield (kg/plot)} = \frac{\text{Area of single plot (m}\times\text{m)} \times \text{Average yield per plant (g)}}{\text{Spacing} \times 1000}$$

xiii. Gross yield of roots per hectare

Gross yield of roots per hectare was calculated by using the following formula-

$$\text{Gross yield (t/ha)} = \frac{\text{Area (ha)} \times \text{Average yield per plant (g)} \times 10000}{\text{Spacing} \times 1000 \times 1000}$$

xiv. Marketable yield per plot

Marketable yield was recorded excluding cracked and branched roots from each plot and expressed in kg.

Marketable yield (kg/plot) = Gross yield - Non marketable yield (number of cracked root and branched root)

xv. Marketable yield per hectare (t)

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

3.13. Harvesting

The crop was harvested periodically for data collection. Randomly selected ten plants were harvested each time from each unit plot at 10 days interval. Harvesting was done when the roots attained at 90 DAS at each plot for all treatments.

3.14. Statistical Analysis

The recorded data on different growth and yield parameters were calculated for statistical analysis. Analyses of variances (ANOVA) for most of the characters under consideration were performed with the help of MSTAT program. Treatment means were separated by Duncane's Multiple Range Test (DMRT) at 5% level of significance for interpretation of the results.

CHAPTER IV

RESULTS AND DISCUSSION

The results of the present experiment were presented in Tables 2 to 13 and figures 2 to 11 on the effect of sowing time and spacing on the growth and yield of carrot. The results of the analysis of variance of the data on different plant characters obtained from present investigation were presented in Appendices III to V. The tabulated results have been discussed below under the following headings.

4.1. Plant height

Different levels of organic manure influenced significantly on plant height of carrot (Appendix III). At 30, 60 and 90 DAS the maximum plant heights were recorded maximum (17.03, 34.74 and 47.77cm) when applied O_1 (cowdung @ 20 t/ha) which were statistically similar (16.73, 33.89 and 47.42 cm) to when applied O_3 (vermicompost @ 10 t/ha). Plant heights (15.67, 33.37 and 42.91cm) for same DAS recorded minimum from control plots (Table-2). Among the different organic manure cowdung followed by vermicompost more effective than control. Rashid and Shakur (1986) reported similar results in plant height.

The plant heights were recorded at 30, 60 and 90 days after sowing (DAS). At 30, 60 and 90 DAS plant height (16.82, 34.22 and 46.83 cm) were measured maximum when seeds were sown in 15 November (S_2) which were statistically similar (16.33, 34.09 and 45.48 cm) to those of seeds sown in 30 November (S_3) ; the minimum plant height (16.23, 33.31 and 44.92 cm) were measured seedlings obtained from seeds sown in November 1 (S_1) at same DAS, respectively (Table-3). Among the different sowing time S_2 15 November followed by S_3 30 November were more effective as compared to S_1 November 1 for plant height of carrot. There were optimum environmental conditions for carrot grown on mid November among the other two sowing dates. The results were in partial agreement with the findings of Pariari and Maity (1992). They obtained tallest plant height from early sowing.

Interaction of organic manure and sowing time was found in terms of plant height of carrot (Appendix III). The maximum plant height (20.77, 39.40 and 53.67 cm) was recorded from 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha at 30, 60 and 90 DAS; respectively. On the other hand, the minimum plant height (13.67, 26.60 and 31.10 cm) was found in plants of control plot and sown in November 01 at 30, 60 and 90 DAS; respectively (Table-4). It was revealed that optimum level of organic manure and sowing time ensured maximum plant height.

Table 2: Effect of organic manure on plant height of carrot

Treatment	30 DAS	60 DAS	90 DAS
O_0	15.67 c	33.37 c	42.91 d
O_1	17.03 a	34.74 a	47.77 a
O_2	16.40 b	33.50 b	44.89 c
O_3	16.73 b	33.89 b	46.42 b
LSD (0.05)	0.488	0.89	0.79
CV (%)	3.04	2.71	1.78

O_0 = Control (No manure)

O_1= Cowdung (20 t/ha)

O_2= Poultry litter (12 t/ha)

O_3=Vermicompost (10 t/ha)

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Table 3: Effect of sowing time on plant height of carrot

Treatment	30 DAS	60 DAS	90 DAS
S_1	16.23 b	33.31 bc	44.92 c
S_2	16.82 a	34.22 a	46.83 a
S_3	16.33 b	33.89 b	45.48 b

LSD (0.05)	0.42	0.77	0.69
CV (%)	3.04	2.71	1.78

Here,

S_1 = 1stsowing , November 01, 2010

S_2=2ndsowing ,November 15, 201

S_3= 3rdsowing , November30, 2010

Table 4. Combined effect of organic manure and sowing time on plant height of carrot

Treatment	Plant height (cm)		
	30 DAS	**60 DAS**	**90 DAS**
S_1O_0	13.67 f	13.67 f	31.10 g
S_1O_1	18.67 b	18.67 b	46.67 cd
S_1O_2	16.87 cd	16.87 cd	44.97 e
S_1O_3	15.53 e	15.53 e	48.77 b
S_2O_0	13.90 f	13.90 f	39.83 f
S_2O_1	20.77 a	20.77 a	53.67 a
S_2O_2	17.07 c	17.07 c	47.27 cd
S_2O_3	16.03 de	16.03 de	46.73 cd
S_3O_0	13.90 f	13.90 f	40.67 f
S_3O_1	18.63 b	18.63 b	48.80 b

S_3O_2	16.73 cd	16.73 cd	46.47 d
S_3O_3	15.73 e	15.73 e	48.03 bc
LSD (0.05)	0.8467	1.557	1.381
CV (%)	3.04	2.71	1.78

O_0 = Control (No manure)
O_1= Cowdung
O_2= Poultry litter
O_3= Vermicompos

S_1 = 1st sowing , November 01, 2010
S_2 =2nd sowing , November 15, 2010
S_3 = 3rd sowing , November 30, 2010

4.2. Number of leaves per plant:

Different levels of organic manure influenced the number of leaves per plant.(Appendix III). The maximum number of leaves per plant (7.40, 9.30 and 14.09 cm) was recorded from O_1 (cowdung @ 20t/ha) which was statistically similar (7.01 cm, 9.01 cm and 12.80 cm) to O_3 (vermicompost @10 t/ha); respectively. The minimum leaf number (6.3, 8.02 and 12.09 cm) was found from control plots; respectively for same DAS (Table-5).

A significant variation was noted on leaves per plant in three sowing times (Appendix III). The maximum number of leaves per plant (7.08, 9.03 and 13.22cm) was observed from November 15 (S_2); whereas, the minimum number of leaves per plant (6.63, 8.34 and 12.65 cm) was attained from sowing of November 01 (S_1) at same DAS; respectively (Table-6). Among the different sowing time S_2 followed by S_3 was more effective than S_1 in context of number of leaves per plant. The present results partially agreed with the results obtained by Bussell and Dallenger (1972).

Combined effect of organic manure and sowing time showed also significant in terms of leaves per plant (Appendix III). The maximum number of leaves per plant (8.69, 11.03 and 15.77 cm) was observed in 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha at 30, 60 and 90 DAS; respectively. The minimum number of leaves per plant (4.49, 7.09 and 8.43 cm) was found in plants of

control plot and sown in November 01 at 30, 60 and 90 DAS; respectively (Table-7).

Table 5: Effect of organic manure on number of leaves per plant of carrot

Treatment	30 DAS	60 DAS	90 DAS
O_0	6.3 d	8.02 d	12.09 c
O_1	7.40 a	9.30 a	14.09 a
O_2	6.5 c	8.42 c	12.43 bc
O_3	7.01 b	9.01 b	12.80 b
LSD (0.05)	0.48	0.20	0.37
CV (%)	4.68	2.42	2.97

Here,

O_0 = Control (No manure)

O_1= Cowdung (20 t/ha)

O_2= Poultry litter (12 t/ha)

O_3=Vermicompost (10 t/ha)

Table 6: Effect of sowing time on number of leaves per plant of carrot

Treatment	30 DAS	60 DAS	90 DAS
S_1	6.63 b	8.34 c	12.65 b
S_2	7.08 a	9.03 a	13.22 a
S_3	6.74 b	8.70 b	12.69 b
LSD (0.05)	0.27	0.18	0.32
CV (%)	4.68	2.42	2.97

Here,

S_1 = 1stsowing , November 01, 2010

S_2=2ndsowing ,November 15, 201

S_3= 3rdsowing , November30, 2010

Table 7. Combined effect of organic manure and sowing time on number leaves per plant of carrot

Treatment	Number of leaves per plant		
	30 DAS	60 DAS	90 DAS
S_1O_0	4.49 e	7.09 g	8.433 e
S_1O_1	7.43 bcd	8.23 f	14.30 bc
S_1O_2	7.59 bc	8.76 de	14.57 b
S_1O_3	7.59 bc	8.75 de	13.57 d
S_2O_0	4.76 e	7.26 g	9.06 e
S_2O_1	8.69 a	11.03 a	15.77 a
S_2O_2	7.00 d	8.63 e	13.73 cd
S_2O_3	7.19 cd	9.38 c	13.67 cd
S_3O_0	4.91 e	7.26 g	8.86 e
S_3O_1	7.90 b	10.35 b	14.87 b
S_3O_2	7.13 cd	8.50 ef	13.73 cd
S_3O_3	7.16 cd	9.06 cd	13.67 cd
LSD (0.05)	0.540	0.355	0.644
CV (%)	4.68	2.42	2.97

O_0 = Control (No manure) $S_1 = 1^{ST}$ sowing , November 01, 2010
O_1= Cowdung $S_2 = 2^{nd}$sowing , November 15, 2010
O_2= Poultry litter $S_3 = 3^{rd}$ sowing , November 30, 2010
O_3= Vermicompos

4.3. Fresh weight of leaves

Different organic manures significantly influenced the fresh weight of leaves per plant (Appendix IV). Fresh weight of leaves 88.62 (g) was recorded maximum from the plants grown with O_1 (cowdung @ 20 t/ha) while the minimum fresh weight of leaves 72.18 (g) was obtained in control plots (Table-8).

Sowing times also influenced the fresh weight of leaves significantly. (Appendix IV). Maximum fresh weight of leaves 80.13 (g) was recorded in November 15 (S_2). Early and late sowing plots produced the similar fresh weight of leaves. The minimum fresh weight of leaves 77.83 (g) was observed from November 01 (S_1). Among the different sowing time S_2 followed by S_3

was more effective than S_1 in context of weight of fresh leaves per plant (Table -9).

Combined effect of organic manures and sowing time on fresh weight of leaves per plant was also significant (Appendix IV). The maximum fresh weight of leaves per plant 101.2 (g) was observed from the treatment combination of 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha and the minimum fresh weight of leaves per plant 53.60 (g) was recorded from plants of control plot and sown in November 01 (Table-10).

4.4. Dry matter contents of leaves (%)

A significant variation was observed on dry matter of leaves due to use of different organic manures (Appendix IV). The maximum dry matter of leaves per plant (14.58%) was recorded from O_1 (cowdung @ 20 t/ha) while the minimum (11.72%) from control plots (Table-8).

Dry weight of leaves under study varied significantly due to three different sowing times (Appendix IV). The dry matter of leaves varied from (12.51%) to (13.89%). The maximum dry weight of leaves (13.89%) was observed in November 15 (S_2). The minimum dry matter of leaves (12.51%) was recorded from November 01 (S_1). Among the different sowing time S_2 followed by S_3 was more effective than S_1 in context of weight of dry leaves per plant (Table -9).

A significant was found due to combined effect of organic manure and sowing time on dry weight of leaves (Appendix IV). The maximum dry matter of leaves (19.07%) was observed from the treatment combination of 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha and the minimum dry weight of leaves per plant (9.06%) was recorded from control plot and sown in November 01 (Table-10).

4.5. Length of root

A significant variation was observed in root length due to use of different organic manures (Appendix IV). The longest root per plant 21.50 (cm) was

recorded from O_1 (cowdung @ 20 t/ha) while the shortest 13.05(cm) from control plots (Table-8).

The length of root of carrot was significantly influenced by three sowing times (Appendix IV).The longest root 20.46 (cm) was obtained from November 15 (S_2). The shortest root 10.23 (cm) was observed from November 01 (S_1). Among the different sowing time S_2 followed by S_3 was more effective than S_1 in context of root length (Table-9).

Due to combined effect of organic manures and sowing time showed significant variation on root length of carrot (Appendix IV). The longest root 20.98 (cm) was observed from the treatment combination of 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha followed by others. The shortest root 11.64 (cm) was recorded from control plot and sown in November 01 (Table-10).

4.6. Diameter of root

Diameter of root was significantly influenced by the application of organic manure (Appendix IV). The maximum diameter of root per plant 7.23 (cm) was recorded from O_1 (cowdung @ 20 t/ha) while the minimum 6.12 (cm) from control plots (Table-8).

The diameter of root of carrot was significantly influenced by three sowing times (Appendix IV). The maximum diameter of root 7.00 (cm) was observed from November 15 (S_2). The minimum diameter of root 6.40 (cm) was observed from November 01 (S_1). Among the different sowing time S_2 followed by S_3 was more effective than S_1 in context of diameter of root (Table -9).

A significant was found due to combined effect of organic manures and sowing time on diameter of root (Appendix IV). The maximum diameter of root 7.50 (cm) was observed from the treatment combination of 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha followed by others. The minimum diameter of root 3.40 (cm) was recorded from control plot and sown in November 01 (Table-10).

Table 8. Effect of organic manure on growth of carrot

Treatment	Fresh weight of leaves per plant(g)	Dry matter of leaves (%)	Length of root (cm)	Diameter of root (cm)
O_0	72.18 d	11.72 d	13.05 c	6.12 c
O_1	88.62 a	14.58 a	21.50 a	7.23 a
O_2	74.88 c	12.90 c	19.40 b	6.37 c
O_3	78.94 b	13.38 b	21.20 a	6.84 b
LSD (0.05)	1.292	0.271	0.4789	0.321
CV (%)	1.68	2.11	2.46	3.81

Here,

O_0 = Control (No manure)

O_1= Cowdung (20 t/ha)

O_2= Poultry litter (12 t/ha)

O_3=Vermicompost (10 t/ha)

Table 9. Effect of sowing time on growth of carrot

Treatment	Fresh weight of leaves per plant(g)	Dry matter of leaves (%)	Length of root (cm)	Diameter of root (cm)
S_1	77.83 b	12.51 c	10.23 c	6.40 b
S_2	80.13 a	13.89 a	20.46 a	7.00 a
S_3	78.01 b	13.03 b	19.95 b	6.45 b
LSD (0.05)	1.119	0.234	0.414	0.278
CV (%)	1.68	2.11	2.46	3.81

Here,

S_1 = 1stsowing , November 01, 2010

S_2=2ndsowing ,November 15, 201

S_3= 3rdsowing , November30, 2010

Table 10. Combined effect of organic manure and sowing time on growth of carrot

Treatment	Fresh weight of leaves per plant(g)	Dry matter of leaves (%)	Length of root (cm)	Diameter of root (cm)
S_1O_0	53.60 h	9.06 h	11.64 f	3.40 f
S_1O_1	89.70 c	14.67 b	15.86d	4.80 bc
S_1O_2	73.23 e	11.43 e	14.81e	4.16 de
S_1O_3	66.73 f	10.80 f	15.71d	8.43 cd
S_2O_0	56.67 g	10.27 g	16.75c	3.76 ef
S_2O_1	101.2 a	19.07 a	20.98 a	7.50 a
S_2O_2	96.93 b	15.13 b	19.93b	4.80 bc
S_2O_3	83.20 d	13.27 d	20.83 ab	4.36 cd
S_3O_0	56.70 g	10.30 g	16.50 c	3.66 ef
S_3O_1	94.77 b	15.03 b	20.72 ab	5.20 b
S_3O_2	81.77 d	13.93 c	19.67b	4.66 bcd
S_3O_3	89.33 c	14.77 b	20.57 b	4.66 bcd
LSD (0.05)	2.237	0.469	0.282	0.556
CV (%)	1.68	2.11	2.46	3.81

O_0 = Control (No manure)
O_1= Cowdung
O_2= Poultry litter
O_3= Vermicompost

S_1 = 1st sowing , November 01, 2010
S_2 =2nd sowing , November 15, 2010
S_3 = 3rd sowing , November 30, 2010

4.7. Fresh weight of root

A significant variation was observed on fresh weight of root per plant due to use of different organic manures (Appendix IV). The maximum fresh weight of roots per plant 117.9 (g) was recorded from O_1 (cowdung @ 20 t/ha) while the minimum 102.7 (g) from control plots (Table-11).

Fresh weight of roots under study varied significantly due to three different sowing times (Appendix IV). The weight of fresh roots varied from 107.2g to 117.5g. The maximum fresh weight of root 117.5 (g) was observed from November 15 (S_2). The minimum fresh weight of root 107.2 (g) was observed from November 01 (S_1). Among the different sowing time S_2 followed by S_3 was more effective than S_1 in context of fresh weight of root per plant (Table-12).

Due to combined effect of organic manures and sowing time showed significant variation on fresh weight of root (Appendix IV). The maximum

fresh weight of root per plant 145.7 (g) was observed from treatment combination of 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha followed by others. The minimum fresh weight of root per plant 79.67 (g) was recorded from control plot and sown in November 01 (Table-13).

4.8. Dry matter content of root (%)

A significant variation was observed on dry weight of root per plant due to use of different organic manures (Appendix IV). The maximum dry matter of root per plant (13.57%) was recorded from O_1 (cowdung @ 20 t/ha) while the minimum (11.76%) from control plots (Table-11).

Dry weight of root under study significantly varied due to three different sowing times (Appendix IV). The weight of dry roots varied from (12.27%) to (13.11%). The maximum dry weight of root (13.11%) was observed from November 15 (S_2). The minimum dry weight of root (12.27%) was observed from November 01 (S_1). Among the different sowing time S_2 followed by S_3 was more effective than S_1 in context of weight of dry root (Table-12).

A significan variation was found due to combined effect of organic manures and sowing time on dry matter of root (Appendix IV). The maximum dry matter of root (16.66%) was observed from the treatment combination of 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha. The minimum dry weight of root per plant (7.83%) was recorded from control plot and sown in November 01 (Table-13).

4.9. Percentage of cracking root:

Organic manure had no significant effect on the cracking percentage of roots (Appendix V). The highest percentage of root cracking (4.81%) was observed from control plot which was followed by O_2 (poultry litter @ 12 t/ha).The lowest (4.08%) was found in O_1 (cowdung @ 20 t/ha) (Table-11).

The mean value of cracking percentage with the treatment of three sowing time not varied significantly (Appendix V). The maximum percentage (4.54%) of cracking root was observed in November 1(S_1) while the minimum (4.13%) in November 15 (S_2) (Table-12).

The combined effect of organic manure and sowing time was showed significant among the treatment combination (Appendix V).). The maximum percentage (5.63%) of cracking root was observed in control plot and sown in November 01. The minimum cracking (2.43%) of root was observed from the treatment combination of 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha (Table-13).

4.10. Percentage of branched root

The highest percentage of branched root (5.10%) was observed from treatment O_0 (control) which was followed by O_2 (poultry litter @ 12 t/ha).The lowest (4.60%) was found in O_1 (cowdung @ 20 t/ha) (Table-11).

The branched root per plant with the treatment of three sowing time varied significantly (Appendix V). The maximum percentage (5.2%) of branched root was observed in November 1 (S_1) while the minimum (4.60%) in November 15 (S_2) (Table-12).

The combined effect of organic manure and sowing time showed significant differences among the treatment combination (Appendix V). The maximum branched root (7.10%) was observed in control plot and sown in November 01. The minimum branched (3.83%) root was observed from treatment combination of 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha (Table-13).

4.11. Gross yield of root per hectare

The gross yield of root (23.58 t/ha) recorded maximum from O_1 (cowdung @ 20 t/ha) which was statistically similar to that of O_3 (vermicompost @ 10 t/ha). The minimum gross yield (20.53 t/ha) was obtained from control plots (Table-11).

The gross yield of carrot (23.50 t/ha) was found maximum from the treatment November 15 (S_2) while the minimum from (21.43t/ha) gross yield was found from November 01 (S_1) (Table-12). The result was partially agreed with Pariari and Maity (1992).

The combined effect of organic manure and sowing time was significantly varied on gross yield of root (Appendix V). However, the maximum yield (29.13t/ha) was obtained from the treatment combination of 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha; whereas the minimum yield (15.93 t/ha) was recorded from control plot and sown in November 01 (Table 13).

4.12. Marketable yield hectare

Marketable yield (22.53 t/ha) obtained maximum when applied (cowdung @ 20 t/ha) which was statistically similar to that of O_3 (vermicompost @ 10 t/ha). The minimum marketable yield (19.74 t/ha) was obtained from control plot. (Table-11).

The maximum marketable yield (22.63 t/ha) was found from the treatment November 15 (S_2) while the minimum gross yield (20.53 t/ha) was found from November 01 (S_1) (Table-12). The result was partially agreed with Pariari and Maity (1992).

The combined effect of organic manure and sowing time was significantly varied on marketable yield of root (Appendix V). However, the maximum (28.65 t/ha) yield was obtained from the treatment combination of 2nd sowing, November 15, 2010 + cowdung @ 20 t/ha.; whereas the minimum (14.82 t/ha) yield was recorded from control plot and sown in November 01 (Table-13).

Table 11. Effect of organic manure on yield of carrot

Treatment	Fresh wt. of root per plant	Dry wt. of root per plant	Cracking root per plant	Branched root per plant	Gross yield (kg/plot)	Gross yield (t/ha)	Marketable yield (kg/plot)	Marketable yield (t/ha)
O_0	102.7d	11.76c	4.81 a	5.10 a	6.16 d	20.53d	5.92 c	19.74 c
O_1	117.9 a	13.57a	4.08 b	4.60 b	7.07 a	23.58a	6.76 a	22.53 a
O_2	109.4 c	12.60b	4.52 a	4.86 b	6.57 c	21.89c	6.27 b	20.92 b
O_3	114.8b	12.75b	4.10 b	4.81 b	6.88 b	22.96b	6.65 a	22.19 a
LSD (0.05)	2.980	0.2004	0.413	0.9791	0.1803	0.5963	0.1955	0.6522
CV (%)	2.74	1.63	9.66	20.66	2.76	2.74	3.13	3.12

O_0 = Control (No manure)

O_1= Cowdung (20 t/ha)

O_2= Poultry litter (12 t/ha)

O_3=Vermicompost (10 t/ha)

Table 12. Effect of sowing time on yield of carrot

Treatment	Fresh wt. of root per plant	Dry wt. of root per plant	Cracking root per plant	Branched root per plant	Gross yield (kg/plot)	Gross yield (t/ha)	Marketable yield (kg/plo)	Marketable yield (t/ha)
S_1	107.2 b	12.27 c	4.54 a	5.20 a	6.44 b	21.43 b	6.15 b	20.53 b
S_2	117.5 a	13.11 a	4.13 b	4.60 b	7.05 a	23.50 a	6.78 a	22.63 a
S_3	108.9 b	12.63 b	4.46 ab	4.74 b	6.52 b	21.78 b	6.26 b	20.89 b
LSD (0.05)	2.581	0.1735	0.3582	0.8479	0.1561	0.5164	0.1693	0.5648
CV (%)	2.74	1.63	9.66	20.66	2.76	2.74	3.13	3.12

S_1 = 1stsowing , November 01, 2010
S_2=2ndsowing ,November 15, 2010
S_3=3rdsowing,November,302010

Table 13. Combined effect of organic manure and sowing time on yield of carrot

Treatment	Fresh wt. of root per plant	Dry wt. of root per plant	Cracking root per plant	Branched root per plant	Gross yield (kg/plot)	Gross yield (t/ha)	Marketable yield (kg/plot)	Marketable yield (t/ha)
S_1O_0	79.67 h	7.833 h	5.63 a	7.10 a	4.82 h	15.93 h	4.44 i	14.82 i
S_1O_1	130.0 b	13.53 e	4.06 def	4.50 bc	7.77 b	26.00 b	7.55 b	25.20 b
S_1O_2	118.7 de	13.90 cd	4.74 bcd	4.43 bc	7.12 de	23.73 de	6.82 de	22.74 de
S_1O_3	114.0 ef	13.43 ef	4.73 bcd	5.38 bc	6.84 ef	22.80 ef	6.56 ef	21.89 ef
S_2O_0	84.67 h	8.16 gh	5.10 ab	5.23 bc	5.08 h	16.93 h	4.81 h	16.03 h
S_2O_1	145.7 a	16.66 a	2.43 g	3.83 c	8.74 a	29.13 a	8.59 a	28.65 a
S_2O_2	110.0 fg	15.33 b	3.64 f	3.83 c	6.60 fg	22.00 fg	6.38 f	21.27 fg
S_2O_3	115.0 ef	14.20 c	3.86 ef	4.36 bc	6.90 ef	23.00 ef	6.65 ef	22.17 ef
S_3O_0	83.00 h	8.26 g	4.80 bc	5.67 ab	4.98 h	16.60 h	4.73 hi	15.78 hi
S_3O_1	125.0 bc	13.93 cd	4.16 cdef	4.06 bc	7.50 bc	25.00 bc	7.23 bc	24.13 bc
S_3O_2	106.0 g	13.17 f	4.83 bc	4.30 bc	6.36 g	21.20 g	6.03 g	20.14 g
S_3O_3	122.7 cd	13.60 de	4.56 bcde	5.43 abc	7.36 cd	24.53 cd	6.99 cd	23.33 cd
LSD (0.05)	5.16	0.3470	0.716	1.696	0.3122	1.033	0.3387	1.130
CV (%)	2.74	1.63	9.66	20.66	2.76	2.74	3.13	3.12

O_0 = Control (No manure)

O_1= Cowdung

O_2= Poultry litter

O_3=Vermicompo

S_1 = 1st sowing , November 01, 2010

S_2 =2nd sowing , November 15, 2010

S_3 = 3rd sowing , November 30, 2010

CHAPTER V

SUMMERY AND CONCLUSION

An experiment was conducted at the Horticulture farm of Sher-e-Bangla Agricultural University,Dhaka to evaluate the effects of organic manure and sowing time on the growth and yield of carrot during November 01, 2010 to November 30, 2010 .The experiment comprised of two different factors such as (i)four organic manure Viz. O_0 (Control, no manure) , O_1 (Cowdung @ 20 t/ha) , O_2 (Poultry litter @ 12 t/ha) , O_3 (Vermicompost @ 10 t/ha) and (ii) three sowing time viz, S_1(1^{st} sowing, November 01, 2010) ,S_2 (November 15, 2010) and S_3 (November 30, 201), respectively.

The tallest plant height (17.03, 34.74 and 47.77 cm at same DAS; respectively) was observed from treatment O_1. The tallest plant height (16.82, 34.22 and 46.83 cm at 30, 60 and 90 DAS; respectively) was observed from the treatment of S_2 .The tallest plant height (20.77, 39.40 and 53.67 cm) was observed from treatment combination of S_2O_1. Whereas the shortest (16.23, 33.31 and 44.92 cm at 30, 60 and 90 DAS; respectively) was found from S_1. The shortest plant height (15.67, 33.37 and 42.91 cm at 30, 60 and 90 DAS; respectively) was found from O_0 .The shortest plant height (13.67, 26.60 and 31.10 cm at 30, 60 and 90 DAS; respectively) was observed from treatment S_1O_0.

The maximum number of leaves per plant (7.40, 9.30 and 14.09 at same DAS; respectively) was observed from treatment O_1. The maximum number of leaves per plant (7.08, 9.03 and 13.22 at 30, 60 and 90 DAS; respectively) was observed from the sowing time of S_2.The maximum number of leaves per plant (8.69, 11.03 and 15.77) was observed from treatment combination of S_2O_1. Whereas, the minimum number of leaves per plant (6.63, 8.34 and 12.65 cm at 30, 60 and 90 DAS; respectively) was found from S_1 . The minimum number of leaves per plant (6.3, 8.02 and 12.09 cm at 30, 60 and 90 DAS; respectively) was found from O_0 . The minimum number of leaves per plant (4.49, 7.09 and 8.43 cm at 30, 60 and 90 DAS; respectively) was observed from treatment S_1O_0.

The maximum fresh weight of leaves per plant was (88.62 g) was recorded from O_1. The maximum fresh weight of leaves (80.13 g) was found to the plants were sown of S_2. The maximum fresh weight of leaves per plant (101.2 g) was observed from the treatment combination of S_2O_1. Whereas, the minimum fresh weight of leaves (77.83 g) was observed from S_1.The minimum fresh weight of leaves (72.18 g) was observed from O_0 . The minimum fresh weight of leaves (53.60 g) was recorded from treatment S_1O_0 .

The highest dry matter (14.58%) was recorded from O_1. The S_2 treatment gave the maximum dry matter (13.89%) of leaves. The maximum (19.07%) dry matter content of leaves per plant was found in the treatment S_2O_1. Whereas, S_1 gave the minimum dry matter (12.51%), O_0 gave (11.72%) and treatment S_1O_0 gave (9.06%).

The length of root was differed among the different sowing times. The longest (20.46 cm) root was found in the treatment of S_2 and shortest (10.23 cm) was found in S_1. The tallest (21.50 cm) root was noticed in O_1 whereas the shortest (13.05cm) was found in O_0. But in the combined treatment of S_2O_1 was produced tallest (20.98 cm) while $S_1O_0$was produced the shortest root (11.64 cm).

The fresh weight root and dry weight of root varied significantly among the sowing times and different organic manure. The maximum (117.5 g) fresh weight of root and (13.11%) dry matter content of root was obtained in S_2.The maximum fresh weight of root was (117.9 g) and (13.57%) dry matter content of root was recorded from O_1. The maximum fresh weight of root (145.7 g) and maximum dry matter content of root (16.66%) was observed from the treatment combination of S_2O_1. Whereas the minimum (107.2 g) fresh weight and (12.27 %) dry weight of root was obtained from S_1. The minimum (102.7 g) fresh weight and (11.76 %) dry matter content of root was noticed from O_0. The minimum (79.67 g) fresh weight and (7.83%) dry matter content of root was observed from treatment combination S_2O_1.

There was significant variation was recorded among the different sowing times and organic manure in respect of cracking percentage and branched percentage of

carrot root. The highest cracking (4.54%) and branched (5.20%) was obtained under spacing S_1 and the highest cracking (4.81%) and branched (5.10%) was recorded from O_0. The highest (5.63%) cracking was observed in the treatment combination of S_1O_0. Similarly, the height (7.10%) branched was found in S_1O_0. The minimum cracking (4.13%) and branched (4.60%) was observed in S_1.The minimum cracking (4.08%) and branched (4.60%) was observed in O_1. The minimum (2.43%) cracking and (3.83%) branched was observed in the combined treatment of S_2O_1.

The maximum gross yield (23.58 t/ha) was found from treatment O_1. The maximum gross yield (23.50 t/ha) was found from treatment S_2. However, the maximum (29.13t/ha) was obtained from the treatment combination of S_2O_1. The minimum gross yield (21.43 t/ha) was found from treatment S_1. The minimum gross yield (20.53 t/ha) was found from treatment O_0. However, the minimum (15.93 t/ha) was obtained from treatment combination of S_1O_0.

The maximum marketable yield (22.53 t/ha) was found from treatment O_1. The maximum marketable yield (22.63 t/ha) was found from treatment S_2. However, the maximum (28.65 t/ha) was obtained from the treatment combination of S_2O_1. The minimum marketable yield (20.53 t/ha was found from treatment S_1. The minimum marketable yield (19.74 t/ha) was found from treatment O_0. However, the minimum (14.82 t/ha) was obtained from treatment combination of S_1O_0.

Conclusion: Considering the present experiment, further studies in the following areas may be suggested:

1. Experimental result revealed that sowing time 15th November gave the highest yield.

2. Organic manure such as cowdung may be used for higher yield of carrot

3. Under the present study it was observed that the highest yield were found from S_2O_1 and the lowest yield were recorded from the treatment combination of S_1O_0

4. Different levels of organic manure combination may also practice.

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APPENDICES

Appendix I. Characteristics of Sher-e-Bangla Agricultural University (SAU) Farm soil analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of experimental field

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

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% Clay	30
Textural class	Silty-clay
P^H	5.6
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	.01
Available S (ppm)	45

Appendix II. Temperature (°C), rainfall (mm),relative humidity (%), soil temperature (°C) and sunshine (lux) during the experimental period

Month	*Air temperature (°C)		*Relative humidity (%)	*Rainfall (mm)	*Sunshine (hr)
	Maximum	Minimum			
October, 2010	34.5	22	67	112	6.4
November,2010	32.4	17.2	73	00	6.3
December,2010	30.0	11	70	00	6.2
January, 2011	27.8	8.2	69	00	5.9
February, 2011	31.0	13	54	00	6.8
March, 2011	34.5	16	57	20	6.9

*Monthly average
*Source: Bangladesh Meteorological Department (Climate & weather division) Agargaon, Dhaka-1207.

Appendix III. Analysis of variance of the data on plant height and number of leaves of carrot influenced by organic manure and sowing time

Source of variation	Degree of freedom	Mean square					
		Plant height (cm)			Number of leaves		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Replication	2	0.126	2.436	3.741	0.503	0.021	0.577
Factor A	3	3.109**	3.452**	46.992**	2.033**	2.973**	6.871**
Factor B	2	1.191**	2.873**	11.552NS	0.682**	1.419**	1.197**
Interaction (A×B)	6	23.662**	79.533**	86.250**	8.711**	5.909**	31.525**
Error	22	0.250	0.845	0.665	0.102	0.044	0.145

**=significant at 0.01 level probability
NS=Non significant at 0.05 level probability

Appendix IV. Analysis of variance of the data on weight of fresh leaf, dry weight of leaf, root length, diameter of root, fresh weight of root and dry weight of carrot

Source of variation	Degree of freedom	Mean square					
		Weight of fresh leaf (g)	Dry weight of leaf (g)	Root length (cm)	Diameter of root (cm)	Fresh weight of root per plant	Dry weight of root per plant
Replication	2	26.964	1.028	0.812	0.087	40.444	0.569
Factor A	3	466.953**	12.574**	27.100*	2.374**	400.324*	4.956**
Factor B	2	19.525**	5.852**	2.806**	1.314**	367.028*	2.124**
Interaction (A×B)	6	1327.31**	36.566**	110.242**	4.440**	1909.21*	43.784**
Error	22	1.746	0.077	0.240	0.108	9.293	0.042

**=significant at 0.01 level probability
NS=Non significant at 0.05 level probability

Appendix V. Analysis of variance of the data on cracking root per plant, branched root per plant, gross yield and marketable yield of carrot is influenced by organic manure and sowing time

Source of variation	Degree of freedom	Mean square					
		Cracking root per plant	Branched root per plant	Gross yield (kg/plot)	Gross yield (ton/ha)	Marketable yield (kg/plot)	Marketable yield (ton/ha)
Replication	2	0.126	2.863	0.145	1.618	0.086	0.991
Factor A	3	1.114**	0.379*	1.438**	16.013**	1.310**	14.651**
Factor B	2	0.563NS	1.180NS	1.304**	14.681**	1.361**	15.122**
Interaction (A×B)	6	3.010**	4.433**	6.776**	76.369**	7.270**	80.697**
Error	22	0.179	1.003	0.034	0.372	0.040	0.445

***=**significant at 0.05 level probability
**=significant at 0.01 level probability
NS=Non significant at 0.05 levelprobability