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Influence of Organic Nutrient Sources and Neem (*Azadirachta*) Products on Growth and Yield of Carrot

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ABSTRACT

The experiment consisted of two factors which are as follows: factor A: Three levels of organic manures, Oo Control (no organic manure), OC Cowdung (10 t ha-1) and OV- Vermicompost (3.5 tha-1). Factor B: Three levels of neem product N_0 - Control (no neem products), N_1 - Neem leaf powder (250 kg ha^{-1}) and N_2- Neem oil cake (250 kg ha^{-1}). 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, vermicompost gave the highest marketable yield (32.20 t ha^{-1}) whereas; control produced the lowest marketable (12.50 t ha-1) yield. The highest gross yield (27.89 t ha^{-1}) and marketable (25.60 t.ha^{-1}) yield was obtained from N1 and the lowest from N0. For combined effect N_1O_v produced the highest marketable yield (29 t ha-1) whereas, the lowest (9.00 tha^{-1}) from N_0O_0. So, it may be concluded that vermicompost with neem leaf powder was found suitable for growth and yield of carrot.

Keywords: Neem leaf, powder, neem oil cake, organic carrot, vermicompost, yield.

INTRODUCTION

Carrot (*Daucus carota* L.) is an important vegetable root crops belongs to the family Apiaceae and 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 ha and total production of 14000 metric tons in Bangladesh (BBS, 2010). Rashid (1999) mentioned an average yield of 25 tha^{-1} 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). 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. Vermicompost which is produced by earthworms is a rich source of 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 controls include Meloidogyne root-knot nematode, rhizoctonia root-rot fungus and rice stunt virus (Anonymous, 1992; Anjorin *et al*., 2004). Neem products improve soil structure as well as increases water holding capacity. 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 percent N, P_2O_5 and K_2O, respectively (Yawalkar et al., 1996). Neem cake contains azadiractin, miliantriol, etc. having insecticidal and nematicidal properties (Anon., 2001). 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 and to find out the interaction effect of organic manures and neem products on carrot production.

MATERIALS AND METHODS

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 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 tha^{-1}) and O_V = Vermicompost (3.5 t ha^{-1}). Factor B: Three levels of neem product N_o = Control (no neem products), N_1 = Neem leaf powder (250 kg ha^{-1}) and N_2 = Neem oil cake (250 kg ha^{-1}). "New kuroda" variety of carrot was used for the experiment. The two-factor experiment was laid out Randomized Complete Block Design (RCBD) with three replications. 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 plant height, number of leaves $plant^{-1}$, fresh weight of leaves $plant^{-1}$, % dry matter of leaves, length of root, diameter of root, fresh weight of root $plant^{-1}$, % dry matter of root, % of deformed roots, % of rotten roots, marketable yield of root ha^{-1}. % dry matter of leaves, % dry matter of root, cracked root (%) and rotten root (%) were calculated by following formula-

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

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

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

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

The collected data on aforementioned parameters 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).

RESULTS AND DISCUSSION

Plant height

The plant height varied significantly due to the application of organic manures (Fig. 1). At 100 days, the tallest plant (36 cm) was obtained from O_v while the shortest plant (22 cm) was obtained from the control. Neem products had a significant effect on plant height (Fig. 2). At 100 days, the highest plant height (31.80 cm) was obtained from N_1 while the lowest plant height (21.5 cm) was obtained from the control. In case of interaction effect (Table 1), at 100 days, the tallest plant 31.75 cm was obtained from neem leaf powder with vermicompost (N_1O_v) while the shortest plant 21.75cm was obtained from the control treatment (N_0O_0).

Number of leaves $plant^{-1}$

Application of organic manures increased the number of leaves per plant significantly (Fig. 3). 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. Number of leaves is varied due to effect of neem products (Fig. 4). At 85 DAS, the higher number of leaves per plant (11.67) was observed from N_1, while the lower number of leaves per plant (9.2) was found under O_0. The comparison showed that the

number of leaves was greater at 85 DAS than that of 100 DAS. 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 agreed with the findings of Sediyama et al. (1998). Incase of interaction effect the maximum number of leaves per plant was recorded in N_1O_v and the minimum number obtained from N_0O_0 (Table 1).

Fresh weight of leaves plant^{-1}

The fresh weight of leaves per plant increased significantly with the application of vermicompost (Table 2). The maximum fresh weight of leaves (102.89 g) per plant was recorded from the vermicompost (O_v) while the minimum (64.89 g) was from the control (O_0). Neem leaf powder (N_1) gave the maximum fresh weight of leaves (90 g plant^{-1}) and control (N_0) showed the minimum fresh weight of leaves (67.56 g plant^{-1}). In case of combined effect, neem leaf powder with vermicompost (N_1O_v) gave the highest fresh weight of leaves (96.5 g plant-1) while the lowest fresh weight of leaves (66.23 g plant-1) was obtained from the control (N0O0) (Table 5).

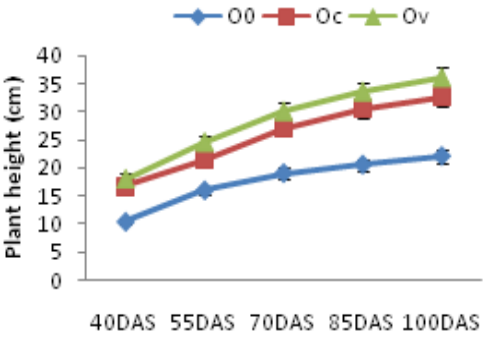

Fig. 1. Effect of organic manures on plant height of carrot

here, O_0 = No organic manures (control), O_c = Cowdung, O_v = vermicompost. Vertical bars represent the standard error of the treatment means.

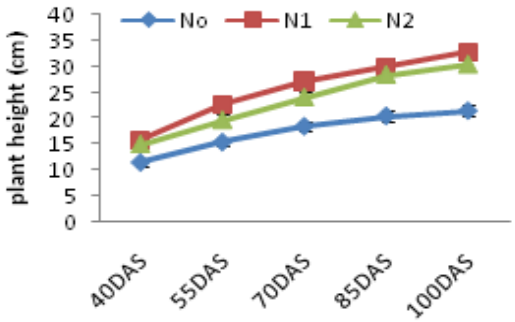

Fig. 2. Effect of neem products on plant height of carrot

N_o =No neem products (Control), N_1 = Neem leaf powder, N_2 = Neem oil cake, Vertical bars represent the standard error of the treatment means.

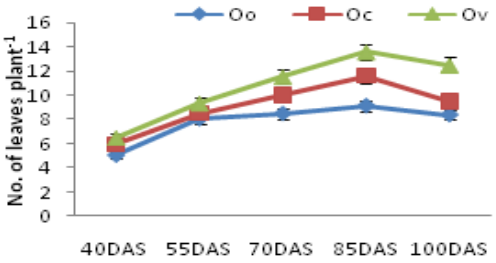

Fig. 3. Effect of organic manures on number of leaves of carrot

N_o =No neem products (Control), N_1 = Neem leaf powder, N_2 = Neem oil cake, Vertical bars represent the standard error of the treatment means.

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.

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 obtained from vermicompost (O_v) and the lowest dry matter (7.1%) was obtained from the control (O_0) (Table 2). Dry matter of

leaves was also significantly influenced by different neem products (Table 3). 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 maximum dry matter (11.1%) was obtained from vermicompost with neem leaf powder (N_1O_v) and the minimum percent dry matter was obtained from the combination of O_0N_0 (7.05%).

Length of root

The longest root length (16.20 cm) was obtained from the application of vermicompost (O_c) and the shortest (10.50 cm) was from control (O_0) (Table 2). Significant influence was observed due to the effect of different neem products on the length of root (Table 3). The longest root length (14 cm) was obtained from neem leaf powder (N_1) and control (N_0) showed the lowest root length (10 cm). The combined effect of vermicompost with neem leaf powder (N_1O_v) gave the longest (15.10 cm) root length and the shortest (10.25 cm) length of root was obtained from the control treatment (N_0O_0).

obtained in diameter of root by the application of neem products. The maximum root diameter (4.18 cm) was obtained from neem leaf powder (N_1) and the minimum root diameter (3.24 cm) was produced from control (N_0) (Table 4). Root diameter varied significantly due to combined effect of organic manures and neem products. The highest diameter of root (4.5 cm) was found from vermicompost with neem leaf powder (N_1O_v) and the lowest (3.23 cm) was recorded from control (N_0O_0) treatment (Table 4).

Fresh weight of root plant^{-1}

The maximum fresh weight of root (170 g) was recorded from vermicompost (O_v) and minimum was the control (O_0) (90 g). A significant variation was observed in fresh weight of root by the effect of neem product. The highest fresh weight of root (147 g) was recorded from (N_1) and 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 4). The maximum (158.5

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

Treatments Combination	Plant height (cm) at different days after sowing (DAS)					Number of leaves per plant at different days after sowing (DAS)				
	40	55	70	85	100	40	55	70	85	100
N_0O_0	11.00f	15.68g	18.75g	20.50f	21.75h	5.00c	7.67d	8.27g	9.00g	8.17d
N_0O_v	14.75c	19.97d	24.25d	27.00d	28.75e	5.54bc	7.87d	9.74e	10.73	9.67c
N_0O_c	14.15cd	18.47e	22.75e	25.50e	27.00f	6.10ab	9.34ab	11.27b	13.43b	12.34a
N_1O_0	13.25de	19.37d	23.12e	25.25e	26.90f	5.37c	8.60c	9.07f	9.40f	8.54d
N_1O_v	17.00a	23.62a	28.62a	31.75a	33.90a	6.00ab	8.90bc	10.80c	11.80c	10.80b
N_1O_c	16.40ab	22.12b	26.79b	30.25bc	32.15c	6.34a	9.57a	12.34a	13.85a	12.60a
N_2O_0	12.75e	17.85f	21.55f	24.50e	26.25g	5.10c	7.97d	8.80f	9.10fg	8.50d
N_2O_v	16.50ab	22.10b	27.05b	31.00ab	33.25b	6.10ab	8.47c	10.20d	11.20d	9.90c
N_2O_c	15.90b	20.60c	25.55c	29.5c	31.50d	6.37a	9.07b	10.93c	13.60ab	12.54a
Level of Significance	*	**	**	**	*	*	**	**	**	*

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) and the control (O_0) gave the lowest (3.21 cm) from (Table 2). A significant variation was

g) fresh weight of root was recorded from plant grown over the neem leaf powder with vermicompost (N_1O_v) and the minimum (87.5 g) was found from the control (N_0O_0). The present findings disagreed with the results of Viera *et al.* (1998).

Table 2. 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 Plant^{-1} (cm)	Diameter of root plant^{-1} (cm)	Dry matter of root (%)	Fresh weight of root plant^{-1} (g)	Marketable yield tha^{-1}	Deformed Root (%)	Root rotting (%)
0_0	64.89c	7.10c	10.50c	3.21c	10.60c	90c	12.50c	22.23a	8.33a
0_c	92b	10.50b	14.10b	4.20b	15b	155b	26.70b	8.33b	5.56b
0_v	102.89a	12.20a	16.20a	4.77a	17a	170a	32.20a	5.56c	4.16b
Level of Significance	**	**	**	**	**	**	**	**	**

0_0 = No organic manures (Control), 0_c = Cowdung, 0_v = vermicompost, ** = $P \leq 0.01$, * = $P \leq 0.05$

Table 3. Effect of neem products on growth and yield parameters of carrot

Neem products	Fresh weight of leaves (g)	Dry Matter of leaves (%)	Root Length Plant^{-1} (cm)	Diameter of root Plant^{-1}(cm)	Dry matter of root (%)	Fresh weight of root Plant^{-1} (g)	Marketable yield tha^{-1}	deformed root (%)	Root rotting (%)
N_o	67.56c	7c	10.00c	3.24c	10.2c	85c	11.34c	25a	11.12a
N_1	90a	10a	14.20a	4.18a	14.9a	147a	25.60a	11.12b	2.78b
N_2	80.70b	8.5b	13.30b	4.07b	14b	130b	22.27b	8.33c	3.47b
Level of Significance	**	**	**	**	**	**	**	**	**

N_o =No neem products (Control), N_1 = Neem leaf powder, N_2 = Neem oil cake, ** = $P \leq 0.01$, * = $P \leq 0.05$.

Table 4. Interaction effect of organic nutrient sources and neem products on growth and yield parameters of carrot.

Treatment combinations	Fresh wt. of leaves (g)	Dry matter of leaves (%)	Root length (cm)	Diameter of root (cm)	Dry matter of root (%)	Fresh wt. of root (g)	deformed root (%)	Root rotting (%)	Marketable yield of root tha^{-1}
N_o0_o	66.23h	7.05f	10.25g	3.23e	10.40e	87.17g	23.62a	9.73a	09.00g
N_o0_c	79.80e	8.75cd	12.05f	3.40de	12.60dc	127.5d	15.28c	7.64b	21.72d
N_0O_v	85.30d	9.6bc	13.10de	4.01bc	13.60c	120.7e	16.67b	8.34b	19.15e
N_1O_o	77.45f	8.55d	12.25ef	3.70cd	12.75d	118.5e	16 68b	5.56cd	19.00e
N_1O_c	91b	10.25b	14.05bc	4.19ab	14.95c	158.5a	8.34e	3.47e	29.00a
N_1O_v	96.50a	11.10a	15.20a	4.50a	15.95a	151b	9.73d	4.17e	26.15b
N_2O_o	72.80g	7.80e	11.90f	3.60de	12.30e	110f	15.28c	5.90c	17.38f
N_2O_c	86.35c	9.50bc	13.70cd	4.13ab	14.50c	150b	6.95f	3.82e	27.30b
N_2O_v	92b	10.35ab	14.93b	4.42a	15.50b	142.5c	8.33e	4.52de	24.50c
Level of Significance	**	**	**	*	**	**	**	*	**

0_0 = No organic manures, 0_c = Cowdung, 0_v = vermicompost, and N_o =No neem products, N_1 = Neem leaf powder, N_2 = Neem oil cake, ** = $P \leq 0.01$, * = $P \leq 0.05$.

Dry matter of root (%)

The percent dry matter of root varied significantly by organic manures (Table 2). 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 (O_0). Use of different neem products showed significant influence on the percent dry matter of root (Table 3). 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). 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).

Deformed roots (%)

Organic manures had significant effect on the deformed percentage of roots (Table 2). The highest percentage of deformed root (22.23%) was observed from the control (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 3). The highest (25%) percentage of deformed root recorded from control (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 4). 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.

Rotting roots (%)

The percentage of rotting of roots was significantly affected by the organic manures treatment (Table 2). However, the highest rotting percentage of roots (8.33%) was recorded in control (O_0) whereas the lowest rotting percentage (4.16%) was observed in vermicompost (O_v). The maximum rotting percentage of roots (11.12%) was recorded from no neem products (N_0) and the minimum (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 4). The highest percentage of rotten root (9.73%) was recorded from no organic nutrients with no neem products (N_0O_0) and the lowest (3.47%) was obtained from the vermicompost with neem leaf powder (N_1O_v).

Marketable yield of roots (tha^{-1})

Marketable yield of roots varied significantly due to different organic nutrient sources. The maximum marketable yield (32.20 tha^{-1}) was obtained from vermicompost treatment (O_v), while the minimum yield (9.00 tha^{-1}) was found from control treatment (O_0) (Table 2). The marketable yield of carrot per hectare was found statistically significant due to neem products (Table 3). The highest yield (25.60 tha^{-1}) was obtained from neem leaf powder (N_1) and the lowest (11.34 tha^{-1}) from no neem products. A significant combined effect of organic manures and neem products was observed on marketable yield of root per hectare (Table 4). The highest marketable yield of root per hectare (29 tha^{-1}) was recorded from neem leaf powder with vermicompost (N_1O_v) while the lowest marketable yield of carrot root per hectare (11.92 tha^{-1}) was found from the treatment combination of N_0O_0.

CONCLUSION

It is concluded that organic manures and neem products are greatly influenced the different plant growth characters. They also have a potential effect on growth yield and yield contributing character. Vermicompost with neem leaf product gave the maximum yield of carrot. Different levels of organic manures with neem products combination can be practiced for obtaining better yield.

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