Effect of Different Types of Organic Manure and Mulching on the Growth and Yield of Carrot (Daucus Carota L.)

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Abstract- An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Bangladesh during the period from November 2013 to March 2014 to study the effect of different types of organic manure (no organic manure, cowdung, compost and litter) and mulching on (non-mulch, water hyacinth, rice straw and black polythene) the growth and yield of carrot. The experiment was conducted in a Randomized Complete Block Design with three replications. Application of organic manure and mulching significantly influenced the growth and yield of carrot. Cowdung resulted in the highest gross yield (39.05 t/ha) whereas, the plants received no organic manure produced the lowest for the same (33.03 t/ha). The highest gross (39.12 t/ha) and marketable (35.79 t/ha) yield was obtained from the black polythene mulch while the lowest was obtained from non mulched plot. Cowdung with black polythene mulch produced the highest yield (42.75 t/ha) followed by that of application of litter with black polythene mulch (41.46 t/ha). The lowest (32.00 t/ha) was recorded from the control.

Index Terms- Carrot, organic manure, mulch, growth and yield

I. INTRODUCTION

Carrot (*Daucus carota* L.) is one of the most ancient vegetables. It is grown in spring, summer and autumn in temperate countries and during winter in tropical and subtropical countries [1]. Carrot is a member of the family Apiaceae [2] and said to be originated in Mediterranean region and its cultivation as a crop also began in that region [3]. Carrot contains appreciable amount of carotene, thiamin and riboflavin [4]. It is also an excellent source of iron, vitamin-B, vitamin-C and sugar [5]. It can play an important role to protect the blindness in children providing vitamin-A. Furthermore, carrot has some important medicinal values [6,1].

Carrot grows successfully in Bangladesh during rabi season and mid November to early December is the best time for its cultivation to get satisfactory yield [7]. The area under carrot cultivation was 899 thousand hectares with total production of 19374 thousand tones in the world [8]. Rashid and Sarker [9] mentioned an average yield of 35 t/ha of carrot. This production is relatively low compared to other carrot producing countries like, Israel, UK and Sweden where the yield are reported to be 61.538, 57.683 and 54.348 t/ha, respectively [8].

The cultivation of carrot requires an ample supply of plant nutrient. Use of organic manures essential for its proper growth and development. Supply of organic manure improve soil structure as well as increases its water holding capacity. It facilitates aeration in soil. Recently organic farming is appertained by consumers as it enhances quality of the produce. Inorganic cultivation leaves residual effect in crops which is behind to cause hazard to public health and environment. In Bangladesh carrot is grown during winter season when rainfall is scanty. Irrigation is essential for increased crop cultivation. But it increases cost of production. Under such condition, mulching may be practice in crop cultivation which can replace irrigation to minimize cost of production. Mulch is again highly effective in checking evaporation and is hence recommended for most home garden use of valued crops [10]. It stimulates microbial activity in soil through improvement of agro-physical properties. Mulching increases yield in many horticultural crops like potato, sweet potato, carrot and ginger [11,12,13]. Considering the above facts, an experiment was undertaken to study the effect of different types of organic manure and mulching on growth and yield of carrot cv. New Kuroda.

II. MATERIALS AND METHODS

The experiment was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November 2013 to March 2014 to study the effect of different types of organic manure (no organic manure, cowdung, compost and litter) and mulching on (non-mulch, water hyacinth, rice straw and black polythene) the growth and yield of carrot. The location of the experimental site was at 23.74^0 N latitude and 90.35^0 E longitudes with an elevation of 8.45 meter from the sea level. Soil of the study site was silty clay loam in texture. The area represents the Agro-Ecological Zone of Madhupur tract (AEZ-28) with pH 5.8-6.5, ECE 25.28.

The seeds of carrot cv. New Kuroda, a Japanese variety, were used in the experiment. The seeds were produced and packed by Takii and Co. Ltd. Kyoto, Japan. The experiment

consisted of two factors which are as follows: Factor A: Organic manure: O_0 = Control (no organic matter), O_1 = Cowdung (25 t/ha), O_2 = Compost (35.00 t/ha) and O_4 = Litter (24.00 t/ha) and Factor B: Mulching material: M_0 = Control (no mulching material), M_1 = Water hyacinth , M_2 = Rice straw and M_3 = Black Polythene. The two-factor experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. There were 48 unit plots altogether in the experiment. The size of each plot was 1.5 ×1 m. The distance between blocks and between plots were kept respectively 1 and 0.5 m. The following doses of manures and fertilizers were recommended for carrot production by Rashid and Shakur [9]. The seeds were soaked in water for 24 hours and then wrapped with piece of thin cloth. The treated seeds were sown is field on 29 November 2013. Mulches of water hyacinth and straw were applied immediately after seed sowing while that of black polythene sheet with small holes at proper spacing was spreaded over the plot before seed showing and emerged easily through the holes. The crop was harvested on 19 March 2014 i.e. after 105 days after sowing (DAS).

Ten plants were sampled randomly from each unit plot for the collection of per plant data. The data collected from the experimental plots 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% and 1% level of probability [14].

III. RESULTS AND DISCUSSION

Plant height

Plant height varied significantly due to the application of different organic manure at harvest time (105 DAS) (Table 1). The highest plant height (42.43 cm) was found from O_1 (cowdung) and the lowest plant height (25.36 cm) was recorded from 0_0 (control treatment). The plant height varied also significantly due to different types of mulching practices at harvest time (105 DAS) (Table 1). The highest plant height (43.00 cm) was found from M_3 (black polythene mulch) and the lowest plant height (28.81 cm) was recorded form M_0 (control treatment). Maity *et al.* [15] in their experiment reported that mulch increased the plant growth and yield of ginger.

The plant height was significantly influenced by the combined effect of organic manure and mulching at harvest time (105 DAS) (Table 1). The highest plant height (48.10 cm) was found from O_3M_3 (litter with black polythene mulch) but statistically same (49.51 cm) O_1M_3 (cowdung with black polythene mulch) and the lowest (21.29 cm) from O_0M_0 (control treatment).

Number of leaves per plant

Application of organic manure increased the number of leaves per plant significantly at harvest time (105 DAS) (Table 1). The highest number of leaves per plant (12.27) was found from O_1 (cowdung) and the lowest (9.85) was recorded form O_0 (control treatment). The number of leaves per plant varied also significantly due to different types of mulching practices at harvest time (105 DAS) (Table 1). The highest number of leaves per plant (12.27) was found from M_3 (black polythene mulch) and the lowest (10.25) was recorded form M_0 (control treatment).

The number of leaves per plant was significantly influenced by the combined effect between organic manure and mulching at harvest time (105 DAS) (Table 1). The highest number of leaves per plant (13.10) was recorded to O_1M_3 (cowdung and black polythene mulch) and the lowest number of leaves per plant (9.00) was observed from O_0M_0 (control treatment).

Dry matter percent of leaves

Organic manure had significant effect on dry matter of leaves per plant (Table 1). The highest dry manure of leaves (16.13%) was recorded from O_1 (Cowdung) and the lowest dry matter (13.17%) was recorded from O_0 (control treatment). Dry matter of leaves was significantly influenced by different mulches (Table 1). The highest dry matter of leaves (16.09%) was recorded from M_3 (black polythene) and the lowest dry matter of leaves (14.26%) was found M_0 (control treatment).

The combined effect of different organic manure and mulching on percentage of dry matter of leaves was significant (Table 1). The highest dry matter (18.00%) was obtained from O_1M_3 (cowdung with black polythene) and the lowest (12.65%) was found O_0M_0 (Control treatment).

Length of root

The length of carrot root was found to be statistically significant due to the effect of organic manure (Table 1). The longest root (16.49 cm) was obtained from O_1 (cowdung) and the shortest (14.07 cm) was from O_0 (control treatment). Significant influence was observed due to the effect of mulching on the length of root (Table 1). The longest root (16.44 cm) was obtained from M_3 (black polythene mulch) and the lowest root length (14.64 cm) was found M_0 (control treatment).

The interaction effect between organic manure and mulching treatment was significant (Table 1). The combined effect of O_1M_3 (cowdung with black polythene mulch) gave the longest (17.42 cm) root and the shortest (13.07 cm) length of root was obtained from O_0M_0 (control treatment).

Diameter of root

Diameter of carrot root was significantly influenced by the application of organic manure (Table 1). The highest diameter (4.73 cm) was obtained from O_1 (cowdung) and the lowest diameter (3.24 cm) was obtained from O_0 (control treatment). Diameter of carrot roots was significantly influenced by mulching (Table 1). The maximum root diameter (4.70 cm) was obtained from M_3 (black polythene mulch) and the lowest root diameter (3.62 cm) was obtained from M_0 (control treatment).

Root diameter varied significantly due to combined effect of organic manure and mulching (Table 1). The maximum thickness of root (5.54 cm) was found from O_1M_3 (cowdung with black polythene mulch) and the minimum (2.92 cm) was recorded from O_0M_0 (control treatment).

Table 1. Effect of different organic manure and mulching treatment on growth of carrot

Treatment	Plant height (cm)	Number of leaves per Plant	Dry matter of leaves (%)	Root length per plant (cm)	Diameter of root per plant (cm)	Dry matter of root (%)
Organic manure						
0_0	25.36 c	9.85 b	13.17 d	14.07 d	3.24 d	9.68 d
0_1	42.43 a	12.27 a	16.13 a	16.49 a	4.73 a	11.19 a
0_2	38.62 b	11.75 a	15.30 c	15.85 c	4.24 c	10.79 c
0_3	41.00 a	12.03 a	15.78 b	16.22 b	4.48 b	11.07 b
$LSD_{(0.05)}$	2.300	1.021	0.337	0.146	0.091	0.074
Mulch material						
M_0	28.81 d	10.25 c	14.26 d	14.64 d	3.62 d	10.07 d
M_1	40.77 b	12.02 a	15.20 b	16.09 b	4.37 b	10.98 b
M_2	34.90 c	11.35 b	14.83 c	15.46 c	4.01 c	10.47 c
M_3	43.00 a	12.27 a	16.09 a	16.44 a	4.70 a	11.22 a
$LSD_{(0.05)}$	2.012	0.622	0.337	0.146	0.091	0.074
Organic manure × Mulch material						
0_0M_0	21.29 j	9.00 h	12.65 j	13.07 m	2.92 h	9.30 l
0_0M_1	26.35 hi	10.00 g	13.23 hi	14.48 k	3.42 I	9.90 j
0_0M_2	24.01 ij	10.01 g	13.03 i	14.03 l	3.11 j	9.50 k
0_0M_3	29.81 gh	10.40 g	13.79 h	14.72 j	3.52 I	10.04 ij
0_1M_0	32.15 fg	10.90 e	15.00 fg	15.47 h	4.12 g	10.48 h
0_1M_1	47.05 ab	12.90 ab	16.03 c	16.93 b	4.88 c	11.51 b
0_1M_2	41.01 cd	12.20 bc	15.50 c-e	16.12 ef	4.40 e	10.95 e
0_1M_3	49.51 a	13.10 a	18.00 a	17.42 a	5.54 a	11.84 a
0_2M_0	30.75 g	10.60 ef	14.59 g	14.93 ij	3.63 h	10.17 i
0_2M_1	43.35 bc	12.50 a-c	15.60 c-e	16.33 de	4.53 de	11.14 d
0_2M_2	35.80 ef	11.30 de	15.31 d-f	15.73 g	4.22 fg	10.64 g
0_2M_3	44.60 bc	12.60 ab	15.70 cd	16.40 cd	4.60 d	11.20 d
0_3M_0	31.05 g	10.53 fg	14.81 fg	15.12 l	3.81 h	10.34 h
0_3M_1	46.33 ab	12.70 ab	15.93 cd	16.62 c	4.66 d	11.35 c

[31]	0_3M_2 f	38.80 de	11.90 cd	15.49 c-e	15.94 fg	4.31 f	10.80
[32]	0_3M_3 a	48.10 a	13.00 a	16.90 b	17.22 a	5.16 b	11.80
[33]	$LSD_{(0.05)}$ 0.149	3.752	0.743	0.675	0.293	0.182	
[34]	CV (%)	4.73	3.84	3.76	5.92	4.54	6.75

Dry matter percent of root

The per cent dry matter of root also varied significantly by organic manure (Table 1). The highest dry matter of roots (11.19%) was recorded to O_1 (cowdung) and the lowest dry matter of roots (9.68%) was obtained from O_0 (control treatment). Application of mulch materials showed significant influence on the per cent dry matter of root (Table 1). The highest dry matter of root (11.22%) was found M_3 (black polythene mulch) and the lowest (10.07%) was found M_0 (control treatment).

Significant combined effect of organic manure and mulching was observed on dry matter percentage of roots (Table 1). The highest dry matter of roots (11.84%) was observed in O_1M_3 (cowdung with black polythene mulch) and the lowest dry matter (9.30 %) was recorded from O_0M_0 (control treatment).

Cracking percentage of roots

Organic manure had significant effect on the cracking percentage of roots (Table 2). The highest percentage of root cracking (5.05%) was observed from O_1 (cowdung) and the lowest percentage of root cracking (3.42%) was found O_0 (control treatment). The percentage of cracked roots production of carrot was significantly influenced by the different types of mulching treatments (Table 2). The highest percentage of root cracking (5.07%) recorded from M_3 (black polythene mulch) and the lowest percentage of root cracking (3.74%) was found M_0 (control treatment).

Root cracking varied significantly due to combined effect of organic manure and mulching (Table 2). The highest cracked root (5.76%) was recorded from O_1M_3 (cowdung with black polythene mulch) and the lowest (2.5%) was observed from O_0M_0 (control treatment).

Rotting percentage of roots

The percentage of rotting of roots was significantly affected by the organic manure treatment (Table 2). The highest rotting percentage of roots (3.34%) was recorded O_1 (cowdung) and the lowest rotting percentage (1.54%) was observed O_0 (control treatment). The percentage of rotting roots of carrot was significantly affected by the mulching treatments (Table 2). The highest rotting percentage of roots ((3.24%) was recorded from M_3 (black polythene mulch) and the lowest rotting percentage (2.38%) was observed M_0 (control treatment).

The combined effect of organic manure and mulching was observed on rotting percentage of roots (Table 2). The highest percentage of rotten root (3.97%) was recorded from O_3M_3 (litter with black polythene mulch) but statistically similar result (3.89%) given O_1M_3 (cowdung with black polythene mulch) and the lowest (1.13%) was obtained from O_0M_0 (control treatment).

Fresh weight of root per plant

The fresh weight of root per plant significantly differed with organic manure treatments (Table 2). The maximum fresh weight of root (146.50 g) was recorded from O_1 (cowdung) and the lowest fresh weight of root (123.96 g) was recorded from O_0 (control treatment). The fresh weight of root per plant significantly differed with mulching (Table 2). The highest fresh weight of root (146.74 g) was recorded from M_3 (black polythene mulch) and the lowest fresh weight of root (128.65 g) was recorded from M_0 (control treatment).

A significant combined effect of organic manure and mulching was observed on fresh weight of root per plant (Table 2). The maximum (160.35 g) fresh weight of root was recorded from O_1M_3 (cowdung with black polythene mulch) and the minimum (120.14 cm) was found from O_0M_0 (control treatment).

Gross yield of roots per plot

Statistically significant variation due to different organic manure were found in gross yield of roots per plot (Table 2). The maximum gross yield per plot (5.85 kg) was obtained from O_1 (cowdung) and the minimum (4.95 kg) was recorded from O_0 (control treatment). The yield of carrot root per plot was found to be statistically significant due to the effect of mulching (Table 2). The highest yield (5.86 kg) was recorded M_3 (black polythene mulch) and the lowest root yield (5.14 kg) was recorded from M_0 (control treatment).

The interaction of different organic manure and mulching was found to be significant on gross yield of root per plot (Table 2). The maximum gross yield per plot (6.41 kg) was found from O_1M_3 (cowdung with black polythene mulch) and the minimum gross yield of root (4.80 kg) was recorded from O_0M_0 (control treatment).

Table 2. Effect of different organic manure and mulching treatment on yield of carrot

Treatment	Fresh weight of root per plant (g)	Gross yield of root per plot (kg)	Marketable yield of root per plot (kg)	Root cracking (%)	Root rotting (%)
Organic manure					
0_0	123.96 d	4.95 d	4.71 d	3.42 d	1.54 d
0_1	146.50 a	5.85 a	5.59 a	5.05 a	3.34 a
0_2	138.65 c	5.54 c	5.18 c	4.59 c	2.99 c
0_3	143.07 b	5.72 b	5.24 b	4.89 b	3.26 b
$LSD_{(0.05)}$	0.481	0.026	0.026	0.079	0.186
Mulch material					
M_0	128.65 d	5.14 d	4.82 d	3.74 d	2.38 d
M_1	141.80 b	5.67 b	5.23 b	4.76 b	2.88 b
M_2	134.99 c	5.39 c	5.01 c	4.38 c	2.63 c
M_3	146.74 a	5.86 a	5.37 a	5.07 a	3.24 a
$LSD_{(0.05)}$	0.481	0.026	0.026	0.079	0.186
Organic manure × Mulch material					
0_0M_0	120.14 n	4.80 n	4.62 m	2.50 m	1.13 h
0_0M_1	125.37 m	5.01 m	4.79 k	3.76 kl	1.61 fg
0_0M_2	124.74 m	4.98 m	4.73 l	3.61 l	1.52 g
0_0M_3	125.60 m	5.02 m	4.73 l	3.82 jk	1.91 f
0_1M_0	134.85 j	5.38 j	4.99 l	4.43 h	2.80 e
0_1M_1	150.63 c	6.02 c	5.48 c	5.26 b	3.60 ab
0_1M_2	140.18 g	5.60 g	5.16 g	4.76 ef	3.10 cd
0_1M_3	160.35 a	6.41 a	5.79 b	5.76 a	3.89 a
0_2M_0	128.77 l	5.14 l	4.79 k	3.93 j	2.90 de
0_2M_1	143.45 f	5.73 f	5.27 f	4.90 de	2.93 de
0_2M_2	136.87 i	5.46 i	5.06 h	4.52 gh	2.93 de
0_2M_3	145.53 e	5.82 e	5.34 e	5.00 cd	3.20 c
0_3M_0	130.85 k	5.23 k	4.87 j	4.11 i	2.70 e
0_3M_1	147.75 d	5.91 d	5.40 d	5.11 bc	3.40 bc
0_3M_2	138.19 h	5.52 h	5.10 h	4.63 fg	3.00 d
0_3M_3	155.50 b	6.22 b	6.61a	5.71 a	3.97 a
$LSD_{(0.05)}$	0.963	0.052	0.052	0.158	0.372
CV (%)	2.73	8.43	5.82	6.98	3.62

Marketable yield of roots per plot

The marketable yield of carrot root per plot was found to be statistically significant due to effect of organic manure (Table 2). The highest marketable yield (5.59 kg/plot) of root per plot was recorded from O_1 (cowdung) and the lowest marketable yield (4.71 kg) was recorded from O_0 (control treatment). Marketable yield of roots per plot varied significantly due to different mulch treatments (Table 2). The highest marketable yield of root (5.37 kg/plot) was obtained from M_3 (black polythene mulch) and the lowest yield (4.82 kg/plot) was recorded from M_0 (control treatment).

The combined effect of marketable yield of root per plot was significantly influenced by organic manure and mulching treatments (Table 2). The highest marketable yield of root per plot (6.61 kg) was observed from O_3M_3 (litter with black polythene mulch) and the lowest yield (4.62 kg) was obtained from O_0M_0 (control treatment).

IV. CONCLUSION

Different types of organic manure and mulching had significant combined effects of plant height at all other dates of observations. The highest total yield and marketable yield of carrot root was recorded from 6.41 kg/plot, 42.75 t/ha and 6.61 kg/plot, 38.61 t/ha the application of cowdung with black polythene mulch treatment.

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