Original Research Article

EFFECT OF ORGANIC MANURE AND MULCHING ON THE GROWTH AND YIELD OF CARROT (*Daucus carota* L.)

ABSTRACT

An experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2017 to February 2018. The research consisted of two factors, Factor A: four levels of organic manure, O_0: no organic manure), O_1: Cowdung (20 ton/ha), O_2: Vermicompost (10 ton/ha) and O_3: Cowdung, 10 ton/ha + Vermicompost, 5 ton/ha and Factor B: four mulches, M_0: No mulch, M_1: Water hyacinth, M_2: Black polythene and M_3: Wood ash, respectively. The experiment was laid out in Randomized Complete Block Design with three replications. Organic manure and mulching influenced significantly all the studied parameters. In case of organic manure the maximum plant height (44.55 cm) root length (14.73 cm), root diameter (4.11 cm), root weight (124.50 g), root yield (24.90 t/ha) and marketable root yield (23.85 ton/ha) were recorded from O_2 (Vermicompost) treatment. In case of mulches, maximum plant height (44.81 cm), root length (15.20 cm), root diameter (3.91 cm), root weight (117.85 g), root yield (23.57 t/ha) and marketable root yield (21.95 t/ha) found in M_2 (Black polythene) treatment. And the combined effect of the highest root yield (29.06 t/ha) was obtained from O_2M_2 (Vermicompost + black polythene) and lowest (13.20 t/ha) from O_0M_0 (control). So, it can be concluded that 10 ton/ha vermicompost with black polythene mulch was the best for carrot cultivation. The highest gross return (Tk. 563200), net return (Tk. 446355) and BCR (4.82) were obtained from the treatment combination from O_2M_2 where the lowest gross return (Tk. 207800), net return (Tk.112755) were obtained from O_0M_0 and lowest BCR (1.67) from O_1M_0.

Keywords: Carrot, Daucus carota, mulching,organic manure

1. INTRODUCTION

Carrot (*Daucus carota* L.) is one of the most ancient vegetable. It is grown in spring, summer and autumn in temperate countries and during winter in tropical and subtropical countries [1] and extensively cultivated in North and South America, Europe, Asia, North Africa [2]. It belongs to Apiaceae family and said to be originated in Mediterranean region and its cultivation as a crop also began in that region [3]. It has high nutritive value and possible diversified use in making different palatable foods like soups, stews, curries, salad, pickles, halua and jam. It contains appreciable amount of carotene, which can contribute a lot to overcome blindness of children in Bangladesh. The carrot is one of the profitable crops in Bangladesh. The edible part of this crop is characterized by its high beta carotene content, a precursor of vitamin A [4] and acts as an excellent source of iron, calcium, phosphorus, vitamin B, sugar and folic acid.

It has been reported that the entire production of carrot was 14075 metric tons under 1415 ha in Bangladesh during 2009-2010 year [5]. An average yield of carrot is about 25 tons/ha in Bangladesh [6] whichbaregcomparatively low from major carrot producer countries [7]. It grows successfully in Bangladesh during Rabi season when temperature ranges from 11.17ºC to 28.9ºC [8] and mid November to early December is the best time for its cultivation to get satisfactory yield [9]. The cultivation of carrot requires an ample supply of plant nutrient. Use of organic manure is essential for its proper growth and development. Organic matter content of Bangladesh soil is below 1% in about 60% cultivable land as compared to an ideal minimum value of 5% organic matter. In the area of continuous cropping, organic matter is supplied to soil through cowdung, compost, poultry manure etc. Several attempts have been made to increase the yield potential of root crops, but farmers are concerned with the use of inorganic fertilizers which results in decrease fertility of soil, soil health, contents of organic matter and decreases the microbial activity of soil [10]. Vermicompost is regarded ecologically sound bio-fertilizer and also cost–effective and eco-friendly [11]. Vermicompost is a potential source of readily available nutrients, growth enhancing substances and a number of beneficial micro-organisms like N-fixing, P- solubilizing and cellulose decomposing organisms [12,11]. It has been studied that the vermicompost effects on the plant growth, yield and quality of crops considerably. As a result, the seed germination, vigour, flowering and fruiting of plant, tuberization, development of root size colour shelf life and quality are apparently improved [13,14]. On an average Vermicompost contains 1.6% N, 0.7% P, 0.8% K, 0.5% Ca and 0.2% Mg. (Source: Panjab State Council for Science and Technology). In Bangladesh cowdung is used as an organic manure. Due to inadequate knowledge about the merits of organic manure, the farmers habituated extensive use of inorganic fertilizers. On an average, well rotten cowdung contains 0.5% N, 0.2% P_2O_5 and 0.5% K_2O [15]. In Bangladesh carrot is grown during winter season when the rainfall is scanty. So irrigation is essential for cultivation. But it increases the cost of cultivation. Under such condition mulching may be useful in reducing irrigation requirement. To serve this purpose water hyacinth, wood ash and black polythene sheets may be used as mulching materials. Mulching is highly effective in checking evaporation loss of soil moisture. Mulching protects the loss of soil moisture by soil evaporation induced by wind and reduces the irrigation requirement [16]. It increases the efficiency of applied N-fertilizer and irrigation [17]. Different mulches regulate soil moisture and temperature, suppress weeds and improve germination and emergence [18]. In addition, mulches increase microbial activity in the soil [19]. Higher yield and better quality, less infestation of insects diseases, earliness, prolong growing season, higher nutritive value of the produced, improved storability are the advantages of mulching [20]. In some extent, mulches reduce the invasion of insects and diseases [21].

2. MATERIAL AND METHODS

2.1 Experimental site

The experiment was conducted at the Horticulture Farm of the Sher-e-Bangla Agricultural University, Dhaka during November, 2017 to February, 2018. Laboratory works were done at Horticulture Laboratory in Sher-e-Bangla Agricultural University, Dhaka-1207.

2.2 Experiment Frame Work

The research was consisted of two factors: Factor A: four level of organic manure as O_0 = No organic manure, O_1= Cowdung (20 ton/ha), O_2 = Vermicompost (10 ton/ha), O_3 = Cowdung(10 ton/ ha) + Vermicompost (5 ton/ha). Factor B: Different type of mulches M_0 = No mulch, M_1 = Water hyacinth M_2 =Black polythene M_3 = Wood ash. The two factor experiment was laid out in a RCB design with three replications. The whole experimental area was 24.5m x 5.75 m which was divided into three blocks. Each block was again divided into 16 plots and hence there were 48 (16 x 3) unit plots. The treatments were assigned randomly in each block separately. The size of unit plot was 1.25m x 1.0m. The distance between two adjacent blocks and plots were 1.0 m and 0.5 m respectively.

2.3 Manure and fertilizer application:

The sources of applied N, P_2O_5, K_2O were as cowdung, vermicompost. The entire amounts of cowdung and vermicompost were applied during the final land preparation as per treatments.

2.4 Application of mulching:

Before sowing of seeds mulching was done with water hyacinth, wood ash and black polythene as per treatments. Fresh water hyacinth as chopped into small pieces (8-10cm) and dry then placed over the plots with a thickness of 12cm approximately. Black polythene sheet with small holes at plant distance was spread over the plots accordingly so that the seedlings could emerge easily through the holes.

2.5 Economic analysis

In computing economics, the varying levels of organic manure and different types of mulches were taken into consideration apart from other costs common to all the treatments as per package of practices. The benefit cost ratio (BCR) was calculated as follows:

BCR = Gross return per hectare (Tk.) ÷ Cost of production per hectare (Tk.)

2.6 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.

3. RESULTS AND DISCUSSION

3.1 Plant height

Plant height of carrot has measured at 30, 50, 70 days after sowing and at harvest. Figure 1, Showing that the maximum plant height was found (44.55cm) from the O_2 (Vermicompost 10 ton/ha) treatment at harvest, while the minimum height was observed (38.99cm) from O_0 (control) treatment. [22] reported similar results in plant height. Among the mulches materials treatment M_2 (black polythene) mulch produced the tallest plant (18.88 cm, 33.81 cm, 41.01 cm and 44.81 cm) at 30, 50, 70 DAS and at harvest respectively and followed by the M_1 (Water hyacinth) mulch at the same DAS. The shortest plant was observed for the treatment M_0 (control) (Figure 2).

The combined effect of organic manure and mulching was found significantly influenced in terms of plant height of carrot (Table 1). The maximum plant height (23.16 cm, 36.37 cm, 42.77 cm and 48.13 cm) was recorded from O_2M_2 (Vermicompost, 10 ton/ha + black polythene mulch) treatment at 30, 50, 70 DAS and at harvest respectively. On the other hand, the minimum plant height (12.00 cm, 17.22 cm, 30.93 cm and 35.43 cm) was found in plants of control plot O_0M_0 (No organic + no mulch) treatment at 30, 50, 70 DAS and at harvest respectively. [22] reported that combined application of 6 ton/ha vermicompost with water hyacinth mulch in carrot was the best for obtaining plant height, number of leaves, root length, root fresh weight and highest marketable yield.

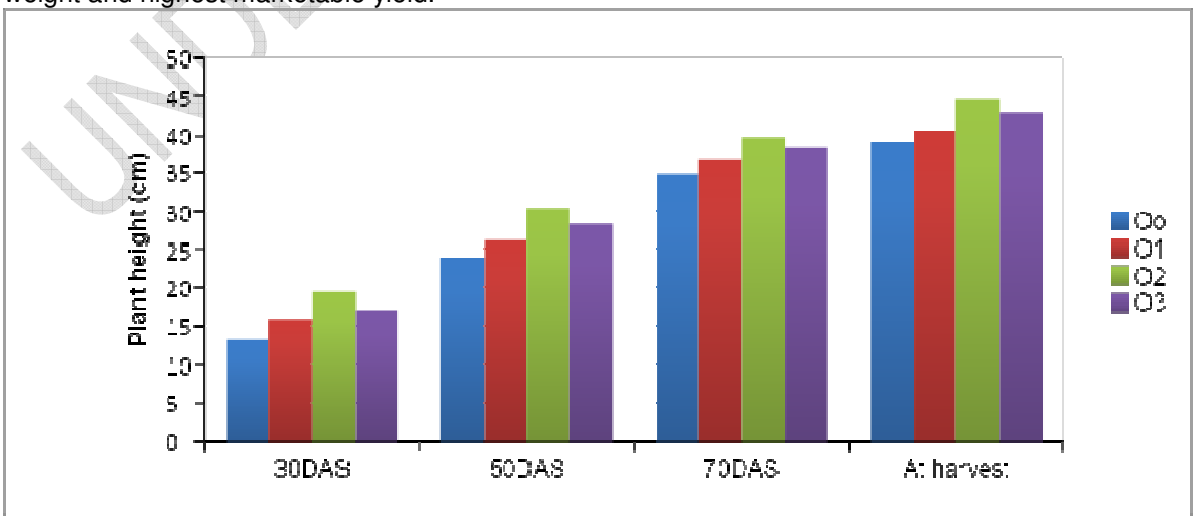

Figure 1: Effect of different organic manure on plant height at different days after sowing

[O_0 = No organic manure, O_1= Cowdung (20 ton/ha), O_2 = Vermicompost (10 ton/ha), O_3 = Cowdung (10 ton/ha) + Vermicompost (5 ton/ha)]

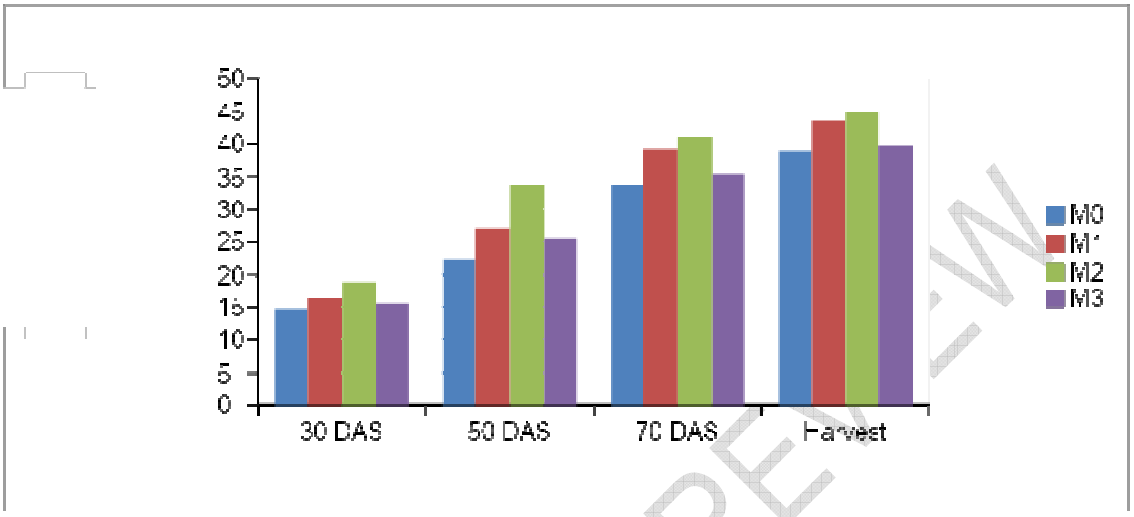

Figure 2: Effect of different mulches on plant height at different days after sowing

[M_0 = No mulch, M_1 = Water hyacinth, M_2 =Black polythene, M_3 = Wood ash]

3.2 Number of leaves per plant

The maximum number of leaves per plant (5.58, 10.48 and 11.72) was recorded from O_2 (Vermicompost, 10 ton/ha) treatment at 50, 70 DAS and at harvest respectively. The minimum leaf number (4.36, 8.25and 10.24) was found from O_0 (control) treatment respectively for same DAS(Figure 3). [23] state that the addition of vermicompost at ratio of 15 ton/ha, significantly increased plant growth and yield compared to control.

Table 1: Combined effect of organic manure and mulching on plant height at different days of carrot

Treatments	Plant height (cm)			
	30 DAS	50 DAS	70 DAS	Harvest
O_0M_0	12.00	17.22	30.93	35.43
O_0M_1	13.86	24.47	37.47	40.07
O_0M_2	14.36	32.20	39.33	42.33
O_0M_3	12.40	21.90	31.07	38.13
O_1M_0	13.47	20.30	31.67	35.73
O_1M_1	16.73	26.90	38.93	43.00
O_1M_2	17.57	32.40	40.67	43.67
O_1M_3	15.73	24.80	35.53	39.87
O_2M_0	17.87	26.83	37.13	43.53
O_2M_1	18.53	29.50	40.73	46.07
O_2M_2	23.16	36.37	42.77	48.13
O_2M_3	17.87	28.67	38.1	40.47
O_3M_0	15.20	25.10	35.67	40.87
O_3M_1	16.87	27.00	39.47	44.80
O_3M_2	20.47	34.26	41.27	45.13
O_3M_3	15.87	26.83	36.73	40.40
CV (%)	8.41	9.67	9.25	10.98

LSD (0.05)	2.53	2.21	4.29	4.04

[O_0 = No organic manure, O1= Cowdung (20 ton/ha), O_2 = (Vermicompost (10 ton/ha), O_3 = Cowdung(10 ton/ha)+ Vermicompost (5 ton/ha), M_0 = No mulch, M_1 = Water hyacinth, M_2 =Black polythene, M_3 = Wood ash]

At 50, 70 DAS and at harvest, the maximum number of leaves per plant (5.56, 10.55 and 12.08) was obtained from M_2 (Black polythene) treatment while the minimum number of leaves per plant (4.55, 8.15 and 10.02) at the same DAS was found from M_0 (No mulch) treatment (Figure 4). [24] reported that the treatment black polythene mulch was best among the various mulch treatments and recorded maximum plant height, number of leaves per plant, leaf fresh weight, leaf dry weight, root weight, root length, root diameter and total root yield of carrot.

The combined effect of different organic manure and mulch materials showed significant differences due to their application on number of leaves per plant of carrot at 50, 70 DAS and at harvest (Table-2). The maximum number of leaves per plant At 50, 70 DAS and at harvest was recorded 6.50, 11.77 and 13.00 respectively from treatment combination O_2M_2 (Vermicompost, 10 ton/ha + black polythene) while the minimum number of leaves per plant at 50, 70 DAS and at harvest were 3.73, 7.06 and 9.16, respectively from O_0M_0 (No organic manure + no mulch).

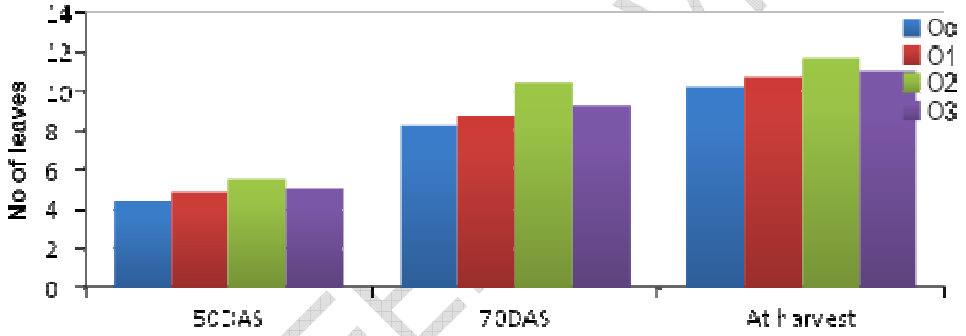

Figure 3: Effect of different organic manure on no. of leaves per plant at different days after sowing

[O_0 = No organic manure, O_1= Cowdung (20 ton/ha), O_2 = Vermicompost (10 ton/ha), O_3 = Cowdung (10 ton/ha) + Vermicompost (5 ton/ha)]

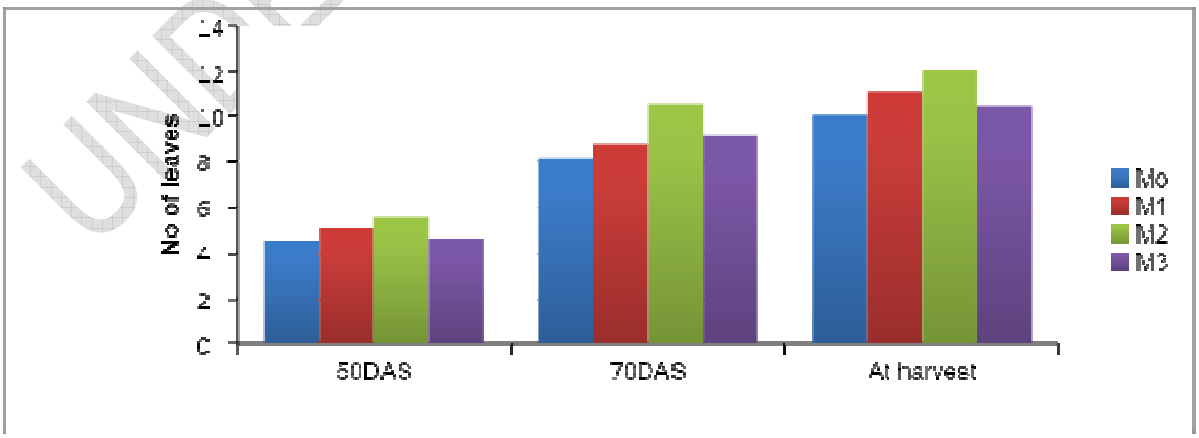

Figure 4: Effect of different mulches on no. of leaves per plant at different days after sowing

[M_0 = No mulch, M_1 = Water hyacinth, M_2 =Black polythene, M_3 = Wood ash]

3.3 Root length (cm)

The longest root length 14.73 cm was recorded from O_2 (Vermicompost (10 ton/ha) treatment while the shortest root length 11.91 cm was observed from control plot (Table 3). This finding is an agreement with the result of [25], they reported that the root length of carrot varied with different amount of manure application. Root length differed significantly due to the different mulch application. Maximum root length (15.21 cm) was recorded at treatment M_2 (Black polythene) and it was significantly different than other treatments. The minimum root length (11.96 cm) was found at M_0 (No mulch) (Table 5). This result is in accordance with the findings of [26].

The combined effect of organic manures and mulches showed significant variation on root length of carrot (Table 7). The longest root 17.00 cm was observed from the treatment combination of O_2M_2 (Vermicompost, 10 ton/ha + black polythene). The shortest root length (10.50 cm) was recorded from control O_0M_0 (No organic manure + no mulch) treatment.

3.4 Root diameter (cm)

Diameter of root was significantly influenced by the application of different level of organic manure (Table 3). The maximum diameter of root (4.12 cm) was recorded from O_2 (Vermicompost, 10 ton/ha) treatment and it was significantly different than other organic manure treatments. On the other hand, the minimum root diameter (3.14 cm) was observed from O_0 treatment (control). Root diameter was also significantly varied due to the use of different mulching materials in carrot (Table 5). The highest root diameter (3.92 cm) was obtained at the mulches treatment M_2 (Black polythene). The lowest root diameter of root (3.15 cm) was obtained at the treatment of M_0 (No mulch).

The maximum diameter of root (4.50 cm) was observed from the treatment combination of O_2M_2 (Vermicompost, 10 ton/ha + black polythene). The minimum diameter of root (2.43 cm) was recorded from control O_0M_0 (No organic manure + no mulch) treatment (Table 7).

3.5 Root weight per plant (g)

A significant variation was observed on root weight per plant due to use of different organic manures (Table 3). The maximum root weight per plant 124.50 g was recorded from O_2 (Vermicompost, 10 ton/ha) treatment. While the minimum root weight (47.58 g) was recorded from control plots. [27] found that organic manures increased the yield of carrot (10%-20%) compared with control. Different mulches materials showed significant variation for root weight per plant 0f carrot (Table 5). The highest root weight per plant (117.85 g) was found from M_2 (Black polythene). The lowest root weight per plant (92.23 g) was recorded from control treatment.

The maximum root weight per plant (82.53 g) was observed from treatment combination of O_2M_2 (Vermicompost, 10 ton/ha + black polythene) treatment. The minimum root weight per plant (35.73 g) was recorded from control plot O_0M_0 (No organic manure+ no mulch) (Table 7). [28] reported that combindly application of vermicompost (6 ton/ha) and water hyacinth mulching gave the highest marketable (27.89 ton/ha) and the gross yield (29.48 ton/ha) of carrot.

3.6 Root yield per plot (kg)

The maximum root weight per plot 3.11 kg was recorded from O_2 (Vermicompost, 10 ton/ha) treatment. While the minimum root weight (2.13kg) from control plots (Table 3). Different mulch materials showed significant variation for root weight per plot of carrot (Table 5). The highest root weight per plot (2.95 kg) was found from M_2 (Black polythene) treatment. The lowest root weight per plot (2.31kg) was recorded from control.

The combined effect of organic manures and mulch materials was found significant variation was observed on root weight per plot (Table 7). The maximum root weight per plot (3.63 kg) was observed from treatment combination of O_2M_2 (Vermicompost, 10 ton/ha + black polythene). The minimum root weight per plot (1.65 kg) was recorded from control plot O_0M_0 (No organic manure + no mulch).

3.7 Yield per ha (ton)

The root yield (24.90 ton/ha) recorded maximum from O_2 (Vermicompost, 10 ton/ha) treatment. The minimum root yield (17.00 ton/ha) was obtained from control O_0 (No organic manure) treatment (Table 4).

The highest root yield (23.57 ton/ha) was recorded from M_2 (Black polythene) treatment, while the lowest (18.45 ton /ha) was obtained from the control (Table 6).
The combined effect of organic manure and mulches was significantly varied on root yield (Table 8). However, the maximum root yield (29.07 ton/ha) was obtained from the treatment combination of O_2M_2 (Vermicompost, 10 ton/ha + black polythene) which was statistically significant different from the other treatments; whereas the minimum yield (13.20 ton/ha) was recorded from control plot O_0M_0 (No organic manure + no mulch).

3.8 Marketable yield (ton/ha)

The marketable root yield (23.85 ton/ha) recorded maximum from O_2 (Vermicompost, 10 ton/ha) treatment. The minimum root yield (13.82 ton/ha) was obtained from control O_0 (No organic manure) treatment (Table 4). The highest marketable yield per ha (21.95 ton) was recorded from M_2 (Black polythene) treatment, while the lowest (15.63 ton/ha) was obtained from the control (Table 6).
The combined effect of organic manures and mulches was significantly varied on Marketable yield per ha (Table 8). However, the maximum Marketable root yield per ha (28.16 ton) was obtained from the treatment combination of O_2M_2 (Vermicompost, 10 ton/ha + black polythene) which was statistically significant different from the other treatments; whereas the minimum yield (10.39 ton) was recorded from control plot O_0M_0 (No organic manure + no mulch).

3.9 Dry matter percentage of root (%)

The maximum dry matter of root per plant (16.06N%) was recorded from O_2 (Vermicompost, 10 ton/ha) treatment while the minimum (12.16 %) from control plots (Table 4). Root dry weight was markedly increased and achieved maximum (15.46 %) values in treatment of M_2 (Black polythene) treatment. The lowest root dry weight (13.36 %) was observed in control (Table 6).
A significant effect of organic manures and mulches combination on root dry weight was found (Table 8). The highest values of root dry weight (17.78 % were recorded due to O_2M_2 (Vermicompost, 10 ton/ha + black polythene) treatment. On opposition to, the lowest ones (10.90 %) were proceeded from combination O_0M_0 (No organic manure + no mulch).

Table 2: Combined effect of organic manure and mulching on leaves number per plant at different days of carrot

Treatments	Leaves number		
	50 days	70 days	Harvest
O_0M_0	3.73	7.06	9.17
O_0M_1	4.0	8.13	10.40
O_0M_2	5.0	9.27	10.80
O_0M_3	4.6	8.53	10.60
O_1M_0	4.67	7.80	9.27
O_1M_1	5.00	8.47	11.20
O_1M_2	5.20	10.20	12.00
O_1M_3	4.47	8.47	10.27
O_2M_0	5.13	9.53	11.53
O_2M_1	6.00	9.93	11.60
O_2M_2	6.50	11.77	13.00
O_2M_3	4.67	10.67	10.73
O_3M_0	4.67	8.20	10.13
O_3M_1	5.20	8.63	11.14
O_3M_2	5.50	10.95	12.50
O_3M_3	4.80	9.13	10.20
CV (%)	8.16	9.68	10.58
LSD (0.05)	0.83	0.85	0.38

[O_0 = No organic manure, O_1= Cowdung (20 ton/ha), O_2 = Vermicompost (10 ton/ha), O_3 = Cowdung (10 ton/ha) + Vermicompost (5 ton/ha), M_0 = No mulch, M1 = Water hyacinth, M_2 =Black polythene, M_3 = Wood ash]

Table 3: Effect of organic manure on yield parameters at harvest stage

Organic Manure	Root length (cm)	Root diameter (cm)	Root weight per plant (g)	Root weight per plot (kg)
O_0	11.91	3.14	85.83	2.13
O_1	13.19	3.42	96.67	2.42
O_2	14.74	4.12	124.50	3.11
O_3	13.30	3.73	116.41	2.81
CV (%)	11.45	12.62	12.43	10.27
LSD (0.05)	0.86	0.29	5.39	0.22

Table 4: Effect of organic manure on yield parameters at harvest stage

Organic Manure	Yield (ton/ha)	Marketable yield (ton/ha)	Root dry matter (%)
O_0	17.0	13.82	12.16
O_1	19.33	16.92	12.86
O_2	24.90	23.85	16.06
O_3	22.29	20.39	13.97
CV (%)	11.56	10.37	11.42
LSD (0.05)	1.92	1.57	0.45

Table 5: Effect of different mulching on yield parameters at harvest stage

Mulching	Root length (cm)	Root diameter (cm)	Root weight Per plant (g)	Root weight Per plot (kg)
M_0(No mulch)	11.98	3.15	92.23	2.31
M_1(Water hyacinth)	12.98	3.75	109.39	2.71
M_2(Black polythene)	15.21	3.92	117.85	2.95
M_3(Wood ash)	13.57	3.59	103.93	2.59
CV (%)	11.45	12.62	12.43	10.27
LSD (0.05)	0.78	0.22	4.37	0.18

Table 6: Effect of different mulching on yield parameters at harvest stage

Organic Manure	Yield (ton/ha)	Marketable yield (ton/ha)	Root dry matter (%)
O_0	18.45	15.63	12.62
O_1	21.71	19.24	13.87
O_2	23.57	21.95	15.46
O_3	20.78	18.17	13.11
CV (%)	11.56	10.37	11.42
LSD (0.05)	1.13	1.31	0.41

Table 7: Combined effect of organic manure and mulching on yield parameters of Carrot

Treatments	Root length (cm)	Root diameter (cm)	Root weight Per plant (g)	Root weight Per plot (kg)
O_0M_0	10.5	2.43	66	1.65
O_0M_1	12.13	3.44	96.27	2.32
O_0M_2	13.93	3.51	98.40	2.46
O_0M_3	11.07	3.16	82.67	2.07
O_1M_0	11.86	2.87	76.67	1.92
O_1M_1	13.00	3.60	102.27	2.56
O_1M_2	14.23	3.65	106.40	2.66
O_1M_3	13.67	3.55	101.33	2.53
O_2M_0	12.93	3.81	114	2.85
O_2M_1	13.74	4.17	122.53	3.06

O_2M_2	17.00	4.50	145.33	3.63
O_2M_3	15.27	4.00	116.13	2.90
O_3M_0	12.60	3.49	112.27	2.81
O_3M_1	13.07	3.80	116.50	2.91
O_3M_2	15.67	4.00	121.27	3.03
O_3M_3	14.27	3.65	115.60	2.89
CV (%)	11.45	12.62	12.43	10.27
LSD (0.05)	1.72	0.20	15.79	0.48

Table 8: Combined effect of organic manure and mulching on yield parameters of Carrot

Treatments	Yield (ton/ha)	Marketable yield (ton/ha)	Root dry weight (%)
O_0M_0	13.20	10.39	10.90
O_0M_1	18.59	14.12	12.80
O_0M_2	19.68	16.68	13.91
O_0M_3	16.53	14.08	11.05
O_1M_0	15.33	13.40	11.81
O_1M_1	20.45	19.08	12.85
O_1M_2	21.28	19.96	14.34
O_1M_3	20.24	15.24	12.45
O_2M_0	22.80	20.80	14.95
O_2M_1	24.51	23.36	16.12
O_2M_2	29.07	28.16	17.78
O_2M_3	23.23	23.08	15.42
O_3M_0	22.45	17.92	12.81
O_3M_1	23.31	20.40	13.73
O_3M_2	24.27	23.00	15.83
O_3M_3	23.12	20.26	13.53
CV (%)	11.56	10.37	11.42
LSD (0.05)	3.85	3.18	0.71

4. CONCLUSION

On the basis of results of the present study, it may be concluded that efficient production of carrot is increased by the judicial application of organic manure with black polythene. Experimental result revealed that the organic manure vermicompost (10 ton/ha) gave the highest yield. Mulching materials such as black polythene may be used for higher yield of carrot. Application of Vermicompost (10 ton/ha) with black polythene mulch is one of the most effective management practices to improve soil productivity. Thus, considering crop productivity, economic return and maintaining soil fertility, combined application of vermicompost (10 ton/ha) with black polythene mulch may be recommended to farmers for profitable carrot production with affecting the soil health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bose, T. K. and Som. M. G. 1990. Vegetable crops in India, Naya Prakash, Calcutta, India. 408-442.
2. Thomson H. C, Kelly W. C.1957. Vegetable crop. (5th Edition) McGraw Hill book, New York, USA. 227-335.
3. Shinohara, S. E. 1984. Technology of Horticultural root crops. Pakistan J. Biol. Sci,.3(2): 13-16.
4. Chandha, K. L. 2003. Hand book of horticulture. Indian Council of Agricultural Research (ICAR), New Delhi.
5. BBS, 2010. Yearbook of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Dhaka, Bangladesh. p. 124.
6. Rashidi, M. Abbassi, S. and Gholami, M. 2009. Interactive effects of plastic mulch and tillage method on yield and yield components of tomato (Lycopersicon esculentum). American Eurasian J. Agric. Env. Sci., 5: 420-427.
7. FAO, 2004. Production Year Book. Food and Agriculture Organization, Rome, Italy, 61(2): 99-111.
8. Alim, A. 1974. An Introduction to Bangladesh Agriculture. 1st Edn, Alim M, Dhaka. p. 9.
9. Rashid, M. M. 1993. Sabji Biggyan, 1st Edn. Golam Moyenuddin, Director, Text Book Division, Bangla Academy, Dhaka. pp. 502-507.
10. Chen, Y. P., Liu, Q., Liu, Y. J., Jia, F. A. and He, X. H. 2014. Responses of soil microbial activity to cadmium pollution and elevated CO2. Sci.Rep., 4(1) 4287-4289.
11. Amooaghaie, R. and Golmohammadi, S. 2017. Effect of Vermicompost on Growth, Essential Oil, and Health of Thymus Vulgaris. Compost sci. utilization 25(3):1-12
12. Archana, A. B. and Anubha, K. 2011. Standardization of Herbal Drugs: An Overview IRJP. 2 (12), 56-60.
13. Ansari, A. A. 2008. Effect of vermicompost and vermiwash on the productivity of spinach (Spinacia oleracea), onion (Allium cepa) and potato (Solanum tuberosum). World J. Agric. Sci. 4(5): 554-557.
14. Chanda, G. C., Bhunia, G. and Chakraborty, S. K. 2011. The effect of vermicompost and other fertilizers on the cultivation of tomato plants. J Hortic. Forest., 3(2): 42-45.
15. Yawalkar, K. S., Agrawal, J. P. and Bokde, S. 1984. Manures and Fertilizers. Agric. Horticultural Publishing House, Nagpur-440010, India. pp. 29-85.
16. Roy, A. K., Mushi, A. A. and Khan, A. H. 1990. Effect of different mulches on the growth of potato. Bangladesh J.Bot., 19(1): 41-46.
17. Rhee, K. M., Yoon, J. H. and Park, J. K. 1990. Effect of polythene film mulching on the changes of soil chemical properties during the sesame cropping season, Res. Rep. Rur. Adm., soil Fert. Abstr. 54: 116-27.
18. Frazier, W. A. 1957. Plastic mulches for horticultural crop. Bull. Agril Exptl. Stat., p. 562.
19. Aldefer, R. B. 1946. Seasonal variability in aggregation of hagers town silt loam. Soil sci., 62: 151-168.
20. Ahmed, K. U. 1999. Influence of different mulches on growth and yield of sweet potato. MS Thesis, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh.
21. Brown, J. E., Stevens, C., Vsborn, M. C. and Bryce, H. M. 1989. Black plastic mulch and spun bonded polyster row cover as method of southern blight control in bell peper. Plant Dis., 73(11): 931-932.
22. Rashid, M. M. and Shakur, M. A. 1986. Effect of date of planting and duration of growing period on the yield of carrot. Bangladesh Hort., 14(2): 28-32.
23. Azarmi, R., Ziveh, P. S. and Satari, M. R. 2008. Effect of Vermicompost on Growth, Yield and Nutrition Status of Tomato (Lycopersicum esculentum). Pakistan J. Bio. Sci. 11: 1797-1802.

24. Jaysawal, N., Singh, Dr. G., Kanojia, Dr. A. and Debbarma, B. 2018. Effect of different mulches on growth and yield of carrot (Daucus carota L.). Int. J. chem. stud., 6(4): 381-384.
25. Schuch, S. M. L., Soares M. H. G. and Schuck, E. 1999. Evaluation of carrot cultivars using two sources for organic manures, in Porto Alegre County, RS, Brazil.Pesquisa-Agropecuaria-Gaucha, 5 (2): 193-200.
26. Rahman, M. A., Islam, T., Mamun, M. A. A., Rahman, M. S. and Ashraf, Ms. S. (2018). Yield and Quality Performance of Carrot under Different Organic and Inorganic Nutrient Sources with Mulching Options. Asian J. Agric. Hort. Res. 1(4): 1-8.
27. Lang, H. 1984. Use of carrot cultivars and organic manures in early carrot growing for reliability, yield and quality. Kar to effelbau. 35(2): 65-69.