

**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<sub>0</sub>: no organic manure), O<sub>1</sub>: Cowdung (20 ton/ha), O<sub>2</sub>: Vermicompost (10 ton/ha) and O<sub>3</sub>: Cowdung, 10 ton/ha + Vermicompost, 5 ton/ha and Factor B: four mulches, M<sub>0</sub>: No mulch, M<sub>1</sub>: Water hyacinth, M<sub>2</sub>: Black polythene and M<sub>3</sub>: 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<sub>2</sub> (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<sub>2</sub> (Black polythene) treatment. And the combined effect of the highest root yield (29.06 t/ha) was obtained from O<sub>2</sub>M<sub>2</sub> (Vermicompost + black polythene) and lowest (13.20 t/ha) from O<sub>0</sub>M<sub>0</sub> (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<sub>2</sub>M<sub>2</sub> where the lowest gross return (Tk. 207800), net return (Tk.112755) were obtained from O<sub>0</sub>M<sub>0</sub> and lowest BCR (1.67) from O<sub>1</sub>M<sub>0</sub>.

*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.

26 It has been reported that the entire production of carrot was 14075 metric tons under 1415 ha in  
27 Bangladesh during 2009-2010 year [5]. An average yield of carrot is about 25 tons/ha in Bangladesh [6]  
28 which is comparatively low from major carrot producer countries [7]. It grows successfully in  
29 Bangladesh during Rabi season when temperature ranges from 11.17°C to 28.9°C [8] and mid November  
30 to early December is the best time for its cultivation to get satisfactory yield [9]. The cultivation of carrot  
31 requires an ample supply of plant nutrient. Use of organic manure is essential for its proper growth and  
32 development. Organic matter content of Bangladesh soil is below 1% in about 60% cultivable land as  
33 compared to an ideal minimum value of 5% organic matter. In the area of continuous cropping, organic  
34 matter is supplied to soil through cowdung, compost, poultry manure etc. Several attempts have been  
35 made to increase the yield potential of root crops, but farmers are concerned with the use of inorganic  
36 fertilizers which results in decrease fertility of soil, soil health, contents of organic matter and decreases  
37 the microbial activity of soil [10]. Vermicompost is regarded ecologically sound bio-fertilizer and also cost-  
38 effective and eco-friendly [11]. Vermicompost is a potential source of readily available nutrients, growth  
39 enhancing substances and a number of beneficial micro-organisms like N-fixing, P- solubilizing and  
40 cellulose decomposing organisms [12,11]. It has been studied that the vermicompost effects on the plant  
41 growth, yield and quality of crops considerably. As a result, the seed germination, vigour, flowering and  
42 fruiting of plant, tuberization, development of root size colour shelf life and quality are apparently  
43 improved [13,14]. On an average Vermicompost contains 1.6% N, 0.7% P, 0.8% K, 0.5% Ca and 0.2%  
44 Mg. (Source: Panjab State Council for Science and Technology). In Bangladesh cowdung is used as an  
45 organic manure. Due to inadequate knowledge about the merits of organic manure, the farmers  
46 habituated extensive use of inorganic fertilizers. On an average, well rotten cowdung contains 0.5% N,  
47 0.2% P<sub>2</sub>O<sub>5</sub> and 0.5% K<sub>2</sub>O [15]. In Bangladesh carrot is grown during winter season when the rainfall is  
48 scanty. So irrigation is essential for cultivation. But it increases the cost of cultivation. Under such  
49 condition mulching may be useful in reducing irrigation requirement. To serve this purpose water  
50 hyacinth, wood ash and black polythene sheets may be used as mulching materials. Mulching is highly  
51 effective in checking evaporation loss of soil moisture. Mulching protects the loss of soil moisture by soil  
52 evaporation induced by wind and reduces the irrigation requirement [16]. It increases the efficiency of  
53 applied N-fertilizer and irrigation [17]. Different mulches regulate soil moisture and temperature, suppress  
54 weeds and improve germination and emergence [18]. In addition, mulches increase microbial activity in  
55 the soil [19]. Higher yield and better quality, less infestation of insects diseases, earliness, prolong  
56 growing season, higher nutritive value of the produced, improved storability are the advantages of  
57 mulching [20]. In some extent, mulches reduce the invasion of insects and diseases [21].

## 59 2. MATERIAL AND METHODS

### 61 2.1 Experimental site

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

### 66 2.2 Experiment Frame Work

67 The research was consisted of two factors: Factor A: four level of organic manure as O<sub>0</sub> = No organic  
68 manure, O<sub>1</sub> = Cowdung (20 ton/ha), O<sub>2</sub> = Vermicompost (10 ton/ha), O<sub>3</sub> = Cowdung(10 ton/ ha) +  
69 Vermicompost (5 ton/ha). Factor B: Different type of mulches M<sub>0</sub> = No mulch, M<sub>1</sub> = Water hyacinth M<sub>2</sub>  
70 =Black polythene M<sub>3</sub> = Wood ash. The two factor experiment was laid out in a RCB design with three  
71 replications. The whole experimental area was 24.5m x 5.75 m which was divided into three blocks. Each  
72 block was again divided into 16 plots and hence there were 48 (16 x 3) unit plots. The treatments were  
73 assigned randomly in each block separately. The size of unit plot was 1.25m x 1.0m. The distance  
74 between two adjacent blocks and plots were 1.0 m and 0.5 m respectively.

### 76 2.3 Manure and fertilizer application:

77 The sources of applied N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O were as cowdung, vermicompost. The entire amounts of cowdung  
78 and vermicompost were applied during the final land preparation as per treatments.

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#### 2.4 Application of mulching:

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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.

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#### 2.5 Economic analysis

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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:

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

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#### 2.6 Statistical analysis

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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.

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### 3. RESULTS AND DISCUSSION

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#### 3.1 Plant height

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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<sub>2</sub> (Vermicompost 10 ton/ha) treatment at harvest, while the minimum height was observed (38.99cm) from O<sub>0</sub> (control) treatment. [22] reported similar results in plant height. Among the mulches materials treatment M<sub>2</sub> (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<sub>1</sub> (Water hyacinth) mulch at the same DAS. The shortest plant was observed for the treatment M<sub>0</sub> (control) (Figure 2).

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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<sub>2</sub>M<sub>2</sub> (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<sub>0</sub>M<sub>0</sub> (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.

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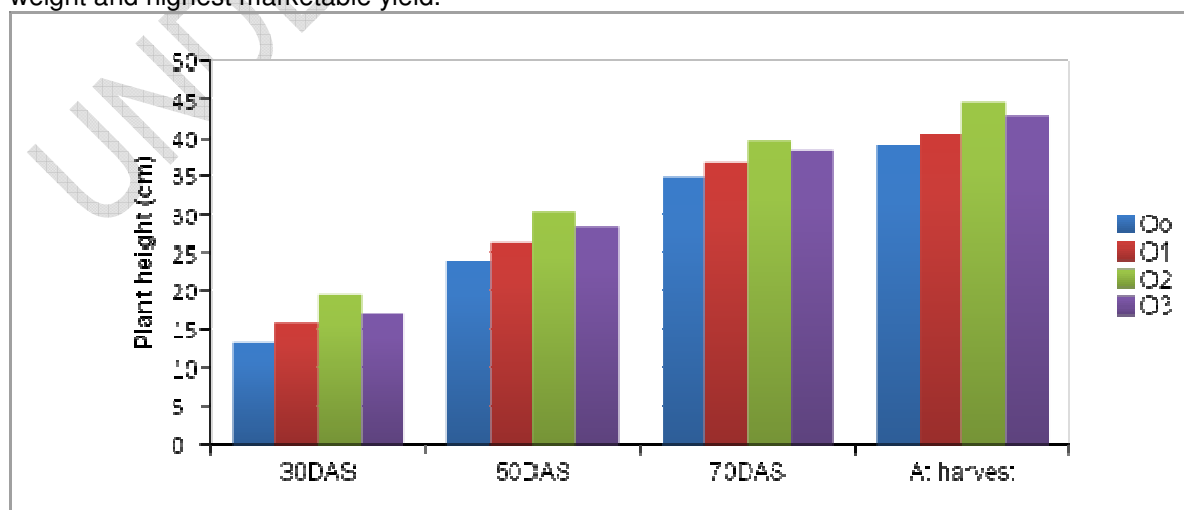
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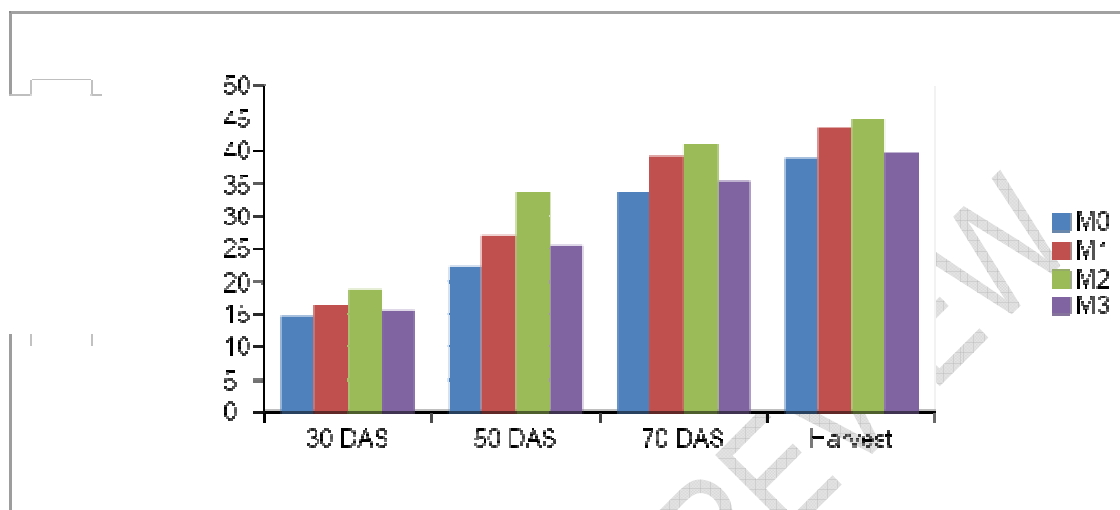
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**Figure 1: Effect of different organic manure on plant height at different days after sowing**

[O<sub>0</sub> = No organic manure, O<sub>1</sub>= Cowdung (20 ton/ha), O<sub>2</sub> = Vermicompost (10 ton/ha), O<sub>3</sub> = Cowdung (10 ton/ha) + Vermicompost (5 ton/ha)]



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

[M<sub>0</sub> = No mulch, M<sub>1</sub> = Water hyacinth, M<sub>2</sub> = Black polythene, M<sub>3</sub> = 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<sub>2</sub> (Vermicompost, 10 ton/ha) treatment at 50, 70 DAS and at harvest respectively. The minimum leaf number (4.36, 8.25 and 10.24) was found from O<sub>0</sub> (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.

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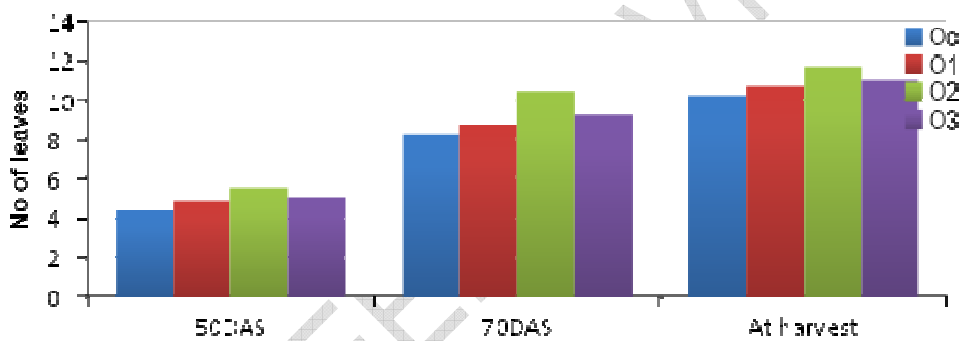
**Table 1: Combined effect of organic manure and mulching on plant height at different days of carrot**

Treatments	Plant height (cm)			
	30 DAS	50 DAS	70 DAS	Harvest
O <sub>0</sub> M <sub>0</sub>	12.00	17.22	30.93	35.43
O <sub>0</sub> M <sub>1</sub>	13.86	24.47	37.47	40.07
O <sub>0</sub> M <sub>2</sub>	14.36	32.20	39.33	42.33
O <sub>0</sub> M <sub>3</sub>	12.40	21.90	31.07	38.13
O <sub>1</sub> M <sub>0</sub>	13.47	20.30	31.67	35.73
O <sub>1</sub> M <sub>1</sub>	16.73	26.90	38.93	43.00
O <sub>1</sub> M <sub>2</sub>	17.57	32.40	40.67	43.67
O <sub>1</sub> M <sub>3</sub>	15.73	24.80	35.53	39.87
O <sub>2</sub> M <sub>0</sub>	17.87	26.83	37.13	43.53
O <sub>2</sub> M <sub>1</sub>	18.53	29.50	40.73	46.07
O <sub>2</sub> M <sub>2</sub>	23.16	36.37	42.77	48.13
O <sub>2</sub> M <sub>3</sub>	17.87	28.67	38.1	40.47
O <sub>3</sub> M <sub>0</sub>	15.20	25.10	35.67	40.87
O <sub>3</sub> M <sub>1</sub>	16.87	27.00	39.47	44.80
O <sub>3</sub> M <sub>2</sub>	20.47	34.26	41.27	45.13
O <sub>3</sub> M <sub>3</sub>	15.87	26.83	36.73	40.40
CV (%)	8.41	9.67	9.25	10.98

136 LSD (0.05) 2.53 2.21 4.29 4.04  
 137 [O<sub>0</sub> = No organic manure, O<sub>1</sub>= Cowdung (20 ton/ha), O<sub>2</sub> = Vermicompost (10 ton/ha), O<sub>3</sub> = Cowdung( 10 ton/ha)+  
 138 Vermicompost (5 ton/ha), M<sub>0</sub> = No mulch, M<sub>1</sub> = Water hyacinth, M<sub>2</sub>=Black polythene, M<sub>3</sub> = Wood ash]

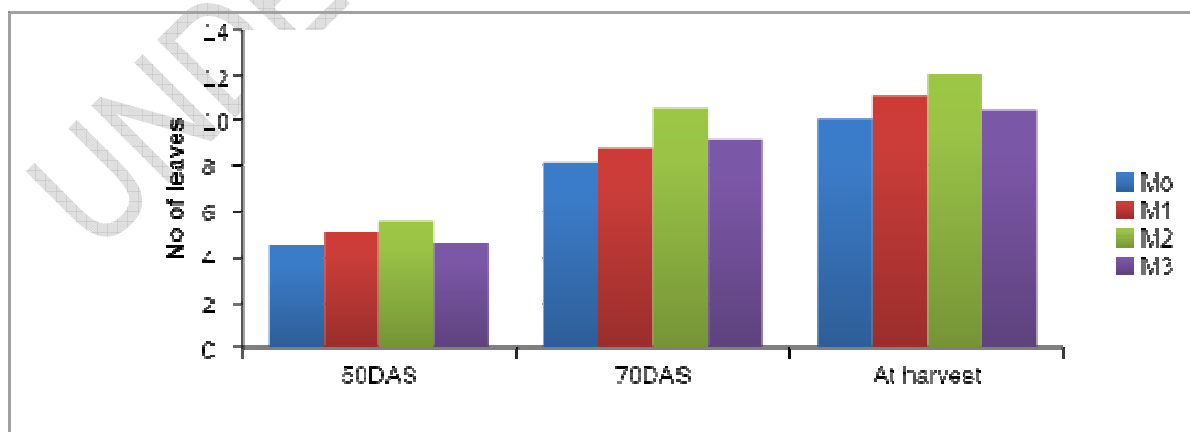
139 At 50, 70 DAS and at harvest, the maximum number of leaves per plant (5.56, 10.55 and 12.08) was  
 140 obtained from M<sub>2</sub> (Black polythene) treatment while the minimum number of leaves per plant (4.55, 8.15  
 141 and 10.02) at the same DAS was found from M<sub>0</sub> (No mulch) treatment (Figure 4). [24] reported that the  
 142 treatment black polythene mulch was best among the various mulch treatments and recorded maximum  
 143 plant height, number of leaves per plant, leaf fresh weight, leaf dry weight, root weight, root length, root  
 144 diameter and total root yield of carrot.

145 The combined effect of different organic manure and mulch materials showed significant differences due  
 146 to their application on number of leaves per plant of carrot at 50, 70 DAS and at harvest (Table-2). The  
 147 maximum number of leaves per plant At 50, 70 DAS and at harvest was recorded 6.50, 11.77 and 13.00  
 148 respectively from treatment combination O<sub>2</sub>M<sub>2</sub> (Vermicompost, 10 ton/ha + black polythene) while the  
 149 minimum number of leaves per plant at 50, 70 DAS and at harvest were 3.73, 7.06 and 9.16, respectively  
 150 from O<sub>0</sub>M<sub>0</sub> (No organic manure + no mulch).  
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 154 **Figure 3: Effect of different organic manure on no. of leaves per plant at different days after**  
 155 **sowing**

156 [O<sub>0</sub> = No organic manure, O<sub>1</sub>= Cowdung (20 ton/ha), O<sub>2</sub> = Vermicompost (10 ton/ha), O<sub>3</sub> = Cowdung (10 ton/ha) +  
 157 Vermicompost (5 ton/ha)]  
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 161 **Figure 4: Effect of different mulches on no. of leaves per plant at different days after sowing**  
 162 [M<sub>0</sub> = No mulch, M<sub>1</sub> = Water hyacinth, M<sub>2</sub> =Black polythene, M<sub>3</sub> = Wood ash]

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### 164 **3.3 Root length (cm)**

165 The longest root length 14.73 cm was recorded from O<sub>2</sub> (Vermicompost (10 ton/ha) treatment while the  
166 shortest root length 11.91 cm was observed from control plot (Table 3). This finding is an agreement with  
167 the result of [25], they reported that the root length of carrot varied with different amount of manure  
168 application. Root length differed significantly due to the different mulch application. Maximum root length  
169 (15.21 cm) was recorded at treatment M<sub>2</sub> (Black polythene) and it was significantly different than other  
170 treatments. The minimum root length (11.96 cm) was found at M<sub>0</sub> (No mulch) (Table 5). This result is in  
171 accordance with the findings of [26].

172 The combined effect of organic manures and mulches showed significant variation on root length of carrot  
173 (Table 7). The longest root 17.00 cm was observed from the treatment combination of O<sub>2</sub>M<sub>2</sub>  
174 (Vermicompost, 10 ton/ha + black polythene). The shortest root length (10.50 cm) was recorded from  
175 control O<sub>0</sub>M<sub>0</sub> (No organic manure + no mulch) treatment.  
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### 177 **3.4 Root diameter (cm)**

178 Diameter of root was significantly influenced by the application of different level of organic manure (Table  
179 3). The maximum diameter of root (4.12 cm) was recorded from O<sub>2</sub> (Vermicompost, 10 ton/ha) treatment  
180 and it was significantly different than other organic manure treatments. On the other hand, the minimum  
181 root diameter (3.14 cm) was observed from O<sub>0</sub> treatment (control). Root diameter was also significantly  
182 varied due to the use of different mulching materials in carrot (Table 5). The highest root diameter (3.92  
183 cm) was obtained at the mulches treatment M<sub>2</sub> (Black polythene). The lowest root diameter of root (3.15  
184 cm) was obtained at the treatment of M<sub>0</sub> (No mulch).

185 The maximum diameter of root (4.50 cm) was observed from the treatment combination of O<sub>2</sub>M<sub>2</sub>  
186 (Vermicompost, 10 ton/ha + black polythene). The minimum diameter of root (2.43 cm) was recorded  
187 from control O<sub>0</sub>M<sub>0</sub> (No organic manure + no mulch) treatment (Table 7).  
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### 189 **3.5 Root weight per plant (g)**

190 A significant variation was observed on root weight per plant due to use of different organic manures  
191 (Table 3). The maximum root weight per plant 124.50 g was recorded from O<sub>2</sub> (Vermicompost, 10 ton/ha)  
192 treatment. While the minimum root weight (47.58 g) was recorded from control plots. [27] found that  
193 organic manures increased the yield of carrot (10%-20%) compared with control. Different mulches  
194 materials showed significant variation for root weight per plant of carrot (Table 5). The highest root weight  
195 per plant (117.85 g) was found from M<sub>2</sub> (Black polythene). The lowest root weight per plant (92.23 g) was  
196 recorded from control treatment.

197 The maximum root weight per plant (82.53 g) was observed from treatment combination of O<sub>2</sub>M<sub>2</sub>  
198 (Vermicompost, 10 ton/ha + black polythene) treatment. The minimum root weight per plant (35.73 g) was  
199 recorded from control plot O<sub>0</sub>M<sub>0</sub> (No organic manure+ no mulch) (Table 7). [28] reported that combin-  
200 dly application of vermicompost (6 ton/ha) and water hyacinth mulching gave the highest marketable (27.89  
201 ton/ha) and the gross yield (29.48 ton/ha) of carrot.  
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### 203 **3.6 Root yield per plot (kg)**

204 The maximum root weight per plot 3.11 kg was recorded from O<sub>2</sub> (Vermicompost, 10 ton/ha) treatment.  
205 While the minimum root weight (2.13kg) from control plots (Table 3). Different mulch materials showed  
206 significant variation for root weight per plot of carrot (Table 5). The highest root weight per plot (2.95 kg)  
207 was found from M<sub>2</sub> (Black polythene) treatment. The lowest root weight per plot (2.31kg) was recorded  
208 from control.

209 The combined effect of organic manures and mulch materials was found significant variation was  
210 observed on root weight per plot (Table 7). The maximum root weight per plot (3.63 kg) was observed  
211 from treatment combination of O<sub>2</sub>M<sub>2</sub> (Vermicompost, 10 ton/ha + black polythene). The minimum root  
212 weight per plot (1.65 kg) was recorded from control plot O<sub>0</sub>M<sub>0</sub> (No organic manure + no mulch).  
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### 214 **3.7 Yield per ha (ton)**

215 The root yield (24.90 ton/ha) recorded maximum from O<sub>2</sub> (Vermicompost, 10 ton/ha) treatment. The  
216 minimum root yield (17.00 ton/ha) was obtained from control O<sub>0</sub> (No organic manure) treatment (Table 4).

216 The highest root yield (23.57 ton/ha) was recorded from M<sub>2</sub> (Black polythene) treatment, while the lowest  
 217 (18.45 ton /ha) was obtained from the control (Table 6).

218 The combined effect of organic manure and mulches was significantly varied on root yield (Table 8).  
 219 However, the maximum root yield (29.07 ton/ha) was obtained from the treatment combination of O<sub>2</sub>M<sub>2</sub>  
 220 (Vermicompost, 10 ton/ha + black polythene) which was statistically significant different from the other  
 221 treatments; whereas the minimum yield (13.20 ton/ha) was recorded from control plot O<sub>0</sub>M<sub>0</sub> (No organic  
 222 manure + no mulch).

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### 224 3.8 Marketable yield (ton/ha)

225 The marketable root yield (23.85 ton/ha) recorded maximum from O<sub>2</sub> (Vermicompost, 10 ton/ha)  
 226 treatment. The minimum root yield (13.82 ton/ha) was obtained from control O<sub>0</sub> (No organic manure)  
 227 treatment (Table 4). The highest marketable yield per ha (21.95 ton) was recorded from M<sub>2</sub> (Black  
 228 polythene) treatment, while the lowest (15.63 ton/ha) was obtained from the control (Table 6).

229 The combined effect of organic manures and mulches was significantly varied on Marketable yield per ha  
 230 (Table 8). However, the maximum Marketable root yield per ha (28.16 ton) was obtained from the  
 231 treatment combination of O<sub>2</sub>M<sub>2</sub> (Vermicompost, 10 ton/ha + black polythene) which was statistically  
 232 significant different from the other treatments; whereas the minimum yield (10.39 ton) was recorded from  
 233 control plot O<sub>0</sub>M<sub>0</sub> (No organic manure + no mulch).

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### 235 3.9 Dry matter percentage of root (%)

236 The maximum dry matter of root per plant (16.06N%) was recorded from O<sub>2</sub> (Vermicompost, 10 ton/ha)  
 237 treatment while the minimum (12.16 %) from control plots (Table 4). Root dry weight was markedly  
 238 increased and achieved maximum (15.46 %) values in treatment of M<sub>2</sub> (Black polythene) treatment. The  
 239 lowest root dry weight (13.36 %) was observed in control (Table 6).

240 A significant effect of organic manures and mulches combination on root dry weight was found (Table 8).  
 241 The highest values of root dry weight (17.78 % were recorded due to O<sub>2</sub>M<sub>2</sub> (Vermicompost, 10 ton/ha +  
 242 black polythene) treatment. On opposition to, the lowest ones (10.90 %) were proceeded from  
 243 combination O<sub>0</sub>M<sub>0</sub> (No organic manure + no mulch).

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

Treatments	Leaves number		
	50 days	70 days	Harvest
O <sub>0</sub> M <sub>0</sub>	3.73	7.06	9.17
O <sub>0</sub> M <sub>1</sub>	4.0	8.13	10.40
O <sub>0</sub> M <sub>2</sub>	5.0	9.27	10.80
O <sub>0</sub> M <sub>3</sub>	4.6	8.53	10.60
O <sub>1</sub> M <sub>0</sub>	4.67	7.80	9.27
O <sub>1</sub> M <sub>1</sub>	5.00	8.47	11.20
O <sub>1</sub> M <sub>2</sub>	5.20	10.20	12.00
O <sub>1</sub> M <sub>3</sub>	4.47	8.47	10.27
O <sub>2</sub> M <sub>0</sub>	5.13	9.53	11.53
O <sub>2</sub> M <sub>1</sub>	6.00	9.93	11.60
O <sub>2</sub> M <sub>2</sub>	6.50	11.77	13.00
O <sub>2</sub> M <sub>3</sub>	4.67	10.67	10.73
O <sub>3</sub> M <sub>0</sub>	4.67	8.20	10.13
O <sub>3</sub> M <sub>1</sub>	5.20	8.63	11.14
O <sub>3</sub> M <sub>2</sub>	5.50	10.95	12.50
O <sub>3</sub> M <sub>3</sub>	4.80	9.13	10.20
CV (%)	8.16	9.68	10.58
LSD (0.05)	0.83	0.85	0.38

247 [O<sub>0</sub> = No organic manure, O<sub>1</sub>= Cowdung (20 ton/ha), O<sub>2</sub> = Vermicompost (10 ton/ha), O<sub>3</sub> = Cowdung (10 ton/ha) +  
 248 Vermicompost (5 ton/ha), M<sub>0</sub> = No mulch, M<sub>1</sub> = Water hyacinth, M<sub>2</sub> =Black polythene, M<sub>3</sub> = Wood ash]

249 **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 <sub>0</sub>	11.91	3.14	85.83	2.13
O <sub>1</sub>	13.19	3.42	96.67	2.42
O <sub>2</sub>	14.74	4.12	124.50	3.11
O <sub>3</sub>	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

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251 **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 <sub>0</sub>	17.0	13.82	12.16
O <sub>1</sub>	19.33	16.92	12.86
O <sub>2</sub>	24.90	23.85	16.06
O <sub>3</sub>	22.29	20.39	13.97
CV (%)	11.56	10.37	11.42
LSD (0.05)	1.92	1.57	0.45

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253 **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 <sub>0</sub> (No mulch)	11.98	3.15	92.23	2.31
M <sub>1</sub> (Water hyacinth)	12.98	3.75	109.39	2.71
M <sub>2</sub> (Black polythene)	15.21	3.92	117.85	2.95
M <sub>3</sub> (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

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255 **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 <sub>0</sub>	18.45	15.63	12.62
O <sub>1</sub>	21.71	19.24	13.87
O <sub>2</sub>	23.57	21.95	15.46
O <sub>3</sub>	20.78	18.17	13.11
CV (%)	11.56	10.37	11.42
LSD (0.05)	1.13	1.31	0.41

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257 **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 <sub>0</sub> M <sub>0</sub>	10.5	2.43	66	1.65
O <sub>0</sub> M <sub>1</sub>	12.13	3.44	96.27	2.32
O <sub>0</sub> M <sub>2</sub>	13.93	3.51	98.40	2.46
O <sub>0</sub> M <sub>3</sub>	11.07	3.16	82.67	2.07
O <sub>1</sub> M <sub>0</sub>	11.86	2.87	76.67	1.92
O <sub>1</sub> M <sub>1</sub>	13.00	3.60	102.27	2.56
O <sub>1</sub> M <sub>2</sub>	14.23	3.65	106.40	2.66
O <sub>1</sub> M <sub>3</sub>	13.67	3.55	101.33	2.53
O <sub>2</sub> M <sub>0</sub>	12.93	3.81	114	2.85
O <sub>2</sub> M <sub>1</sub>	13.74	4.17	122.53	3.06



O <sub>2</sub> M <sub>2</sub>	17.00	4.50	145.33	3.63
O <sub>2</sub> M <sub>3</sub>	15.27	4.00	116.13	2.90
O <sub>3</sub> M <sub>0</sub>	12.60	3.49	112.27	2.81
O <sub>3</sub> M <sub>1</sub>	13.07	3.80	116.50	2.91
O <sub>3</sub> M <sub>2</sub>	15.67	4.00	121.27	3.03
O <sub>3</sub> M <sub>3</sub>	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

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**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 <sub>0</sub> M <sub>0</sub>	13.20	10.39	10.90
O <sub>0</sub> M <sub>1</sub>	18.59	14.12	12.80
O <sub>0</sub> M <sub>2</sub>	19.68	16.68	13.91
O <sub>0</sub> M <sub>3</sub>	16.53	14.08	11.05
O <sub>1</sub> M <sub>0</sub>	15.33	13.40	11.81
O <sub>1</sub> M <sub>1</sub>	20.45	19.08	12.85
O <sub>1</sub> M <sub>2</sub>	21.28	19.96	14.34
O <sub>1</sub> M <sub>3</sub>	20.24	15.24	12.45
O <sub>2</sub> M <sub>0</sub>	22.80	20.80	14.95
O <sub>2</sub> M <sub>1</sub>	24.51	23.36	16.12
O <sub>2</sub> M <sub>2</sub>	29.07	28.16	17.78
O <sub>2</sub> M <sub>3</sub>	23.23	23.08	15.42
O <sub>3</sub> M <sub>0</sub>	22.45	17.92	12.81
O <sub>3</sub> M <sub>1</sub>	23.31	20.40	13.73
O <sub>3</sub> M <sub>2</sub>	24.27	23.00	15.83
O <sub>3</sub> M <sub>3</sub>	23.12	20.26	13.53
CV (%)	11.56	10.37	11.42
LSD (0.05)	3.85	3.18	0.71

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**4. CONCLUSION**

On the basis of results of the present study, it may be concluded that efficient production of carrot is increased by the judicious 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.

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**COMPETING INTERESTS**

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Authors have declared that no competing interests exist.

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