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Effect of organic manures and mulching on growth and yield of carrot

R. Rani, M.A. Malek and M. Robbani
Department of Horticulture, Patuakhali Science and Technology University, Patuakhali, Bangladesh
E-mail: malek_pstu@yahoo.com

Abstract: The experiment comprised of two factors such as - organic manures viz. F_0 (control), F_1 (cowdung), F_2 (vermi-compost), F_3 (poultry manure), and mulches viz. M_0 (control), M_1 (rice straw), M_2 (water hyacinth) respectively. It was laid out in Randomized Complete Block Design (RCBD) with three replications. The results of the experiment shown that different organic manures and mulches had significant influences of all the parameters studied. The fresh weight of root (121.31g), and dry matter of root (17.49%) were found the highest from cowdung treatment and the lowest 103.62g, 13.86% from control. Again, the highest fresh weight of root (122.34g), dry matter of root (17.06%) was found from water hyacinth mulch treatment and the lowest 109.29g and 15.78% were found from control. For combined effect, maximum fresh weight of root (134.51g) and dry matter of root (18.87%) were found from application of cowdung with water hyacinth mulch and minimum 103.27g and 13.82% from control treatment. In addition, the highest total yield (57.93 t/ha) and marketable yield (49.11 ton/ha) were recorded from cowdung treatment and the lowest 51.78 t/ha and 41.44 ton/ha were obtained from control. In case of mulching, the highest total yield (57.69 t/ha) and marketable yield (47.14 ton/ha) were found from water hyacinth mulch and the lowest 54.61 t/ha and 45.12 ton/ha were from control treatment. For combined effect, maximum total yield (59.83 t/ha) and marketable yield 49.80 ton/ha were observed from the treatment of cowdung with water hyacinth mulch and minimum total yield (51.61 t/ha) and marketable yield (41.30 ton/ha) were from control treatment. It may be concluded that the combination of cowdung with water hyacinth mulch can be used to obtain higher growth and yield of carrot.
Key words: Carrot, organic manures, mulches, yield.

Introduction

Carrot (*Daucus carota* L.) is one of the most ancient vegetables. Popularity of carrot is increasing day by day for its 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. Carrot grows successfully in Bangladesh during Rabi season when temperature ranges from 11.17ºC to 28.9ºC (Alim, 1974) and mid November to early December is the best time for its cultivation to get satisfactory yield (Rashid, 1993). The area of carrot cultivation was 95313 ha with a total production of 4089663 tons in the world (FAO, 2004). In Bangladesh, the production statistics of carrot is not available but the average yield of carrot is 35 t ha^{-1} (Rashid and Shakur, 1986), which is low compared to other carrot producing countries like Netherlands (67.87 t ha^{-1}), UK (66.66 t ha^{-1}), Austria (55.84 t ha^{-1}), Switzerland (53.33 t ha^{-1}), Israel (52.00 t ha^{-1}), Kuwait (51.19 t ha^{-1}), Belgium (50.64 t ha^{-1}) and Sweden (49.6 t ha^{-1}) (FAO, 2004). The cultivation of carrot requires an ample supply of plant nutrient. Use of organic manures 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. Carrot production is affected by several factors viz. soil, seed, fertilizer, irrigation and cultural practices. Among these cultural practices specially mulching play an important role on growth and yield of carrot production. It helps to utilize moisture in the soil and to meet up the need of irrigation and thus to increase crop yield. Mulching protects the loss of soil moisture by soil evaporation induced by wind and reduces the irrigation requirements (Roy *et al*, 1990). Different mulches regulate soil moisture and temperature, suppress weeds and improve germination and emergence. Higher yield and better quality, less infestation of insect diseases, earliness, prolong growing growing season, higher nutritive value of the produced, improved storability are the advantages of mulching (Ahmed, 1999). In Bangladesh carrot is grown during winter season when rainfall is scanty. Irrigation is essential for increasing crop cultivation that also increases cost of production. Under such condition, mulching may be practiced in crop cultivation which can replace irrigation to minimize cost of production. To serve this purpose rice straw and water hyacinth may be used as mulching materials. Mulching is highly effective in checking evaporation loss of soil moisture. It increases the efficiency of applied N-fertilizer and irrigation (Rhee *et al*., 1990). Several mulches suppress weed growth and improve soil water conservation, soil structure and fertility (Frazier, 1957). In addition, mulches increase microbial activity in the soil (Aldefer, 1946). In some extent, mulches reduce the invasion of insects and diseases (Brown *et al*., 1989). It also increased yield in many horticultural crops like potato, sweet potato, carrot and ginger (Choudhury *et al.,* 1993; Jaiswal *et al.,* 1996*)*. Considering the above facts, the experiment was undertaken to study the effect of different types of organic manures and mulching materials on growth and yield of carrot.

Materials and Methods

The experiment was conducted at Germplasm Centre, Department of Horticulture, Patuakhali Science and Technology University during November, 2015 to March, 2016. The selected land was medium high land. The seed of carrot cv. New Kuroda, a Japanese variety, was used. It was comprised of two factors such as - organic manures viz. F_0 (control), F_1 (cowdung), F_2 (vermi-compost), F_3 (poultry manure), and mulches viz. M_0 (control), M_1 (rice straw), M_2 (water hyacinth) respectively. The factors consist of 12 treatments combinations. It was laid out in Randomized Complete Block Design (RCBD) with three replications. The whole experimental area was 14.6 m x 5.9 m which was divided into three blocks. Each block was again divided into 12 plots and hence there were 36 (12 x 3) unit plots. The size of unit plot was 1.2 m x 1.0 m. The distance between two

adjacent blocks and plots were 0.5m and 0.3m respectively. The land of the experimental field was first opened on November 5, 2015 with a power tiller. The soil was treated with insecticides at the time of final ploughing. The amount of different types of organic manures was applied in this experiment is given below: Control (F_0): no manures used, Cowdung (F_1): 35 t/ha, Vermi-compost (F_2): 35 t/ha, Poultry manure (F_3): 20 t/ha. Carrot seeds were soaked into water for 24 hours and then wrapped with a piece of thin cloth and then were spread over polythene sheet for 3 hours to dry out the surface water prior to sowing. The seeds were treated with Vitavax-200 @ 3g/100g seed. Seeds were used @ 3 kg/ha, 40g of seeds were used for the experimental area. Seeds were sown on 3 December 2015 in the plot. Sowing was done thinly in lines spaced at 20 cm from row to row and 10 cm from plant to plant. Seeds were sown at a depth of 2 cm and covered with a fine layer of soil followed by light watering by water can. Thereafter, the plots were covered with mulch materials according to the treatments to maintain required temperature and moisture. The cover of mulch materials were removed after emergence of seed sprout. Emergence of seedlings started about six days after sowing and seedlings were thinned out two times. Weeding and Irrigating were done whenever it necessary. The crop was harvested after 90 days of each sowing for data collection when the foliage turned pale yellow (Bose *et al*., 1990). Randomly selected 10 plants were harvested each time from each unit plot for per plant and together with rest of entire plot per plot for data collection. Haque and Bhuyan (1983) suggested that carrots should be harvested in Bangladesh within 110-125 days after sowing for maximum yield and quality. The following parameters were assessed: plant height, number of leaves per plant, fresh weight of roots, root length, root diameter and root dry matter, gross yield and marketable yield per plot as well as per hectare. Data were analyses with the help of MSTATc program. Treatment means were separated by LSD at 5% and 1% level of significance for interpretation of the results.

Results and Discussion

Data on different parameters were analyzed and the results have been presented in tables and figures.

Effect of organic manures on growth and yield of carrot: The plant height was recorded at 90 days after sowing (DAS). The variation was highly significant due to the application of different organic manures. The tallest (46.93 cm) plant was observed from cowdung (F_1) treatment while the shortest (43.48 cm) from the control (F_0) (Table 1) treatment. Rashid and shakur (1986) also reported similar results in plant height variation over the period of crop growth. The number of leaves per plant was recorded at 90 days after sowing (DAS). The variation was highly significant due to the application of different organic manures. Maximum number of leaves per plant (11.97) was observed from cowdung (F_1) treatment while minimum (11.19) from the control (F_0) (Table 1). Maximum fresh weight of leaves per plant (86.63g) was recorded from cowdung (F_1) treatment which was statistically identical with vermicompost (F_2) treatment while minimum (64.73g) weight from the control (F_0) treatment at final harvest of the crop (Table 1). The length of carrot root was found to be statistically highly significant due to the effect of different organic manures. The longest root (17.54 cm) was obtained from the application of cowdung (F_1) which was statistically similar with vermicompost (F_2) application while the shortest (15.71 cm) was from control (F_0) treatment (Table 1). The highest diameter of root (10.44 cm) was obtained from cowdung (F_1) which was significantly differed from the vermicompost (F_2) application. The lowest diameter of root (9.56 cm) was observed in crops of control (F_0) treatment (Table 1). The findings agreed with Akand (2003). The highest fresh weight of root (121.31g) was recorded from cowdung (F_1) application which was statistically similar with the application of vermicompost (F_2) while the lowest fresh weight of root (103.62g) was obtained from control (F_0) (Table 2). The dry matter of root also varied significantly with the application of different organic manures. The dry matter of roots was recorded to be the highest (17.49%) in plants raised with cowdung (F_1) treatment which was followed by the application of vermicompost (F_2) treatment while the lowest dry matter of root (13.86%) was obtained from control (F_0) treatment (Fig. 1). Highly significant variation was found in respect of yield by different organic manures. The highest total yield (6.98 kg/plot and 57.93 ton/ha) was found from the treatment of cowdung (F_1) which was statistically identical with the vermicompost (F_2) application while the lowest (6.21 kg/plot and 51.78 ton/ha) total yield was found from the control (F_0) treatment (Table 2). The highest marketable yield (49.11 ton/ha) was obtained from the application of cowdung (F_1) which was significantly varied with vermicompost (F_2) treatment while the lowest marketable yield (41.44 ton/ha) was obtained from control (F_0) treatment (Fig. 2).

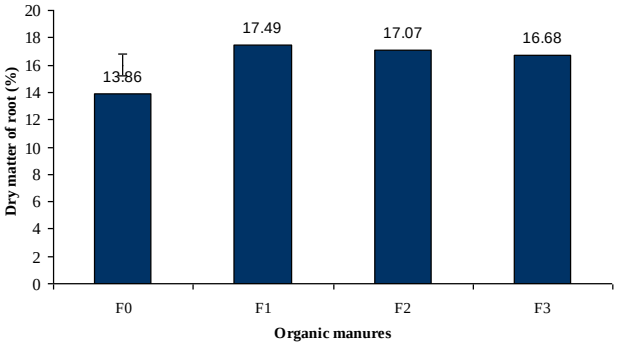

Fig. 1. Effect of organic manures on percentage of dry matter of root of carrot

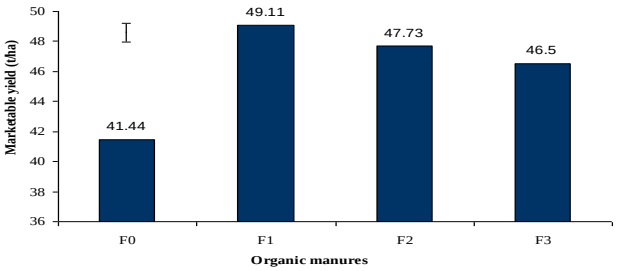

Fig. 2. Effect of organic manures on marketable yield of carrot ha^{-1}

Table 1. Effect of organic manures and mulching on growth and yield of carrot

Treatment	Plant height at 90 DAS (cm)	Number of leaves per plant at 90 DAS	Fresh wt. of leaves /plant (g)	Root length (cm)	Diameter of root (cm)
Manures					
F_0	43.48	11.19	64.73	15.71	9.56
F_1	46.93	11.97	86.63	17.54	10.44
F_2	46.21	11.96	84.69	17.26	10.18
F_3	45.93	11.88	84.02	17.22	10.13
LSD at 5%	0.90	0.24	2.31	0.48	0.21
LSD at 1%	1.21	0.32	3.10	0.65	0.28
Level of sign.	**	**	**	**	**
Mulching					
M_0	44.53	11.50	73.94	16.38	9.90
M_1	44.69	11.71	82.42	17.13	9.88
M_2	47.70	12.05	83.71	17.28	10.45
LSD at 5%	0.78	0.21	2.00	0.42	0.18
LSD at 1%	1.05	0.28	2.68	0.56	0.25
Level of sign.	**	**	**	**	**
CV (%)	2.06	2.11	3.02	2.99	2.20

** = 1% levels of probability; NS = Non significant; CV = Coefficient of variation

Table 2. Effect of organic manures and mulching on yield of carrot

Treatment	Fresh wt. of root/ plant	Dry matter of leaves (%)	Total yield (kg/plot)	Total yield (t/ha)
Manures				
F_0	103.62	13.56	6.21	51.78
F_1	121.31	16.89	6.98	57.93
F_2	118.10	16.42	6.90	57.62
F_3	115.39	16.16	6.84	57.02
LSD at 5%	3.82	0.21	0.19	1.63
LSD at 1%	5.13	0.28	0.26	2.19
Level of significance	**	**	**	**
Mulching				
M_0	109.29	14.94	6.55	54.61
M_1	112.18	15.88	6.73	55.96
M_2	122.34	16.45	6.92	57.69
LSD at 5%	3.31	0.18	0.17	1.41
LSD at 1%	4.44	0.24	0.23	1.89
Level of significance	**	**	**	**
CV (%)	3.48	1.37	3.02	3.04

Effect of mulch materials on growth and yield of carrot: The plant height was recorded at 90 days after sowing (DAS). The tallest (47.70 cm) plant was observed from the mulching of water hyacinth (M_2) while the shortest (44.53 cm) from the control (M_0) (Table 1). The increasing plant height due to mulching might be accounted for providing favourable soil moisture and a favourable temperature condition for proper plant growth (Yu *et al*., 1981). The number of leaves per plant was recorded at 90 days after sowing (DAS). Maximum number of leaves per plant (12.05) was observed from the mulching of water hyacinth (M_2) while the shortest (11.50) from the control (M_0) treatment (M_0) (Table 1). The higher number of leaves per plant obtained due to mulching might be attributed to higher plant height caused by advantageous condition utilized by the plants. A slight increase in the number of leaves per plant due to the application of mulch in carrot was also observed by Mia (1996). A significant variation was observed on fresh weight of leaves per plant due to use of different mulches. Maximum fresh weight of leaves per plant was 83.71g was recorded from M_2 (water hyacinth) treatment which was statistically identical with rice straw (M_1) mulch while minimum (73.94g) weight from the control (M_0) treatment at final harvest of the crop (Table 1). The increased fresh weight of leaves with different mulches treatment might be attributed to the supply of moisture that possibly accelerated the cell division and elongation activities producing more leaves and their development leading to increased fresh weight of leaves (Dey, 2000). The longest root (17.28 cm) was obtained from the application of water hyacinth mulch (M_2) which was statistically identical with the application of rice straw (M_1) mulch while the shortest (16.38 cm) was from control (M_0) treatment (Table 1). Diameter of carrot root was significantly influenced by the application of different mulches. The highest diameter of root (10.45 cm) was obtained from water hyacinth (M_2) mulch which was followed by control (M_0) treatment. The lowest diameter of root (9.88 cm) was observed from rice straw mulch (Table 1). The fresh weight of root per plant significantly differed with two mulches. The highest fresh weight of root (122.34g) was recorded from the mulching of water hyacinth (M_2) which was followed by rice straw (M_1) mulch while the lowest fresh weight of root (109.29g) was obtained from control (M_0) treatment (Table 2). The dry matter of roots was recorded to be the highest (17.06%) in plants raised with the mulching of water hyacinth (M_2) treatment which was followed by control (M_0) while the lowest dry matter of root (15.10%) was obtained from rice straw (M_1) treatment (Fig. 3). Statistically highly significant variation due to different mulches was found in total yield of roots per plot and hectare. Maximum total yield (6.92 kg/plot and 57.69 ton/ha) was found from the treatment of water hyacinth mulch (M_2) which significantly varied with the treatment of rice straw (M_1)

while minimum (6.55 kg/plot and 54.61 ton/ha) total yield was found from the control (M_0) treatment (Table 2). Maximum marketable yield per hectare (47.14 ton/ha) was found from the treatment of water hyacinth (M_2) which was statistically identical with rice straw (M_1) mulch while minimum (45.12 ton/ha) was respectively found from the control (M_0) treatment (Fig. 4).

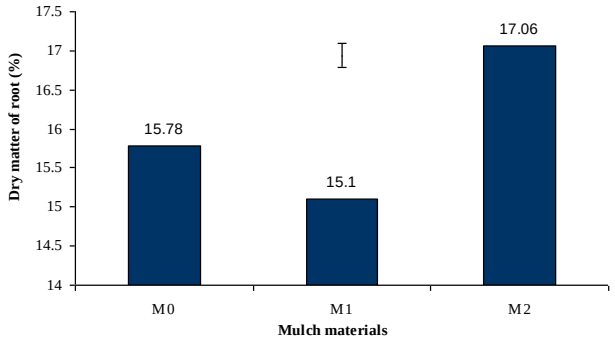

Fig. 3. Effect of mulch materials on percentage of dry matter of root

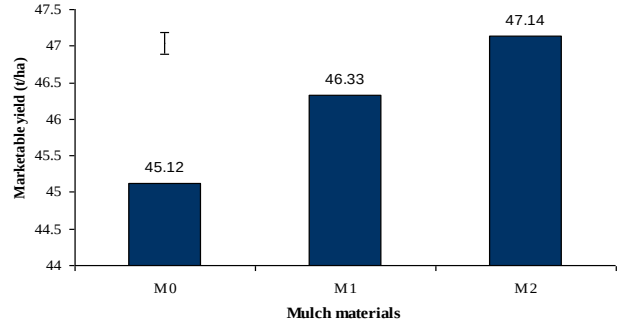

Fig. 4. Effect of mulching on marketable yield of carrot per hectare

Combined effect of organic manures and mulch materials on growth and yield of carrot: The plant height was recorded at different stages of growth 90 days after sowing (DAS). A significant interaction was found between application of different organic matter and mulching on plant height. The tallest (50.25 cm) plant was observed from treatment combination of F_1M_2 (cowdung + water hyacinth mulch) while the shortest (43.38 cm) from treatment combination of F_0M_0 (Table 3). The number of leaves was recorded at 90 days after sowing (DAS). Maximum number of leaves per plant (12.39 cm) was observed from treatment combination of F_1M_2 (cowdung + water hyacinth mulch) while minimum (10.87 cm) number from treatment combination of F_0M_0 (Table 3). Maximum fresh weight of leaves per plant (99.03g) was observed from the treatment of F_1M_1 (cowdung + rice straw) which was statistically similar with the combination of F_3M_2 (poultry manure + water hyacinth) while minimum fresh weight of leaves per plant (61.50g) was recorded from the treatment of F_0M_2 (control + water hyacinth) (Table 3). Highly significant interaction was found between organic manures and mulches on root length of carrot. The longest root (18.27 cm) was obtained from the treatment combination of F_1M_2 (cowdung + water hyacinth) mulch which was statistically similar with the treatment combination of F_1M_1 (cowdung + rice straw) while the shortest (15.50 cm) was from control (F_0M_0) treatment (Table 3). The interaction effect of organic manures and mulches statistically influenced the root diameter of carrot. The highest root diameter (11.31 cm) was observed from the treatment combination of F_1M_2 (cowdung + water hyacinth) which was followed by F_2M_2 (vermicompost + water hyacinth) treatment combination while the lowest (9.47) diameter of root was obtained from F_0M_0 treatment (Table 3).

Table 3. Combined effect of organic manures and mulching on growth and yield of carrot

Treatments	Plant height at 90 DAS (cm)	Number of leaves per plant at 90 DAS	Fresh wt. of leaves/plant (g)	Root length (cm)	Diameter of root (cm)
F0M0	43.38	10.87	61.50	15.50	9.47
F0M1	43.72	11.38	71.33	15.58	9.55
F0M2	43.34	11.33	61.36	16.06	9.65
F1M0	45.10	11.85	78.81	16.52	9.96
F1M1	45.44	11.68	99.03	17.83	10.05
F1M2	50.25	12.39	82.05	18.27	11.31
F2M0	44.85	11.70	78.42	16.49	10.10
F2M1	44.93	11.92	80.31	17.70	9.98
F2M2	48.86	12.27	95.35	17.58	10.47
F3M0	44.80	11.59	77.01	17.03	10.07
F3M1	44.66	11.87	78.10	17.42	9.95
F3M2	48.33	12.19	96.06	17.20	10.36
LSD at 5%	1.56	0.41	4.00	0.84	0.37
LSD at 1%	2.09	0.55	5.37	1.13	0.31
Level of sign.	**	**	**	**	**
CV (%)	2.06	2.11	3.02	2.99	2.20

The highest fresh weight of root (134.51g) was recorded from the plants grown with the organic fertilizer cowdung and the application of water hyacinth mulch ie, combined treatment F_1M_2 which is statistically similar with the treatment combination of F_2M_2 ie, combined application of vermicompost and water hyacinth mulch while the lowest (103.27g) was obtained from the combined treatment of control (F_0M_0) (Table 4). Combination of organic manures and mulches significantly influenced the dry weight of root. The highest dry weight of root (18.87%) was obtained on cowdung (F_1) with the mulching of water hyacinth (M_2) ie, the combined treatment F_1M_2 gave the highest result which was followed by F_2M_2 (vermicompost + water hyacinth) while the lowest dry weight of root (13.82%) was observed on control treatment ie, combined treatment of F_0M_0 gave the lowest result (Fig. 5).

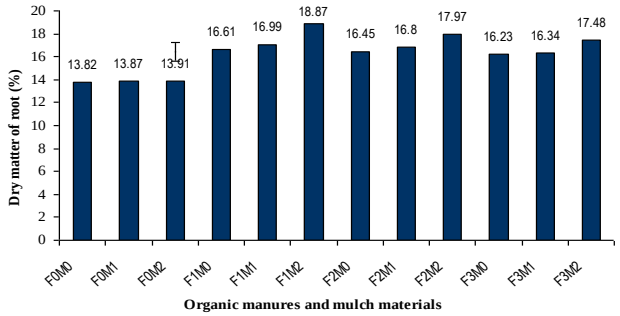

Fig. 5. Effect of organic manures and mulch materials on percentage of dry matter of root

Maximum dry weight of leaves (17.89%) was obtained from the combined application of cowdung (F_1) with the mulching of water hyacinth (M_2) ie, from F_1M_2 which was followed by the combined application of F_2M_2 (vermicompost + water hyacinth) and minimum dry weight of leaves (13.46%) was observed on control treatment i.e. combined treatment of F_0M_0 (Table 4). The combined effect of the application of organic manures and mulching materials had a highly significant effect on total yield of root. However, maximum (7.18 kg/plot and 59.83 ton/ha) yield was obtained from the treatment combination of F_1M_2 (cowdung + water hyacinth) which was statistically similar with the treatment combination of F_2M_2 (vermicompost + water hyacinth) and minimum yield (6.19 kg/plot and 51.61 ton/ha) was from the treatment combination of F_0M_1 and F_0M_0 respectively (Table 4).

Table 4. Combined effect of organic manures and mulching on yield of carrot

Treatment	Fresh wt. of root/ plant	Dry matter of leaves (%)	Total yield (kg/plot)	Total yield (t/ha)
F0M0	103.27	13.46	6.19	51.61
F0M1	103.37	13.52	6.20	51.66
F0M2	104.21	13.69	6.25	52.05
F1M0	113.27	15.77	6.79	56.60
F1M1	116.14	17.02	6.96	57.36
F1M2	134.51	17.89	7.18	59.83
F2M0	111.01	15.33	6.66	55.47
F2M1	115.14	16.67	6.90	57.79
F2M2	128.15	17.25	7.15	59.61
F3M0	109.60	15.20	6.57	54.77
F3M1	114.09	16.32	6.84	57.02
F3M2	122.50	16.97	7.11	59.27
LSD at 5%	6.62	0.36	0.34	2.82
LSD at 1%	8.88	0.48	0.45	3.79
Level of significance	**	**	**	**
CV (%)	3.48	1.37	3.02	3.04

The highest marketable yield per hectare (49.80 ton/ha) was obtained from the treatment combination of F_1M_2 (cowdung + water hyacinth) which was statistically identical with the treatment combination F_1M_1 (cowdung + rice straw) and the lowest marketable yield per hectare (41.30 ton/ha) was obtained from the control (F_0M_0) treatment (Fig. 6). It may be concluded that cowdung can be used as organic manures and water hyacinth as mulch material and the combination of cowdung with water hyacinth mulch can be used to obtain higher growth and yield of carrot. Further studies can be done with more levels of organic manures and different mulch materials.

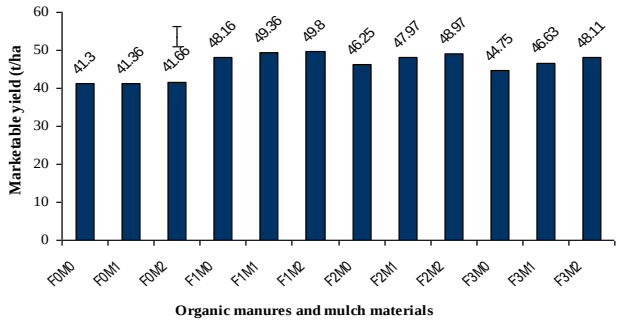

Fig. 6. Effect of organic manures and mulching on marketable yield of carrot ha^{-1}

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