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EFFECT OF ORGANIC, BIO AND MINERAL FERTILIZATION ON VEGETATIVE GROWTH PARAMETERS OF CARROT PLANTS

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ABSTRACT

Two field experiments were conducted during the two successive winter seasons of 2009/2010 and 2010/2011 in a private farm at Bani-Ebad near Deckernis canter, Dakahlia Governorate to study the effect of mineral, organic, bio-fertilization and their interaction on growth characters of carrot (*Daucus carota* L.). cv. shantenay.

In general, it can be concluded that:

The highest values of leaf length, number of leaves/plant, root length, fresh weight of leaves and dry matter % were obtained as a result of trilateral interaction (compost plus bio-fertilizer mixture and 100% NPK). Meanwhile triple interaction compost plus EM and 100% NPK occupied the second order. The lowest value in this case obtained from application of 50% NPK alone.

The highest values of shoot/ root ratio were recorded when plants treated with compost plus bio-fertilizer mixture and 75%NPK followed by plants treated with compost plus bio-fertilizer mixture and 100%NPK after 120 days from sowing date in both seasons.

INTRODUCTION

Carrot (*Daucus carota* L.) is a member of family Apiaceae and considers as popular vegetable crops, and one of the main vegetable crops in Egypt. The fleshy roots are eaten as raw in salads, boiled or steamed in vegetable dishes and also used with other vegetables in the preparation of soap, baby foods, as well as, its use in industries to produce juice and jam. In addition, it also has a medical value, it is rich in carotenes content the source of vitamin A. The cultivated area of carrot in Egypt reached 13,651 fed. in 2010 and the total production was 175,923 tons, according to the Ministry of Agriculture Statistics.

There is a great need for further studies under Egyptian condition to establish recommendation for reducing the amount of chemical NPK fertilizers to raise the quantity, improve the quality and limit the environmental pollution. It has focused the light on the use untraditional fertilizer especially the organic (compost) and bio-fertilizers.

However, it is essential to adopt a system of organic fertilizer in vegetables due to increasing the objectives against the chemical farming as a main source of soil and water pollution as well as food products.

Bio-fertilizers are microbial preparations containing, primary beneficial role in famishing a proper rhizosphere for plant growth thus, it causes minerals solubilizing, facilitate minerals (especially N) uptake (Abou-Hussein *et al.,* 2002a).

A mixture of microorganisms, i.e., (Azotobacter chroococcum bacteria, which fix nitrogen; Bacillus circulans bacteria, which make potassium more available and *Mycorrhiza* fungi, which increases phosphorus availability was used to improve yield and quality of many vegetative crops such as, lettuce (Hanafy Ahmed *et al* ., 2000), potato (Kushwah and Banafar, 2003), pepper (Dawa *et al*., 2012) and garlic (Dawa *et al*., 2012).

EM is a mixture of beneficial and effective microorganisms that is used as a soil amendment (Woodward, 2003). EM contains selected species of microorganisms, including predominant populations of lactic acid bacteria, yeasts, smaller numbers of photosynthetic bacteria, actinomycetes and other types of organisms. All of these are claimed to be mutually compatible with one another and are able to coexist in culture.

The present investigation aimed to study the effect of organic, bio and mineral fertilization on growth, yield, chemical constituents and quality of carrot. Also to study to what extent the organic and bio-fertilizer can replace some of the recommended NPK doses (mineral fertilizers).

MATERIALS AND METHODS

Two field experiments were conducted in a private farm at Bani-Ebad near deckernis canter, Dakahlia Governorate during two successive winter seasons of 2009/2010 and 2010/2011 to investigate the effect of mineral, organic, bio-fertilization and their interaction on growth characters, yield, chemical constituents and quality of carrot (*Daucus carota* L.). cv. shantenay.

Seeds of Shantenay cultivar were sown at a rate of 2.5 kg /fed in plots 3m long and 70 cm wide. Experimental units was 2.1 m^2. Sowing dates were on 30 and 20 October for the first and second seasons, respectively.

Mechanical and chemical analysis of soil:

Soil samples were taken at random from the experimental field area at a depth of 0 – 30 cm from soil surface before sowing to estimate the mechanical and chemical soil properties as shown in Table 1. Experimental design and treatments:

The experiments of the study were executed in a strip split plot design with three replicates. Each experiment included 18 treatments comprising two organic fertilizers (compost), three bio-fertilizers and three mineral fertilizer levels.

Table 1: Mechanical and chemical analysis of the experimental soil during 2009/2010 and 2010/2011 seasons:

Soil properties	**2009-2010**	**2010-2011**
Sp%	58	56
PH*	8.17	8.05
EC** dS^{-1}	0.87	0.93
Mechanical analysis%:		
Coarse sand%	2.7	1.9
Fine Sand%	17.5	19.2
Silt%	32.9	33.1
Clay%	46.9	45.8
Texture class	Clayey	Clayey
OM %	1.92	1.97
Available (ppm):		
N	46	49
P	5.78	5.12
K	325	342
Fe	12.3	13.5
Mn	7.6	8.1
Zn	3.2	2.9
Ions meq/100g soil		
Ca^{++}	1.12	0.98
Mg^{++}	0.85	0.72
Na^{+}	3.41	2.98
K^{+}	0.07	0.08
CO_3^{--}	0.00	0.00
HCO_3^{--}	1.80	1.86
Cl^{-}	2.12	2.33
$SO4^{--}$	1.47	0.57

- ***Soil suspension (1:2.5)** **** Soil extraction (1:5)**

The vertical plots were assigned to two organic fertilizer treatments (compost) as follows:

1- Without compost.

2- Compost (4 ton/fed) was incorporated in the soil before seed sowing.

The Horizontal plots were devoted to the three bio-fertilizer treatments as follows:

1- Without bio-fertilization.

2- Bio-fertilizer mixture was applied to the soil at the rate of 20 L/fed.

3- Effective Microorganisms (EM) was added to the soil at a rate of 2 ml/1L.

The sub – plots were located to three mineral fertilization levels as follows:

1- 100 % of NPK fertilizers as recommended by the Ministry of Agric. and soil Recl. (MASR) for carrot plant (60 kg N+40 kg P_2O_5+62 kg K_2O per fed.)

2- 75 % NPK.

3- 50 % NPK.

Each treatment was replicate three times; thus, the total numbers of the experimental plots were 54 plots. All other agricultural practices were conducted as a Ministry of Agriculture recommendation.

Organic fertilizer:

Compost of rice straw was mixed with the surface layer of the soil before seed sowing, at a rate of 4 ton/ fed. Some chemical properties of used the compost were presented at Table 2.

Bio-fertilizer:

Bio-fertilizer mixture (*Azotobacter chroococcum* bacteria, which fix nitrogen; *Bacillus circulans* bacteria, which make potassium more available and Mycorrhiza fungi, which increase phosphorus availability) were kindly provided from the unit of bio-fertilizers, Fac. of Agric., Ain shams Univ., Cairo, Egypt. Bio-fertilizer mixture was added to the soil after 6 and 8 weeks from seed sowing at a rate of 20 L/fed.

Effective Microorganisms (EM) was obtained from Ministry of Agriculture laboratories Cairo, Egypt. EM was applied to the soil surface at a rate of 2 ml/L water, twice. Once after 6 week from seed sowing and the other 2 weeks later.

Mineral fertilizer:

Ammonium nitrate (33.5 % N), Ca-super phosphate (15.5 % P_2O_5) and potassium sulphate (48 % K_2O) were the respective sources of N, P and K. Three treatments of N, P and K fertilizers at the rates of 50, 75 and 100 % from the recommended doses for carrot plants, i.e., 60, 40 and 62 $kg.fed^{-1}$ for N, P and K, respectively were used. Treatments of N, P and K fertilizers were divided into two equal doses and applied after 6 and 10 weeks from seed sowing.

Table 2: Some chemical properties of compost during 2009/2010 and 2010/2011seasons:

Compost properties	2009-2010	2010-2011
Sp%	230	218
PH(1:5)	6.13	6.18
EC(1:10)dS^{-1}	4.68	4.49
OM%	37.2	37.7
C%	21.6	21.9
N%	1.14	1.23
C/N	19.0	17.8
P%	0.23	0.27
K%	0.44	0.51
Total (ppm):		
Fe	136	141
Mn	87.5	79.2
Zn	9.7	7.2

Sampling:

Nine plants from each treatment were taken at 120 and 160 days after sowing and following data were recorded.

Vegetative growth:

1. Leaves length. It was measured starting from the tip of the longest leaf to the base of leaves.
2. Root length.
3. Root diameter. It was measured 1 cm from the shoulders.

4. Number of leaves per plant.
5. Fresh weight of leaves / plant.
6. Dry matter percentage of plant leaves.
7. Shoot/ root ratio
8. Core/corlex ratio.

Statistical analysis:

All data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip split – plot design as published by Gomez and Gomez (1984) by means of "MSTAT-C" Computer software package.

Averages were compared using least significant difference (LSD) method at 5 % levels of probability according to the procedure outlined by Snedcor and Cochran (1980).

RESULTS AND DISCUSSION

Vegetative growth parameters of carrot plant.

The parameters used for measuring vegetative growth in this study are leaf length, number of leaves/plant, fresh weight of leaves/plant, dry matter % of leaves, root length, root diameter, shoot/root ratio and core/corlex ratio

1. Leaf length and number of leaves/plant.

Effect of organic fertilizer:

Results shown in Table 3 indicate the impact of organic fertilization using compost on leaf length and number of leaves/plant. Evident superiority of compost treatment over control treatment in these measurements after 120 and160 days from sowing and the differences were significant in the two seasons except number of leaves/plant in the second season after 160 days from sowing.

Effect of bio-fertilizer:

Data in Table 3 show presence of significant differences in measurements of leaf length and number of leaves/plant under the influence of bio-fertilization treatments (mixture and EM) comparing with control treatment (without bio-fertilizer). The superiority in leaf length and number of leaves/plant were obtained by using bio-fertilizer mixture treatment followed by application with EM after 120 and 160 days from sowing, while control treatment (without bio-fertilizer) gave least values comparing with bio-fertilizer mixture or EM, and the differences were significant in the two seasons except leaf length in the second season after 160 days from sowing.

Effect of mineral fertilizer:

Table 3 also shows the significant differences among the three mineral treatments (100%, 75% and 50% NPK) in their effects on characters of leaf length and number of leaves/plant at 120 and 160 days from sowing date in both seasons.

It is clear from the result in Table 3 that the lower percentage of mineral fertilization used (50% NPK) gave lower values of leaf length and number of leaves/plant, while treatment of 100% NPK ranked first order, followed by 75% in both seasons at 120 and 160 days from sowing date and the differences were significant.

Table 3: Leaf length and number of leaves/plant of carrot at 120 and 160 days from sowing (DFS) as affected by organic, bio and mineral fertilization as well as their interactions during 2010 and 2011 seasons.

Characters / Treatments	Leaf length (cm)				Number of leaves/plant			
	2009/2010		2010/2011		2009/2010		2010/2011	
	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS
A- Organic fertilizer:								
Without	36.89	35.35	38.50	36.35	6.46	8.77	8.31	10.83
Compost	40.91	39.69	43.23	42.33	6.90	10.58	9.27	10.96
F. test	*	*	*	*	*	*	*	NS
B-Bio-fertilizer:								
Without	36.39	35.92	40.40	38.88	6.26	9.29	8.32	10.56
Mixture	41.26	39.64	41.66	39.62	7.01	10.16	9.03	11.16
EM	39.05	36.99	40.53	39.51	6.76	9.57	9.01	10.96
LSD at 5 %	1.30	1.77	0.83	NS	0.26	0.31	0.15	0.18
C- Mineral fertilizer:								
100 %	41.73	41.18	43.25	41.68	7.39	10.68	9.50	11.93
75 %	39.49	37.61	41.79	39.22	6.93	10.06	8.75	11.12
50 %	35.48	33.77	37.55	37.12	5.72	8.29	8.12	9.64
LSD at 5 %	0.65	0.74	0.71	0.56	0.20	0.22	0.20	0.20
D- Interactions:								
A X B	NS	*	NS	*	*	NS	*	NS
A X C	*	*	NS	*	*	NS	*	*
B X C	NS	*	NS	*	*	NS	*	*
A X B X C	*	NS	NS	*	*	*	*	*

Mixture : (Azotobacter+ Bacillus circulans+Mycorrhiza fungi)
EM: (Effective Microorganisms)
100% NPK: (60 kg N, 40 kg P_2O_5, 62 kg K_2O, recommended mineral fertilizer)

Effect of interactions:

From Table 3 it is clear that the interaction between organic and bio-fertilizers (A×B) gave significant effects after 160 days from sowing for leaf length in the first and second season and for number of leaves/plant character after 120 from sowing date in both seasons.

The interaction between organic and mineral fertilizer (A×C) took the same direction as the previous interaction with the significant exception of leaf length after 120 days in the first season, and for number of leaves/plant after 160 days from sowing date in the second season.

The interaction between (B×C) also was as the interaction between bio and mineral fertilizer (A×B) except the significant influence of number of leaves/plant in the second season.

Table 3 shows that the impact of triple interaction among organic, bio and mineral fertilizer (A×B×C) which gave significant effects on leaf length and number of leaves/plant at 120 and 160 days from sowing date in both seasons except the effect on leaf length at 160 and 120 days from sowing in the first and second season, respectively.

Data in Table 4 show that the highest values of leaf length and number of leaves/plant were a result of trilateral interaction of compost plus bio-fertilizer mixture and 100% NPK meanwhile, triple interaction compost plus EM and 100% NPK occupied the second order at 160 days from sowing in both seasons. The lowest values in this case obtained from the plants treated with 50% NPK alone.

Table 4: Leaf length and Number of leaves/plant of carrot plant at 120 and 160 days from sowing (DFS) as affected by the interaction among organic, bio and mineral fertilization during 2010 and 2011 seasons.

Treatments / Characters			Leaf length (cm)				Number of leaves/plant			
			2009/2010		2010/2011		2009/2010		2010/2011	
Organic	Bio	Mineral	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS
Without	Without	100 %	35.82	35.22	40.44	35.89	6.36	9.55	8.33	11.80
		75 %	32.44	33.44	38.44	34.22	6.08	9.33	8.33	11.33
		50 %	33.55	29.89	34.89	33.11	5.25	6.78	7.39	8.61
	Mixture	100 %	43.11	42.11	41.66	37.77	7.75	10.44	10.00	12.00
		75 %	39.00	40.11	42.22	38.44	7.58	9.44	8.33	11.11
		50 %	37.33	35.33	36.55	34.44	5.25	7.61	8.00	9.83
	EM	100 %	42.33	37.44	39.66	38.22	6.91	9.33	8.22	12.11
		75 %	37.00	32.22	38.89	37.67	6.72	8.77	8.11	10.89
		50 %	31.44	32.43	33.78	37.44	5.58	7.67	8.11	9.66
Compost	Without	100 %	42.00	42.00	45.55	45.00	7.16	10.55	10.11	11.33
		75 %	42.00	39.33	43.44	45.22	6.61	10.22	8.22	10.66
		50 %	32.55	35.66	39.67	39.89	6.11	9.33	7.55	9.66
	Mixture	100 %	45.11	45.44	46.11	47.22	8.41	12.22	9.66	12.22
		75 %	44.22	41.55	44.22	39.55	6.66	11.61	9.44	11.83
		50 %	38.77	33.89	39.22	40.33	6.41	9.66	8.77	10.11
	EM	100 %	42.00	44.89	46.11	46.00	7.75	12.00	10.66	12.11
		75 %	42.33	39.00	43.55	40.22	7.91	11.00	10.11	10.89
		50%	39.22	35.44	41.22	37.55	5.72	8.69	8.89	10.00
LSD at 5 %			1.59	NS	NS	1.38	0.48	0.53	0.50	0.48

2. Fresh weight and dry matter % of leaves.

Effect of organic fertilizer:

As for the effect of organic fertilization using compost on fresh weight of leaves and dry matter % of leaves, data in Table 5 show that evident superiority of compost over control treatment in the two seasons.

Effect of bio-fertilizer:

Data in Table 5 show the presence of significant differences in measurements of fresh weight of leaves and dry matter percentage of leaves under the influence of bio fertilization treatments (mixture and EM) comparing with control treatment (without bio-fertilizer). The highest values were recorded form the plants treated with bio-fertilizer mixture after 120 and 160 days from sowing date in both seasons.

Effect of mineral fertilizer:

Data present in Table 5 show the significant differences among the three mineral treatments (100%, 75% and 50% NPK) in their effects on characters of fresh weight of leaves and dry matter% of leaves at 120 and 160 days from sowing date in both seasons.

It is clear from the results that the lower percentage of mineral fertilization used (50% NPK) gave lower values of fresh weight of leaves and dry matter percentage of leaves at 120 and 160 days from sowing date in both seasons. The highest values were recorded from the plant treated with 100% NPK followed by 75% NPK in both seasons at 120 and 160 days from sowing date and the differences were significant.

Effect of interactions:

Concerning, the interaction effect between organic and bio-fertilizer (A×B) on fresh weight of leaves and dry matter % of carrot leaves, data present in Table 5 show significant effects after 120 and 160 days from sowing in the first and second season except fresh weight of leaves after 120 days from sowing and dry matter percentage of leaves after 160 days from sowing in the second season had insignificantly effect.

The interaction between organic and mineral fertilizer (A×C) took the same direction as the previous interaction, data gave significant effects after 120 and 160 days from sowing in the first and second season except, dry matter percentage of leaves after 160 days from sowing had insignificant effect in the second season.

Table 5: Fresh weight of leaves and dry matter of leaves percentage of carrot plant at 120 and 160 days from sowing (DFS) as affected by organic, bio and mineral fertilization as well as their interactions during 2010 and 2011 seasons.

Characters / Treatments	Fresh weight of leaves (g)				Leaves dry matter (%)			
	2009/2010		2010/2011		2009/2010		2010/2011	
	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS
Without	16.01	10.97	22.63	13.18	14.30	18.58	14.09	15.36
Compost	21.10	16.40	28.94	19.19	14.46	19.32	14.90	16.34
F. test	*	*	*	*	*	*	*	*
Without	13.61	11.56	23.61	15.56	14.17	18.83	14.06	15.67
Mixture	23.39	16.19	28.86	16.86	14.65	19.65	14.66	16.08
EM	18.66	13.30	24.88	16.13	14.32	18.37	14.77	15.78
LSD at 5 %	1.00	0.51	1.16	0.87	0.13	0.27	0.08	0.14
100 %	23.46	17.62	30.05	19.99	14.66	19.47	14.64	15.88
75 %	17.67	13.20	26.33	17.01	14.30	18.87	14.41	15.88
50 %	14.53	10.24	20.98	11.55	14.19	18.51	14.43	15.77
LSD at 5 %	0.53	0.56	1.02	0.63	0.21	0.21	0.06	NS
A X B	*	*	NS	*	*	*	*	NS
A X C	*	*	*	*	*	*	*	NS
B X C	*	*	*	*	*	*	*	*
A X B X C	*	*	*	*	*	*	NS	*

Mixture : (Azotobacter+ Bacillus circulans+Mycorrhiza fungi)
EM: (Effective Microorganisms)
100% NPK: (60 kg N, 40 kg P_2O_5, 62 kg K_2O, recommended mineral fertilizer)

The interaction between bio and mineral fertilizer (B×C) in the same Table indicate that there were significantly effects on fresh weight of leaves and dry matter percentage of leaves of carrot plants after 120 and 160 days during both seasons.

Table 5 also shows the significant impact of triple interaction among organic, bio and mineral fertilizer (A×B×C) on fresh weight of leaves and dry matter percentage of leaves of carrot plants at 120 and 160 days from sowing date in both seasons except leaves dry matter % in the second season after 120 days from sowing .

Data presented in Table 6 indicate that the highest values were a result of trilateral interaction compost plus bio-fertilizer mixture and 100% NPK followed by compost plus EM and 100% NPK which occupied the second order at 160 and 120days from sowing date for fresh weight of leaves in both seasons. While, compost plus bio-fertilizer mixture and 100% NPK in both seasons at 160 days from sowing gave the highest value of dry matter percentage.

Table 6: Fresh weight of leaves and dry matter of leaves percentage of carrot plant at 120 and 160 days from sowing (DFS) as affected by the interaction among organic, bio and mineral fertilization during 2010 and 2011 seasons.

Characters / Organic & bio & min. fertilization			Fresh weight of leaves (g)				Leaves dry matter (%)			
			2009/2010		2010/2011		2009/2010		2010/2011	
			120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS
Without	Without	100 %	17.25	13.02	20.24	12.58	15.83	18.43	14.53	14.33
		75 %	8.64	9.09	21.09	16.00	14.23	19.13	14.46	15.26
		50 %	7.82	4.97	20.02	13.01	15.63	20.33	14.46	15.26
	Mixture	100 %	25.17	15.73	28.21	15.66	14.30	19.16	14.06	15.33
		75 %	20.59	9.50	23.98	17.50	13.63	18.56	14.30	15.33
		50 %	13.09	9.76	26.39	9.20	13.43	16.50	15.26	15.46
	EM	100 %	19.00	13.46	23.06	13.37	14.63	18.46	15.40	16.33
		75 %	18.25	11.33	21.94	13.23	13.56	18.33	14.33	15.46
		50 %	14.28	11.87	18.75	8.05	13.50	18.23	15.46	15.46
Compost	Control	100 %	24.06	17.07	32.05	21.84	13.46	20.00	15.20	16.33
		75 %	13.76	12.98	25.82	17.81	14.43	19.46	15.06	16.40
		50 %	10.14	12.24	16.02	12.13	14.33	20.43	15.40	16.53
	Mixture	100 %	32.88	28.70	38.51	26.38	15.40	20. 46	16.23	16.66
		75 %	20.35	20.77	31.16	17.11	15.56	18.43	16.26	16.40
		50 %	22.39	12.70	25.21	11.60	13.60	17.23	16.33	15.53
	EM	100 %	28.28	17.74	38.24	30.08	14.33	20.43	14.40	16.33
		75 %	24.46	15.52	33.99	20.41	14.36	19.33	15.33	16.46
		50%	13.59	9.90	19.49	15.33	14.66	18.23	15.46	16.40
LSD at 5 %			1.30	1.38	1.49	1.55	0.52	0.51	0.48	0.58

3. Root length and diameter of carrot

Effect of organic fertilizer:

It is evident from data in Table 7 that compost application significantly enhanced root length and diameter of carrot plants than control treatment after 120 and 160 days from sowing date in both seasons.

Effect of bio-fertilizer:

As for the effect of bio-fertilizer, results indicate that bio-fertilizer shows significant increases in root length and diameter than the control treatment during both growing seasons. On other words; the highest value for these parameters were obtained by application of bio-fertilizer mixture following by application with EM after 120 and 160 days from sowing, while control treatment (without bio-fertilizer) gave lowest values in both seasons.

Effect of mineral fertilizer:

Referring the effect of mineral concentrations treatments, it's evident from the same Table that fertilization with 100% NPK was superior for increasing the mean values of root length and diameter of carrot plants followed by 75% NPK. While the lowest one was realized from the plant received 50% NPK after 120 and 160 days from sowing date in the first and second season.

Table 7: Root length and diameter of carrot at 120 and 160 days from sowing (DFS) as affected by organic, bio and mineral fertilization as well as their interactions during 2010 and 2011 seasons.

Characters / Treatments	Root length (cm)				Root diameter (cm)			
	2009/2010		2010/2011		2009/2010		2010/2011	
	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS
A- Organic fertilizer:								
Without	10.26	11.37	10.65	11.79	3.35	4.09	3.95	5.00
Compost	10.80	12.30	11.58	12.77	3.80	4.50	4.32	5.33
F. test	*	*	*	*	*	*	*	*
B-Bio fertilizer:								
Without	10.09	11.02	10.46	11.79	3.49	4.11	3.96	4.98
Mixture	11.19	12.39	11.57	12.55	3.69	4.36	4.33	5.23
EM	10.32	12.10	11.32	12.50	3.55	4.41	4.11	5.28
LSD at 5%	0.59	0.33	0.24	0.05	0.10	0.17	0.21	0.14
C- Mineral fertilizer:								
100 %	11.46	12.63	12.00	13.26	3.90	4.67	4.45	5.41
75 %	10.56	11.99	11.28	12.25	3.50	4.29	4.14	5.26
50 %	9.58	10.89	10.06	11.34	3.33	3.92	3.81	4.82
LSD at 5%	0.29	0.26	0.23	0.20	0.12	0.16	0.17	0.15
D- Interactions:								
A X B	*	*	NS	*	NS	NS	NS	NS
A X C	*	*	*	*	*	NS	NS	NS
B X C	*	*	*	*	NS	NS	NS	NS
A X B X C	*	*	*	*	NS	NS	NS	NS

Mixture : (Azotobacter+ Bacillus circulans+Mycorrhiza fungi)
EM: (Effective Microorganisms)
100% NPK: (60 kg N, 40 kg P_2O_5, 62 kg K_2O, recommended mineral fertilizer)

Effect of interactions:

With respect to the interaction effects between organic fertilizer and bio-fertilizer (A×B) on the growth parameters (root length and diameter) of carrot plants, data present in Table 7 show that the interaction gave significant effect on root length in both seasons except root length in the second season after 120 days from sowing. While, the interaction had insignificant effects on root diameter after 120 and 160 days from sowing date in both seasons.

Concerning, the interaction effect between organic and mineral fertilizer (A×C) on root length and diameter, data demonstrate in the same Table, root length were significantly affected by the interaction after 120 and 160 days from sowing date in both seasons. Meanwhile, the interaction (A×C) had insignificantly effects on root diameter after 120 and 160 days from sowing date in both seasons except root diameter after 120 days from sowing in the first season.

The interaction between bio and mineral fertilizer (B×C) also was as the interaction between (A×C) except the significant influence of root diameter in the first season after 120 days from sowing dates.

Concerning the triple interaction among organic, bio and mineral fertilizer (A×B×C), it is clear from Table 7 that root length parameters at 120 and 160 days from sowing in both seasons were influenced significantly. Meanwhile, root diameter was not affected.

Data in Table 8 demonstrate that the interactions among organic, bio and mineral fertilization (A×B×C). It shows a significant effect on root length of carrot plants while; such effect of these treatments had insignificant effects on root diameter. In this connect, the highest values of root length was obtained from which fertilization with compost plus bio-fertilizer mixture and 100%NPK followed by plants fertilized with compost plus EM and 100%NPK after 160 days from sowing. These results were true in the both seasons.

Table 8: Root length and diameter of carrot plants at 120 and 160 days from sowing (DFS) as affected by the interaction among organic, bio and mineral fertilization during 2010 and 2011 seasons.

Characters / Organic & bio & min. fertilization			Root length (cm)				Root diameter (cm)			
			2009/2010		2010/2011		2009/2010		2010/2011	
			120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS
Without	Without	100 %	11.00	11.33	11.11	12.05	3.45	4.34	4.13	4.94
		75 %	9.77	10.33	9.77	11.11	3.20	4.02	3.64	4.69
		50 %	8.80	9.55	9.44	10.22	3.13	3.51	3.51	4.51
	Mixture	100 %	11.91	13.16	12.05	12.94	3.72	4.58	4.59	5.29
		75 %	11.91	12.61	11.55	11.50	3.39	4.15	4.19	5.22
		50 %	9.62	10.11	9.50	11.22	3.27	3.81	3.70	4.68
	EM	100 %	11.11	12.50	11.66	12.77	3.45	4.62	4.02	5.45
		75 %	9.50	12.11	10.39	12.61	3.38	4.06	4.12	5.22
		50 %	8.75	10.66	10.38	11.72	3.16	3.69	3.65	4.99
Compost	Without	100 %	11.33	12.33	11.22	13.50	4.30	4.43	4.51	5.56
		75 %	10.54	11.66	11.61	12.77	3.56	4.33	4.15	5.41
		50 %	9.08	10.94	9.61	11.11	3.28	4.03	3.84	4.76
	Mixture	100 %	12.04	13.27	13.00	14.28	4.32	4.80	4.94	5.68
		75 %	11.42	13.17	12.27	12.94	3.80	4.59	4.51	5.61
		50 %	10.25	12.11	11.05	12.44	3.65	4.24	4.07	4.90
	EM	100 %	11.37	13.22	13.00	14.05	4.14	5.22	4.54	5.52
		75 %	10.22	12.05	12.11	12.55	3.66	4.61	4.25	5.44
		50%	10.97	12.00	10.39	11.33	3.51	4.25	4.08	5.07
LSD at 5 %			0.73	0.64	0.57	0.51	NS	NS	NS	NS

4. Shoot/root ratio and core/corlex ratio of carrot

Effect of organic fertilizer:

Data in Table 9 show that compost application resulted significant increases in shoot/root ratio and core/corlex ratio of carrot roots comparing with control treatment after 120 and 160 days from sowing date in both seasons except after 120 days from sowing in the second season.

Table 9: Shoot/root ratio and core/corlex ratio of carrot at 120 and 160 days from sowing (DFS) as affected by organic, bio and mineral fertilization as well as their interactions during 2010 and 2011 seasons.

Characters / Treatments	Shoot/root ratio				Core/corlex ratio			
	2009/2010		2010/2011		2009/2010		2010/2011	
	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS
A- Organic fertilizer:								
Without	0.274	0.113	0.323	0.105	0.835	0.865	0.951	0.937
Compost	0.289	0.142	0.326	0.131	0.874	1.023	1.020	1.021
F. test	*	*	NS	*	*	*	NS	*
B-Bio fertilizer:								
Without	0.232	0.121	0.306	0.134	0.850	0.951	0.993	0.962
Mixture	0.349	0.141	0.352	0.110	0.846	0.947	1.034	1.019
EM	0.263	0.120	0.316	0.109	0.868	0.933	0.928	0.956
LSD at 5 %	0.007	0.003	0.016	0.007	NS	NS	0.084	0.37
C- Mineral fertilizer:								
100 %	0.304	0.140	0.342	0.134	0.897	0.985	1.086	1.019
75 %	0.260	0.124	0.313	0.122	0.863	0.938	0.961	0.972
50 %	0.281	0.118	0.318	0.098	0.804	0.908	0.909	0.946
LSD at 5 %	0.005	0.006	0.018	0.004	0.033	0.044	0.048	0.39
D- Interactions:								
A X B	*	*	NS	*	*	*	*	NS
A X C	*	*	*	*	*	NS	NS	NS
B X C	*	*	*	*	NS	*	NS	NS
A X B X C	*	*	*	*	*	NS	NS	NS

Mixture : (*Azotobacter+ Bacillus circulans*+Mycorrhiza fungi)
EM: (Effective Microorganisms)
100% NPK: (60 kg N, 40 kg P_2O_5, 62 kg K_2O, recommended mineral fertilizer)

Effect of bio-fertilizer:

Regarding the effect of bio-fertilizer, data in Table 9 show that significant superiority of bio-fertilizer mixture in shoot/root ratio parameter after 120 and 160 days from sowing in the first season and after 120 days from sowing in the second season. While the same superiority is recorded in core/corlex ratio in the second season in both samples of measurements. EM and without bio-fertilizer treatments exchanged the superiority in the mentioned previous measurements in both seasons.

Effect of mineral fertilizer:

Concerning, data presented in Table 9 show the significant differences among the three mineral treatments (100%, 75% and 50% NPK) in their effects on characters of shoot/root and core/corlex ratio of carrot roots at 120 and 160 days from sowing date in both seasons.

It is clear from the result in Table 9 that the lowest percentage of mineral fertilization used (50% NPK) gave the lowest values of shoot/root ratio and core/corlex ratio of carrot root plants at 120 and 160 days from sowing date in both seasons. Meanwhile, the highest value of shoot/root ratio and core/corlex ratio of carrot root plants were recorded from the plants fertilized with 100% NPK in both seasons after 120 and 160 days from sowing date and the differences were significant.

Effect of interactions:

The interaction affect between organic and bio-fertilizers (A×B) in shoot/root ratio and core/corlex ratio of carrot root plants, data present in Table 9 indicate that the interaction gave significant effects except shoot/root ratio after 120 days from sowing date and core/corlex ratio after 160 days from sowing date in the second season.

The interaction between organic and mineral fertilizers (A×C) in the same Table reflect that the interaction gave significant effects in shoot/root ratio but had insignificant effects in core/corlex ratio in both season except core/corlex ratio after 120 days from sowing in the first season.

The interaction between bio and mineral fertilizers (B×C) also gave significant effects in shoot/root ratio however, had insignificant effects on core/corlex ratio in both season except, core/corlex ratio after 160 days from sowing in the first season.

Table 9 shows significant effects of the impact of triple interaction among organic, bio and mineral fertilization (A×B×C) except core/corlex ratio after 160 days from sowing in the first season and after 120 and 160 days from sowing in the second season.

Table 10 shows that the highest values of shoot/root were recorded when plants treated with compost plus bio-fertilizer mixture and 75%NPK followed by plants treated with compost plus bio-fertilizer mixture and100%NPK after 120 days from sowing date in both season. While the interaction had insignificant effects on core/corlex ratio in both season except after 120 days from sowing date in the first season.

Table 10: Shoot/root ratio and core/corlex ratio of carrot plants at 120 and 160 days from sowing (DFS) as affected by the interaction among organic, bio and mineral fertilization (ABC) during 2010 and 2011 seasons.

Characters / Organic & bio & min. fertilization			Shoot/root ratio				Core/corlex ratio			
			2009/2010		2010/2011		2009/2010		2010/2011	
			120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS	120 DFS	160 DFS
Without	Without	100 %	0.300	0.133	0.310	0.103	0.870	0.847	1.100	0.867
		75 %	0.210	0.110	0.343	0.137	0.733	0.833	0.963	0.943
		50 %	0.200	0.080	0.253	0.153	0.767	0.747	0.863	0.877
	Mixture	100 %	0.320	0.127	0.390	0.090	0.933	0.970	1.070	1.030
		75 %	0.320	0.090	0.310	0.097	0.850	0.907	0.947	0.973
		50 %	0.310	0.120	0.343	0.070	0.770	0.797	0.840	0.970
	EM	100 %	0.250	0.110	0.327	0.097	0.907	0.880	0.963	1.013
		75 %	0.280	0.107	0.290	0.123	0.863	0.893	0.907	0.873
		50 %	0.273	0.140	0.230	0.073	0.820	0.910	0.903	0.883
Compost	Control	100 %	0.310	0.140	0.313	0.173	0.910	1.170	1.153	1.083
		75 %	0.180	0.127	0.333	0.140	0.980	1.023	0.950	1.013
		50 %	0.193	0.137	0.280	0.100	0.840	1.087	0.927	0.987
	Mixture	100 %	0.407	0.210	0.437	0.160	0.907	1.093	1.207	1.043
		75 %	0.487	0.123	0.447	0.130	0.810	0.967	1.083	1.067
		50 %	0.250	0.177	0.293	0.113	0.807	0.950	1.060	1.030
	EM	100 %	0.237	0.120	0.273	0.183	0.853	0.950	1.020	1.077
		75 %	0.320	0.137	0.307	0.103	0.940	1.007	0.917	0.963
		50%	0.220	0.107	0.357	0.077	0.823	0.957	0.860	0.927
LSD at 5 %			0.013	0.012	0.013	0.011	0.076	NS	NS	NS

Results mentioned previously can be discussed as follow:

Obtained results can be discussed by clarifying the direct and indirect effects of used treatments on vegetative growth.

A- Vegetative growth and yield of carrot plants.

Effect of compost fertilization:

Our results can be attributed to the positive impacts of compost on physical and chemical properties of soil, where organic matter improved soil drainage, ventilation and increased the soil ability to water retain. It is known that compost is used as a soil amendment which improves holding capacity of soils and increases availability of elements such as boron (Aggelides and Londra, 2000),

which consider an essential micronutrient for plants, it is essential for cell wall formation, synthesis of cytokinins, nucleic acid, it facilitates sugar translocation in plants and it influences cell development and elongation (Hu and Brown, 1994; Broun and Hu, 1997), which in turn enhances vegetable growth parameters (Tables 3,5,7 and 9).

Compost fertilizer also enhances the ability of vegetables to stand up to common diseases. Furthermore, it activates many species of living organisms which release phytohormones and may stimulate absorption of nutrients and plant growth. Such organisms need nitrogen for multiplication.

This is plausible reasons that use of compost with inorganic fertilizer show a beneficial effect on dry matter accumulation which reflected in increasing growth parameters. (Arisha *et al*., 2003).

Many researchers have identified the influence of compost on physical properties of soil (Bazzoffi *et al*., 1998 and Tester, 1990) they reported that compost increases total porosity and enhances the soil structure and quality of the poro system, which reflected indirectly on the positive effect of plant growth.

Changes in physical properties of soil are usually ascribed to the dilution effect as a result of mixing the soil with organic material of lower density (Tester, 1990). Although, these effects are clearly identified just after compost application in rather compacted and heavy soil (Celik *et al*., 2004), sandy soil (Turner *et al*., 1994) or when high rates of compost (90 t ha-1year-1) were applied (Giusquiani *et al*., 1995).

Also, the obtained favorable effect due to application of compost on vegetative growth parameters (Tables 3,5,7 and 9) of carrot might be as a result of adequate supply of macro and micro nutrient as shown in Table 2.

Due to all these positive effects of compost, vegetative growth, Our findings are in agreement with those obtained by Reddy *et al.* (2000), Maynard (2005), Ashwini kumar *et al*. (2007) and Merghany *et al*. (2008) on carrot, El-sayed *et al*. (2007) and (2010) on potato and Shehata *et al*. (2011) on strawberry.

Effect of bio-fertilizers:

Obtained results in Tables (3,5,7 and 9) show superiority of bio-fertilizer treatments over the control (without bio-fertilizer). Where the bio-fertilizer mixture treatment often occupied the first order followed by EM. Both of treatments contain many different types of microorganisms, the positive impact that happened may be due to the effect of these organisms on growth whether directly or indirectly.

Bio-fertilizer mixture contains: *Azotobacter chroococcum*, *Bacillus circulans* and Mycorrhiza fungi. While the basic groups of microorganisms in EM are lactic acid bacteria, yeast and phototrophic bacteria.

Generally, bio-fertilizer plays an important role in improving nutrient supplies by plant roots. *Azotobacter* is a non-symbiotic bacteria grows along with one inside the root as well as stems to some extent, and fixes the atmospheric nitrogen and benefits the crop. While mycorrhiza fungi are the structures resulting from the symbiosis between these fungi and plant root, and are directly involved in plant mineral nutrition. It increases the uptake of less mobile nutrients, especially phosphorus and micronutrients like zinc and copper and also it has appositive impact on water uptake (Ortas *et al*., 2001). It can also benefit plants by stimulating the production of growth regulating substances, increasing photosynthesis and resistance of pests and soil borne diseases (Al-Karaki, 2006).

As for *Bacillus circulans* it is important for potassium solubilization and other mineral nutrients. The roles played by the aforementioned microorganisms are caused the superiority of bio-fertilizer mixture treatment over other treatments in most of vegetative growth parameters and quality of carrot plants.

EM consists of Lactic acid bacteria, Yeasts, Actinomycetes and Photosynthetic bacteria (Xu 2000). The positive impacts of EM may be due to its components of these microorganisms and its performance on enhancing growth parameters of carrot plants.

The impact of these components of microorganisms and its performance on enhancing growth of carrot plants as shown in Tables 3,5,7 and 9. These results are in agreement with those obtained by Higa and Parr (1994), Prasad *et al*. (2002) and Shabana (2004) on tomato, Wahba *et al.* (2004) and Ashwini kumar *et al*. (2007) on carrot and Constantino *et al*. (2008) on pepper who reported that bio-fertilizer increases vegetative growth parameters.

Effect of NPK

Concerning the effect of mineral fertilizer on plant growth parameters and quality parameters of carrot, which showed the evident superiority of NPK especially at the rate 100% from the recommended doses over other treatments in the most cases. We can attribute these results, to the direct and indirect influences of NPK nutrients on vegetative growth parameters of carrot which reflected on improvement of yield and its components.

The detected pronounced positive effects of 100% NPK of the recommended rate or 75% NPK combined with bio-fertilizer mixture or EM and compost on vegetative growth might be due to the relatively low available amount of nitrogen and phosphorus in the used experimental soil as shown in Table 1 in both growing seasons.

It is known that nitrogen has greater influence on growth of crop plants than any other essential plant nutrient. It plays a pivotal role in many physiological and biochemical processes in plants. Nitrogen is a component of many important organic compounds ranging from proteins to nucleic acids. It is a constituent of the chlorophyll molecule, which plays an important role in plant photosynthesis. Many enzymes are proteinaceous; hence, N plays a key role in many metabolic reactions. Nitrogen is also a structural constituent of cell walls. (Fageria and Baligar, 2005a).

Phosphorus plays an important role in energy storage and transfer in crop plants. Adenosine diphosphate (ADP) and adenosine triphosphate (ATP), summarized through both respiration and photosynthesis, are compounds with high-energy phosphate groups that drive most physiological processes in plants including photosynthesis, respiration, protein nucleic acid synthesis, and ion transport across cell membranes (Wood, 1998). Phosphorus is an essential part of the structure of triphosphopyridine nucleotide (DPN and TPN). The DPN and TPN act as carriers of electrons or hydrogen between sites of oxidation and reduction reactions, which occur in respiration, fermentation, and photosynthesis (Fageria and Gheyi, 1999).

Potassium plays many vital rols in crop plants. It increases root and improves water and nutrient uptake also it reduces respiration, preventing energy losses, aids in photosynthesis and dry matter formation, helps translocation of sugars and starch, increases the protein content of plants, maintains turgor and reduces water loss and wilting, it is suspected that part of the function of K is related to the formation of chlorophyll precursor or to the prevention of the decomposition of chlorophyll, it is implicated in increased uptake and transport of Fe in plants. (Huber and Arny, 1985).

The results of mineral fertilizer on vegetative growth are in agreement with those obtained by Shanmugasundaram and Savithri (2002), Abdel-Mawgoud *et al.* (2005), Singh and Gupta (2005), Omostoso and Shittu (2007), Mohamed (2007) and Okonwu and Mensah (2012).

Obtained data in Tables 4, 6, 8 and 10 show that the interaction among compost plus bio-fertilizer mixture and 100% NPK and compost plus EM and 100% NPK which gave the highest values of aforementioned parameters, these results attribute to the positive collection effects of organic, bio and mineral fertilization on vegetative growth of carrot plants. These results were in agreement with those obtained by Badran and Safwat (2004), Patil (2008) and Khan *et al*. (2012).

CONCLUSION

The results obtained give a great important to organic and bio-fertilizers to get a good vegetative growth which reflect on yield and quality of carrots as well as minimizing usage of mineral fertilizers which in turn reduce environmental pollution and decrease production costs.

In spite of the highest vegetative growth was obtained from the treatment of compost plus bio-fertilizer mixture or EM and 100% NPK but we recommend using compost plus bio-fertilizer mixture or EM and 75% NPK where it gave a good growth parameters which gave in the future a good yield with high quality as well as minimizing the palliation and production costs.

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تأثير التسميد العضوى والحيوى والمعدنى على قياسات النمو الخضرى لنباتات الجزر

حسام محمد السعيد عبد النبى ، كوثر كامل ضوه ، السيد ابراهيم الجميلى و سمر محمد عبد الحميد
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أجريت تجربتان حقليتان على نباتات الجزر (شنتناى) خلال الموسمين الشتويين ٢٠١٠/٢٠٠٩ و ٢٠١١/٢٠١٠ بهدف دراسة تأثير التسميد الحيوى والعضوى والمعدنى والتفاعل بينهم على صفات النمو الخضرى لنبات الجزر . اقيمت هذه التجربة فى مزرعة خاصة بمركز بنى عبيد محافظة الدقهلية ونفذت التجربه فى تصميم الشرائح المتعامده المنشقة فى ثلاث مكررات واشتملت التجربة على ١٨ معامله تمثل التفاعل بين ٢ معاملة من التسميد العضوى و٣ معاملات من التسميد الحيوى و٣ معاملات من التسميد المعدنى وكان اجمالى عدد الوحدات التجريبية ٥٤ وحده.

انتهت الدراسة الى ان:

التسميد العضوى بالكمبوست مع التسميد الحيوى والمعدنى ١٠٠% اعطى اعلى القيم لقياسات النمو الخضرى ما عدا نسبه النمو الخضرى / النمو الجذرى حيث تفوقت معامله التسميد العضوى بالكمبوست مع التسميد الحيوى والمعدنى ٧٥%. وذلك التفوق فى النمو الخضرى سيكون له دور فعال فى زيادة كمية المحصول وتحسين صفات الجودة عند توافر كافة العوامل الاخرى المسببه لانتقال الكربوهيدرات من الاوراق للتخزين فى الجذور.

النتائج المتحصل عليها توضح تفوق معاملة (كمبوست مع التسميد الحيوى و ١٠٠% تسميد معدنى) الا ان المعامله التى نوصى بها هى معاملة (كمبوست مع التسميد الحيوى و ٧٥% من الاسمده المعدنية الموصى بها) حيث اخذت المرتبة الثانية واعطت نمو خضرى جيد مقارنه بالكنترول ولكنها تقلل كمية الاسمده المستخدمة وبالتالى تقلل التلوث البيئى والتكاليف.