J. Agric. Sci. Mansoura Univ., 34 (5): 5195 - 5208, 2009

EFFECT OF ORGANIC, BIO- AND MINERAL FERTILIZATION ON GROWTH, YIELD, OIL PRODUCTIVITY AND CHEMICAL CONSTITUENTS OF CORIANDER PLANT

Abdalla, M. Y. A.
Veget. and Flor. Dept., Fac. of Agric., Mansoura Univ.

ABSTRACT

This experiment was conducted at the Experimental Station and in the Laboratory of Vegetable and Floriculture Department, Faculty of Agriculture, Mansoura University during the two successive seasons of 2005/2006 and 2006/2007 to study the effect of fertilization with cattle manure, bio-fertilizer and/or mineral NPK on growth, yield, oil production and chemical composition of coriander plant.

Regarding the effect of organic fertilization, the obtained results indicated that the application of cattle manure significantly increased plant height (cm), number of branches/plant, herb dry weight/plant (g), number of umbels/plant, yield of seeds/plant (g), yield of seeds/fed. (kg), essential oil (%), essential oil yield/plant (ml), essential oil yield/fed. (liter), leaves content of chlorophyll a, b and carotenoids (mg/g fresh weight), as well as the percentages of N, P and K in both seasons. The superiority in all previous traits was for the plants growing in the soil fertilized with the highest level of cattle manure (25 m^3/fed.) as compared with the lower levels.

The plants fertilized with either 100% NPK or 75% NPK plus the two bio-fertilizers (effective microorganisms and phosphorein) gave the best results in all investigated parameters in both seasons, whereas the least values were recorded by the plants fertilized with the two bio-fertilizers either individually or together.

The interaction between cattle manure, bio- and/or NPK treatments were the most effective on the previous parameters. The highest values in all measurements were obtained due to the high cattle manure level (25 m^3/fed.) in combination with the two bio-fertilizers plus 75% NPK or 100% NPK alone. Such two superior treatments gave almost equal results which assure the possibility of replacing 25% of the chemical NPK by the use of effective microorganisms plus phosphorein in fertilizing medicinal or aromatic plants such as *Coriandrum sativum*.

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is an annual plant belongs to family Apiaceae and is widely used as a spice and in food and pharmaceutical industries. The coriander plant yields both the fresh green herb and seeds that contain 0.2 - 1% essential oil. The main components of coriander essential oil are linalool (65 - 70%) and alpha-pinene. These materials are used as a starting material for synthetic production of other flavoring agents, such as citral. The aromatic leaves, seeds, as well as, essential oil of coriander are used in flavoring of many food products (Bedoukian, 1967 and Stary and Jirasck, 1975). The therapeutic properties of coriander essential oil are as an analgesic, aphrodisiac, anti-spasmodic, carminative, depurative, digestive, revitalizing, stimulant and stomachic. Coriander oil is used for lowering blood pressure, arteriosclerosis, anthelmintic to some worms, antiseptic and can be useful to refresh and awake the mind. It can help for mental fatigue, migraine pain, tension and nervous weakness. Coriander oil's warming effect is also helpful for alleviating pain such as rheumatism, arthritis and muscle spasms (Chaudhry

and Tariq, 2006). Also, it has been referred to as an anti-diabetic and anti-inflammatory (Gray and Flatt, 1999). Recently, it has been studied for its cholesterol-lowering effects (Chithra and Leelamma, 1999). Kubo *et al*. (2004) reported that the volatile oils found in the leaves of the coriander plant may have antimicrobial properties against food born pathogen, such as Salmonella species.

The important role of chemical fertilizers in increasing the medicinal and aromatic plants production is fully recognized. However, in the recent years, many constraints have been raised due to their adverse impacts on public health, environment and National Income. To confront this problem, it is necessary to develop alternative methods of supplying nutrients to the growing plants. Many scientists consider the utilization of bio-organic fertilizers today as a promising alternative technique particularly for maintaining the fertility and productivity of agricultural soils, in addition to reducing the risk of environmental pollution (Nicholson *et al*., 1999 and Galal and Ali, 2004).

Many authors studied the effect of organic manure treatments on growth, yield, volatile oil and chemical composition of aromatic seed crops as Osman (2000) and Aly *et al*. (2007 a and b) on *Coriandrum sativum*; Abd El-latif (2002) and Abd El-Naeem (2008) on *Carum carvi*; Badran and Safwat (2004); Mohamed and Abdou (2004) and Tanious (2008) on *Foeniculum vulgare* who demonstrated that organic fertilization treatments significantly increased vegetative growth traits, seed yield, volatile oil parameters, as well as, chemical constituents compared with control.

Bio-fertilization technology has taken a part in minimizing production costs and avoiding the environmental hazards (Galal and Ali, 2004). The beneficial effects of bio-fertilizer treatments on vegetative growth traits, yield, volatile oil and chemical composition of aromatic plants were obtained by Surendra *et al*. (2002) and Aly *et al*. (2007 a and b) on *Coriandrum sativum*; Gomaa and Abo-Aly (2001) and Badran *et al*. (2003) on anise; Abdou and El-Sayed (2002); Al-Shareif (2006) and Abd El-Naeem (2008) on caraway and Abdou *et al*. (2004 a and b) and Tanious (2008) on fennel. Since, they found that bio-fertilization treatments (N_2-fixing bacteria and/or phosphate dissolving bacteria) led to an increment in vegetative growth characters, yield, volatile oil (percent and yield) as well as chemical constituents (chlorophyll a, b and carotenoids contents and N, P and K% in the leaves of the plants).

Therefore, the present study aimed to evaluate the response of *Coriandrum sativum* plants to cattle manure, bio-fertilizer and/or mineral NPK.

MATERIALS AND METHODS

The present work was conducted at the Experimental Station and in the Laboratory of Vegetable and Floriculture Department, Faculty of Agriculture, Mansoura University during the two successive seasons of 2005/2006 and 2006/2007 to study the effect of cattle manure in combination with bio-fertilizer and/or mineral NPK on growth, yield, oil productivity and chemical composition of coriander plants. Table (a) shows the physical and chemical properties of the used soil in both seasons.

Table (a): Physical and chemical properties of the used soils during the two seasons of 2005/2006 and 2006/2007

Soil properties	Seasons	
	First season (2005/2006)	Second season (2006/2007)
Coarse sand (%)	3.49	2.95
Fine sand (%)	22.28	21.20
Silt (%)	25.48	26.45
Clay (%)	48.75	49.40
Soil texture	clayey	clayey
E. C. (dS/m)	1.22	1.31
pH	7.70	7.60
O. M. (%)	0.95	1.05
Ca^{++} (meq/l)	5.21	5.09
Mg^{++} (meq/l)	4.12	4.01
K^{+} (meq/l)	0.37	0.35
Na^{+} (meq/l)	10.19	10.78
HCO_3^{-} (meq/l)	2.31	1.95
Cl^{-} (meq/l)	10.43	10.80
SO_4^{--} (meq/l)	7.40	7.52
N (mg/100 g soil)	23.00	29.00
P (mg/100 g soil)	7.80	8.20
K (mg/100 g soil)	299.00	322.00

*** O. M.= Organic matter * E. C. and soluble ions were determined in the soil paste extract**

The experimental unit (plot) was 3 × 2.75 meters and contained 4 rows, 60 cm apart and seeds were sown in hills, 25 cm apart, on October 20th in both seasons. Seedlings were thinned to 2 plants/hill, after five weeks from sowing.

The layout of this experiment during both seasons was split plot design with three replicates (Mead *et al*., 1993). The main plots included four cattle manure treatments (0, 15, 20 and 25 m^2/fed.), while, the sub-plots were devoted to five treatments; 100% NPK (control), effective microorganisms (E.M.), phosphorein (Phos.), E.M.+Phos. and E.M.+phos.+75% NPK. Control treatment (non-bio-fertilized) was fertilized with the recommended NPK mineral fertilization, i.e. 150, 300 and 100 kg/fed. of ammonium nitrate (33.5% N), calcium superphosphate (15.5% P_2O_2) and potassium sulphate (48% K_2O), respectively. So, 75% NPK was 112.5, 225 and 75 kg/fed., respectively. Cattle manure and mineral phosphorus were added during soil preparation for cultivation in both seasons. The chemical analysis of cattle manure is shown in Table (b). Mineral N and K were divided into three equal batches and added at one- month interval, starting from November 27th in both seasons. The bio-fertilizers were applied twice to the soil beside the plants at the rate of 2.0 kg/fed. of phosphorein and/or 50 cm^3/hill of E.M. (1 ml contains 10^7 cells of bacteria). The first dose was added after 47 days from planting date, while the second one was applied one month later in both seasons, and then plants were irrigated immediately. Other agricultural practices were carried out as prevailing in the region.

Table (b): Chemical analysis of the used cattle manure for 2005/2006 and 2006/2007 seasons

Properties	2005/2006	2006/2007
Organic matter (%)	29.05	29.15
C/N ratio	16.40	15.50
pH (1:10 suspension)	7.64	6.96
Total N (%)	0.48	0.68
Total P (%)	0.44	0.35
Total K (%)	1.45	1.38
Total Ca (%)	0.28	0.48
Total Mg (%)	1.21	1.19
Total sulphate SO_4 (%)	1.33	1.36

The plants were harvested on April 10th in both seasons and the following data were recorded during the two seasons:

- Vegetative growth characters: plant height (cm), number of branches/plant and herb dry weight (g/plant).
- Yield and its component: number of umbels/plant, seed yield/plant (g), also seed yield/fed. (kg) was calculated.
- Essential oil determination: essential oil % of seeds according to British Pharmacopeia (1963), essential oil yield (ml/plant and liter/fed.).
- Chemical analysis: chlorophyll a, b and carotenoids (mg/g fresh weight) were determined in the fresh leaves according to the method cited from Fadl and Sari El-Deen (1978). Nitrogen (%) was determined by Microkjeldahel method as described by A.O.A.C. (1980), phosphorus (%) was determined colometrically using the method described by Jackson (1973), while potassium (%) was estimated using flame-photometery method according to Cottenie *et al*. (1982).

The obtained data were statistically analyzed according to MSTAT (1986). The differences between means were tested using L.S.D. at 5% level.

RESULTS AND DISCUSSION

Effect on vegetative growth:

Data presented in Table (1) disclosed that plant height (cm), number of branches/plant and herb dry weight/plant were significantly increased due to all cattle manure treatments over control (without cattle manure) in both seasons. The highest values for the three characters were obtained when cattle manure was applied at 25 m^3/fed. In addition, significant differences were also detected between the four levels of cattle manure. Similar results were found by Osman (2000) and Aly *et al*. (2007 a) on *Coriandrum sativum*.

Data in Table (1) revealed that all bio-fertilizer treatments alone or with mineral NPK treatment decreased plant height, number of branches/plant and herb dry weight/plant, in the two seasons, in comparison with the mineral NPK (100%) treatment. There were significant differences in the aforementioned parameters due to fertilizing with only bio-fertilizers. However, non significant differences being obtained from plants treated with bio-fertilizers+75% NPK in comparison with mineral NPK (100%). In agreement with these results were those obtained by Aly *et al*. (2007 a) on

coriander, Kandeel *et al*. (2004), Abdou *et al*. (2004 a) and Badran and Safwat (2004) on fennel and El-Mekawy and Aly (2005) on *Nigella sativa* regarding the roles of bio-fertilizers with NPK fertilization treatments on enhancing plant growth.

The interaction between cattle manure and bio- alone or with mineral NPK fertilization treatments was significant for plant height, number of branches/plant and herb dry weight/plant in both seasons. The highest values were obtained due to cattle manure at 25 m^2/fed. in combination with 100% NPK or bio-fertilizers+75 % NPK, while the least values in this respect were of the interaction between 0% cattle manure and phosphorein.

Table (1): Effect of cattle manure, bio- and/or NPK fertilization treatments on plant height, number of branches and herb dry weight of *Coriandrum sativum* L. plant during 2005/2006 and 2006/2007 seasons

Treatments	Cattle manure (m^3/fed.)									
	First season (2005/2006)					Second season (2006/2007)				
	0	15	20	25	Mean (B)	0	15	20	25	Mean (B)
	Plant height (cm)									
100% NPK	80.3	84.9	88.1	91.0	86.1	83.1	88.0	92.3	95.8	89.8
E. M.	76.4	80.5	83.7	86.4	81.8	78.9	83.7	87.8	90.7	85.3
Phos.	75.3	79.2	82.3	84.8	80.4	77.6	82.8	86.7	89.5	84.2
E. M.+Phos.	77.8	81.7	84.9	87.5	83.0	80.2	85.4	89.5	93.6	87.2
Bio-+75% NPK	79.9	84.1	87.6	90.2	85.5	82.3	87.6	91.7	94.8	89.1
Mean (A)	77.9	82.1	85.3	88.0	----	80.4	85.5	89.6	92.9	----
L.S.D. at 5%	A: 1.6	B: 1.4	AB: 2.8			A: 1.8	B: 0.9	AB: 1.8		
	Number of branches/plant									
100% NPK	10.23	11.48	12.01	13.05	11.69	10.26	11.56	12.00	13.16	11.75
E. M.	7.11	8.13	8.75	9.41	8.35	7.28	8.16	9.01	9.81	8.57
Phos.	5.13	6.61	7.58	8.99	7.08	5.23	6.81	7.75	9.12	7.23
E. M.+Phos.	8.25	8.96	9.24	9.87	9.08	8.50	9.22	9.50	10.11	9.33
Bio-+75% NPK	10.11	11.31	11.78	12.89	11.52	10.12	11.45	11.86	13.11	11.64
Mean (A)	8.17	9.30	9.87	10.84	----	8.28	9.44	10.02	11.06	----
L.S.D. at 5%	A: 0.46	B: 0.51	AB: 1.02			A: 0.77	B: 0.75	AB: 1.14		
	Herb dry weight/plant (g)									
100% NPK	62.32	69.91	73.14	79.41	71.20	63.09	70.52	73.85	80.96	72.11
E. M.	48.45	49.52	53.29	57.38	52.16	44.85	50.18	55.41	60.33	52.69
Phos.	38.91	40.26	46.18	54.65	45.00	32.17	41.88	47.66	56.10	44.45
E. M.+Phos.	50.24	54.57	56.37	60.11	55.32	52.28	56.70	58.43	62.19	57.40
Bio-+75% NPK	61.57	68.89	71.81	78.60	70.22	62.24	70.49	72.94	80.65	71.58
Mean (A)	52.30	56.63	60.16	66.03	----	50.93	57.95	61.65	68.05	----
L.S.D. at 5%	A: 3.21	B: 2.53	AB: 5.06			A: 4.62	B: 3.41	AB: 6.82		

*** E. M. = Effective microorganisms * Phos. = Phosphorein *Bio- = Bio-fertilizers (E. M.+Phos.)**

Effect on yield parameters:

In this regard, data in Table (2) pointed out that plants treated with cattle manure gave significantly, in both seasons, higher number of umbels/plant and higher seed yield per plant and per feddan than those of

untreated control plants. Among these three cattle manure fertilization treatments, the high level (25 m^3/fed.) gave the highest values in the two seasons.

The role of organic fertilization in promoting number of umbels/plant and seed yield/plant and /fed. was reported by Osman (2000) and Aly *et al*. (2007 a) on coriander and Mohamed and Abdou (2004) and Tanious (2008) on fennel.

Table (2): Effect of cattle manure, bio- and/or NPK fertilization treatments on number of umbels and seed yield of *Coriandrum sativum* L. plant during 2005/2006 and 2006/2007 seasons

Treatments	Cattle manure (m^3/fed.)									
	First season (2005/2006)					Second season (2006/2007)				
	0	15	20	25	Mean (B)	0	15	20	25	Mean (B)
	Number of umbels/plant									
100% NPK	33.12	41.05	43.55	49.11	41.71	33.18	41.21	43.81	49.65	41.96
E. M.	27.65	35.85	41.41	45.82	37.68	27.70	36.12	41.49	46.29	37.90
Phos.	24.10	33.71	38.34	42.11	34.57	25.12	33.89	38.00	42.56	34.89
E. M.+Phos.	29.41	38.31	43.62	47.55	39.72	29.95	39.61	43.81	48.18	40.39
Bio-+75% NPK	32.55	40.12	43.21	48.95	41.21	32.71	40.35	44.38	49.36	41.70
Mean (A)	29.37	37.81	42.03	46.71	----	29.73	38.24	42.30	47.21	----
L.S.D. at 5%	A: 1.68	B: 1.12	AB: 2.24			A: 2.83	B: 0.81	AB: 1.62		
	Yield of seeds/plant (g)									
100% NPK	19.87	25.45	32.94	35.92	28.54	20.58	27.88	34.28	40.10	30.71
E. M.	16.55	22.21	25.08	28.66	23.13	17.15	22.76	26.35	29.15	23.85
Phos.	14.46	20.90	24.50	27.01	21.72	15.64	22.91	24.18	27.29	22.50
E. M.+Phos.	17.80	23.76	27.92	34.48	25.99	18.84	24.96	27.97	35.94	26.93
Bio-+75% NPK	19.71	27.59	30.22	35.35	28.22	20.50	26.47	33.61	39.78	30.09
Mean (A)	17.68	23.98	28.13	32.28	----	18.54	25.00	29.28	34.45	----
L.S.D. at 5%	A: 1.78	B: 0.73	AB: 1.46			A: 2.22	B: 2.08	AB: 4.16		
	Yield of seeds/fed. (kg)									
100% NPK	529.7	678.5	878.2	957.6	761.0	548.7	743,3	913.9	1069.1	818.7
E. M.	441.2	592.1	668.6	764.1	616.5	457.2	606.8	702.5	777.1	635.9
Phos.	385.5	557.2	653.2	720.1	579.0	417.0	610.8	644.6	727.5	599.9
E. M.+Phos.	474.5	633.4	744.3	919.2	692.9	502.3	665.4	745.7	958.2	717.9
Bio-+75% NPK	525.5	735.5	805.7	942.4	752.3	546.5	705.7	896.0	1060.5	802.2
Mean (A)	471.3	639.3	750.0	860.6	----	494.3	666.4	780.6	918.4	----
L.S.D. at 5%	A: 40.6	B: 19.3	AB: 38.6			A: 85.2	B: 55.45	AB: 110.9		

*** E. M. = Effective microorganisms * Phos. = Phosphorein *Bio- = Bio-fertilizers (E. M.+Phos.)**

Concerning bio- alone or with mineral NPK fertilization treatments, all of them except bio-+75 % NPK in the two seasons, gave significantly lower number of umbels/plant, seed yield (g/plant and kg/fed.) in comparison with mineral NPK (100% dose). The least records in number of umbels/plant and seed yield compared with 100% NPK mineral treatment were produced as a result of applying phosphorein alone.

In agreement with these results were those reported by Aly *et al*. (2007 a) on coriander and Abd El-Naeem (2008) on caraway.

The interaction between cattle manure and bio- alone or with mineral NPK fertilization treatments was significant in the two seasons. The highest values were obtained due to cattle manure (25 m^3/fed.) in combination with 100% NPK followed by 75% NPK+bio-fertilizers then bio-fertilizers, as clearly shown in Table (2).

Effect on essential oil productivity:

The obtained results in Table (3) indicated that cattle manure as organic fertilizer at the three levels (15, 20 and 25 m^3/fed.) significantly increased essential oil percentage and essential oil yield (ml/plant and liter/fed.) in coriander seeds over those of control plants in the two seasons. The highest values were obtained from the high level of cattle manure (25 m^3/fed.). In agreement with these results were those found by Osman (2000) and Aly *et al*. (2007 a) on coriander and Badran and Safwat (2004) on fennel.

Table (3): Effect of cattle manure, bio- and/or NPK fertilization treatments on essential oil productivity of *Coriandrum sativum* L. plant during 2005/2006 and 2006/2007 seasons

Treatments	Cattle manure (m^3/fed.)									
	First season (2005/2006)					Second season (2006/2007)				
	0	15	20	25	Mean (B)	0	15	20	25	Mean (B)
	Essential oil (%)									
100% NPK	0.48	0.50	0.53	0.56	0.52	0.47	0.51	0.54	0.57	0.52
E. M.	0.46	0.47	0.49	0.51	0.48	0.45	0.47	0.50	0.51	0.48
Phos.	0.44	0.44	0.47	0.48	0.46	0.43	0.43	0.48	0.50	0.46
E. M.+Phos.	0.47	0.48	0.50	0.54	0.50	0.47	0.49	0.52	0.55	0.51
Bio-+75% NPK	0.48	0.49	0.53	0.56	0.52	0.47	0.52	0.54	0.58	0.53
Mean (A)	0.47	0.48	0.51	0.53	----	0.46	0.48	0.52	0.54	----
L.S.D. at 5%	A: 0.02 B: 0.02 AB: 0.04					A: 0.02 B: 0.01 AB: 0.02				
	Essential oil yield/plant (ml)									
100% NPK	0.095	0.127	0.175	0.200	0.149	0.097	0.142	0.185	0.228	0.162
E. M.	0.076	0.104	0.123	0.146	0.112	0.077	0.107	0.132	0.148	0.114
Phos.	0.064	0.092	0.115	0.129	0.100	0.067	0.099	0.116	0.136	0.104
E. M.+Phos.	0.084	0.114	0.140	0.186	0.131	0.089	0.122	0.145	0.197	0.137
Bio-+75% NPK	0.095	0.135	0.160	0.197	0.147	0.096	0.138	0.181	0.231	0.161
Mean (A)	0.083	0.115	0.143	0.171	----	0.085	0.121	0.152	0.187	----
L.S.D. at 5%	A: 0.018 B: 0.006 AB: 0.012					A: 0.020 B: 0.013 AB: 0.026				
	Essential oil yield/fed. (liter)									
100% NPK	2.54	3.39	4.65	5.36	3.98	2.58	3.79	4.93	6.09	4.35
E. M.	2.03	2.78	3.28	3.90	2.99	2.06	2.85	3.51	3.96	3.09
Phos.	1.70	2.45	3.07	3.46	2.67	1.79	2.63	3.09	3.64	2.78
E. M.+Phos.	2.23	3.04	3.72	4.96	3.48	2.36	3.26	3.87	5.27	3.69
Bio-+75% NPK	2.52	3.60	4.27	5.28	3.92	2.59	3.67	4.84	6.15	4.31
Mean (A)	2.20	3.05	3.80	4.59	----	2.28	3.24	4.05	5.02	----
L.S.D. at 5%	A: 0.51 B: 0.16 AB: 0.32					A: 0.63 B: 0.34 AB: 0.68				

*** E. M. = Effective microorganisms * Phos. = Phosphorein *Bio- = Bio-fertilizers (E. M.+Phos.)**

Data indicated also that the treatments of E.M. and Phos. individually or in combination decreased essential oil (%) in both seasons compared with 100% NPK or bio-+75% NPK fertilization treatments with significant differences when each of bio-fertilizers was used alone. On the other hand, the effect of bio-+75% NPK treatment was equal with that of 100% NPK treatment in the first season while increased in the second one. Also, the treatments of E.M. and/or Phos. decreased essential oil yield/plant (ml) in the two seasons, in comparison with 100% NPK or bio-+75% NPK treatments. Regarding the essential oil yield/fed., control treatment (100% NPK) gave the highest values in both seasons. The differences among control and other treatments reached the significancy level, except for the treatment of bio-+75% NPK.

In accordance with these results concerning NPK were those reported by Ayat (2007) on coriander. Meantime, some other authors proved the capability of bio-fertilizers in increasing essential oil (%) and yield as Badran *et al*. (2003) on anise, and Al-Shareif (2006) and Abd El-Naeem (2008) on caraway.

The interaction between main- and sub-plot treatments was significant for essential oil (%) and yield (per plant and per fed.) in both seasons as shown in Table (3). The best interaction treatment was obtained from fertilizing coriander plants with cattle manure at the high rate (25 m^3/fed) plus 100% NPK, followed by bio-+75% NPK, then bio-fertilizers (E.M.+Phos.).

Effect on chemical constituents:

- Photosynthetic pigments

It is evident from data in Table (4) that all three tested cattle manure treatments significantly increased the contents of chlorophyll a, b and carotenoids (mg/g fresh weight) in the leaves of coriander plants in the two seasons over those of the untreated control plants (without cattle manure). Among such three organic fertilization treatments, the high level of cattle manure (25 m^3/fed.) gave the highest values in the two seasons. In this respect, Aly *et al*. (2007 b) pointed out that organic manure treatments enhanced the photosynthetic pigments in fresh leaves of coriander plants.

Chlorophyll a, b and carotenoids contents in the fresh leaves of coriander plants were increased due to bio-fertilizers+75% NPK compared with 100% NPK treatment in both seasons without significant differences in between. On the opposite, the three photosynthetic pigments were significantly reduced due to bio-fertilizers treatments either alone or together compared with 100% NPK. These findings are in agreement with those of Aly *et al*. (2007 b) on coriander and Abdou and El-Sayed (2002) on caraway.

The interaction between cattle manure, bio- and/or NPK fertilization treatments was significant in the two growing seasons for chlorophyll a, where the highest values were obtained due to the use of cattle manure (25 m^3/fed.) in combination with bio.+75% NPK or 100% NPK treatment.

Table (4): Effect of cattle manure, bio- and/or NPK fertilization treatments on chlorophyll a, b and carotenoids content (mg/g fresh weight) in the leaves of *Coriandrum sativum* L. plant during 2005/2006 and 2006/2007 seasons

Treatments	Cattle manure (m^3/fed.)									
	First season (2005/2006)					Second season (2006/2007)				
	0	15	20	25	Mean (B)	0	15	20	25	Mean (B)
	Chlorophyll a									
100% NPK	2.015	2.103	2.173	2.224	2.129	2.027	2.119	2.189	2.241	2.144
E. M.	1.737	1.826	1.895	1.946	1.851	1.765	1.858	1.927	1.975	1.881
Phos.	1.730	1.814	1.871	1.932	1.837	1.751	1.835	1.890	1.958	1.859
E. M.+Phos.	1.845	1.936	2.005	2.057	1.961	1.869	1.957	2.021	2.079	1.982
Bio-+75% NPK	2.026	2.113	2.184	2.237	2.140	2.034	2.126	2.198	2.246	2.151
Mean (A)	1.871	1.958	2.026	2.079	----	1.889	1.979	2.045	2.100	----
L.S.D. at 5%	A: 0.052	B: 0.025	AB: 0.050			A: 0.057	B: 0.023	AB: 0.046		
	Chlorophyll b									
100% NPK	0.671	0.701	0.724	0.743	0.710	0.677	0.706	0.730	0.746	0.715
E. M.	0.579	0.609	0.632	0.649	0.617	0.589	0.619	0.643	0.658	0.627
Phos.	0.575	0.602	0.624	0.643	0.611	0.582	0.611	0.631	0.652	0.619
E. M.+Phos.	0.615	0.644	0.668	0.686	0.653	0.623	0.652	0.674	0.692	0.660
Bio-+75% NPK	0.675	0.704	0.728	0.746	0.713	0.678	0.708	0.731	0.749	0.717
Mean (A)	0.623	0.652	0.675	0.693	----	0.630	0.659	0.682	0.699	----
L.S.D. at 5%	A: 0.018	B: 0.028	AB: N. S.			A: 0.017	B: 0.031	AB: N. S.		
	Carotenoids									
100% NPK	0.692	0.721	0.746	0.768	0.732	0.695	0.728	0.751	0.768	0.736
E. M.	0.596	0.629	0.655	0.667	0.637	0.609	0.638	0.661	0.679	0.647
Phos.	0.590	0.618	0.648	0.660	0.629	0.603	0.630	0.650	0.671	0.639
E. M.+Phos.	0.635	0.665	0.684	0.708	0.673	0.645	0.674	0.698	0.713	0.683
Bio-+75% NPK	0.697	0.728	0.743	0.767	0.734	0.696	0.729	0.754	0.768	0.737
Mean (A)	0.642	0.672	0.695	0.714	----	0.650	0.680	0.703	0.720	----
L.S.D. at 5%	A: 0.019	B: 0.040	AB: N. S.			A: 0.016	B: 0.045	AB: N. S.		

*** E. M. = Effective microorganisms * Phos. = Phosphorein *Bio- = Bio-fertilizers (E. M.+Phos.)**

- N, P and K percentages in the leaves

Data in Table (5) indicated that N, P and K (%) were gradually increased by the gradual increase in cattle manure levels. The highest values in this concern were obtained from the highest level of cattle manure (25 m^3/fed.) in both seasons. These results are in accordance with the previous ones obtained by Aly *et al*. (2007 b) on coriander plants.

In regard to bio-fertilizers treatments, there were significant decreases in N, P and K (%) in coriander leaves due to E.M. and Phos. treatments in comparison with 100% NPK treatment, while the treatment of E.M.+Phos, resulted a reduction in N, P and K (%) with significant differences only for K (%) in the first season. Meantime, the treatment of bio-fertilizers plus 75% NPK gave higher percentages of N and P in leaves of the plants than those plants of 100% NPK treatment in both seasons. Similar results were obtained by Badran *et al*. (2003) on anise, Al-Shareif (2006) on caraway and Tanious (2008) on fennel.

Table (5): Effect of cattle manure, bio- and/or NPK fertilization treatments on N, P and K percentages in the leaves of *Coriandrum sativum* L. plant during 2005/2006 and 2006/2007 seasons

Treatments	Cattle manure (m^3/fed.)									
	First season (2005/2006)					Second season (2006/2007)				
	0	15	20	25	Mean (B)	0	15	20	25	Mean (B)
	N									
100% NPK	1.23	1.28	1.31	1.35	1.29	1.20	1.26	1.28	1.34	1.27
E. M.	1.19	1.21	1.24	1.26	1.23	1.18	1.22	1.26	1.28	1.24
Phos.	1.17	1.19	1.20	1.22	1.20	1.17	1.21	1.22	1.22	1.21
E. M.+Phos.	1.21	1.27	1.31	1.32	1.28	1.22	1.28	1.30	1.33	1.28
Bio-+75% NPK	1.23	1.29	1.32	1.36	1.30	1.22	1.29	1.33	1.38	1.31
Mean (A)	1.21	1.25	1.28	1.30	----	1.20	1.25	1.28	1.31	----
L.S.D. at 5%	A: 0.03	B: 0.02	AB: 0.04			A: 0.03	B: 0.02	AB: 0.04		
	P									
100% NPK	0.22	0.24	0.28	0.34	0.27	0.24	0.27	0.31	0.37	0.30
E. M.	0.19	0.22	0.25	0.30	0.24	0.22	0.23	0.28	0.30	0.26
Phos.	0.22	0.23	0.28	0.32	0.26	0.22	0.26	0.28	0.31	0.27
E. M.+Phos.	0.23	0.25	0.26	0.28	0.26	0.22	0.26	0.28	0.34	0.28
Bio-+75% NPK	0.23	0.25	0.30	0.36	0.29	0.24	0.28	0.33	0.39	0.31
Mean (A)	0.22	0.24	0.27	0.32	----	0.23	0.26	0.30	0.34	----
L.S.D. at 5%	A: 0.02	B: 0.02	AB: 0.04			A: 0.03	B: 0.02	AB: 0.04		
	K									
100% NPK	0.86	0.93	0.95	1.02	0.94	0.84	0.96	0.96	1.09	0.96
E. M.	0.71	0.80	0.86	0.92	0.82	0.75	0.83	0.88	0.94	0.85
Phos.	0.74	0.82	0.90	0.97	0.86	0.73	0.81	0.86	0.99	0.85
E. M.+Phos.	0.73	0.80	0.86	0.98	0.84	0.82	0.86	0.98	1.01	0.92
Bio-+75% NPK	0.81	0.84	0.97	1.03	0.91	0.86	0.93	0.94	1.05	0.95
Mean (A)	0.77	0.84	0.91	0.98	----	0.80	0.88	0.92	1.02	----
L.S.D. at 5%	A: 0.07	B: 0.04	AB: N. S.			A: 0.07	B: 0.05	AB: N. S.		

*** E. M. = Effective microorganisms * Phos. = Phosphorein *Bio- = Bio-fertilizers (E. M.+Phos.)**

The interaction between cattle manure, bio- and/or NPK fertilization treatments was significant in the two seasons for N and P (%) in the leaves, while it was non significant for K (%). The highest percentages were obtained due to the high cattle manure level (25 m^3/fed.) in combination with bio.+75% NPK or 100% NPK treatment.

The results of this experiment revealed the promotive effect of cattle manure on vegetative growth traits, seed yield, essential oil (percentage and yield), as well as, chemical composition. These effects could be attributed to that cattle manure supplies plants with many essential nutrients and serves as a soil amendment by adding organic matter that improves moisture and nutrient retention of the soil (Galal and Ali, 2004).

Growth and production of coriander plants, in this experiment, were significantly reduced when plants were fertilized with only bio-fertilizers compared with the plants which received NPK fertilization. However, growth,

seed yield, volatile oil (percentage and yield) as well as, pigments contents and N, P and K (%) in coriander leaves were significantly enhanced when plants were fertilized with bio-fertilizers plus 75% NPK. The role of E.M. as a bio-fertilizer in promoting growth and production might be attributed to the increase in soil available nitrogen, as a result of fixing the atmospheric nitrogen and consequently increasing the formation of metabolites which encourage the growth (Sperenat, 1997). Phosphorein increases phosphorus uptake (Hassan and Abdel-Monem, 1997). The improve in growth and production of plants by bio-fertilizers cannot be due to the increase in nutrient uptake only but also due to the synthesis of plant growth regulators (Hassan, 1997). The current research indicated that the best results were obtained due to chemical NPK (full dose of 100%) and 75% NPK plus bio-fertilizers. Such two treatments gave almost equal results which assure the possibility of replacing 25% of the chemical NPK by using E.M.+phosphorein in fertilizing medicinal or aromatic plants such as *Coriandrun sativum*. This partial substitution of mineral NPK by using bio-fertilizers can be useful in reducing overall cost of chemical fertilizers and avoiding their environmental hazards and harmful impacts on public health.

REFERENCES

Abd El-Latif, T. A. (2002). Effect of organic manure and bio-fertilizers on caraway plants (*Carum carvi*, L.). J. Agric. Sci., Mansoura Univ., 27 (5): 3459-3468.

Abd El-Naeem, L. M. (2008). Effect of some organic and bio-fertilization treatments on caraway plants. M. Sc. Thesis, Fac. Agric., Minia Univ.

Abdou, M. A. H. and A. A. El-Sayed (2002). Effect of planting date and bio-fertilization treatments on growth and yield characters of *Carum carvi*, L. Proc. 2nd Inter. Conf. Hort. Sci., 10-12 Sept. 2002, Kafr E-Sheikh, Tanta Univ., 423-433.

Abdou, M. A. H.; A. A. El-Sayed; F. S. Badran and R. M. Salah El-Deen (2004 a). Effect of planting density and chemical and bio-fertilization on fennel plants. 1- Effect of planting density and some chemical (nofatrin) and biochemical (biogein) fertilizers. Annals Agric. Sci., Moshtohor, 42 (4): 1907-1922.

Abdou, M. A. H.; A. A. El-Sayed; F. S. Badran and R. M. Salah El-Deen (2004 b). Effect of planting density and chemical and bio-fertilization on fennel plants. 2- Effect of NPK chemical fertilization and bio-fertilization treatments. Annals Agric. Sci., Moshtohor, 42 (4): 1923-1937.

Al-Shareif, A. M. O. (2006). Response of caraway plants grown in sandy soil under drip irrigation to some bio-fertilization and antioxidant treatments. M. Sc. Thesis, Fac. Agric., Minia Univ.

Aly, M. K.; M. A. Mohamed; F. A. Attia; A. A. El-Sayed and M. H. S. Abd El-Gawad (2007 a). Effect of some organic and bio-fertilization treatments on coriander plants. 1- Vegetative growth and yield. Proc. 1st Inter. Conf. Desert Cultivation, Problems and Solutions, Minia Univ., 27-29 March 2007, p: 101-112.

Aly, M. K.; M. A. Mohamed; F. A. Attia; A. A. El-Sayed and M. H. S. Abd El-Gawad (2007 b). Effect of some organic and bio-fertilization treatments on coriander plants. 2- Volatile oil and chemical composition. Proc. 1st Inter. Conf. Desert Cultivation, Problems and Solutions, Minia Univ., 27-29 March 2007, p: 113-125.

A.O.A.C. (1980). Association of Official Analytical Chemists, Official Methods of Analysis, 12 Edit. Washington, D.C. USA.

Ayat, A. M. (2007). Effect of bio-fertilization with macro, micro nutrients and antioxidants on coriander plants grown in new reclaimed land. M. Sc. Thesis, Fac. Agric., Minia Univ.

Badran, F. S. and M. S. Safwat (2004). Response of fennel plants to organic manure and bio-fertilizers in replacement of chemical fertilization. Egypt. J. Agric. Res., 82 (2): 247- 256.

Badran, F. S.; F. A. Attia; E. T. Ahmed and H. S. Soliman (2003). Effect of chemical and biological fertilization on growth, yield and oil production of anise plants. 2- Effect of NP mineral/bio-fertilization and micronutrient treatments. Proc. 1st, Egypt and Syrian. Conf. Agric. and Food, El Minia, 8-11 Dec. 2003, 1 (1): 113-130.

Bedoukian, P. Z. (1967): Perfumery and Flavouring Synthesis. El-Sevier Publishing Co.

British Pharmacopeia (1963). Determination of Volatile Oil in Drugs. The Pharmaceutical Press, London.

Chaudhry, N. M. A. and P. Tariq (2006). Bactericidal activity of black pepper, bay leaf, aniseed and coriander against oral isolates. Pak. J. Pharm. Sci., vol. 19 (3): 214-218.

Chithra, V. and S. Leelamma (1999). Hypolipidemic effect of coriander seeds (*Coriandrum sativum*): mechanism of action. Plant Foods Hum. Nutr., 51 (2): 167-172.

Cottenie, A.; M. Verloo; M. Velghe and R. Camerlynck (1982). Chemical analysis of Plant and Soils. Laboratory of Analytical and Agro chemistry, State Univ., Ghent, Belgium.

El-Mekawy, M. and M. Aly (2005). Effect of irrigation intervals and bio-fertilization on growth and oil yield of *Nigella sativa*, L. under El-Arish conditions. J. Agric. Res., Tanta Univ., 31 (1): 72-89.

Fadl, M. S. and S. A. Sari El-Deen (1978). Effect of N-benzyladenine on photosynthetic pigments and total soluble sugars in olive seedling grown under saline condition. Res. Bull., Fac. Agric., Ain Shams Univ., 843.

Galal, Y. G and B. E. Ali (2004). Bio-fertilization and organic farming approaches. Advances in agricultural research in Egypt. Special Issue vol. 5 (1): 99-176. Published by Agricultural Research Center, Giza, Egypt.

Gomaa, A. O and H. E. Abo-Aly (2001). Efficiency of bio-fertilization in the presence of both inorganic and organic fertilizers on growth, yield and chemical constituents of anise plants. Annals Agric. Sci., Moshtohor, 39 (2): 1089-1099.

Gray, A. M. and P. R. Flatt (1999). Insulin-releasing and insulin-like activity of the traditional anti- diabetic plant *Coriandrum sativum* (coriander). Br. J. Nutr., 81 (3): 203-209.

Hassan, M. E. (1997). Plant growth-promoting rhizobacteria: An overview for Egypt. Proceeding of the Training Course on Bio-Organic Farming Systems for Sustainable Agriculture. Cairo, Egypt, July, 1997, p. 212-216.

Hassan, M. E. and M. A. Abdel-Monem (1997). Bio-fertilizers, production and uses. Proceeding of the Training Course on Bio-Organic Farming Systems for Sustainable Agriculture. Cairo, Egypt, July, 1997, p. 217-226.

Jackson, M. L. (1973). Soil Chemical Analysis. Prentice-Hall of India Private Limited M-97, New Delhi, India, 498pp.

Kandeel, Y. M.; F. A. Menesy; M. M. Khalafalla and W. M. Gad (2004). Effect of some commercial bio-fertilizers on growth, seed, volatile oil yield and chemical composition of *Foeniculum vulgare*, Mill. J. Agric. Res., Tanta Univ., 30 (3): 721-737.

Kubo, I.; K. Fujita; A. Kubo; K. Nihei and T. Ogura (2004). Antibacterial activity of coriander volatile compounds against *Salmonella choleraesuis*. J. Agric. Food Chem., 52 (11): 3329-3332.

Mohamed, M. A. and M. A. H. Abdou (2004). Growth and oil production of fennel (*Foeniculum vulgare*, Mill): Effect of irrigation and organic fertilization. Biological Agriculture and Horticulture, 22: 31-39.

MSTAT (1986). A Microcomputer Program for the Design, Management and Analysis of Agronomic Research Experiments (version 4). East Lansing, Michigan State Univ., USA.

Nicholson, F. A.; B. J. Chanbers; K. A. Smith and R. Harrison (1999). Spring applied organic manures as a source of nitrogen for cereal crops: experiments using field equipment. J. Agric. Sci., Cambridge, 133: 353-363.

Osman, Y. A. H. (2000). The possibility of production of coriander (*Coriandrum sativum*, L.) under Sinai conditions. Ph. D. Thesis, Fac. Agric., Cairo University, Egypt.

Sperenat, M. (1997). Nitrogen Fixing Organisms. Chapman and Hall, London.

Stary, F. and V. Jirasck (1975). A Concise Guide in Colour Herbs. Hamlyn, London, New York, Sydney, Toronto.

Surendra, C.; G. R. Choudhary; A. C. Chaudhari and S. Kumar (2002). Effect of nitrogen and bio-fertilizers on the yield and quality of coriander (*Coriandrum sativum*, L.). Annals of Agric. Res., India, 23: 634-637.

Tanious, C. S. T. (2008). Effect of some organic and bio-fertilization treatments on fennel plants. M. Sc. Thesis, Fac. Agric., Minia Univ.

تـأثير التسميد العضوى، الحيوى والمعدنى علـى النمـو، المحصـول، إنتاجيـة الزيـت والتركيب الكيمائى لنبات الكزبرة

محمد يونس على عبد الله
قسم الخضر والزينة- كلية الزراعة- جامعه المنصورة

أجري هذا البحث فى محطة تجارب ومعمل قسم الخضر والزينة بكلية الزراعة جامعة المنصورة خلال الموسمين ٢٠٠٦/٢٠٠٥ و٢٠٠٧/٢٠٠٦ لدراسة تأثير التسميد العضوى (سماد الماشية)، السماد الحيوى و/أو السماد المعدنى (NPK) على النمو الخضرى، المحصول، إنتاج الزيت والتركيب الكيمائى لنبات الكزبرة.

بالنسبة لتأثير التسميد العضوى، فلقد أوضحت النتائج المتحصل عليها أن إضافة سماد الماشية قد أدت إلى زيادة معنوية فى إرتفاع النبات (سم)، عدد الأفرع/نبات، وزن العشب الجاف/نبات (جم)، عدد النورات الخيمية/نبات، محصول البذور/نبات (جم)، محصول البذور/فدان (كجم)، نسبة الزيت العطرى (%)، محصول الزيت العطرى/نبات (ملليتر)، محصول الزيت العطرى/فدان (لتر)، محتوى الأوراق من كلوروفيللى أ، ب والكاروتينويدات (مجم/جم وزن طازج) وكذلك النسبة المئوية لكل من النيتروجين، الفوسفور والبوتاسيوم وذلك فى كلا الموسمين. ولقد كان التفوق فى كل الخصائص السابق ذكرها للنباتات النامية فى التربة المسمدة بالمعدل الأعلى من سماد الماشية (٢٥ م^{٣}/فدان) وذلك عند مقارنتها بالنباتات النامية فى التربة المسمدة بالمعدلات الأقل.

أما بالنسبة لتأثير التسميد المعدنى و/أو الحيوى فلقد أعطت النباتات التى حصلت على ١٠٠% NPK أو تلك التى سمدت بمعدل ٧٥% NPK مع السمادين العضويين المستخدمين فى التجربة (effective microorganisms و phosphorein) أفضل النتائج فى جميع القياسات المدروسة فى كلا الموسمين، فى حين أن أقل القيم لجميع القياسات قد سجلت للنباتات التى سمدت فقط بإحدي السمادين الحيويين أو كلاهما معا.

ولقد كانت معاملات التفاعل بين سماد الماشية، الأسمدة الحيوية و/أو السماد المعدنى NPK الأكثر فاعلية على نتائج القياسات. حيث سجلت أعلى القيم فى جميع القياسات محل الدراسة نتيجة استخدام سماد الماشية بمعدل ٢٥ م^{٣}/فدان مجتمعا مع السمادين الحيويين و٧٥% NPK أو مع ١٠٠% NPK فقط. تلك المعاملتان أعطيتا تقريبا نتائج متساوية خلال الموسمين مما يمكن معه تدعيم إمكانية استبدال ٢٥% من السماد الكيمائى (NPK) بالسمادين الحيويين السابق ذكرهما وذلك لتسميد النباتات الطبية أو العطرية مثل الكزبرة.