

EFFECT OF MINERAL, ORGANIC AND BIO-FERTILIZER ON GROWTH AND YIELD OF FENNEL PLANTS

Bayoumi, N.A.*; T.T. Mahrous * and H. A. Madkour **

* Menoufia univ faculty of Agric.

** Soil, Water and Environ. Research Institute

ABSTRACT

A field experiment was conducted at the experimental farm of the Horticulture Research station, South El-Tahrir province during the two successive seasons to study the influence of mineral, organic and bio-fertilizer on some growth characters, dry matter, yield, fruit oil content and nutrients content of Fennel plants.

Mineral fertilizers were applied to the soil either alone or together with the studied organic fertilizer (FYM) and bio-fertilizer N₂-fixers. Nitrogen fertilizer was added at a rate of 0, 150, 300 kg fed⁻¹ and FYM was added at a rate of 15, 30 m³/fed.

Fennel plants height and number of branch affected by applied fertilizer. The maximum fennel plant height was occurred by the addition of half dose of mineral N + 30 m³/fedden FYM and inoculation the seeds by N₂ - fixers.

Seed index (weight of 100 fruits) and fruit yield per feddan was significantly affected by applied mineral, organic and bio-fertilizer. The maximum seed index and fruit yield for fennel was achieved during the 2nd season by application of 1/2 dose of N + 30 m³ FYM/fed. and seed inoculation with N₂-fixers.

Dry matter yield at age of 40 days of fennel plant was considerably affected by application of bio-fertilizers. The maximum dry matter was achieved by addition of half dose of mineral N and full dose FYM and seeds inoculated with N₂-fixers.

The obtained data showed that application of mineral, organic and bio-fertilizers markedly increased NPK concentration and uptake of fennel plants.

Oil percentage was markedly affected by mineral N, organic matter and bio-fertilizer. The maximum fennel oil percentages were recorded by addition of half dose of mineral N, full doses of FYM and N₂-fixers.

INTRODUCTION

Medicinal and aromatic plants commercially produced on about 90.000 in Egypt feddans, representing an annual export income of more than \$110 million. Egyptian exports of medicinal and aromatic plants occupy the fifth order among all agricultural Egyptian exports. However, the exportation of these crops now faces serious problems due to using chemical fertilizers and pesticides which reduce the exports of these crops due to the concern for human health and environment. Accordingly, the strategy of biological production of medicinal and aromatic plants in desert soils has gained more and more importance during the past few years. Biological production technology of medicinal and aromatic plants can provide the basis for achieving economic and environmental sustainability in Egypt.

Fennel (*Foeniculum vulgare Mill*) is an important crop plant of considerably medicinal value, being carminative and stomachic. Fruits are also used in preparation of pickles and in households as an important chewing ingredient after meals. Fennel essential oil is used to flavor different food preparations and in perfumery industries.

Most of new reclaimed soils in Egypt are sandy. These soils are poor in organic matter and essential nutrient elements.

Nitrogen fertilizer application is the major factor that affect plants production and seed quality of plants, (Kandeel *et al.*, 1992, Ceylan *et al.*, 1994 and Biswas *et al.*, 1995). Organic manure is involved in medicinal and aromatic plants in many countries due to its affects on physical and chemical and biochemical of soil and plant characteristics (El-Ghadban (1998) and Osamn (2000).

Great efforts have been exerted to a large scale in the world to get the full benefits of the soil biological activity and in particular bacteria species, which are able to fix atmospheric nitrogen. Harridy *et al.* (1988) and Bertand *et al.* (2000) obtained an enhancement of growth characters, fruit production of Rosella plants and oil seed rape by using *Azospirillum*, *Azotobacter* and *Achromobacter* strains.

MATERIALS AND METHODS

A field experiments was conducted at the experimental farm of the Horticulture Research station, South El-Tahrir province during the two successive season (1997 and 1998) to study the influence of mineral, organic and bio-fertilizers on some growth characters, dry content of Fennel (*Foeniculum vulgare L.*) plants.

The experiment consists of 14 treatments represent the combinations between mineral, organic and bio-fertilizer as it is shown in the following:

1. Control : without fertilizer
2. Ammonium sulphate at rate 150 kg/fed.
3. Ammonium sulphate at rate of 300 kg/fed.
4. Farmacyard manure (FYM) 15 m³/fed.
5. Farmacyard manure (FYM) 30 m³/fed.
6. Ammonium sulphate at rate 150 kg/fed. +: FYM 30 m³/fed.
7. Ammonium sulphate at rate 300 kg/fed. +: FYM 30 m³/fed.
8. N₂-fixer: seeds inoculated with N₂-fixer (*Asospirillum Sp*, *Azotobacter chroococcum* *Klebsiella Pneumonia* and *Bacillus Spolymexa*).
9. Ammonium sulphate at rate 150 kg/fed + N₂-fixer
10. Ammonium sulphate at rate 300 kg/fed + N₂-fixers
11. FYM 15m³/fed.+ N₂-fixers
12. FYM 30 m³/fed.+ N₂-fixers
13. Ammonium sulphate at rate 150 kg/fed + FYM 30 m³/fed.+ N₂-fixer
14. Ammonium sulphate at rate 300 kg/fed + FYM 30 m³/fed.+ N₂-fixer

The experiment was designed in split plot design with five replicates. The experimental plot area was 2 x 1.8 m prepared containing rows 60 cm a part. The spaces between plants were 30 cm. Soil, plant analyses and organic manure analyses Tables (1 and 2) were carried out according to Richards (1954), and Jackson 1937. Essential oil percentages were determined in air dried fruits as described in British pharmacoeia (1963).

Table (1): Some physical and chemical characteristics of experimental soil.

A- Physical properties.

season	Total CaCO ₃ %	W.H.C %	Field capacity %	Particle size distribution%				Textural grad
				Coors sand	Fine sand	silt	clay	
1 st	4.60	14.8	8.87	54.20	34.30	8.30	3.20	Sandy
2 nd	4.83	14.7	8.82	53.37	32.93	9.40	4.10	sandy

b- Chemical properties.

season	pH (1:2.5)	EC dS/m	Soluble cations (meq/L)				Soluble anions (meq/L)			
			Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	CO ₃ ⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁼⁼
1 st	8.0	1.50	6.5	2.30	5.10	0.11	-	6.50	5.61	1.90
2 nd	8.0	1.55	6.73	2.42	4.78	0.13	-	6.10	5.23	2.73
Available nutrients (ppm)										
season	N	P	K	Fe	Mn	Zn				
1 st	10	5.40	270	4.3	1.4	0.90				
2 nd	11	6.41	282	4.4	1.5	0.83				

Table (2): Chemical analysis of used FYM.

Fertilizer characteristics	1 st season	2 nd season
Density	342 kg/m ³	350 kg/m ³
Moisture %	7.70	8.10
Total N (%)	0.84	0.95
Organic mater (%)	35.24	36.43
C/N ratio	24.33	22.24
NH ₃ ⁺ -N (ppm)	47.70	63.80
NO ₃ ⁻ -N (ppm)	184.10	205.30
Total P (%)	0.30	0.52
Total K (%)	1.80	1.95
Fe (ppm)	833.50	981.10
Mn (ppm)	198.60	173.80
Zn (ppm)	109.90	149.70
Cu (ppm)	40.90	42.10

RESULTS AND DISCUSSION

1. Effect of mineral, organic and bio-fertilizer on growth of fennel plants:

1.1 Plant height:

The obtained results in Table (3) showed the effect of mineral organic and bio-fertilizers on the height of fennel plants. Data revealed that application of the three types of the tested fertilizers significantly elongate the plant height either at the first or the second seasons of cultivation. However, application of bio-fertilizer N₂-fixers alone showed no influence on the plant height.

Table (3): Plant height (cm) and number of branches of fennel plants grown in sandy soil as affected by application of mineral, organic and biofertilizers during seasons 1997-1998.

Seasons Treatments	Plant height																	
	1997						1998						1998					
	None inoculated		N ₂ - fixers		Means		None inoculated		N ₂ - fixers		Means		None inoculated		N ₂ - fixers		Means	
Control	67.33	68.23	67.78	68.43	69.23	68.83	8.00	8.10	8.30	8.10	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
1/2 N	90.10	100.07	95.09	90.43	100.87	95.65	8.10	8.10	8.30	8.10	8.00	8.10	8.20	8.20	8.20	8.20	8.20	8.70
1 N	92.20	98.30	95.25	92.90	99.30	96.10	8.30	8.30	8.30	8.10	8.00	8.10	8.30	8.30	8.30	8.30	8.30	8.95
1/2 OM	80.90	83.77	82.34	79.80	83.50	81.65	8.10	8.10	8.10	8.10	8.00	8.10	8.20	8.20	8.30	8.30	8.30	8.05
1 OM	84.20	88.43	86.30	84.37	88.33	86.35	8.20	8.20	8.20	8.30	8.30	8.20	8.20	8.20	8.30	8.30	8.30	8.32
1/2 N+ 1 OM	98.00	117.33	107.7	88.00	121.43	104.7	9.60	9.60	9.60	10.10	10.10	9.60	9.60	9.60	9.60	9.60	9.60	9.62
1N + 1 OM	98.70	104.33	101.5	99.20	105.33	102.3	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.70
Means	88.04	94.35	91.19	86.16	95.43	90.80	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.28	8.74

L.S.D at 1%	Treatment (T)		N ₂ -fixers (TB ₁)		Treatment (T)		N ₂ -fixers (TB ₁)	
	5.12	3.65	2.15	1.62	5.69	4.06	1.77	1.31
5%					1.00	0.71	0.26	0.19
					0.82	0.59	0.30	0.22

In non inoculated seeds organic matter application enhanced the plant height by more than 16% compared with the control either in the first or the second season of growth. An obvious improve for the effect of organic matter appeared with the addition of bio-fertilizer. Application of N mineral fertilizer followed the influence of organic application either with or without bio-fertilizer addition at both season of growth. The promotion in the plant height induced by application of half N or N treatments was more than 32% compared with the control. However the combination of N-fertilizer with bio-fertilizer increased the plant height by more than 46%. Application of complete dose of N and OM tremendously elongated at the plant height by more than 46% compared with the control. N₂-fixers showed an immense augmentation in the plant height when added to the combination of N and OM fertilizer. On the other hand the application of 1/2 N + 1 OM with bio-fertilizer demonstrated the highest influence on the plant height either at the first and the second seasons of growth. Wherever the highest figures of the plant height (121.43 cm) were induced by the application of half N + 1 OM combined with N₂-fixer at the second season that is equal to an increase of 77.5% more than the control.

This result emphasis that the best influence of added fertilizers occurred with application of half dose of nitrogen and one dose of organic fertilizers. This enhancement may be ascribed to the beneficial influence of the addition of half dose of N fertilizer with 1 OM on stimulating the activity of bacteria specially N₂-fixers bacteria which promote the release and availability of N and P, in addition increased the availability of other nutrients in the soil and growth promotion substances. Similar results have been reported by Harridy *et al.* (1998), Bertand *et al.* (2000) and Nassar *et al.* (2000).

1.2. Number of branches:

The obtained data in Table (3) denoted the applied, ineral. Organic and bio-fertilizer on the number of branches of fennel plants. Data revealed that application of the three types of the tested fertilizers significantly increased the number of branches either at the first or the second seasons of cultivation. However, application the bio-fertilizer alone showed no influence on the number of branches in non inoculated seeds. Organic matter application enhanced the number of branches by more than 1% compared with the control either in the first or the second season of growth. An obvious improvement for the effect of organic matter appeared with the addition of bio-fertilizer. Showed nearly equal to N₂-fixers for their influence on the number of branches. Application of mineral N fertilizer followed the influence of organic application either with or without bio-fertilizer addition at both seasons of growth. The promotion in the number of branches induced by application of 1/2 N was more than 2% compared with the control. However the combination of N fertilizer with bio-fertilizer increased the number of branches by more than 13%. Application of full dose of N and OM tremendously promoted the number of branches by more than 20% compared with the control>

N₂-fixers showed an immense augmentation on the number of branches when added in combination with N and OM fertilizer. On the other

hand, the application of 1/2 N + 1 OM with the bio-fertilizer demonstrated the highest influence on the number of branches in the both seasons of growth, wheresoever the highest figures of the number of branches (10.57) was induced by the application of 1/2 N + 1 OM combined with P-dissolver at the second season.

The results pointed out that application of nitrogen and organic fertilizer with N₂-fixers achieved the higher numbers of branches. That referred to stimulating the influence of nitrogen either from the organic or the mineral source on activation of N₂-fixers and its enhancing effect on the availability of N on plant growth, similar results have been obtained in the first season. The obtained results are in coincidence with the finding of Amin (1997) and Ashour *et al.* (1998).

2.1. Seed index

Data in Table (4) showed that the seed index (weight of 100 fruits) of fennel plant as affect by the application of mineral, organic and bio-fertilizer addition on the three types of tested fertilizers significantly increased the seed index either in the first or the second seasons of cultivation. However, application of bio-fertilizer, showed no influence on the seed index. In non inoculated seeds, organic matter application enhanced the seed index by more than 7% compared with the control either in the first or second season of growth.

Application of N mineral fertilizer followed the influence of organic application either with or without the bio-fertilizer addition at both seasons of growth. The promotion in the seed index induced by application of 1/2 N or 1 N treatments was more than 3% compared with the control. However, the combination of N fertilizer with the bio-fertilizer increased the seed index by more than 11%. Application of recommended dose of N and 1 OM tremendously increased the seed index by more than 20% compared with the control.

N₂-fixers showed an immense augmentation in the seed index when added to the combination of N and OM fertilizer.

On the other hand the application of 1/2 N + 1 OM with the bio-fertilizer demonstrated the highest influence on the seed index either at the first or the second seasons of growth.

2.2. Fruit yield per feddan:

Data in Table (4) showed the influence of the mineral, organic and bio-fertilizers on the fruit yield of fennel plant per feddan in both seasons of growth.

The types of tested fertilizers significantly increased the fruit yield per feddan either at the first or the second seasons of cultivation. However, application of bio-fertilizer, showed no influence on the fruit yield per feddan. In non inoculated seeds, organic matter application enhanced the fruit yield per feddan by more than 18% compared with the control either in the first or the second season of growth.

An obvious improvement for the effect of organic matter appeared with adding the bio-fertilizers. Application of mineral N fertilizer followed the

influence of organic application either with or without the bio-fertilizer application at both seasons of growth. The promotion in the fruit yields per feddan induced by application of 1/2 N or N treatments was more than 17% compared with the control. However, addition of N fertilizer with bio-fertilizer increased the fruit yields per feddan by more than 30%. Application of complete dose of N and OM tremendously increased the fruit yield of fennel per feddan by more than 59% compared with the control.

N₂-fixers showed an immense augmentation in fruit yield of fennel per feddan when added to the combination of N and OM fertilizer. On the other hand the application of 1/2 N + 1 OM with the bio-fertilizers demonstrated the highest influence on the fruit yield of fennel per feddan either at the first or the second season of growth wheresoever the highest figure of fruit yield per feddan (1524.83 kg/fed.) about 94% more than the control was induced by the application of 1/2 N + 1 OM combined with N₂-fixers at the first season. These results agreed with the finding Amin (1997) and Nassar *et al.* (2000).

2.3. Dry matter:

The obtained results for the effect of mineral, organic and bio-fertilizers on the dry matter of fennel plants presented in Table (5). The data revealed that application of the three types of the tested fertilizers significantly increased the dry matter yield either at the first or the second seasons of cultivation. However, application bio-fertilizer alone showed no effect on the dry matter yields. In non inoculated seeds, application of organic matter enhanced the dry matter yield by more than 52% compared with the control either in the first or the second season of growth.

An obvious improvement for the effect of organic matter appeared with application of the bio-fertilizer.

Application of mineral N fertilizer followed the influence of organic application either with or without bio-fertilizer application at the both season of growth. The promotion in the dry matter induced by application of 1/2 N or N treatments was more than 82% compared with the control. However, the combination of N fertilizer with bio-fertilizer increased the dry matter yield by more than 106% compared with the control. Application of recommended dose of N and OM tremendously increased the dry matter yield by more than 128% compared with the control.

N₂-fixers showed an immense augmentation in the dry matter when added to the combination of N and OM fertilizer. On the other

3. Macronutrients contents and uptake of fennel plants as affected by mineral, organic and bio-fertilizers:

The obtained results in (Table b) manifest that the treatments of bio-fertilizer alone slightly stimulate the concentration and uptake of N by fennel plants. Application of the three types of the tested fertilizers significantly increased the concentration of N either at first or the second seasons of cultivation.

However, application the bio-fertilizer alone showed no influence on the concentration of N. In non inoculated seeds organic matter application enhanced the concentration of nitrogen by more than 12% compared with the control either in the first or the second season of growth.

Table (4): fruit yield per feddaan (kg) and seed index (weight of 100 fruits(g) of fennel plants grown in sandy soil as affected by application of mineral, organic and biofertilizers during seasons 1997-1998.

Seasons	Fruit yield kg/feddaan															
	1997				1998				1997				1998			
	None inoculated	N ₂ -fixers	Means	None inoculated	N ₂ -fixers	Means	None inoculated	N ₂ -fixers	Means	None inoculated	N ₂ -fixers	Means	None inoculated	N ₂ -fixers	Means	
Control	785.2	785.6	785.4	752.2	765.5	758.9	0.84	0.86	0.85	0.81	0.85	0.83	0.85	0.85	0.83	
1/2 N	914.8	1069.8	992.3	905.5	1061.3	983.1	0.87	1.01	0.94	0.90	0.98	0.94	1.01	0.94	0.94	
1 N	1057.3	1186.7	1122.0	1045.8	1175.1	1110	1.00	1.02	1.01	1.00	1.04	1.02	1.02	1.01	1.02	
1/2 OM	926.3	1185.0	1055.7	944.2	977.1	260.5	0.89	0.96	0.93	0.87	1.04	0.96	0.96	0.87	0.96	
1 OM	1005.7	1066.0	1038.8	1003.3	119.5	1061	0.91	0.99	0.95	0.93	1.19	1.06	0.99	0.95	1.06	
1/2 N+ 1 OM	1038.9	1524.8	1281.9	956.1	1458.3	1207	0.92	1.12	1.02	0.92	1.42	1.17	1.12	1.02	1.17	
1N + 1 OM	1248.8	1249.7	1249.3	1235.0	1240.5	1237	1.01	1.04	1.03	1.07	1.07	1.07	1.04	1.03	1.07	
Means	996.7	1252.2	1038.5	963.17	1113.9	1038	0.92	1.00	0.96	0.93	1.07	1.08	1.00	0.96	1.07	
L.S.D at 1%	27.2		18.4	39.2		17.0	0.05	0.05	0.05	0.067	0.048	0.048	0.05	0.067	0.048	
5%	19.4		13.6	28.0		12.6	0.039	0.037	0.037	0.048	0.036	0.036	0.037	0.048	0.036	

Table (5): dry matter yield (g) and oil percentage at age 40 days of fennel plants grown in sandy soil as affected by application of mineral, organic and biofertilizers during seasons 1997-1998.

Seasons	Dry matter yield												Oil percentage					
	1997				1998				1997				1998					
	None inoculated	N ₂ -fixers	Means	None inoculated	N ₂ -fixers	Means	None inoculated	N ₂ -fixers	Means	None inoculated	N ₂ -fixers	Means	None inoculated	N ₂ -fixers	Means			
Control	1.10	1.63	1.37	1.31	1.51	1.41	1.46	1.48	1.47	1.51	1.60	2.31	1.51	1.60	2.31			
1/2 N	2.00	3.90	2.95	2.10	3.80	2.95	1.64	1.97	1.81	1.63	1.87	1.75	1.63	1.87	1.75			
1 N	2.46	3.10	2.78	2.41	3.20	2.81	1.87	1.91	1.89	1.85	1.87	1.86	1.85	1.87	1.86			
1/2 OM	1.67	1.99	1.83	1.87	2.01	1.94	1.88	1.88	1.88	1.89	1.88	1.89	1.89	1.88	1.89			
1 OM	2.21	2.75	2.48	2.31	3.15	2.73	1.96	1.97	1.97	1.79	1.98	1.89	1.79	1.98	1.89			
1/2 N+ 1 OM	2.31	4.89	3.59	2.71	4.95	3.83	1.99	2.10	2.01	2.00	2.17	2.08	2.01	2.17	2.08			
1N + 1 OM	2.51	3.19	2.85	2.73	3.92	3.33	2.14	2.07	2.11	2.10	2.06	2.05	2.10	2.06	2.05			
Means	2.04	3.06	2.55	2.20	3.22	2.71	1.85	1.91	1.86	1.824	1.92	1.87	1.824	1.92	1.87			
L.S.D at 1%	0.22		0.112	0.160		0.089	0.127	0.091	0.091	0.168	0.077	0.077	0.168	0.077	0.077			
5%	0.157		0.083	0.114		0.066	0.051	0.038	0.038	0.120	0.057	0.057	0.120	0.057	0.057			

An obvious improvement for the effect of organic matter appeared with application of bio-fertilizer. Application of mineral N fertilizer followed the influence of organic application either with or without the bio fertilizer, addition at the both seasons of application of 1/2 N or N treatments was more than 16% compared with the control. However, the combination of N fertilizer with the bio-fertilizer increased the concentration of N by more than 34%. Application of complete dose of N and OM tremendously increased the concentration of N by more than 19% compared with the control.

N₂-fixers showed in immense augmentation in the concentration of N in fennel plant when applied to the combination of N and OM fertilizer. On the other hand the application of 1/2 N + OM with the bio-fertilizer demonstrated the highest influence on the concentration of N in fennel plants either at the first and the second season of growth. Wheresoever the highest figure of the concentration of nitrogen (3.12%) which about 53% more than the control was induced by the application of 1/2 N + 1 OM combined with N₂-fixers at the second season. Similar results for the effect of different fertilizers on the N concentration in different plants have been reported by Hassouna *et al.*, (1998) and Anga (2001).

Nitrogen uptake in (Table 6) elucidate the same trend of N concentration as affected by application of mineral, organic and bio-fertilizers. Data show that application of 1/2 N + 1 OM with inoculation of N₂-fixers, gave the highest effect at the second season (15.44 mg/plant). This increase was more than five-fold compared to the control for the first and second seasons. Similar results were obtained by Agwah(1993) and Harridy *et al.* (1998). This may be attributed to the stimulating influence of the fertilizers on plant vegetative growth, consequently dry matter yield, N concentration and its uptake.

3.2 Phosphorus concentration and uptake:

The obtained result for the effect of mineral, organic and bio-fertilizers on the P concentration of fennel plants are presented in (Table 6 b). Data revealed that application of the three types of the tested fertilizers significantly increased the P-concentration either at the first or the second seasons of cultivation. However, application of the bio-fertilizer alone showed no influence on the p-concentration. In non-inoculated seed organic matter application enhanced the P-concentration by more than 38% compared with the control either in the first or the second seasons of growth. The effect of organic matter appeared with adding the bio-fertilizers. Application of mineral N followed the influence of organic application either with or without the bio-fertilizer addition at the both season of growth. The promotion in the P-concentration induced by application of 1/2 N treatments was more than 39% compared with the control.

Application of complete dose of N and OM tremendously increased the P concentration by more than 75% compared with the control.

N₂-fixers showed an immense augmentation in the P-concentration with N and OM fertilizer. On the other hand the application of 1/2 N + OM with the bio-fertilizer demonstrated the highest influence on P-concentration either at the first and the second season of growth. Phosphorous uptake (Table

6) illustrated that applied mineral, organic and bio-fertilizer achieved the highest increased in P uptake in both seasons. These increase were more than double-fold in both seasons in treatment 1N + 1 OM application, while application 1/2 N + 1 OM + N₂-fixers promoted uptake by fennel plants by more than seven-fold compared with the control. The enhancing effect of mineral, organic, and bio-fertilizers on P-concentration and P uptake may be due to its effect on increasing the availability of the added phosphorus and other nutrients in the soil, sequentially, augmented with Ashour *et al.* (1996) and Nassar *et al.* (2000).

Table (6): Nitrogen, phosphorus and potassium concentration (%) and uptake (mg/plant) of fennel plants grown in sandy soil as affected by application of mineral, organic and biofertilizers during seasons 1997-1998.

a-Nitrogen

Seasons	None inoculated		N ₂ -fixers		None inoculated		N ₂ -fixers	
	Con (%)	Uptake (mg/plant)	Con (%)	Uptake (mg/plant)	Con (%)	Uptake (mg/plant)	Con (%)	Uptake (mg/plant)
Control	2.03	2.20	2.05	3.34	2.04	2.70	2.11	3.19
1/2 N	2.10	4.20	2.81	11.0	2.13	4.50	2.84	10.8
1 N	2.31	5.70	2.36	7.30	2.33	5.60	2.39	7.60
1/2 OM	2.27	3.80	2.30	4.60	2.28	4.30	2.31	4.60
1 OM	2.29	5.06	2.34	6.40	2.33	5.40	2.41	7.60
1/2 N+ 1 OM	2.37	5.50	2.96	14.5	2.39	6.50	3.12	15.44
1N + 1 OM	2.40	6.00	2.45	7.80	2.43	6.63	2.49	9.76

b-Phosphorus

Seasons	None inoculated		N ₂ -fixers		None inoculated		N ₂ -fixers	
	Con (%)	Uptake (mg/plant)	Con (%)	Uptake (mg/plant)	Con (%)	Uptake (mg/plant)	Con (%)	Uptake (mg/plant)
Control	0.130	0.143	0.13	0.210	0.13	0.175	0.149	0.225
1/2 N	0.181	0.360	0.23	0.897	0.18	0.380	0.231	0.880
1 N	0.200	0.490	0.21	0.650	0.21	0.506	0.213	0.680
1/2 OM	0.180	0.300	0.18	0.370	0.18	0.338	0.199	0.400
1 OM	0.203	0.449	0.23	0.640	0.23	0.520	0.236	7.743
1/2 N+ 1 OM	0.213	0.492	0.27	1.335	0.24	0.650	0.291	1.440
1N + 1 OM	0.227	0.520	0.25	0.810	0.24	0.663	0.254	0.995

c-Potassium

Seasons	None inoculated		N ₂ -fixers		None inoculated		N ₂ -fixers	
	Con (%)	Uptake (mg/plant)	Con (%)	Uptake (mg/plant)	Con (%)	Uptake (mg/plant)	Con (%)	Uptake (mg/plant)
Control	2.31	3.00	2.35	3.55	2.31	2.54	2.34	3.81
1/2 N	2.55	5.35	3.90	14.82	2.53	5.06	3.89	15.17
1 N	2.30	5.54	3.66	11.71	2.99	7.35	3.63	11.25
1/2 OM	2.68	5.00	2.88	5.80	2.78	4.64	2.81	5.59
1 OM	3.07	7.09	3.11	9.79	3.00	6.63	3.10	8.53
1/2 N+ 1 OM	2.88	7.80	4.43	21.90	2.91	6.70	4.15	20.30
1N + 1 OM	3.30	9.00	4.09	16.03	3.19	8.01	4.07	12.98

3.3 Potassium concentration and uptake:

Data in (Table 6) demonstrated that application of mineral, organic and bio-fertilizer markedly increased potassium concentration in fennel plants.

However, application bio-fertilizer either N_2 -fixer showed no influence on the K concentration. In non-inoculated seeds organic matter application enhanced the K concentration by more than 16% compared with the control, either in the first or the second season of growth. An obvious improvement for the effect of organic matter appeared with adding the two types of bio-fertilizer gave the same trend for their influence on K concentration.

Application of mineral N fertilizer followed the influence of organic application either with or without bio-fertilizers addition at the both season of growth. The promotion in the K concentration induced by application of $1/2N$ or N treatments was more than 9% compared with the control. However, addition of N fertilizer with the bio-fertilizer increased the K concentration by more than 57% compared with the control. When it was added alone half or complete dose of N and OM tremendously raised the K concentration by more than 38% compared with the control. N_2 -fixers showed an immense augmentation in the K concentration when added to the combination of N and OM fertilizer. On the other hand the application of $1/2 N + OM$ with the bio-fertilizers demonstrated the highest influence on the K concentration either at the first and the second season of growth whersoever the highest figures of K concentration (4.43%) by about 92% compared with the control was induced by the application of $1/2 N + 1 OM$ combined with N_2 -fixers at the second season. Potassium uptake as shown in (Table 6) gave the same trend, wherever addition of mineral, organic and bio-fertilizer considerably promoted K uptake. Application of $1N + 1OM$ treatment remarkably raised K uptake by more than two-fold in both seasons in comparison with the control. While application $1/2N + 1OM + N_2$ -fixers increased K uptake of fennel plants by more than seven fold in both seasons compared with the control.

The data also revealed that application of $1/2N + 1OM + N_2$ -fixers in 2nd season appeared the most beneficial effect on the uptake of K by plants (21.9 mg/plant). This may be due to the stimulating effect of these fertilizers on the plant growth, where the bulk of potassium is mainly taken up during the vegetative growth stage consequently, increased its concentration and uptake. This increase in the K uptake can also be occurred as a result of enhancing the metabolic activity of the plant root when mineral nutrient are supplied through the fertilizers application into the soil. The aforementioned stimulating effect of mineral, organic and bio-fertilizer on the uptake of K by plants are in consonance with Lin *et al.* (1983) and Kapulnik *et al.* (1985a, 1985b, 1987).

4- Essential oil content of fennel plant as affected by mineral, organic and bio-fertilizer

The beneficial effect of the applied fertilizers on the oil percentage of fennel plant were elucidated in (Table 5). Application of three types of the tested fertilizers (mineral, organic and bio-fertilizer) significantly increased the oil percentage of fennel plants either at the first or the second season of cultivation. In non inoculated seeds organic matter application enhanced the oil percentage by more than 29% compared with the control either in the first or the second season of growth.

An obvious improve for the affect of organic matter appeared with the application of bio-fertilizer. Application of mineral N fertilizer followed the influence of organic application either with or without the bio-fertilizer addition at both season of growth. The promotion in the oil percentage induced by application of $\frac{1}{2}$ N or N treatments was more than 12% compared with the control. However the combination of N fertilizer with the bio-fertilizer increased the oil percentage by 29% more than the control.

Application of complete dose of N and OM tremendously increased the oil percentage by more than 46.5% compared with the control.

N₂- fixers showed an immense augmentation in the oil percentage when applied to the combination of N and OM fertilizer. On the other hand the application of $\frac{1}{2}$ N + OM with the bio-fertilizer demonstrated the highest influence on the oil percentage either at the first and the second season of growth. The same observation were obtained by Amin (1997) and Harridy *et al.* (1998).

REFERENCES

- Agwah, E.M.R. and A.F. Shahaby, (1993). Associative effect of *Azotobacter* on vitamin C; chlorophyll content and growth of lettuce under field conditions. *Annals of Agric. Sci., Cairo*, 38(2):423-434.
- Amin, I.S. (1997). Effect of bio-and chemical fertilization on growth and production on (*Cariandrum sativum*, *Foeniculum vulgare* and *carum carvil*) plants. *Annals of Agric. Sc., Moshtohor*, 35(4):2327-2334.
- Anga, M.A.H. (2001). Studies on the effect mineral and biofertilization on yield and quality of spanch (*Spinacia oleracea* L.) M.Sc. Thesis faculty of Agric. Alex. University.
- Ashour, S.A. (1998): Influence of biofertilizers and phosphorus application on growth and yield of potato. *J. Agric. Sci. Mansoura University*, 23(7):3351-3358.
- Bertand, H.C.; Plassard, X.; Pinochet, B.; Touraine, N. and J.C. Cleyetmarel (2000): Stimulation of the ionic transport system in *Brassica napus* by a plant growth promoting rhizobacteria (*Achromobacter sp.*) *Can. J. Microbiol.*, 46: 229-236.
- Biswas, D.; Ali S.; and M. Khera (1995), Response of Gobhi Sarson (*Brassica napus* L. ISN-706) to nitrogen and sulphur. *J. of the Indian Soc. Of Soil Sci.*, 43(2): 220-223.
- British Pharmacopoeia (1963). The pharmaceutical. Press 17 Bloomsburg, Squire, W.C.I. London.
- Ceylan, A.; Bayrm, E. and N. Ozay (1994). The effect of N fertilizer on the yield quality of *Thymus vulgaris* L. in ecological conditions of Bornova-Izmir. *Turkish Journal of Agriculture & Forestry*, 18(4): 249-255 [c.f. Hort. Abst., 65:5368].
- El- Ghadban, A.E.M. (1998). effect of some organic and inorganic fertilizers on growth, oil yield and chemical composition of spearmint and marjoram plants. p.H.D. Thesis. Fac. Agric. Cairo University.

- Harridy, L.M. and Amara, A. and Mervat(1998). effect of presowing inoculation of seeds by nitrogen fixed bacteria on growth, fruit production, sepals yield and chemical composition of roselle plants. Egypt. J. Appl. Sci.,13(6):217-231.
- Hassouna, M.G.; M.A. El-Saedy and H.M.A.Saleh,(1998). N-economy using bio and mineral fertilizers for the growth of cucumber (*Cucumis sativus*), in the calcareous soils of north coast of Egypt. Symposium on Agro-technologies based on biological nitrogen fixation for desert agriculture. April 14-16.(1998) El-Arish. North, Sinai Governorate, Egypt.
- Jackson, M.L.(1973). Soil Chemical Analysis. Prentice-Hall. Englewood Cliffs, N.J., U.S.A.
- Kandeel, A.M.; S.M. Mahamed and A.A.Sadek (1992). Effect of some agricultural treatments on growth and chemical composition of Rosemary plant (*Rosmarinus officinalis* L.) 1-Effect of nitrogen fertilization. Egypt. Journal of Applied Science, 7(6):340-352.
- Kapulnik, Y.; M. Feldman; Y. Okon and Y. and Henis(1985a) Contribution of nitrogen fixed by *Azospirillum* to the N nutrition of spring wheat in Isral. Soil Biol. Biochem., 17:509-515.
- Kapulink, Y.; Gafny, R. and Y. Okon(1985b). Effect of *Azospirillum* ssp inoculation on root development and nitrate uptake in wheat (*Triticum aestivum* c.v.Miriam)in hydroponic systems. Can.J.Bot., 63:627-631.
- Kapulink, Y.; Okon, Y. and Y. Henis (1987). Yield response of spring wheat cultivars (*Triticum aestivum* and *T.turgidum*) to inoculation with *Azospirillum brasilense* under field conditions. Biol. And Fert. Soils., 4:27-35.
- Lin, W.; Y. Okon and R.W.F.Hardy(1983). Enhanced mineral uptake by *Azospirillum brasilense*. Appl. Environ., Microbiol.,45:1775-1779.
- Martin, P.; Glatzle, A.; Kolb, W-Dmaytl., and W.Schidt, (1989). N₂fixing bacteria in the rizosphere, Quantification and hormonal effected on root development Z-pflanzenernahr. Bodenk,152,237-245.
- Nassar, K.E.; M.Y. Gebrail and K.M.Khalil (2000). Efficiency of phosphate-dissolving bacteria (PDB) in combined with different forms and rates of P-fertilization on the quantity and quality of faba bean (*Vicia faba* L.) Minufiya.J.Agric., Res., 25(5):1335-1349.
- Osman, Y.A.H.(2000). The possibility of production of coriander (*Coriandrum sativum* L.) under Sinai condition Ph.D. Thesis Fac. Agric., Cairo University.
- Richards, L.A.(1954). The diagnosis and improvement of saline and alkaline soils. USDA., Handbooh60.

تأثير التسميد المعدني و العضوي و الحيوي على نبات الشمر

نبيل بيومي* - طه طه محروس** - حسب النبی مذكور**

* كلية الزراعة جامعة المنوفية

** معهد بحوث الاراضى والمياه والبيئة- مركز البحوث الزراعية- الجيزة

اجريت تجربة حقلية فى ارض رملية بمحطة بحوث البساتين بالقطاع الجنوبى لمديرية التحرير لدراسة تأثير التسميد المعدنى والعضوى والحيوى على نبات الشمر، حيث تأثيرها على النمو الخضرى ومحصول الثمار ودليل البذور والعشب الجاف ونسبة الزيت والعناصر الغذائية الممتصة.

تم استخدام ثلاثة معدلات من السماد المعدني صفر، ١٥٠، ٣٠٠ كجم للفدان و السماد العضوي بمعدل صفر، ١٥، ٣٠ م^٢ للفدان مع استخدام السماد الحيوي المثبت للنيتروجين الجوي أو بدون استخدامه.

و يمكن تلخيص أهم النتائج المتحصل عليها فيما يلي

- ١- تأثرت أطوال نباتات الشمر و عدد الأفرع في كلا الموسمين بإضافة التسميد النيتروجيني كاملا مع التسميد العضوي تأثيرا كبيرا كما أعطت المعاملة ٪ التسميد النيتروجيني مع المادة العضوية و بكتريا مثبتات النيتروجين أعلى ارتفاع للنبات و أكبر عدد من الأفرع بالنسبة لمعاملة المقارنة
- ٢- تأثر دليل الحبوب Seed index لنبات الشمر و كذلك محصول الحبوب تأثيرا معنويا بالتسميد المعدني و العضوي و الحيوي و كان أعلى دليل للحبوب للمعاملة ٪ التسميد النيتروجيني مع التسميد العضوي الكامل (٣٠ م^٢/فدان) و تلقيح البذور ببكتريا المثبتة للنيتروجين و كانت المعاملة نفس التأثير على محصول الحبوب
- ٣- أوضحت النتائج أن التسميد الحيوي منفرد كان له تأثير معنوي على محتوى نبات الشمر من الأزوت و كذلك امتصاصه و كان لإضافة ٪ معدل التسميد المعدني و التسميد العضوي الكامل مع ملقحات البذور بمثبتات النيتروجين تأثير على تركيز النيتروجين كذلك أدت إضافة الأسمدة المعدنية و العضوية و الحيوية إلى زيادة تركيز الفسفور و البوتاسيوم في النبات و إلى زيادة امتصاصه و كانت أعلى نسبة لهذين العنصرين مع استخدام ٪معاملة التسميد المعدني مع التسميد العضوي الكامل مع مثبتات النيتروجين
- ٤- تأثرت نسبة الزيت في الحبوب بالتسميد المعدني و العضوي و الحيوي و كانت أعلى نسبة للزيت في حبوب نبات الشمر في الموسم الثاني عند استخدام ٪ التسميد المعدني و التسميد العضوي الكامل مع البكتريا المثبتة للنيتروجين