Scientific J. Flowers & Ornamental Plants
www.ssfop.com/journal
ISSN: 2356-7864

EFFECT OF COMPOST/NPK AND BIOFERTILIZATION TREATMENTS ON VEGETATIVE GROWTH, YIELD AND HERB NPK% OF FENNEL PLANTS

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Scientific J. Flowers & Ornamental Plants, 4(2):175-185 (2017).

Received:
15/3/2017
Accepted:
3/4/2017

ABSTRACT: A field experiment was conducted during the two successive seasons of 2012/2013 and 2013/2014 to study the effect of compost/NPK and biofertilization treatments on vegetative growth, yield and herb NPK % of fennel plants.

Obtained results revealed that the best vegetative growth characters (plant height, stem diameter, number of main branches and herb dry weight), yield parameters (number of umbels and fruit yield per plant and per fed) and herb % of NP and K values were obtained due to the use of the full dose of mineral NPK, ¼ compost + ¾ NPK dose or ½ compost + ½ NPK dose with no significant differences being detected between such three fertilization treatments. Concerning biofertilization treatments, all of the prementioned growth, yield and chemical traits were considerably augmented due to the dual treatment (Minia Azotein + phosphorein) followed by Minia Azotein, while phosphorein gave the least values. In regard to the interaction gave between the, two involved factors, the highest growth, yield and chemical composition values were given by fertilizing fennel plants with the full dose of mineral NPK, ¼ compost + ¾ NPK or ½ compost + ½ NPK in combination with dual biofertilizer treatments (Minia Azotein + phosphorein).

There for, it could be advised from the economical and environmental point of view, to supply fennel plants with the treatment of ½ compost + ½ NPK dose in combination with both Minia Azotein plus phosphorein in order to obtain the best fruit yield of fennel plants.

Key words: *Foeniculum vulgare*, compost, NPK, biofertilization, vegetative growth.

INTRODUCTION

Fennel (*Foeniculum vulgare*, Miller) plant is one of the most common and widely cultivated aromatic and medicinal plants in middle Egypt Governorates such as Beni-Suef, Minia and Assuit. It is a 120-180 cm long winter annual herb belonging to Fam. Apiaceae. Fennel is originally native to Mediterranean Sea region from where its cultivation spread out to Europe and Latin America Countries. The fruits which are the used part of fennel plant contain 3.5-5% volatile oil with the most important components being anethole and fenchone. The fruits are commonly used in medicinal folklore and bakery and the volatile oil is involved in many pharmaceutical purposes and food industry.

Different authors indicated the efficiency of organic fertilization, with various sources, in increasing vegetative growth, yield and/or herb N,P and K % of different aromatic seed plants, namely, caraway (Abd El-Latif, 2002

and Abd El-Naeem, 2008); fennel (Badran and Safwat, 2004 and Tanious, 2008); cumin (Badran *et al*., 2007 and Seghatoleslami, 2013); coriander (Abdalla, 2009); *Nigella sativa* (Mahmoud, 2009) and dill (Hassan *et al*., 2010). Concerning mineral NPK fertilization, a good number of investigators insured the role of such treatment on the same growth, yield and chemical composition, such as Badran *et al*. (2001), Khattab and Helmy (2003), Salah-Eldeen (2005) and Tanious (2008) on fennel; Badran *et al*. (2003) on anise; Abd El-Naeem (2008) on caraway; Kenawy (2010) on *Ammi visnaga* and Badran *et al*. (2011) on coriander. Meanwhile, Badran *et al*. (2001) and Tanious (2008) on fennel; Abd El-Latif (2002) and Abd El-Naeem (2008) on caraway; Safwat and Badran (2002) and Shalateet (2006) on cumin; Badran *et al*. (2012) on *Nigella sativa* and Rekaby (2013) on coriander reported the positive influence of N-fixing and/or P- dissolving bacteria.

Therefore, the present study was designed to find out the most suitable organic / mineral NPK / biofertilization combined treatment for attaining the bet vegetative growth characters and fruits yield of fennel plants.

MATERIALS AND METHODS

The present investigation was conducted at Mattay, Minia, Egypt during 2012/2013 and 2013/2014 seasons to study the effect of compost/NPK and biofertilizer treatments on vegetative growth, fruit yield and N, P and K herb % of fennel plants.

Fruits of fennel were sown on the last week of Oct. of both seasons in 3×3.60 meter plots with 60 cm distance between the rows and 50 cm between hills within each row. So, each plot contained 6 rows and 36 hills (2 plants/hill). Plants were thinned twice, 3 weeks from planting date and 2 weeks followed as usual. Physical and chemical properties of the soil are shown in Table (a).

A complete randomized block design following the split-plot arrangement, in three replicates, was executed in this experiment with six compost/NPK treatments in the main plots (A) i.e. control, compost (7.5 ton/fed), ¾ compost + ¼ NPK, ½ compost + ½ NPK, ¼ compost + ¾ NPK and full dose of NPK. The full dose of mineral NPK was added at the rate of 200 kg/fed ammonium nitrate, 33.5% N; 150 kg/fed calcium superphosphate, 15.5% P_2O_5 and 100 kg/fed potassium sulphate, 48.55 K_2O. While the full dose of compost (Compost El-Neel) was added at the rate of 7.5 ton/fed, with physical and chemical properties shown in Table (b).

The sub-plots (B) were control, Minia Azotein, phosphorein and Minia Azotein plus phosphorein. The mineral N and K fertilizer amounts, for each treatment were divided into 3 batches and added after the last thinning and every three weeks thereafter. While compost and phosphorus fertilizer were added during soil preparation.

Table a. Physical and chemical analysis of the soil.

Characters	Value	Characters		Value
Soil type	Clay loam	**Total N (%)**		0.06
Sand (%)	31.70	**Avail. P (%)**		8.90
Silt (%)	25.60	**Exch. K (mg/100 g)**		1.46
Clay (%)	42.70		**Fe**	5.10
Org. Matt. (%)	1.08	**DTPA**	**Cu**	1.29
Ca CO_3 (%)	4.18	**Extr. (ppm)**	**Zn**	1.85
pH (1 : 2.5)	7.86		**Mn**	11.52
E.C. (mmhos/cm)	1.08			

Table b. Physical and chemical properties of the used compost.

Properties	Value	Properties	Value
Dry weight of 1 m^3	450 kg	**C/N ratio**	18.5-14.1
Fresh weight of 1 m^3	650-700kg	**NaCl (%)**	1.1- 1.75
Moisture (%)	25-30	**Total P (%)**	0.5- 0.75
pH (1:10)	7.5- 8	**Total K (%)**	0.8-1.0
E.C. (mmhos/cm)	2 - 4	**Fe (ppm)**	150-200
Total N (%)	1-1.4	**Mn (ppm)**	25-56
Org. matter (%)	32-34	**Cu (ppm)**	75-150
Org. carbon %	18.5-19.7	**Zn ppm**	150-225

The two biofertilizers, Minia Azotein and phosphorein were applied to the soil twice, after 6 and 10 weeks from planting date, at the rate of 50 ml/plant of each biofertilizer, and then plants were irrigated immediately.

Data were recorded for plant height (cm), stem diameter (cm), number of main branches/ plant, herb dry weight (g/plant), number of umbels/ plant and fruit yield(g/ plant and kg/fed). In addition herb N, P and K% were determined according to Wilde *et al.* (1985), Chapman and Pratt (1975) and Cottenie *et al*. (1982), respectively. Obtained data were statically analyzed following the L.S.D. method at 5% according to MSTAT-C (1986).

RESULTS

Vegetative Growth Characters:

Data obtained in Table (1) indicated that the four tested vegetative growth characters, plant height, stem diameter, branches number/plant and herb dry weight/plant were considerably increased, in both seasons, due to all five compost and/or mineral NPK fertilization treatments in comparison with those of control treatment. However, the three treatments of ½ compost + ½ NPK, ¼ compost + ¾ NPK and full dose of NPK were capable of producing significant in the two seasons, compared to control treatment. It was interesting to find out that such three superior treatments were statistically equal, in both season, in giving the tallest plants, thickest stems, more branches number and heaviest herb dry weight/ plant. Numerically, the increase in plant height, stem diameter, branches number and herb dry weight/ plant, due to these three treatments, respectively, over control treatments, reached 15.7, 18.5, and 20.8%; 62.6, 72.7 and 84.2%; 50.2, 70.1 and 89.05 and 21.5, 32.9, and 39.45 in the first season with almost identical trend in the second season as clearly shown in Table (1).

The role of organic fertilization in augmenting vegetative growth traits was also observed by Badran and Safwat (2004) and Tanious (2008) on fennel; Abdalla (2009) on coriander; Mahmoud (2009) on *Nigella sativa* and Hassan *et al.* (2010) on dill. While that of mineral NPK was revealed by Badran *et al.* (2001) and Khattab and Helmy (2003) on fennel; Badran *et al*. (2003) on anise; Kenawy (2010) on *Ammi visnaga* and Badran *et al.* (2011) on coriander.

Concerning biofertilization treatments, the four vegetative growth characters, namely, plant height, stem diameter, branches number and herb dry weight/plant, were increased, in the two seasons, due to Minia Azotein, phosphorein or both of them in combination with control treatment. However, the differences were significant only for stem diameter and number of branches, (Table, 1). Among the three biofertilization treatments, the dual one (Minia Azotein + phosphorein) gave the best results, followed by Minia Azotein, while phosphorein treatment gave the least values and these results were almost identical in both first and second seasons.

On the line with these results were those revealed on different aromatic fruit plants such as fennel (Badran *et al.*, 2001 and Tanious, 2008); caraway (Abd El-Latif, 2002); cumin (Safwat and Badran, 2002) and coriander (Rekaby, 2013).

The interaction between compost/NPK and biofertilization treatments was significant, in the two seasons, for each of plant height, stem diameter, branch number and herb dry weight/plant as shown in Table (1). The best overall results, for the four vegetative growth traits were obtained due to supplying fennel plants with full dose of NPK and ½ compost, in combination with dual biofertilization treatment. No significant differences, in general, were detected between such three combined treatments. So, it is advisable, from the economical and environmental point of view, to fertilize fennel plants with ½ compost + ½ NPK in combination with the dual biofertilization (Minia Azotein + phosphorein) treatment, (Table, 1).

Table 1. Effect of compost/NPK and biofertilization treatments on vegetative growth characters of fennel plants during 2012/2013 and 2013/2014 seasons.

Compost/NPK Treatments (A)	Biofertilizer (B)									
	Control (zero)	M.A.	Phos.	M.A.+ Phos.	Mean (A)	Control (zero)	M.A.	Phos.	M.A.+ Phos.	Mean (A)
	First season (2012/2013)					Second season (2013/2014)				
Plant height (cm)										
Control (zero)	151.4	152.6	152.0	158.7	153.7	152.4	156.1	156.0	160.7	156.3
Compost 7.5ton/fed	163.2	167.6	167.4	168.2	166.6	163.3	165.8	165.1	172.4	166.7
¾ Compost + ¼ NPK	170.8	175.6	175.2	176.7	174.6	173.7	175.0	174.4	175.6	174.6
½ Compost + ½ NPK	176.8	177.6	177.2	179.8	177.9	177.0	178.1	177.2	179.8	178.0
¼ Compost + ¾ NPK	180.9	182.8	181.9	183.1	182.1	180.9	181.8	181.3	182.3	181.6
Full dose of NPK	184.2	185.3	184.8	186.5	185.2	183.7	185.5	184.3	186.2	184.9
Mean (B)	171.2	173.6	173.1	175.5		171.9	173.7	172.9	176.2	
L.S.D. at 5%	A: 9.3	B: N.S		AB: 19.8		A: 8.1	B: N.S		AB: 11.2	
Stem diameter (cm)										
Control (zero)	1.35	1.38	1.36	1.48	1.39	1.32	1.46	1.39	1.50	1.42
Compost 7.5ton/fed	1.52	1.63	1.56	1.71	1.61	1.72	1.86	1.82	1.92	1.83
¾ Compost + ¼ NPK	1.68	2.01	1.86	2.17	1.93	2.28	2.42	2.38	2.56	2.41
½ Compost + ½ NPK	2.16	2.29	2.26	2.32	2.26	2.49	2.62	2.55	2.69	2.59
¼ Compost + ¾ NPK	2.29	2.46	2.35	2.50	2.40	2.58	2.71	2.69	2.74	2.68
Full dose of NPK	2.48	2.59	2.54	2.61	2.56	2.75	2.84	2.80	2.85	2.81
Mean (B)	1.91	2.06	1.98	2.13		2.12	2.31	2.27	2.39	
L.S.D. at 5%	A: 0.45	B: 0.18		AB: 0.44		A: 0.42	B: 0.15		AB: 0.37	
Number of main branches										
Control (zero)	5.56	6.33	6.11	6.78	6.19	5.11	6.22	5.67	6.33	5.83
Compost 7.5ton/fed	7.33	7.78	7.33	8.33	7.69	7.00	8.00	7.33	8.11	7.61
¾ Compost + ¼ NPK	7.66	8.34	8.67	9.22	8.47	8.22	8.67	8.33	9.33	8.08
½ Compost + ½ NPK	9.00	9.33	9.22	9.66	9.30	9.00	9.67	9.14	10.33	9.54
¼ Compost + ¾ NPK	10.11	10.67	10.14	11.20	10.53	10.13	11.00	10.33	11.24	10.68
Full dose of NPK	11.34	11.78	11.67	12.00	11.70	11.33	12.22	12.00	12.67	12.06
Mean (B)	8.50	9.03	8.86	9.53		8.47	9.30	8.80	9.67	
L.S.D. at 5%	A: 2.94	B: 0.91		AB: 2.23		A: 3.01	B: 0.97		AB: 2.38	
Herb dry weight/plant (g)										
Control (zero)	36.40	38.47	38.07	41.45	38.60	34.99	38.90	38.17	41.40	38.37
Compost 7.5ton/fed	41.62	42.40	42.17	43.15	42.34	41.53	43.47	43.30	43.60	42.98
¾ Compost + ¼ NPK	42.22	44.45	43.65	46.23	44.14	43.82	44.17	43.95	45.80	44.43
½ Compost + ½ NPK	45.73	47.17	46.40	48.20	46.88	46.50	47.93	47.16	48.40	47.50
¼ Compost + ¾ NPK	49.90	51.83	51.02	52.42	51.29	49.33	52.07	51.17	52.33	51.23
Full dose of NPK	52.67	54.03	53.45	55.05	53.80	53.52	55.05	54.86	57.04	55.12
Mean (B)	44.76	46.39	45.79	47.75		44.95	46.93	46.44	48.10	
L.S.D. at 5%	A: 8.08	B: N.S		AB: 8.58		A: 8.75	B: N.S		AB: 9.43	

Yield and Yield Components Parameters:

Number of umbels/plant and fruit yield per plant and per fed of fennel plants were augmented in both seasons as a result of using all five compost/ NPK treatments over those of control treatment with significant differences for some of the tested treatments as shown in Table (2). Among the five examined treatments, full dose of NPK, followed by ¼ compost + ¾ NPK and ½ compost + ½ NPK treatments gave the highest number of umbels/plant and heaviest fruit yield per plant and per fed. The increase in fruit yield per fed due to these three treatments, respectively came to 88.3, 77.0 and 61.6% in the first season and 104.2, 96.7 and 74.9% in the second season. No significant differences were existed, in both seasons, for fruit yield per plant and per fed among such three superior treatments as obviously illustrated in Table (2).

In agreement with these results, concerning organic fertilization, were the findings of Abd El-Latif (2002) and Abd-Elnaeem (2008) on caraway; Badran *et al*. (2007) and Seghatoleslami (2013) on cumin and Tanious (2008) on fennel. While, Badran *et al*. (2001), Khattab and Helmy (2003), Salah-Eldeen (2005) and Tanious (2008) on fennel and Abd El-Naeem (2008) on caraway insured the efficiency of mineral NPK fertilizers in augmenting fruit yield.

All three biofertilization treatments (Minia Azotein, phosphorein and both of them) increased the three studied parameters, number of umbels/plant and fruit yield per plant and fed with significant differences for the last two traits in comparison with control treatment in both seasons, (Table, 2). The highest values, for the three tested parameters, were obtained from the dual treatment, followed by Minia Azotein then phosphorein. The same trend of results was observed in both first and second seasons.

Different investigators pointed out the role of biofertilizer in augmenting fruit yield of aromatic seed plants such as Badran *et al*. (2001), Safwat and Badran (2002), Abd-Elnaeem (2008), Badran *et al*. (2012) and Rekaby (2013) on fennel, cumin, caraway, black cumin and coriander, respectively.

Table (2) shows that the interaction between factor A (compost/NPK) and factor B (biofertilizers), for number of umbels/ plant and fruit yield per plant and per fed, was significant in both seasons. Were supplied with full dose of NPK in combination with both Minia Azotein + phosphorein. However, this superior treatment was statistically equal to that one received ½ compost + ½ NPK in combination with the same dual fertilization treatment as shown in Table (2).

Nitrogen, phosphorus and potassium % in the herb:

The herb N, P and K percent were significantly increased, in both seasons, due to majority of compost/NPK fertilization treatments as indicated in Table (3). The highest values for the three nutrients were obtained, in descending order, due to full dose of NPK, ¼ compost + ¾ NPK, ½ compost + ½ NPK, ¾ compost + ¼ NPK and full dose of compost (7.5 ton/fed). It is worth to mention that the differences between the first three previously mentioned treatments, for N, P and K % in both seasons, did not reach the level of significancy as shown in Table (3).

The role of organic fertilization in promoting N, P and K % was given by Abd El-Latif (2002) and Abd El-Naeem (2008) on caraway; Abdalla (2009) on coriander; Mahmoud (2009) on *Nigella sativa* and Hassan *et al*. (2010) on dill. While that of mineral NPK was revealed by Badran *et al*. (2003) on anise; Salah-Eldeen (2005) and Tanious (2008) on fennel; Abd El-Naeem (2008) on caraway and Kenawy (2010) on *Ammi visnaga*.

Obtained data show significant differences among the four biofertilization treatments except phosphorus and potassium 5 in the second season, (Table, 3). However, all of the three examined treatments (Minia Azotein, phosphorein and Minia Azotein +

Table 2. Effect of compost/ NPK and biofertilization treatments on fruit yield characters of fennel plants during 2012/2013 and 2013/2014 seasons.

Compost/NPK Treatments (A)	Biofertilizer (B)									
	Control (zero)	M.A.	Phos.	M.A.+ Phos.	Mean (A)	Control (zero)	M.A.	Phos.	M.A.+ Phos.	Mean (A)
	First season (2012/2013)					Second season (2013/2014)				
	Number of umbels/plant									
Control (zero)	16.67	18.44	17.89	19.22	18.22	24.78	26.33	25.00	27.33	25.86
Compost 7.5ton/fed	21.33	23.11	22.67	24.22	22.83	27.56	28.11	27.89	28.67	28.06
¾ Compost + ¼ NPK	24.89	25.78	25.22	26.44	25.58	29.22	30.44	29.56	31.22	30.11
½ Compost + ½ NPK	27.89	29.55	28.34	32.78	29.64	32.22	34.56	34.22	35.11	34.03
¼ Compost + ¾ NPK	34.00	34.89	34.33	36.67	34.97	39.22	41.17	40.89	42.67	40.99
Full dose of NPK	36.78	37.45	37.00	38.78	37.50	43.45	45.00	43.89	46.05	44.60
Mean (B)	26.93	28.20	27.58	29.69		32.74	34.27	33.57	35.18	
L.S.D. at 5 %	A: 8.68	B: N.S		AB: 12.75		A: 7.87	B: N.S		AB: 11.27	
	Fruit yield/plant (g)									
Control (zero)	21.62	24.28	23.40	26.23	23.88	19.83	23.97	23.92	24.70	23.10
Compost 7.5ton/fed	28.40	30.92	30.38	31.75	30.36	29.38	32.22	31.33	33.35	31.57
¾ Compost + ¼ NPK	32.10	35.60	35.03	36.83	34.89	34.47	36.22	34.93	37.58	35.80
½ Compost + ½ NPK	36.92	38.45	37.73	41.40	38.63	37.83	40.47	40.08	43.27	40.41
¼ Compost + ¾ NPK	41.15	42.72	41.53	43.80	42.30	43.97	45.65	45.22	46.83	45.42
Full dose of NPK	43.65	45.45	44.38	46.47	44.98	46.52	47.13	46.95	48.00	47.15
Mean (B)	33.97	36.24	35.41	37.74		35.33	37.61	37.07	38.95	
L.S.D. at 5 %	A: 7.38	B: 3.17		AB: 7.76		A: 7.47	B: 3.49		AB: 8.55	
	Fruit yield/feddan (kg)									
Control (zero)	649	729	702	787	717	595	719	718	741	693
Compost 7.5ton/fed	852	928	912	953	911	882	967	940	1001	947
¾ Compost + ¼ NPK	963	1068	1051	1105	1047	1034	1087	1057	1128	1076
½ Compost + ½ NPK	1108	1154	1132	1242	1159	1135	1214	1203	1298	1212
¼ Compost + ¾ NPK	1235	1282	1246	1314	1269	1319	1370	1357	1405	1363
Full dose of NPK	1310	1364	1332	1394	1350	1396	1414	1409	1440	1415
Mean (B)	1019	1087	1062	1132		1060	1129	1114	1168	
L.S.D. at 5 %	A: 206	B: 97		AB: 238		A: 226	B: 101		AB: 247	

Table 3. Effect of compost/ NPK and biofertilization treatments on NPK percentage of fennel plants during 2012/2013 and 2013/2014 seasons.

Compost/NPK Treatments (A)	Biofertilizer (B)									
	Control (zero)	M.A.	Phos.	M.A.+ Phos.	Mean (A)	Control (zero)	M.A.	Phos.	M.A.+ Phos.	Mean (A)
	First season (2012/2013)					Second season (2013/2014)				
Herb nitrogen %										
Control (zero)	1.224	1.325	1.314	1.341	1.301	1.273	1.322	1.310	1.341	1.312
Compost 7.5ton/fed	1.336	1.367	1.358	1.371	1.358	1.350	1.374	1.361	1.403	1.372
¾ Compost + ¼ NPK	1.372	1.403	1.399	1.432	1.401	1.409	1.436	1.420	1.486	1.438
½ Compost + ½ NPK	1.437	1.463	1.450	1.482	1.458	1.490	1.505	1.497	1.520	1.503
¼ Compost + ¾ NPK	1.491	1.515	1.510	1.548	1.516	1.531	1.564	1.545	1.568	1.552
Full dose of NPK	1.555	1.588	1.563	1.595	1.575	1.582	1.595	1.587	1.606	1.592
Mean (B)	1.402	1.444	1.432	1.462		1.439	1.466	1.453	1.487	
L.S.D. at 5 %	A: 0.126	B: 0.042		AB: 0.103		A: 0.101	B: 0.039		AB: 0.096	
Herb phosphorus %										
Control (zero)	0.231	0.262	0.269	0.279	0.260	0.237	0.243	0.256	0.263	0.250
Compost 7.5ton/fed	0.304	0.312	0.323	0.334	0.318	0.284	0.289	0.316	0.325	0.303
¾ Compost + ¼ NPK	0.341	0.347	0.350	0.362	0.350	0.331	0.337	0.339	0.347	0.339
½ Compost + ½ NPK	0.364	0.367	0.371	0.393	0.374	0.348	0.354	0.357	0.376	0.359
¼ Compost + ¾ NPK	0.387	0.393	0.402	0.419	0.401	0.378	0.382	0.386	0.389	0.384
Full dose of NPK	0.417	0.434	0.440	0.454	0.436	0.406	0.412	0.419	0.424	0.415
Mean (B)	0.341	0.353	0.359	0.374		0.331	0.336	0.346	0.354	
L.S.D. at 5 %	A: 0.068	B: 0.029		AB: 0.071		A: 0.062	B: N.S		AB: 0.093	
Herb potassium %										
Control (zero)	1.927	2.014	1.958	2.094	1.998	2.219	2.234	2.227	2.242	2.231
Compost 7.5ton/fed	2.242	2.263	2.252	2.282	2.260	2.255	2.264	2.262	2.272	2.263
¾ Compost + ¼ NPK	2.291	2.295	2.292	2.309	2.297	2.283	2.302	2.301	2.321	2.302
½ Compost + ½ NPK	2.324	2.331	2.312	2.336	2.326	2.328	2.345	2.337	2.357	2.342
¼ Compost + ¾ NPK	2.340	2.348	2.344	2.353	2.346	2.359	2.371	2.367	2.388	2.371
Full dose of NPK	2.366	2.382	2.376	2.404	2.382	2.394	2.411	2.405	2.417	2.407
Mean (B)	2.248	2.272	2.256	2.296		2.306	2.321	2.316	2.333	
L.S.D. at 5 %	A: 0.076	B: 0.037		AB: 0.091		A: 0.072	B: N.S		AB: 0.110	

phosphorein) gave higher values of herb N, P and K % than those given by control treatment in both seasons. Moreover, the dual biofertilization treatment surpassed each of Minia Azotein and phosphorein treatments. Meanwhile, phosphorein treatment gave the least values for the three nutrients in both seasons as shown in Table (3).

In accordance with these results were those found by Abd El-Latif (2002) and Abd-Enaeem (2008) on caraway; Shalateet (2006) on cumin and Tanious (2008) on fennel.

The interaction between compost/ NPK and biofertilization treatments was significant in the two experimental seasons for N, P and K % in the herb, as shown in Table (3). The highest overall values of N, P and K herb percent, in the two seasons, were obtained when fennel plants were fertilized by full dose of NPK in combination with the dual biofertilization treatment.

DISCUSSION

The recommended dose of mineral NPK was applied to fennel plants to be compared with some organic and (N-fixing and/or P-dissolving bacteria) commercial products (Minia azotein and/or phosphorein). It was found that NPK treatment overcame such compost and biofertilization treatments in growth, fruit yield NPK percent. The superiority of mineral NPK fertilization could be attributed to the unique biological and physiological roles of each one of such three essential elements in plant growth and development explained by Yagodin (1984).

Nitrogen is a constituent of most organic compounds i.e. amino acids, nucleic acids (RNA and DNA) enzymes, alkaloids, vitamins, phosphatides, purine, and many energy transfer materials such as chlorophylls, ADP and ATP, Bidwall (1974). Phosphorus which has been called the key to life is essential for cell division and for development of meristimatic tissue and it is very important for carbohydrate transformation due to multitude of phosphorylation reaction and to energy rich phosphate bond, (Lambers *et al*., 2000). Potassium is important for growth and elongation probably due to its function as an osmoticum and may react synergistically with IAA; moreover, it promotes CO_2 as simulation and translocation of carbohydrates from the leaves to storage tissues (Mengel and Kirkby 1987).

The beneficial physiological and biological roles of organic fertilization concluded by many investigators as follows:

- Organic manure led to minimizing the losses of nutrients by leaching, (Saber, 1997).
- Adding organic manure to the soil led to significant increase in microbial activities in the root zones, (Taiwo *et al*., 2002).
- Incorporation of organic manure in the soil improves soil permeability and release carbon dioxide and certain organic acids during decomposition, (Mashali, 1997). Different authors such as Hedge *et al.* (1999) and Hauwaka (2000) explained the roles of N- fixing bacteria in:
- Fixation of the atmospheric N which caused an increment of available N which increase, by sequence, the formation of many metabolites.
- It produces adequate photo hormones such as indoleacetic acid, gibberellins and cytokinins.
- Enhancing the uptake of different nutrients and improving water status which leads to stimulating the meristimatic activities of cells and tissues, thereby promoting vegetative growth aspects. The enhancing effects of P- dissolving bacteria, on the other hand, were suggested by Abdou-Elnour *et al*. (1996) and Hauwaka (2000) and could be summarized in:
- Releasing some organic and inorganic acids, as well as CO_2 which are capable of converting tricalcium phosphate (insoluble form) in monocalcium phosphate which is readily available for plant nutrition.

- Increasing phosphorus concentration in the soil and plant tissues and improving water use efficiency and uptake of minerals.

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تأثير معاملات التسميد بالكمبوست/ المعدني والتسميد الحيوي على الصفات الخضرية والمحصولية ونسبة النيتروجين والفوسفور والبوتاسيوم في العشب لنباتات الشمر

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اجريت تجربة حقلية في خلال موسمين ٢٠١٣/٢٠١٢ و ٢٠١٤/٢٠١٣ بهدف دراسة تاثير التسميد بالكمبوست/ المعدني ومعاملات التسميد الحيوي على النمو الخضري والمحصولي ونسبة النيتروجين والفوسفور والبوتاسيوم في عشب نبات الشمر.

أظهرت النتائج أن أفضل الصفات الخضرية (طول النبات - سمك الساق- عدد الأفرع الرئيسية - وزن العشب الجاف للنبات) والصفات المحصولية (عدد النورات للنبات ومحصول الثمار للنبات والفدان) وكذلك النسبة المئوية للنيتروجين والفوسفور والبوتاسيوم في العشب كانت نتيجة استخدام كل من المعدل الكامل من التسميد المعدني وكذلك (٤/٣ معدل السماد المعدني + ٤/١ معدل الكمبوست) و (٢/١ معدل المعدني + ٢/١ معدل الكمبوست) حيث انه لا يوجد اختلاف معنوي في نتائج الثلاث معاملات . اما بالنسبة لمعاملات التسميد الحيوي فان افضل النتائج الخضرية والمحصولية والكيماوية كانت نتيجة استخدام المعاملة (منيا ازوتين + الفوسفورين) تليها المعاملة ب (منيا ازوتين) ثم الفوسفورين. اما بالنسبة لمعاملات التفاعل بين التسميد بالكمبوست/ المعدني والسماد الحيوي فقد نتجت افضل الصفات الخضرية والمحصولية والكيماوية عند تسميد نباتات الشمر بالمعدل الكامل من المعدني او ٤/٣ معدني + ٤/١ كمبوست او ٢/١ معدل التسميد المعدني + ٢/١ معدل الكمبوست بالاضافة الى التسميد الحيوي (منيا ازوتين+ فوسفورين).

لذلك يمكن ان نوصي من وجهة النظر البيئية والاقتصادية باستخدام ٢/١ معدل السماد المعدني مع ٢/١ معدل الكمبوست بالاضافة الي التسميد الحيوي (منيا ازوتين+ فوسفورين) للحصول على افضل محصول ثمار لنباتات الشمر.