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Influence of Magnetic Iron and Organic Manure on Fennel Plant Tolerance Saline Water Irrigation

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Abstract: This study was carried out during the two successive growing seasons of 2011/2012 and 2012/2013 at the farm in North coast, Hamam, Matroh Governorate, Egypt. to investigate effects of magnetite iron (M) at rates of 0, 50 or100 kg/fed. and sheep manure (SM) at rates of 0, 15, 30 and 45 m^3 /fed. on growth, seed yield, essential oil %, essential oil yield and its components and chemical compotition of Fennel (*Foeniculum vulgare* Mill**.**) under saline water irrigation (5664 ppm).

Gradual and significant increases in plant height, number of branches & umbels per plant, fresh & dry weights per plant , fruit yield per plant, essential oil percentage in fruits, and essential oil yield per plant were recorded with increasing the tested M level from zero up to 50 kg/fed. Also, 100 kg/fed. M produced the highest percentages of main components of the essential oil (β- Pinene, anise aldehyde and fenchone). While the highest percentages of (α- Pinene and anethole) resulted under the effect of 50 kg/fed M. On the opposite, The estragole gave lowest percentages comparing to untreated plants. Also, M treatments increased total carbohydrates % and nutrient percentages of N, P and K but it decreased the proline content.

As for SM application treatments, SM at the rate of 45 m^3 /fed. enhanced the above mentioned traits of growth and yield of fruits and essential oil. The highest percentages of (α- Pinene, anise aldehyde, fenchone and anethole) were recorded in essential oil extracted from plants treated with SM at the rate of 45 m^3/fed, comparing to control. On the other hand, the same rate of SM resulted the lowest percentages of estragole compare of untreated plants. On the other hand, this treatment increased total carbohydrates % and nutrient percentages of N, P and K while the proline content decreased.

Interaction treatments of 50 kg/fed M X SM as 45 m^3 /fed. resulted in significant increases in the above mentioned traits (plant growth, fruit yield and essential oil determinations).The highest percentages of (α- Pinene and anise aldehyde) resulted under the effect of 50 kg/fed M X SM at 45 m^3/fed. While the combined between 100 kg/fed. of M and SM at 45 m^3/fed. show the highest values of the (fenchone and anethole) compared to the control. However, interaction treatments between the M and SM gave lower values of the estragole content. In addition, the highest total carbohydrates and Nutrient contents (N,P and K) percentages were recorded in fruits of treated plants with these 50 kg/fed M X SM as 45 m^3 /fed. On the opposite, the all tested treatments gave the lowest proline content compared to the control.

Conclusion: It could be recommend that apply magnetite iron (M) at 50 kg/fed. with 45 m^3 /fed. sheep manure (SM) for enhance fennel growth as well as fruit and essential oil yield and its components under saline water irrigation (5664 ppm).

Keywords: *Foeniculum vulgare*, magnetite iron, sheep manure, fenchone, anethole, anise aldehyde, estragole, proline, carbohydrates.

Introduction

Fennel (*Foeniculum vulgare* Mill., belonging Apiaceae Family) is an important medicinal and aromatic plant due to its estrogenic activities and uses as a carminative, diuretic, anti-inflammatory, antimicrobial, and galactogogue[1]**.** Mature fennel fruits (seeds) contain essential oil and are used as flavoring agents in food products such as liqueurs, bread, pickles, pastries, and cheese. They are also used as a constituent of cosmetic and pharmaceutical products. Fennel is one of the major essential oil plants cultivated and the essential oil concentration in the plants is between 3-6% in the mature fruit[2]. Fennel is also grown on a commercial scale in many regions including Europe (England, Austria, Finland, France, Germany and Tyrol), Asia (China, and Vietnam), South America, and Middle East (Turkey) for the production of specialty products[3]**.** The essential oil has antioxidant, antimicrobial and hepatoprotective activity[4]**.** The essential oil of fennel is used to flavor different food preparations and in perfumery industries. The oil contains fenchone which plays an important role in pharmaceutical and other industries as well as in confectionery[5]**.** The present world market for fennel is valued at approximately US$ 80 million[6]

The total agricultural land in Egypt amounts to nearly 8.4 million feddans (3.5 million ha) and accounts for around 3.5 percent of the total area. One million ha in the irrigated areas suffer from salinization problems, water logging and sodicity[7]**.** The majority of salt-affected soils in Egypt are located in the Northern central part of the Nile Delta and on its Eastern and Western sides. About 900 000 ha suffer from salinization problems in cultivated irrigated areas, 6 % of Northern Delta region are salt-affected, 20 % of the Southern Delta and Middle Egyptian region and 25 % of the Upper Egypt region[8]. Million hectares of arable land too saline for agriculture and hundreds of thousands hectares of agriculture productive land are lost annually for food production due to salinization[9]**.** Salinity stress depresses plant growth and development at different physiological levels. Then mechanism by which salt stress damage plants are still a discussing matter due to very complex nature of the salt stress in plants[10]**.** In Egypt, saline water is used for irrigation in some areas. In the same time, under the arid climatic conditions prevailing in Egypt and associated with the perennial irrigation practices, imperfect drainage system, continuous increase of water–table level and the relatively high salinity levels of water sources particularly in the new reclaimed land, the salinization of Egyptian soils rapidly going to be an acute problem[11]**.**

The magnetite (magnetic iron) is one of the most important factors affecting plant growth especially under salt conditions. magnetite is a natural row rock that has very high iron content, magnetite has a black or brownish-red, it has a hardness of about 6 on the Mohs hardness scale. It is one of two natural row rocks in the world that is naturally magnetic[12]**.** Magnetite (magnetic iron) is considered as one of the most saline soil amendment which enhance crop productivity. Many researchers reported that the application of magnetite at rate within range 50 up on 150 kg/fed. gradually increased plant growth parameters and yield and its components as well as chemical composition[13,14]**.** on roselle plants, noticed that the highest values of plant height, stem diameter, fresh and dry weight of leaves and branches/plant were obtained when magnetic iron was added to the soil compared to the control treatment. [15]on *Copsicum Annuum* L. found that the plant growth, crop yield, fruit quality and some chemical contents with different doses of magnetic treatments, especially under saline irrigation were significant increases. On the other hand, magnetic iron treatments improved plant height, number of leaves/plant, number of branches/plant and dry weights of pepper plant compared to control[16]**.** [17]reported that the increase magnetite doses led to increase of plant growth and the uptake of N, P and K of vegetable crops. [18]showed that the magnetic treatments led to a remarkable increase in plant root and stem length as well as fresh and dry weight during the nursery period of tomato seeds. Also, magnetic iron increased plant growth and leaf mineral content on cauliflower[12]**.** Moreover, some studies reported that, magnetic field had a positive effect on the number of flowers and total yield [19]on strawberry and [20]on pea.

Organic farming is an agricultural practice that raise plants specially vegetables and fruits without the use of synthetic pesticides, herbicides, fertilizers, or plant growth regulators. Organic farming is one of the fastest growing sectors of agriculture worldwide. Its main objective is to create a balance between the interconnected systems of soil organisms, plants, animals and humans. Organic matter is also largely responsible for aggregation, soil moisture-holding capacity, and other improved physical properties of the soil. In clay soils, it improves porosity, reduces waterlogged conditions by increasing drainage, and improves soil texture[21]**.** Increased seed germination, growth and yield are response to plant hormones, micro- and macronutrients exist in compost[22]**.** Moreover compost can exert protective effects against plant diseases occurrence and/or stimulate and enhance plant physiological status with improvements in quantity and quality of crop production[23]**.** Organic matter also inoculates the soil with vast numbers of beneficial microbes (bacteria, fungi, etc.) and augments the habitat required for maintaining microbial populations that reduce soil-borne diseases[24]**.** Generally, excessive amounts of inorganic fertilizers are applied to vegetables in order to achieve a higher yield[25]**.** Also, **[26]**recorded increases in fennel growth, yield and essential oil production under the effect of organic manure applications. [27]indicated that sheep manure had enhancing effects on plant height and essential oil% of *Thymus vulgaris* L plant.

The problem of salinity as one of the major external factors that influence the various metabolic activities of plant is now receiving much attention. However, according to the available literature there is no information about the effect of magnetite alone or in combination with organic manure on plant growth, fruit yield, and essential oil production of fennel plant under salinity stress conditions. Thus, the aim objective of this research was to evaluate to what extent magnetite applications, sheep manure and their interactions can enhance fennel plant growth, fruit yield, and essential oil production under saline water irrigation conditions.

Materials and Methods

This study was carried out at the farm in North coast, Hamam, Matroh Governorate, Egypt. during the two successive seasons of 2011/2012 and 2012/2013. The objective of this study was to investigate the effect of iron magnetite as a natural source of iron, and sheep manure (as an organic fertilizer) on productivity and quality of fennel (*Foeniculum vulgare*, Mill) under saline water irrigation conditions.

Fennel (*Foeniculum vulgare*, Mill) seeds (fruits) were kindly obtained from Medicinal and Aromatic Plants Research Department, Dokki, Giza. The seeds (fruits) of fennel were sown on 15th November and 18th for the two seasons in sandy soil at distances of 30 cm between hills (2-3 seeds/hill), 100 cm between rows. After germination seedlings were thinned leaving two plant per hill. Soil samples were obtained from a depth of 30 cm from the soil surface and analyzed at laboratories of the Agricultural Research Center, Ministry of Agriculture, Giza. The physical and chemical characteristics of the soil are shown in Table (A), according to[28]**.**

Table (A) The main physical and chemical properties analyses of experimental soil

Course sand (%)	**Fine sand (%)**	**Silt(%)**	**Clay(%)**	**Soil Texture**		**OM(%)**		**$CaCO_3$(%)**
12.85	69.37	7.14	10.64	Loamy sand		0.59		1.33
pH (1:2.5)	**EC*(dSm^{-1})**	**Cations (meq/l)**				**Anions (meq/l)**		
		Ca^{++}	**Mg^{++}**	**Na^{+}**	**K^{+}**	**HCO^{-}_3**	**Cl^{-}**	**SO^{--}_4**
7.98	3.88	7.85	12.63	17.53	0.79	4.63	11.84	22.33
Available Macronutrients (mg/kg)			**Available Micronutrients (mg/kg)**					
N	**P**	**K**	**Fe**	**Mn**		**Zn**		**Cu**
40.93	3.55	196	1.73	2.33		0.72		0.080

The experimental design was factorial between magnetite applications (three levels) and sheep manure (four levels) in completely randomized block design with three replicates (blocks). The three magnetite (M) levels were 0, 50 and 100 kg/ fed while the four sheep manure (SM) rates were 0, 15, 30 and 45 m^3/ fed. Each magnetite and sheep manure was applied as one dose at the abovementioned designed levels during soil preparations on 1st November in both seasons. So, the experiment implicated 12 interaction treatments. Each block consisted of 12 rows (one row/treatment, with 10 hills/row).

Magnetite (Magnetic iron), was contained 48.8% Fe3O4, 17.3% Fe O, 26.7% Fe2O3, 2.6% MgO, 4.3% SiO2 and 0.3% CaO, obtained from "El-Ahram Company", El Talbia, Faisal St. area, El-Giza Governorate. The used sheep manure physical and chemical characteristics were determined using methods of[29]**,** it was analyzed as: 25-30 % moisture, 34.1 % O.M., 12.79 C/ N ratio and 7.45 pH as well as 1.89, 0.66 and 2.40 as percentages for available N, P and K, respectively and 259, 188 and 75 as ppm for available Fe, Mn and Zn, respectively.

Throughout the experimental period "from seed sowing to harvesting" for the two tested seasons plants of all treatments were subjected to salinity stress. Since, all treatments were irrigated using saline irrigation water (5664 ppm) through drip irrigation system. Properties of used irrigation water were determined according to[28] they were recorded in Table B.

Table (B). Analysis of the used irrigation water

Moisture (%)	pH	EC(dSm^{-1})	O.C(%)	O.M(%)	C/N	Available Macronutrients (%)			Available Micronutrients (mg kg^{-1})		
						N	P	K	Fe	Mn	Zn
25-30	7.45	8.85	24.17	34.10	12.79	1.89	0.66	2.40	259	188	75

Recorded Data:

Fennel plant responses to the tested magnetite and sheep manure applications were noticed at the two experimental seasons by recording the following data:

1. **Plant growth:**

On completion of the vegetative growth, just before flowering, during the two tested seasons, vegetative growth responses were recorded as plant height (cm), number of branches per plant, fresh and dry weights per plant (g). Three plants from each row were used for such vegetative determinations.

2. **Fruit yield and its components**

At harvesting on May 15th during the two tested seasons number of umbels per plant, seed index represented as weight of 100 seeds (g) and fruit yield per plant (g).

3. **Essential oil determinations:**

Essential oil was extracted from fruit samples of each treatment by distillation according to the method of[30] and oil percentages were recorded. Then, oil yield per plant was calculated. Also, Samples of the extracted essential oils of the first season 2011/ 2012 were subjected to gas-liquid chromatographically (GLC) analysis according to[31,32] to determine percentages of the main components of the volatile oil.

4. **Chemical analysis:**

Chemical determinations were done in harvested fruit samples of the two tested seasons. Total carbohydrates percentage was determined using the method described by[33]**,** total nitrogen was determined using the modified micro Kjeildahl method as described by[34]**,** phosphorus was determined according to[35]**,** potassium was determined using the atomic absorption spectroscopy[36] and free Proline was determined in fresh herb according to[37] method**.**

Statistical analysis

The collected data were subjected to statistical analysis according to[38]**.** Mean separation was done using least significant difference test at 5% level (LSD 0.05).

Results and Discussion

Growth and herb yield:

1. Plant height

The results presented in Table (1) show that in the both seasons, plants receiving no magnetite were significantly shorter than plants supplied with any of the magnetite fertilization treatments. Moreover, raising the Magnetite application rate caused a steady increase in plant height. Accordingly, the tallest plants (149.78 and 145.01cm in the first and second season, respectively) were those fertilized using the highest rate of magnetite (100 kg/fed.). These results are in harmony with those reported by[19] on strawberry, [39]on tomato, [12]on cauliflower. [40]on vegetable crop, [15]on *Copsicum Annuum*, [41]on faba bean and [17]Valencia orange trees and [42]on *Ocimum basilicum*.

The data in Table (1) also show that the sheep manure (SM) treatments had a considerable effect on the height of fennel plants. In the first season, application of the different SM treatments gave significantly taller plants than the control (121.31 cm). Moreover, raising the SM application rate caused a gradual increase in plant height, with the highest SM rate (45 m^3/fed.) being the most effective treatment in this respect. This SM rate gave the tallest plants in the first season (146.97 cm). The data recorded in the second season Table (1) confirmed those of the first season; all SM treatments gave significantly taller plants compared to the control. As in the first season, plant height was increased steadily with increasing the SM application rate, and the tallest plants (with height of 142.13 cm) were those supplied with the highest SM rate. These data are in a greement with the conclusions reached by [43]on *Rosmarinus offcinalis*, [44]on fennel plant, [45]on *Matricaria chamomilla*, [27]on *Thymus vulgaris*, [45]on *Foeniculum vulgare*, [13]on *Hibiscus sabdariffa*, [14]on *Hibiscus sabdariffa*, [47]on *Anethum graveolens*, [48]on *Foeniculum Vulgare* and [49]on Indian spinach.

Regarding the interaction between the effects of M and SM treatments on height of fennel plants, it is clear from the data in the Table (1) that in the first season, plants receiving most of the M and SM treatment combinations were significantly taller than untreated control plants. The tallest plants in the first season were those supplied with M at the rate of 50 kg/fed., combined with SM at 45 m^3/fed. (167.33 cm), followed by plants fertilized using a combination of M at 100 kg/fed. and SM at 30 m^3/fed. (giving values 160.72cm). On the other hand, the shortest plants were those receiving no magnetite and SM treatments, whereas the shortest plants (127.85 cm) were those supplied with 50 kg magnetite /fed. and no SM. The results recorded in the second season (Table 1) confirmed those obtained in the first season. Combining the rate of M (50 kg/fed.) with SM at 45 m^3/fed. gave the tallest plants (with height of 162.22 cm), followed by plants receiving M at 100 kg/fed. combined with SM at 30 m^3/fed. (giving plant height of 157.45 cm) The recorded values were generally decreased by reducing the application rates of M and/or SM. Thus, the shortest plants (98.34 cm) were those receiving no M or SM treatment.

2. Number of branches and umbels/plant

Data presented in Table (1) indicated that application of the M and SM fertilization treatments resulted in significant increase in the number of branches and umbels /plant, but the interaction between the effects of these two types of fertilizers was insignificant (in both seasons).

Regarding the effect of M treatments on the branching of fennel plants, the data in Table (1) show that, in the both seasons, the different M treatments increased the branching and umbels of fennel plants, compared to the control (with 3.76, and 2.91 branches/plant and 33.42 and 26.70 umbels/plant in the first and second season, respectively). Increasing the rate of M from 0 to 100kg/fed. resulted in a significant increase in the number of branches and umbels /plant. The highest number of branches and umbels /plant was obtained in plants fertilized with M at the rate of 100 kg/fed. (with 7.64, and 6.79 branches/plant and 69.23 and 59.97 umbels/plant in the first and second season, respectively). The positive effect of combining M in accordance with the results obtained by [50]on *Solanum melongena*.

Also, the data in Table (1) show that when the rate of SM was raised from 0 to 45 m^3/fed., the number of branches and umbels/plants increased significantly compared to that of unfertilized plants (with values of 4.30 and 3.54 branches/plant and 42.31 and 36.24 umbels/plant in the first and second season, respectively). The highest number of branches and umbels (7.95 and 7.02 branches/plant and 67.89 and 58.10 umbels/plant in the first and second season respectively), were obtained on plants which received SM at 45 m^3/fed. On the other hand, the lowest number of branches and umbels/plant were recorded in plants treated with SM at 15 m^3/fed. (with values of 5.43 and 4.49 branches/plant and 51.08 and 43.60 umbels/plant in the first and second season, respectively). This effect of SM on branching is in harmony with the findings of many authors, including [44]on fennel plant [13]on *Hibiscus sabdariffa*,[14]on *Hibiscus sabdariffa* [47]on *Anethum graveolens*

Concerning the interaction between the effects of M and SM on the number of branches and umbels/plant, the data in the Table (1) show that in the both seasons, this interaction was insignificant. Plants receiving no M or SM treatments had the lowest number of branches and umbels (with values of 3.02 and 2.17 branches/plant and 27.11 and 21.67 umbels/plant in the first and second season, respectively). The combination M at the rate of 50 kg/fed. with SM at 45 m^3/fed. resulted in the highest number of branches and umbels/plant (with 11.22 and 9.52 branches/plant and 85.00 and 73.15 umbels/plant in the first and second season, respectively), followed by the combination between M at 100 kg/fed. and SM at 30 m^3/fed. (giving values of 10.53 and 9.00 branches/plant and 82.35 and 70.28 umbels/plant in the first and second season, respectively). Among plants receiving treatments of both M and SM, those supplied with M at 50 kg/fed., combined with CM at 15 m^3/fed. had the lowest number of branches/plant (with values of 5.98 and5.00 branches/plant and 58.11and 50.89 umbels/plant in the first and second season, respectively).

Table (1). Influence of magnetite iron (M), sheep manure (SM) and their interaction on plant parameters of fennel plants in two seasons.

Magnetite (M) (kg/fed)	First season 2010/2011					Second season 2011/2012				
	Sheep manure (SM) (m^3/fed).									
	0	15	30	45	Mean	0	15	30	45	Mean
Plant height (cm)										
0	102.44	110.00	114.66	117.14	111.06	98.34	104.56	109.14	113.45	106.37
50	127.85	140.55	152.78	167.33	147.13	123.12	138.50	146.70	162.22	142.64
100	133.65	148.30	160.72	156.45	149.78	130.04	141.82	157.45	150.72	145.01
Mean	121.31	132.95	142.72	146.97	136.05	117.17	128.29	137.76	142.13	131.34
LSD.5% M	2.314					1.072				
LSD.5%SM	4.076					2.124				
Interaction	4.161					3.713				
No. of branches/plant										
0	3.02	3.72	4.00	4.30	3.76	2.17	2.60	3.20	3.68	2.91
50	4.78	5.98	7.20	11.22	7.30	4.02	5.00	7.01	9.52	6.14
100	5.10	6.60	10.53	8.33	7.64	4.43	5.87	9.00	7.87	6.79
Mean	4.30	5.43	7.24	7.95	6.23	3.54	4.49	6.07	7.02	5.28
LSD.5% M	3.216					2.415				
LSD.5%SM	2.208					1.620				
Interaction	3.224					2.714				
No. of umbels/plant										
0	27.11	30.52	35.26	40.78	33.42	21.67	23.45	28.15	33.54	26.70
50	47.76	58.11	69.44	85.00	65.08	41.37	50.89	63.15	73.15	57.19
100	52.07	64.62	82.35	77.89	69.23	45.67	56.47	70.28	67.44	59.97
Mean	42.31	51.08	62.35	67.89	55.91	36.24	43.60	53.86	58.10	47.95
LSD.5% M	3.207					2.310				
LSD.5%SM	4.135					3.735				
Interaction	6.115					5.244				
Weight of 100 fruit (g)										
0	0.60	0.65	0.70	0.77	0.68	0.55	0.58	0.63	0.68	0.61
50	0.83	1.00	1.18	1.52	1.33	0.71	0.88	1.10	1.40	1.02
100	0.93	1.05	1.32	1.42	1.18	0.75	0.99	1.27	1.14	1.04
Mean	0.79	0.90	1.07	1.24	1.06	0.67	0.82	1.00	1.07	0.89
LSD.5% M	0.323					0.212				
LSD.5%SM	0.250					0.107				
Interaction	0.374					0.316				

3. Weight of 100 fruit (g)

The effects of M, SM, as well as the combinations of these two types of fertilizer, on the weight of 100 fruit, obtained in Table (1). Results recorded on fennel plants in the both seasons show that plants receiving no M treatments gave significantly lower weight of 100 fruit (0.68and 0.61 g in the first and second seasons, respectively), compared to plants receiving the different M application rates. The results presented in Table (1) also show that, in general, raising the rate of M from 0 to 100 kg/fed. resulted in steady increases in the weight of 100 fruit, with M being most effective when applied at the rate of 100 kg/fed. (giving values of 1.18 and 1.04 g. in the first and second seasons, respectively). These results are in harmony with those reported by [40]on vegetable crop, [15]on *Copsicum Annuum*, [41]on faba bean and [17]Valencia orange trees and [42]on *Ocimum basilicum*.

The data in Table (1) also show that in the both seasons, plants receiving the different SM treatments gave significantly higher weight of 100 fruit than the control (which gave 0.79 and 0.67 g. in the first and second seasons, respectively). Raising the rate of SM fertilization from 0 m^3/fed. (control) to15, 30 or 45 m^3/fed. caused a steady increase in the weight of 100 fruit. Accordingly, SM was most effective when applied at the highest rate (45 m^3/fed.), giving weight of 100 fruit of 1.24 and 1.07 g. in the first and second seasons, respectively). These values were insignificantly higher than those recorded with SM at the rate of 30 m^3/fed. (1.07 and 1.00 g. in the first and second seasons, respectively). These conclusions are in agreement with the findings of [45]on *Matricaria chamomilla*, [27]on *Thymus vulgaris*, [46]on *Foeniculum vulgare*, [13]on *Hibiscus sabdariffa*, [14]on *Hibiscus sabdariffa*, [47]on *Anethum graveolens*, [48]on *Foeniculum Vulgare* and [49]on Indian spinach.

As for the interaction between the effects of M and SM, the data presented in Table (1) show that there were significant increases in weight of 100 fruit when the plants were treated with different combinations of M and SM treatments. During the both seasons, the control plants gave the lowest weight of 100 fruit (with the values of 0.60 and 0.55 g. in the first and second seasons, respectively). On the other hand, the highest values recorded (1.52 and 1.40 g in the first and second seasons, respectively) were obtained from plants fertilized with M at the rate of 50 kg/fed. combined with SM at 45 m^3/fed. The application M at the rate of 100 kg/fed. combined with CM at 30 m^3/fed. gave insignificantly higher weight of 100 fruit. (with the values of 1.32 and 1.27 g. in the first and second seasons, respectively) than combining M at the rate of 50 kg/fed. with SM at 15 m^3/fed. (giving values of 1.00 and 0.88 g in the first and second seasons, respectively).

4. Fresh and dry weights of plant (gm):

Fertilized plants with M at any tested concentration gained significant increases in fresh and dry weights of plant comparing to untreated control plants (Tables 2). Rising M rate up to 100 kg/fed caused steady increases in fresh and dry weights of plant. Such results were repeated during the 2 seasons. However, the highest increments in fresh and dry weights were recorded under the effect of 100 kg/fed magnetite. The maximum values represented M effect recorded 400.75 and 373.80 gm for fresh weight and 188.73 and 162.63 g for dry weight during 1st and 2nd seasons, respectively with 100 kg/fed of magnetite level. These results are in accordance with those reported by [13]on *Hibiscus sabdariffa*, [15]on *Copsicum Annuum* and [42]on *Ocimum basilicum*.

Considerable effects on the fresh and dry weights of plant were recorded after SM applications (Tables 2). All SM treatments resulted significant increases in herb fresh and dry weights/ plant comparing to control. In general, gradual significant increases in both fresh and dry weights of plant were noticed by applying SM at (45 m^3/fed.) , then (30 m^3/fed. And 15m^3/fed.), respectively. The greatest values recorded 403.74, 388.59, 371.48 and 347.56 gm in fresh weight of plant for (45 m^3/fed.) and (30 m^3/fed) during 1st and 2nd seasons, respectively. While, they were recorded 183.05, 176.86, 168.16 and 152.75 gm in herb dry weight of plant (45 m^3/fed.) and (30 m^3/fed) during 1st and 2nd seasons, respectively. These results are in agreement by [45]on *Matricaria chamomilla*, [27]on *Thymus vulgaris* and [46]on *Foeniculum vulgare*.

As for M X SM treatments, data of Tables 2 revealed that fertilizing plants with M or SM at any tested level resulted increases in herb fresh and dry weights/ plant comparing to control plants. Generally, the heaviest herb fresh and dry weights/ plant were noticed in plants received 50 kg/fed M and treated with (45 m^3/fed.) SM, followed by plants applied with 100 kg/fed M and fertilizes by (30 m^3/fed.) SM. This was repeated during the 2 tested seasons.

5. Fruit yield/ plant (gm):

The data recorded on the fruit yield/plant (Table 2) indicate that in the first season, increasing the rate of M resulted in significant increase in fruit yield/plant. Moreover, the highest M rate (100 kg/fed.) was the most effective rate for increasing the fruit yield/plant (giving values of 68.66, g/plant), while the unfertilized plants gave significantly lowest fruit yield/plant (45.21g/plant). The same trend was found in the second season. Accordingly, the highest values of fruit yield/plant (63.00 g/plant) were obtained on plants treated with M at 100 kg/fed, whereas the lowest values were recorded in control plants (giving values of 43.68 g/plant). The increase that was recorded in the herb fresh weight/plant is in agreement with the findings [12]on cauliflower. [40]on vegetable crop, [15]on *Copsicum Annuum*, [41]on faba bean and [17]Valencia orange trees and [42]on *Ocimum basilicum*.

Regarding the effect of SM on the fruit yield/plant, the data in Table (2) show that in the first season, unfertilized plants gave significantly lower fruit yield/plant (49.63 g/plant) than the plants receiving any of the tested fertilization treatments. Raising the application rate of SM from 0 to 45m^3/fed. caused a steady increase in the fruit yield/plant. Accordingly, SM was most effective when it was applied at the rate of 45m^3/fed., giving the highest fruit yield/plant in the first season (67.60 g/plant), followed by the rate of 30 m^3/fed (giving values of 64.79 g/plant).

In the second season, a similar trend was detected. The recorded values (Table 2) showed a steady increase in fruit yield/plant with raising the SM application rate from 0 to 45 m^3/fed. Accordingly, SM was most effective when applied at the highest rate 45m^3/fed., giving fruit yield/plant of 63.39 g/plant. On the other hand, control plants gave the lowest values (48.05 g/plant), while the lowest SM rate (15 m^3/fed.) was the least effective SM treatment for increasing fruit yield/plant, giving values of 53.37 g/plant. The increase that was recorded in the fruit yield/plant that was fertilized with SM (compared to the control) is in agreement with the findings of [46]on *Foeniculum vulgare,* [13]on *Hibiscus sabdariffa,* [14]on *Hibiscus sabdariffa,* [47]on *Anethum graveolens,* [48]on *Foeniculum Vulgare* and [49]on Indian spinach.

Table (2). Influence of magnetite iron (M), sheep manure (SM)) and their interaction on plant parameters of fennel plants in two seasons.

Magnetite (M) (kg/fed)	First season 2010/2011					Second season 2011/2012				
	Sheep manure (SM) (m^3/fed).									
	0	15	30	45	Mean	0	15	30	45	Mean
Fresh weight of plant (gm)										
0	156.01	248.70	300.66	320.00	256.34	143.41	229.12	253.46	273.33	224.83
50	330.45	366.85	402.33	470.84	392.62	317.78	340.11	375.15	442.45	368.87
100	337.30	382.53	462.78	420.37	400.75	328.43	354.00	414.08	398.67	373.80
Mean	274.59	332.69	388.59	403.74	349.90	263.21	307.74	347.56	371.48	329.17
LSD.5% M	**6.421**					**4.325**				
LSD.5%SM	**7.420**					**6.507**				
Interaction	**9.311**					**8.752**				
Dry weight of plant (gm)										
0	75.01	94.58	109.47	122.69	100.44	64.99	84.58	99.41	107.20	89.05
50	126.70	150.53	183.33	220.30	170.22	115.28	138.95	163.47	217.12	158.71
100	138.40	172.55	237.78	206.17	188.73	125.76	149.24	195.37	180.16	162.63
Mean	113.37	139.22	176.86	183.05	153.13	102.01	124.26	152.75	168.16	136.79
LSD.5% M	**5.862**					**3.442**				
LSD.5%SM	**6.512**					**4.753**				
Interaction	**12.670**					**10.670**				
Fruit yield (gm)/plant										
0	40.12	44.33	47.65	48.75	45.21	39.88	43.07	45.35	46.42	43.68
50	51.48	63.28	70.04	80.72	66.38	50.78	57.86	62.59	76.59	61.96
100	57.30	67.35	76.67	73.33	68.66	53.48	59.18	70.56	68.78	63.00
Mean	49.63	58.32	64.79	67.60	60.08	48.05	53.37	59.50	63.93	56.21
LSD.5% M	**3.148**					**2.733**				
LSD.5%SM	**4.074**					**3.621**				
Interaction	**6.357**					**5.307**				

The results in Table (2) show that in the first season, a significant interaction was detected between the effects of the M and SM treatments on fruit yield/plant. Plants receiving no M or SM treatments gave the lowest values of fruit yield/plant (40.12 g/plant). On the other hand, plants receiving M at 50 kg/fed. plus SM at 45 m^3/fed. gave the highest fruit yield/plant (with values of 80.72 g/plant), followed by plants fertilized with M at 100 kg/fed. plus SM at 30 m^3/fed. (giving values 76.67 g/plant). Among plants receiving both M and SM treatments, thoses upplied with M at 50 kg/fed. combined with SM at 15 m^3/fed. gave the lowest herb fruit yield/plant (with values of 63.28 g/plant).

Also, the results recorded in the second season indicated that a significant interaction existed between the effects of M and SM treatments on fruit yield/plant. In the second season, plants receiving M at the rate of 50 kg/fed. combined with SM at 45 m^3/fed. gave the highest fruit yield/plant (76.59 g/plant), while the unfertilized plants gave significantly lower values (39.88g/plant). Among plants receiving both M and SM treatments, the lowest fruit yield/plant (57.86 g/plant) was obtained from plants receiving a combination of M at 50 kg/fed. and SM at 15m^3/fed.

Essential oil determinations:

Recorded data represented essential oil determinations are in Tables 3 and 4.

1. Effect of Magnetite (M) treatments:

Results in Table 3 indicate that fertilized of *Magnetite (M)* at 50 or 100 kg/fed significantly increased percentage of essential oil in fruits comparing to control plants during the 2 seasons. No significant differences were noticed in this respect between the two *(M)* levels. The fruit essential oil % mean was reached 2.762% and 2.791% comparing to 2.327% in control in the 1st season and 2.680% and 2.684% comparing to 2.213% in control plants in the 2nd season for 50 and 100 kg/fed *M* concentrations, respectively. It could be noticed that from the previous discussed results of such research that *M* treatments which improved plant height, branches No/ plant, umbels No/ plant and Fruit yield per plant also increased fruits essential oil percentage.

For essential oil yield/ plant (cc), data of Table 3show that of the two seasons, the different fertilization treatments increased the oil yield/plant significantly, compared to the control. M had significant effect on oil yield/plant during the both seasons. The highest M rate (100 kg/fed.) gave the highest oil yield/plant (1.926 and 1.700 ml/plant in the first and second season respectively), while unfertilized (control) plants gave significantly lower oil yields (1.057 and 0.969 ml/plant in the first and second season respectively).

Data of Table 4 showed *M* treatments effect on the main components of the resulted essential oil. It is clear that fertilized fennel plants with 100 kg/fed *M* resulted in the highest percentages of the main determined essential oil ingredients comparing to control plants or those treated with other tested *M* levels. However, resulted essential oil under the effect of 100 kg/fed *M* contained 3.43% β- Pinene, 8.39% anise aldehyde and 26.31%fenchone. While the highest percentages of α- Pinene and anethole resulted under the effect of 50 kg/fed *M*. On the opposite, The estragole gave lowest percentages 27.64% compare 38.61% of control plants.

Effect of SM application treatments:

All *SM* tested application treatments had significant effects on fruit essential oil % as compare to control during the both seasons (Table 3). However, the unfertilized (control) plants had significantly lower oil contents in the fruits (2.435% and 2.350% in the first and second seasons, respectively), compared to plants receiving the different SM treatments. On the other hand, the highest oil contents were obtained from plants supplied with SM at the rate of 45 m^3/fed. (2.791% and 2.701% in the first and second seasons, respectively). Whereas the lowest SM rate (15 m^3/fed.) was the least effective SM treatment (giving values of 2.435% and 2.350% in the first and second seasons, respectively).

Table (3). Influence of magnetite iron (M), sheep manure (SM) and their interaction on oil determinations of fennel plants in two seasons.

Magnetite (M) (kg/fed)	First season 2010/2011					Second season 2011/2012				
	Sheep manure (SM) (m^3/fed).									
	0	15	30	45	Mean	0	15	30	45	Mean
Essential oil (%)										
0	2.133	2.268	2.408	2.500	2.327	2.093	2.160	2.224	2.373	2.213
50	2.573	2.680	2.782	3.014	2.762	2.451	2.567	2.718	2.983	2.680
100	2.600	2.750	2.953	2.860	2.791	2.507	2.627	2.853	2.747	2.684
Mean	2.435	2.566	2.714	2.791	2.630	2.350	2.451	2.598	2.701	2.526
LSD.5% M	0.197					0.145				
LSD.5%SM	0.244					0.227				
Interaction	0.405					0.352				
Essential oil yield/plant (mL)										
0	0.856	1.005	1.147	1.219	1.057	0.835	0.930	1.009	1.102	0.969
50	1.325	1.696	1.949	2.433	1.851	1.245	1.485	1.701	2.285	1.679
100	1.490	1.852	2.264	2.097	1.926	1.341	1.555	2.013	1.889	1.700
Mean	1.224	1.518	1.787	1.916	1.608	1.140	1.323	1.574	1.759	1.449
LSD.5% M	0.521					0.367				
LSD.5%SM	0.264					0.208				
Interaction	0.515					0.432				

As for essential oil yield per plant (Table 3) as affected by *SM* application treatments, the results show that fertilizing by *SM*, generally, had significantly effect on the resulted oil yield per plant (cc) comparing to untreated control during the two seasons. While, treated plants with 45 m^3/fed. SM resulted the highest significant values represented essential oil yield per plant comparing to control or applying *SM* (15 m^3/fed.). Such results were corroborative in the 2 seasons.

Data represented the main components of the resulted essential oil as affected with *SM* application treatments (Table 4) revealed that the highest percentages of α- Pinene, anise aldehyde, fenchone and anethole (2.72 %, 8.25 %, 26.13 % and 20.01 %, respectively) were recorded in essential oil extracted from plants treated with *SM* at the rate of 45 m^3/fed, comparing to control. On the other hand, the same rate of SM resulted the lowest percentages of estragole 28.47% compare 34.26% of untreated plants. These data are in a greement with the conclusions reached by [51]on coriander plant, [52]on fennel, [44]on fennel plant, [45]on *Matricaria chamomilla*, [46]on *Foeniculum vulgare,* [14]on *Hibiscus sabdariffa,* [48]on *Foeniculum Vulgare* and [49]on Indian spinach.

Table (4). Influence of magnetite iron (M), sheep manure (SM)) and their interaction on the components (%) of essential oil of fennel plants in the first season.

Magnetite (M) (kg/fed)	Sheep manure (SM) (m^3/fed)				
	0	**15**	**30**	**45**	**Mean**
α-Pinene					
0	0.75	1.40	1.25	2.56	1.49
50	0.88	0.96	1.87	3.55	1.82
100	0.92	1.10	3.06	2.05	1.78
Mean	**0.85**	**1.15**	**2.06**	**2.72**	**1.70**
B- pinene					
0	1.12	1.23	1.83	2.30	1.62
50	2.16	4.93	2.86	3.70	3.41
100	3.03	3.15	4.68	2.86	3.43
Mean	**2.10**	**3.10**	**3.12**	**2.95**	**2.82**
Anise aldehyde					
0	4.26	5.64	5.79	6.45	5.54
50	6.05	6.30	7.88	9.52	7.44
100	7.17	8.30	9.30	8.77	8.39
Mean	**5.83**	**6.75**	**7.66**	**8.25**	**7.12**
Fenchone					
0	11.81	14.33	15.26	16.66	14.52
50	18.83	25.60	26.77	29.40	26.10
100	20.15	27.17	28.53	33.18	26.31
Mean	**16.93**	**22.37**	**23.81**	**26.13**	**22.31**
Anethole					
0	13.68	14.35	14.72	15.02	14.44
50	15.60	16.46	18.70	20.35	19.13
100	16.82	17.77	19.27	25.75	18.55
Mean	**15.37**	**16.19**	**17.92**	**20.01**	**17.37**
Estragole					
0	44.88	42.61	36.20	30.73	38.61
50	29.76	27.46	26.46	25.60	26.98
100	28.15	26.36	30.44	24.23	27.64
Mean	**34.26**	**32.14**	**29.42**	**28.47**	**31.07**

Effect of Interaction treatments between M levels and SM application treatments:

It is evident that the interaction between *M* levels and *SM* application treatments had significant effects on oil % in fennel in fruits during all both seasons (Table 3). Plants which received 50 kg/fed *M* combined with *SM* 45 m^3/fed had the highest essential oil percentages their fruits comparing to all other interaction treatments during the both seasons. The mean in this respect recorded 3.014% and 2.983% in 1st and 2nd seasons, respectively). followed by plants fertilized with M at 100 kg/fed. plus SM at 30 m^3/fed. (giving values of 2.953% and 2.853% in the first and second seasons, respectively), whereas the least effective treatment combination was using M at 50 kg/fed. plus SM at 15 m^3/fed.

The combination treatments of *M* levels X *SM* application treatments caused considerable effects on essential oil yield per plant (Table 3). In general, the above 2 mentioned interaction treatments which caused significant increases in essential oil %; *i. e.,* 50 kg/fed M X 45 m^3/fed SM or 100 kg/fed M *X* 30 m^3/fed SM, also caused significant increases in essential oil yield per plant as compare to control and most of the other interaction treatments.

The data in Table (4) state that, the combined between 50 kg/fed. of M and SM at 45 m^3/fed the highest values of the α- Pinene and anise aldehyde contents (with value of 3.55% and 9.52%, respectively). While the combined between 100 kg/fed. of M and SM at 45 m^3/fed. show The highest values of the fenchone and anethole contents (33.18% and 25.75%, respectively) compared to the control. The results in Table (4) show that the interaction treatments between the M and SM gave lower values of the estragole content, compared to the unfertilized plants which gave the highest value of estragole content (44.88%). While the plants received M at the rate of 100 kg/fed. with SM at the rate of 45 m^3/fed resulted the lowest value of estragole content (with 24.23%). The increase in volatile oil content was probably due to the increment in the metabolic activities[53]**.**

Total carbohydrates (%) in fruits:

Data of Table 5 show gradual increases in total carbohydrates % in herb with increasing the applied *M* concentration from 0.00 up to 100 kg/fed. Results of the two seasons, respectively, recorded the highest percentages of carbohydrates (23.05 and 23.82%) under the effect of 100 kg/fed. *M* followed by 22.81 and 23.57% with 100 kg/fed. M applied. Control treatment recorded the least total carbohydrates. These results are in agreement with those published by [12]on cauliflower. [40]on vegetable crop, [15]on *Copsicum Annuum*, [41]on faba bean and [17]Valencia orange trees and [42]on *Ocimum basilicum*. .

For the effect of *SM* application treatments, results in Table 5 show that the highest values of carbohydrates percentages were achieved during the both of seasons by adding *SM* at 45 m^3/fed . While, the least carbohydrates percentages were occurred with control treatment. The mean of total carbohydrates recorded 22.90 and 24.10% for *SM* at 45 m^3/fed during 1st and 2nd seasons, respectively. These conclusions are in agreement with the findings of [46]on *Foeniculum vulgare,* [13]on *Hibiscus sabdariffa,* [14]on *Hibiscus sabdariffa,* [47]on *Anethum graveolens*, [48]on *Foeniculum Vulgare* and [49]on Indian spinach.

The highest total carbohydrates percentages were recorded in plants which received the interaction treatment of 50 kg/fed. of M and SM at 45 m^3/fed, then 100 kg/fed. of M and SM at 30 m^3/fed. This was confirmed during the two seasons (Table 5). These results are in agreement by [54]indicates that the carbohydrate increased proportional in relation to increase in the level of applied organic and magnetic iron.

This general increase in the total carbohydrates content of fertilized plants (compared to the control) that was recorded can be easily explained, since the nitrogen supplied by fertilization is essential in the structure of prophyrines, which are found in the cytochrome enzymes essential in photosynthesis. This increase in the cytochrome enzymes results in an increase in the rate of photosynthesis, and a promotion in carbohydrate synthesis and accumulation. Moreover, the potassium added by fertilization acts as an activator for several enzymes involved in carbohydrate metabolism[55]**.**

Table (5). Influence of magnetite iron (M), sheep manure (SM) and their interaction on the total carbohydrates and nutrient contents (%) of dry weight in fruits and Prolien content in fresh herb of fennel plants in both seasons.

Magnetite (M) (kg/fed)	First season		2010/2011			Second season		2011/2012		
	Sheep manure (Sh) (m^3/fed).									
	0	15	30	45	Mean	0	15	30	45	Mean
carbohydrates (%)										
0	16.80	18.40	19.23	20.20	18.66	16.00	17.20	18.50	19.40	17.78
50	21.18	22.50	23.50	27.10	23.57	20.50	22.00	23.00	25.73	22.81
100	21.60	23.10	25.17	25.00	23.72	21.18	22.60	24.60	23.80	23.05
Mean	19.86	21.33	22.63	24.10	21.98	19.23	20.60	22.03	22.90	21.21
Nitrogen (%)										
0	1.05	1.12	1.19	1.20	1.14	1.02	1.09	1.15	1.18	1.11
50	1.24	1.30	1.36	1.48	1.35	1.21	1.26	1.34	1.44	1.31
100	1.27	1.32	1.45	1.41	1.36	1.23	1.31	1.40	1.38	1.33
Mean	1.19	1.25	1.33	1.36	1.28	1.15	1.22	1.30	1.33	1.25
Phosphorus (%)										
0	0.200	0.208	0.215	0.227	0.213	0.198	0.201	0.210	0.220	0.207
50	0.241	0.285	0.336	0.395	0.314	0.235	0.273	0.308	0.372	0.297
100	0.266	0.314	0.364	0.355	0.325	0.257	0.294	0.342	0.325	0.305
Mean	0.236	0.269	0.305	0.326	0.284	0.230	0.256	0.287	0.306	0.269
Potassium (%)										
0	2.88	3.96	4.02	4.11	3.74	2.80	2.86	3.92	4.09	3.42
50	4.18	4.25	5.31	5.40	4.79	4.16	4.23	5.29	5.38	4.77
100	4.21	4.28	5.36	5.34	4.80	4.19	4.26	5.35	5.32	4.78
Mean	3.76	4.16	4.90	4.95	4.44	3.72	3.78	4.85	4.93	4.32
Prolien (µmol/g f.w.)										
0	41.38	37.55	36.59	27.41	35.37	44.98	42.99	38.94	29.40	39.08
50	38.17	34.91	30.79	23.19	31.77	42.18	40.77	34.52	26.73	36.05
100	36.85	29.70	20.16	16.40	25.78	40.22	38.25	29.39	22.17	32.51
Mean	38.80	34.05	29.18	22.33	31.09	42.46	40.67	34.28	26.10	35.88

c. Nutrient contents

1-Nitrogen (%) in fruits:

Chemical analysis of dried samples of the fennel fruits shown that, in general, the different fertilization treatments increased the N content, compared to that of control plants Table (5) in the both seasons, for M fertilizer, the unfertilized plants having a lower N content (with values of 1.11% and 1.14% in the first and second seasons, respectively). Otherwise, plants receiving M at 100 kg/fed had higher N contents in the both seasons (with values of 1.33% and 1.36% in the first and second seasons, respectively).

The data presented in Table (5) also show that the effectiveness of the different SM treatments for increasing the N content, compared to the control, in the first and second seasons, the control plants having a lower N content (with values of 1.15% and 1.19 % in the first and second seasons, respectively). The highest N contents (1.33 and 1.36 % in the first and second seasons respectively). were found in plants fertilized with SM at 45 m^3/fed. followed by plants fertilized with SM at 30 m^3/fed. (with a value of 1.30% and 1.33% in the first and second seasons respectively). However, the using SM at 15 m^3/fed. resulted the lowest N contents (1.22% and 1.25% in the first and second seasons respectively), compared to another treatment.

Concerning, the effect of the interaction treatments between M and SM on the N content. The data in Table (5) state that, the combined treatments show great effect during the two seasons compared to the control. The unfertilized plants gave lower values of the N content (1.02% and 1.05% in the first and second seasons, respectively). The highest values of the N content obtained when using 50 kg/fed. of M combined with SM at

45 m^3/fed. (1.44% and 1.48% in the first and second seasons, respectively), followed by the fertilized plants by 100 kg/fed. of M plus SM at 30 m^3/fed. (giving values of 1.40 % and 1.45 % in the first and second seasons, respectively).

2. Phosphorus (%) in fruits:

The results recorded in Table (5) in the both seasons show that fennel (*Foeniculum vulgare*) plants receiving the M fertilization treatments had higher P contents in their herb, compared to the unfertilized (control) plants, (with values of 0.0.207 and 0.213% in the first and second seasons, respectively). Accordingly, M was most effective when applied at the highest rate (100 kg/fed.), (giving values of 0.305 and 0.325% in the first and second seasons, respectively).

The data in Table (5) also show that SM at 45 m^3/fed. was generally the most effective treatment in the both seasons, giving the highest values P contents in the fruits recorded (0.306 and 0.326 %, in the first and second seasons, respectively), compared to the control plants (giving values of 0.230 and 0.236 % in the first and second seasons, respectively). However, the application of SM at 15 m^3/fed. giving lower values of P contents (0.256 and 0.269%, in the first and second seasons, respectively).

The results in Table (5) show that in the first and second seasons, there were high effect of the interaction treatments between the M and SM on P content. The unfertilized plants gave lower values of the P content (0.198 and 0.200% in the first and second seasons, respectively)). The plants received M at the rate of 50 kg/fed. plus SM at 45 m^3/fed. resulted the highest values of P content (with 0.372 and 0.395 % in the first and second seasons, respectively). Followed by the plants fertilized by M at 100 kg/fed. plus SM at 30 m^3/fed. (giving values 0.342 and 0.364% in the first and second seasons, respectively).

3. Potassium (%) in fruits:

The results presented in Table (5) show that, the tested of M fertilization treatments had effects on the K content in the fruits of fennel plants. compared to that of control plants in the both seasons, the unfertilized plants having a lower K content (with values of 3.42% and 3.47% in the first and second seasons, respectively). Otherwise, plants receiving M at 100 kg/fed had higher K contents in the first season (with values of 4.82%), but the plants receiving M at 50 kg/fed had higher K contents in the second season (with values of 4.79%).

The data presented in Table (5) also show that the effectiveness of the different SM treatments for increasing the K content, compared to the control, in the both season, the control plants having a lower K content (with values of 3.72% and 3.73% in the first and second seasons, respectively). The highest K contents (5.00% and 4.95% in the first and second seasons, respectively), were found in plants fertilized with SM at 45 m^3/fed. followed by plants fertilized with SM at 30 m^3/fed. (with a value of 4.84% and 4.90% in the first and second seasons, respectively).

Concerning, the effect of the interaction treatments between M and SM on the K content. The data in Table (5) state that, the combined treatments show great effect during the two seasons compared to the control. In the first season, the unfertilized plants gave lower values of the K content (2.80%). The highest values of the K content obtained when using 100 kg/fed. of M combined with SM at 45 m^3/fed. (5.52%) followed by the fertilized plants by 50 kg/fed. of M plus SM at 45 m^3/fed. (giving value 5.38%).

A similar trend was recorded in the second season. With control plants gave lower values of the K content (2.88%), while fertilized plants by 50 kg/fed. of M combined with SM at 45 m^3/fed. gave the maximum values of the K content (5.40%). Using the combination between M at 100 kg/fed. and SM at 30 m^3/fed. giving higher values (5.36%) compared to using 50 kg/fed. of M plus SM at 15 m^3/fed. (giving value of 4.25%). These results are in harmony with those reported by [19]on strawberry, [39]on tomato, [12]on cauliflower. [40]on vegetable crop, [15]on *Copsicum Annuum*, [41]on faba bean and [17]Valencia orange trees and [42]on *Ocimum basilicum*.

4. Prolien content in fresh herb:

The results presented in Table (5) show that, the content of prolien was decrease when the tested of M fertilization treatments increased. However. The highest content of prolien in the both seasons was obtaiened in the unfertilized plants (with values of 35.37and 39.08 µmol/g in the first and second seasons, respectively).

Otherwise, plants receiving M at 100 kg/fed had lowest prolien contents (with values of 25.78 and 32.51 µmol/g in the first and second seasons, respectively).

The data presented in Table (5) also show that the effectiveness of the different SM treatments for decreasing the prolien content, compared to the control, in the both season, the control plants having The highest prolien content (with values of 38.80 and 42.46 µmol/g in the first and second seasons, respectively). The lowest prolien contents (with values of 22.33 and 26.10 µmol/g in the first and second seasons, respectively). were found in plants fertilized with SM at 45 m^3/fed.

Concerning, the effect of the interaction treatments between M and SM on the prolien content. The data in Table (5) state that, the control show great effect during the two seasons compared to the combined treatments. the unfertilized plants gave the highest values of the prolien content (with values of 41.38 and 44.98 µmol/g in the first and second seasons, respectively). The lowest values of the prolien content obtained when using 100 kg/fed. of M combined with SM at 45 m^3/fed. (with values of 16.40 and 22.17 µmol/g in the first and second seasons, respectively).

Discussion

There is no doubt that the increase in magnetite concentration from zero to 100 kg/fed led to an increase in plant growth as: plant height, number of branches and umbels/ plant and herb fresh and dry weights per plant, fruit yield per plant as well as essential oil yield per plant. However, the magnetic treatments improved capacity for nutrient and water uptake, providing greater physical support to the developing shoot, better root growth and development in young seedlings might lead to better root systems throughout the lifetime of a plant. The application of a magnetic field to irrigation water was shown to increase plant nutrient content[39]**.** Magnetic treatments may affect phytohormone production leading to improve cell activity and plant growth[40]**.**

For Sheep manure application effect, results showed that applying SM with any tested application treatments led to an increase in plant growth and essential oil yield. However, the sheep manure may be attributed to enhancing soil aggregation, soil aeration, increasing water holding capacity and offers good environmental conditions for root system[56]**.** [49]found that the increased growth and nutrient content of plant suggest the positive effects of organic manures in amelioration of saline soils by enhancing soil fertility through the release of essential macro and micro elements.

The generally superior effect of organic manures on vegetative growth may be attributed to their effects on the soil, such as improving some of its chemical and physiochemical properties, improving water use efficiency[57], preventing salt injury to plants that sometimes results from concentration of chemical fertilizers through the buffering properties of organic matter[58] **,** and providing the soil with essential macro and micronutrients[59]. Also the addition of manures to the soil increases its cation exchange capacity (CEC) due to the ability of the negatively charged organic matter particles to attract and hold the positively charged cations in the soil, and to provide the plant roots with these cations. Moreover, the addition of manures to the sandy soil increases the soil's water-holding capacity which, in turn, allows higher absorption of water and nutrients from the soil, and enables photosynthesis to occur efficiently within the plant leaves[60]. In the addition, [61]reported that organic matter can improve soil structure, improving root development, providing plant nutrients and enhancing nutrient uptake by plants. Moreover, organic manure facilities water absorption and retention by soil, which has a favorable effect on growth and essential oil components.

According to the results of the present study, proline content of shoots and roots significantly increased under salinity stress. Non inoculated plants accumulated much proline than inoculated ones. Proline is known as the main important osmolyte accumulated under salt stress. These osmolytes play a great role for facilitating water retention in the cytoplasm and to activate water up take in growing tissues[62]**.** Proline act as cytocompostpatible solute in response to Na^+ accumulation and the compost partmentation should be balanced[63]**.**

Conclusively, although all the applied treatments improved the growth and yield parameters of fennel under saline water irrigation conditions, the combination of M at the rate of 50 kg/fed. plus SM at 45 m^3/fed. proved to be the best treatment in increasing the herb fresh and dry weights/plant, fresh and dry herb yields/fed, as well as the oil percentage and oil yield/plant, followed by combining M at 100 kg/fed. with SM at 30 m^3/fed.

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