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STUDY OF THE EFFECT OF ZINC AND IRON SPRAY ON THE VEGETATIVE GROWTH CHARACTERISTICS, TOTAL YIELD OF VOLATILE OIL AND TOTAL PHENOLS OF *ANETHUM GRAVEOLENS*

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ABSTRACT

The research was carried out in plastic houses at College of Agricultural Engineering Sciences- Baghdad University during spring season 2016-2017. The seeds were planted in cork dishes in October and after their germination they were transferred to plastic bands of 8 cm diameter and after two months ,seedlings were transferred to the plastic house and planted On the distance lines between 50 cm and between plants and another 40 cm, Treatments were distributed randomly as Factorial experiment with in the complete random design, by three replicates, at the rate of eight plants in one experimental unit. After a month of cultivation, the plants were spraying with zinc at (0, 75, 150) in the form of zinc sulfate and iron at (0, 100, 200) in the form of iron sulfate for three times and the period from one to another two weeks. The results showed significant effects of Zinc and Iron on most investigated agronomical parameters in which Zn3Fe1 gave the highest of the plant height, the number of secondary branches, the soft and dry weight of 44.3 and 39.3 cm, 34.0 secondary branches/plants, 194.1 g/plant and 17.16 g/plant, respectively. While treatment of Fe2 gave highest number of branches and the total phenolic concentration was 5.11 main branches/plant and 5.09 mg/gm, respectively. The treatment of Zn^3 showed highest number of secondary branches and the soft weight reached 30.1 secondary branches/plants and 108.5 gm/soft weight plant respectively. It is also noted that the treatment of interaction Zn2 Fe2 gave highest content of the volatile oil and total phenols, which amounted to 6.13 mg / g phenol and 0.555 g / 100 g plant.

Keywords: Zinc, Iron, vegetative growth characteristics, *Anethum graveolens*, volatile oil, phenols

Introduction

Medicinal and aromatic plants are an important and essential source of many medications and medicinal remedies; It contains many active compounds, Entering the pharmaceutical industry that can be dispensed with chemical drugs (Jimenez, 2006). Dill *Anethum graveolens* .L is one of the medicinal plants which found in south western Asia and southern Europe, and in the rest of Europe, America and the Arab world. It is a standing plant that ranges between (120-70) cm in height, and the leaves are a feathered composition divided into striped filamentous parts .The stems are soft, and the flowers are completely yellow inside the inflorescences of the Terminal vehicle (Bown and Deni, 2001). Dill contains volatile oil consists of water (8.39%), protein (15.68%), carbohydrates (36%), fibers (14.80%), ash (9.8%) and mineral elements such as calcium, potassium, magnesium, phosphorous, sodium, vitamin A and niacin Pilot oil contains the following major compounds: carvone 30-60%, limonene 33%, phellandrene% 20.61 including pinene, diterpene, myrcene, paramyrcene and apiol myristin (Ishikawa, 2002). Dill seeds are used to get rid of gases and gastritis, and to relieve colon pain, and fermented fennel seeds are also added to food in order to reduce high blood pressure and calm nerves, and push the person to sleep peacefully, remove chronic headache, and also reduce blood sugar by balancing insulin production and strengthening the heart Spleen and for asthma as it is useful in increasing milk secretion in women and ashes resulting from burning seeds benefit in increasing the speed of healing of festering wounds as well as for treating hemorrhoids and breaking up kidney stones and in cases of festering ophthalmia (Hiti, 2000). The specifications of the oil and its effective components differ according to the type of Dill, the location of its cultivation, the used plant part and its growth stage (Suhail, 2010). The results of one of the studies showed the success of plant extracts in the treatment of irritable bowel syndrome after two weeks of treatment, through a clear decrease in symptoms of the disease such as reducing headaches, reducing flatulence, lowering the level of fats and cholesterol (Yazdanparast and Alavi, 2001 and Mohammad, 2012) For diabetes treatment (Panda, 2008) It is an antioxidant and antispasmodic (Al-Ismail and Aburjai, 2004, Bahramikia and Yazdanparast, 2009; Hosseinzadeh *et al*., 2002, Naseri and Heidari, 2007). Zinc is one of the plant nutrients, as it is involved in building many enzymes and building proteins and nucleic acids, DNA, RNA (Thiruppathi *et al*., 2001). It has an important role in the growth and development of the plant through its direct impact on the biological structure of the RNA and the cellular content of the ribosomes and thus its direct effect on the construction of

carbohydrates and proteins and on the biological construction of tryptophan, which results in an effect on the plant's content of oxine (Marschner, 1995), Also, Iron helps in the activity and effectiveness of enzymes within the plant such as cytochromate and ferroxine, since slow growth and low activity of carbon representation and production of dry matter and irregular nutrients of the plant can be caused by a lack of zinc and iron in addition to the transport of electrons and their activity and interaction in the plant needs these two elements (Thiruppathi *et al*., 2001). Because of the importance of this plant from a medical point of view, this experiment aimed to study the effect of spraying with the elements of iron and zinc on increasing the yield of the plant from the volatile oil and total phenols.

Materials and Methods

This research was carried out in plastic houses at College of Agricultural Engineering Sciences- Baghdad University during spring season 2016-2017. The seeds were planted in cork dishes in October and after their germination they were transferred to plastic bands of 8 cm diameter and after two months ,seedlings were transferred to the plastic house and planted On the distance lines between 50 cm and between plants and another 40 cm, Treatments were distributed randomly as Factorial experiment with in the complete random design, by three replicates, at the rate of eight plants in one experimental unit. After a month of cultivation, the plants were spraying with zinc at (0, 75, 150) in the form of zinc sulfate and iron at (0, 100, 200) in the form of iron sulfate for three times and the period from one to another two weeks. Then the required measurements were taken and included the number of the main branches / plant and the number of secondary branches / branch and the soft and dry weight and the percentage of nitrogen mg / g, for phosphorous, for potassium and total phenols and the volatile oil yield (kg / e) Results were analyzed according to the user experience design, using the least significant difference under test level 0.05%.

Results and Discussion

Height of the plant. cm. Plant^{-1}

Results in Table 1 reveal significant differences between the two studied factors and their interaction in plant height, The treatment zn3 produce at the highest 37.8 cm. Plant^{-1} compared to the comparison treatment, which amounted to 26.4 cm. Plant^{-1}, while Iron spraying had no significant effect on plant height. As for the interaction factors, It is observed from the same table that the interaction factors Zn3Fe1 and Zn3Fe3 exceeded the height of the plant 44.3 and 39.3 cm. Plant^{-1} compared to the comparison treatment Zn1Fe1 gave 20.7 cm. Plant $^{-1}$.

Number of main and secondary branches. Plant^{-1}

The results in Table 1 show significant increase in the characteristic of the number of main branches when spraying with iron, which was represented by the treatment factors of Fe2 and Fe3 amounting to 5.11 and 3.33 main branches. Plant-1, respectively, compared to Fe1 gave 2.89 main branches. Plant^{-1} either for zinc spraying did not significantly affect the characteristic of the number of main branches of the plant. The results also show in the same table that the interaction factors for zinc-iron spraying did not significantly affect the number of the main branches of the plant. The same table also indicates a significant increase in the number of branches. Secondary when spraying with zinc and iron and their interference, Zn3 spray treatment was superior to the number of secondary branches amounted to 30.1 secondary branch. Plant^{-1} compared to the comparison treatment, which amounted to 19.6 secondary branch. The comparison, which amounted to 19.3 secondary branches, plant^{-1}, b The ratio of the coefficients of interference observed superiority of overlapping transactions Zn3Fe3 and Zn3Fe1 which gave the highest value reached 35.3 and 34.0 secondary branch. Plant^{-1} compared to the treatment of comparison which gave a secondary branch 9.0. Plant $^{-1}$.

Fresh and dry weight of the plant (g. Plant $^{-1}$)

The results show in Table 2 the treatment of Zn3 gave the highest fresh and dry weight of 108.5 g and 13.28 g. Plant^{-1} compared to the control treatment, which gave 69.9 g. Plant^{-1} and 8.86 g. Plant^{-1}, while the interaction treatment Zn3Fe1 gave the highest fresh weight, 194.1 g. Plant^{-1} compared to the comparison treatment, which gave the lowest amount, 49.1 g. Plant^{-1} fresh weight. As the results in the same table show, the Fe3 , which reached 13.28 Plant^{-1} weight compared to the Fe2 gave lowest dry weight of 9.31 g. Plant^{-1}, the interaction treatment Zn3Fe1 gave the highest dry weight of 17.16 g. Plant^{-1} compared to the comparison treatment of 5.13 g. Plant $^{-1}$.

Plant content of zinc, iron, phosphorus and boron

The results in Table 3, show the treatments Zn2 gave the highest percentage of Iron 0.193% compared to the treatment of Zn3 0.152%, In the same Table Iron spray has a significant effect on Iron plant content, that Fe2 gave the highest percentage of Iron 0.198% compared to the comparison treatment of 0.149%. As the interaction treatment Zn1Fe2 gave the highest percentage of Iron, reached 0.220% in comparison with the control at 0.116%. The same table show Zn3 gave the highest percentage of Zinc 0.0088% compared with the control treatment 0.0052%, Also Fe3, gave 0.0078% compared to the Fe2 treatment, which gave 0.0057%. The results show in Table 4 Zn2 gave the highest percentage of phosphorus at 0.612% compared to the control treatment 0.386%. While Fe3 gave 0.532% compared to the control treatment which reached 0.149%, and the interaction treatment Zn2Fe3 gave the highest percentage of phosphorus at 0.800% compared to the measurement treatment 0.365%. The same table also show Fe3 gave the highest percentage of Boron at 38.49 ppm compared to the measurement treatment at 34.67 ppm, but no significant differences were observed in the boron plant content when spraying with Zinc, Zn3 Fe1 gave the highest percentage of Boron 63.07 ppm compared to Zn3 Fe2 gave the least amount of boron 18.33 ppm.

Plant content of nitrogen and protein

The results in Table 5 show Zn2 gave the highest percentage of nitrogen and protein 3.058% and 19.112% compared to the control treatment that gave 1.711% and 10.693%. Fe3 gave the highest percentage of nitrogen and protein 2.233and 16.7% compared to the control 1.787% and 11.168%, As the same table show the superiority Zn2 Fe3 in the nitrogen and protein characteristic which gave 4.380% and 27.375%, compared to the measurement treatment that gave the lowest amount of protein 7.668%.

The content of the plant from the volatile oil

The results in Table 6 show a significant increase in the amount of the volatile oil of the plant and yield of volatile oil per hectare when spraying the plants with Iron and Zinc, As the treatment of Zn2 gave the highset of the volatile oil and yield of volatile oil per hectare 0.237 g. 100 g^{-1} and 1.42 l oil. h^{-1} compared with the measurement treatment that gave 0.098 g. 100 g^{-1} and 0.434 l. h^{-1}. In the same table, the Fe2 gave 0.296 g. 100 g^{-1} and 1.38 l. h^{-1} compared with measurement treatment, which gave the lowest amount of 0.090 g. 100 g^{-1} and 0.527 l. h^{-1}, respectively, also the interaction treatment Zn2Fe2, which gave the highest amount of volatile oil 0.555 g. 100 g^{-1} and 3.84 l. h^{-1} Compared with the measurement treatment that gave the lowest amount 0.034 g. 100 g^{-1} and 0.087 liters. h^{-1}, respectively**.**

Plant content of phenol

The results in Table 6 show a significant increase on the plant content of total phenols and the total yield in hectares, Zn3 which gave the highest amount amounting to 3.71 mg. g^{-1} and 22.64 g. h^{-1} compared to the comparison treatment that gave the lowest amount of 2.91 mg. g^{-1} and 12,891 g. h^{-1}, respectively, The treatment Fe2 gave the highest amount of total phenols in the plant and in hectare 5.09 mg. Mg.g^{-1} and 23,693 g. h-1, respectively, compared to the comparison treatment, which gave the lowest amount of 2.47 mg. g^{-1} and 13.974 g. h^{-1}, respectively .Interference treatment Zn2Fe2 gave 6.13 mg.g^{-1} and 42.45 g. h^{-1}, respectively, compared to the comparison treatment, which gave 1.20 mg. g^{-1} and 9.224 g. h^{-1}, respectively.

Perhaps the reason for the significant increase in the height of the Dill plant when treated with the elements of Zinc and Iron is due to their role in increasing the activity of Mystic cells and thus increasing cell division and thus increasing the length of the plant. (Prakash and Ganesan, 1997). These results were consistent with Mahdi's (2014) findings that Zinc and Iron spraying have a significant effect on the increase in plant height. The reason for the increase in the number of main and secondary branches of the chippinum plant may be attributed to the function of these micronutrients in stimulating the formation of new cells and then their division in addition to stimulating the formation of new buds which are later on (Singravel *et al*., 2002). It has an important role in the growth and development of the plant through its direct impact on the biological structure of the RNA and the cellular content of ribosomes and thus its direct effect on the construction of carbohydrates and proteins and on the biological construction of tryptophan and thus resulting in an effect on the plant's content of oxine (Marschner, 1995). Also, Iron helps in the activity and effectiveness of enzymes with in the plant such as cytochromes and ferrodexin, as slow growth and low activity of carbon representation and production of dry matter and irregular nutrients to the plant can be caused by a lack of zinc and iron in addition to the transfer of electrons to winch Cook and interact with plants need these two components (Thiruppathi *et al.* , 2001). Perhaps the reason for the increase in the amount of volatile oil and the total phenols in the zinc-treated fermented plant is due to the increased activity of enzymes responsible for carrying out biological processes for the production of primary and secondary compounds in the plant that need energy. Therefore, spraying the plants with nutrients has the effective effect of increasing the process of carbon representation (Maralidhadn and Singh, 1990).

Table 1 : Effect of zinc and iron spray on plant height and number of main and secondary branches of Dill

Plant height					**Number of main branches**					**Number of secondary branches**				
Zn / Fe	**Zn1**	**Zn2**	**Zn3**	**mean Fe**	**Zn / Fe**	**Zn1**	**Zn2**	**Zn3**	**mean Fe**	**Zn / Fe**	**Zn1**	**Zn2**	**Zn3**	**mean Fe**
Fe1	20.7	40.3	44.3	35.1	Fe1	2.67	3.00	3.00	2.89	Fe1	9.0	15.0	34.0	19.3
Fe2	22.7	32.7	29.7	28.3	Fe2	6.00	5.00	4.33	5.11	Fe2	20.0	30.0	21.0	23.7
Fe3	36	31.7	39.3	35.7	Fe3	5.00	2.00	3.00	3.33	Fe3	29.7	21.0	35.3	28.7
L.S.D Interaction	14.91			L.S.D Fe	L.S.D Interaction	N.S			L.S.D Fe	L.S.D Interaction	15.17			L.S.D Fe
mean Zn	26.4	34.9	37.8	N.S	mean Zn	4.56	3.33	3.44	1.743	mean Zn	19.6	22.0	30.1	8.76
L.S.D Zn	8.61				L.S.D Zn	N.S				L.S.D Zn	8.76			

Table 2 : Effect of Zinc and Iron spray on the Fresh and dry weight of the Dill (g. $Plant^{-1}$)

Freash weight					**dry weight**				
Zn / Fe	**Zn1**	**Zn2**	**Zn3**	**mean Fe**	**Zn / Fe**	**Zn1**	**Zn2**	**Zn3**	**mean Fe**
Fe1	49.1	93.0	194.1	112.0	Fe1	5.13	11.53	17.16	11.27
Fe2	50.0	100.7	42.7	64.5	Fe2	6.26	13.85	7.81	9.31
Fe3	110.7	58.2	88.7	85.9	Fe3	15.21	10.66	14.87	13.58
L.S.D Interaction	50.44			L.S.D Fe	L.S.D Interaction	8.132			L.S.D Fe
mean Zn	69.9	83.9	108.5	N.S	mean Zn	8.86	12.01	13.28	4.695
L.S.D Zn	29.12				L.S.D Zn	4.695			

Table 3: Effect of sprinkling with Zinc and Iron on the percentage of Iron and Zinc in the Dill plant

Fe%					Zn%				
Zn / Fe	Zn1	Zn2	Zn3	mean Fe	Zn / Fe	Zn1	Zn2	Zn3	mean Fe
Fe1	0.116	0.194	0.137	0.149	Fe1	0.0033	0.006	0.009	0.0061
Fe2	0.220	0.175	0.200	0.198	Fe2	0.005	0.006	0.0063	0.0057
Fe3	0.175	0.211	0.120	0.168	Fe3	0.0073	0.005	0.113	0.0078
L.S.D Interaction	0.051			L.S.D Fe	L.S.D Interaction	0.0017			L.S.D Fe
mean Zn	0.170	0.193	0.152	0.029	mean Zn	0.0052	0.0056	0.0088	0.0009
L.S.D Zn	0.029				L.S.D Zn	0.0009			

Table 4 : Effect of zinc and iron spray on phosphorus content% and boron ppm

Phosphorus content%					Content boron ppm				
Zn / Fe	Zn1	Zn2	Zn3	mean Fe	Zn / Fe	Zn1	Zn2	Zn3	mean Fe
Fe1	0.365	0.448	0.386	0.400	Fe1	19.33	21.60	63.07	34.67
Fe2	0.400	0.590	0.563	0.517	Fe2	40.97	50.00	18.33	36.43
Fe3	0.393	0.800	0.403	0.532	Fe3	57.10	35.13	23.23	38.49
L.S.D Interaction	0.0165			L.S.D Fe	L.S.D Interaction	2.760			L.S.D Fe
mean Zn	0.386	0.612	0.451	0.0095	mean Zn	39.13	35.58	34.88	1.597
L.S.D Zn	0.0095				L.S.D Zn	1.597			

Table 5 : Effect of zinc and iron spray on nitrogen and protein content of Dill plant

Nitrogen%					Protein%				
Zn / Fe	Zn1	Zn2	Zn3	mean Fe	Zn / Fe	Zn1	Zn2	Zn3	mean Fe
Fe1	1.227	2.537	1.597	1.787	Fe1	7.668	15.856	9.981	11.168
Fe2	1.950	2.257	2.233	2.147	Fe2	12.187	14.106	13.956	13.418
Fe3	1.957	4.380	1.680	2.672	Fe3	12.231	27.375	10.5	16.7
L.S.D Interaction	0.1225			L.S.D Fe	L.S.D Interaction	0.765			L.S.D Fe
mean Zn	1.711	3.058	1.863	0.070	mean Zn	10.693	19.112	11.481	0.437
L.S.D Zn	0.070				L.S.D Zn	0.437			

Table 6 : Effect of Zinc and Iron sprays on the content of the volatile oil and yield of volatile oil per hectare.

volatile oil g.100g^{-1}					yield of volatile oil g.h^{-1}				
Zn / Fe	Zn1	Zn2	Zn3	mean Fe	Zn / Fe	Zn1	Zn2	Zn3	mean Fe
Fe1	0.034	0.088	0.148	0.090	Fe1	0.087	0.507	1.27	0.527
Fe2	0.144	0.555	0.190	0.296	Fe2	0.45	3.84	0.741	1.38
Fe3	0.188	0.068	0.156	0.114	Fe3	1.43	0.362	1.16	0.774
L.S.D Interaction	0.018			L.S.D Fe	L.S.D Interaction	0.073			L.S.D Fe
mean Zn	0.098	0.237	0.164	0.010	mean Zn	0.434	1.42	1.09	0.023
L.S.D Zn	0.0107				L.S.D Zn	0.025			

Table 7 : Effect of zinc and iron sprays on the content and yield of the Dill plant from total phenols

Totol phenol mg.g^{-1}					**yield of** Totol phenol mg.g^{-1}				
Zn / Fe	Zn1	Zn2	Zn3	mean Fe	Zn / Fe	Zn1	Zn2	Zn3	mean Fe
Fe1	1.20	1.60	4.63	2.47	Fe1	3.078	9.224	39.725	13.974
Fe2	4.50	6.13	4.63	5.09	Fe2	14.085	42.45	18.08	23.693
Fe3	3.03	2.50	1.87	2.48	Fe3	23.043	13.325	13.903	16.771
L.S.D Interaction	1.688			L.S.D Fe	L.S.D Interaction	6.863			L.S.D Fe
mean Zn	2.91	3.41	3.71	0.975	mean Zn	12.891	20.48	22.64	2.23
L.S.D Zn	0.975				L.S.D Zn	2.23			

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