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Effect of application of iron fertilizers in two methods 'foliar and soil application' on growth characteristics of *Spathyphyllum illusion*

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ABSTRACT

Iron is a necessary element for plant's growth and since the formation of chlorophyll is not possible without the presence of iron, therefore plants deficiency or deactivation of iron show with chlorosis of their leaves. This research was carried out to determine suitable type of iron fertilizer and use method from it for Spathyphyllum ornamental plant. This experiment was carried out in a completely randomized factorial design with two factor: type of fertilizer in 5 levels (a_1= control without use of fertilizer, a_2= nanoiron fertilizer, a_3= $FeSo_4$,a_4= EDDHA, a_5= Fe-EDTA) and application's method in two levels (b_1= foliar spray, b_2= soil application) on the Spathyphyllum ornamental plant in a same medium of peat – per lit at the rate 1:1. The growth characteristics and the concentrations of some nutrient in Spathyphyllum plant were measured. According to esults iron fertilizers didn't show obvious morphological changes compared to control treatment. Fe-EDTA treatment loss was caused plants with both of methods "foliar and soil application" and it's use don't recommended particularly in primary stages of growth. As regards EDDHA, nanoiron fertilizer and $FeSo_4$ treatments were in the same level in the most of characteristics, use of nanoiron fertilizer is superior because reduce the harmful effects that chemical fertilizers into the environment, in addition lower cost.

Keywords: EDDHA, Fe-EDTA, Foliar spray, Nano iron fertilizer, *Spathyphyllumillusion*

INTRODUCTION

Peace lily belongs to Araceae [1]. *Spathiphyllum* is a very popular flower for indoor and it grows in tropical region of America and Southeast Asia. *Spathiphyllum* is important ornamental foliage which has a beautiful and creative leaves and white spadix [2].

Iron is one of the essential elements but low use and less mobility for plants. Among all the micronutrients plants need to iron more than other[3]. Among micronutrients, Iron (Fe) is a cofactor for approximately 140 enzymes that catalyze unique biochemical reactions [4]. Deficiency or low activity of iron in the plant causes chlorophyll is not produced in sufficient quantities and the leaves are pale. the decrease of chlorophyll leading to the reduction of the

plant food Processor and Finally the yield is reduced. Iron shortage symptoms are first seen as the yellowish color between leaf veins, especially in young leaves, which could result in the necrosis of all these leaves [5].

Although due to the deposition, usability iron sulfate in the soil is limited, however, experiments show that It can be used for iron deficiency, especially when it is mixed with organic materials and prevent from they deposition [6]. Iron chelate example Fe-EDTA is absorbed and useable for plants too however it depends to soil's conditions particularly soil pH and being lime or not [7]. Iron chelates based on EDDHA is stable in soil and prevents from iron deposition for a reasonable period of time. Chelation agent EDDHA stors ferric iron with high power and prevents from it's deposition in soil. Thus the iron concentration in the soil increases but this fertilizers have a problem that is they very high cost [5].

With production of nano fertilizers, this nano compounds rapidly and completely absorbed by plants and fix it's nutrients shortages and needs [8].Base of iron nano fertilizer is natural quality and it made of organic and mineral material. This fertilizer is fully compatible with the environment and agricultural farms and organic materials with added to the soil to make it more organic material is to be [9].The use of nano fertilizer leads to an increased efficiency of the elements, reduce the toxicity of the soil, to at least reach the negative effects caused by the consumption of excessive consumption of fertilizers and reduce the frequency of application of fertilizers [10].

yarnia*et al*. [11] reported that Fe intake, increase yield and quantity of rapeseed and increase the height of the plant, the amount of nitrate reductase activity and photosynthesis too. As well as studies showed that there was a significant linear relationship between Fe concentration and yield[12]. And similarly, Karp*et al*. [13] indicated that Strawberry fruit quality increased with foliar Fe fertilization. Chen *et al*.[14] in an experiment comparison the effect of various Fe fertilizers on growth and propagation of Gladiolus and concluded that flowering Gladiolus occurs a few days earlier in Fe-enriched Peat and as well as cormel number per corm increase in this substrate.

In another study, influence of Khazra iron nano fertilizer on rice yield Was examined and was shown that applied treatments have a significant effect to all Characteristics except grain Thousand weigh [15].the results of the comparison of nano Fe chelate with Fe chelate effect on growth parameters of Ocimum basilicum showed that the replacement of iron fertilizer produced with nanotechnology in comparison with common Fe fertilizer can increase the growth of quantitative and qualitative plant in appropriate concentrations or less [16]. Regarding leaf Fe concentration, it was seen that the effect of foliar $FeSo_4$ on leaf Fe concentrations was higher than of Fe-EDTA in Strawberry cultivars [17].

This trial was conducted to examine and determine the appropriate type of Fe fertilizer and method of its use to dispel the need for Fe in *Spathiphyllum* plant.

MATERIALS AND METHODS

The applied fertilizers in this experiment were nanoiron fertilizer, Fe-EDDHA, Fe-EDTA and $FeSo_4$with pure Fe as 8/6%, 6%, 8% and 19%, respectively, that used in Two Methods 'Foliar and Soil Application'. The pot medium was peat and per lit with equal volume fraction (1:1). The study was carried out in a completely randomized factorial design with 2 factor, 10 treatments in 3 replications. Trial pots treated with fertilizers in 3 splits based on Table 1.

Uniformly transplants of *Spathiphyllum* were used in this experiment. All plants fertilized with a complete fertilizer which contains, N, P, K, Mo, B, Cu and Mg, with concentration 0.005. The study was carried out in the Research Center of Ornamental Plants, Lahidjan, Iran. After the first 15 days that was given only water to plants to be stabilized in the mediums, the first round soil and foliar fertilizing carried out. Fertilizing with Fe resources carried out in 1 stage for soil application at 5 cm above the medium and in 3 stage for foliar application in 15th, 105th and 195th days after cultivation of the plant. For the control treatment, pure water was used. During spraying, the soil surface and plants were covered with plastic to prevent any Fe contamination. The necessary concentrations for each stage fertilizing for every pot shown in Table 1 (the values in the table are for one stage of soil application and every stage of foliar application).

The plants were grown under greenhouse condition for 9 months. Growth parameters including; Number of leaves and plant height (cm) every 14 days once and root length (cm), chlorophyll content using chlorophyll measurement (CCM-200), fresh and dry weight shoot and root (g) at the end of the experiment were measured. Dry matter was

obtained via oven dried at 75° C. concentrations of nitrogen, phosphorus, potassium, zinc, magnesium, iron and manganese were measured. Fe, Mn, Mg and Zn concentrations were determined by atomic absorption spectrophotometer, K concentrations were determined by flame photometer, N and P were determined by using Kjeldahl and spectrophotometer respectively.

Some chemical characteristics of the medium were as follows: pH (5:1) 5.32, EC 0.21 ds m^{-1}, C/N 47, organic carbon 47.6%, total N 0.8%, available Fe, P,K, Na, Ca, Mg as 80, 26.32, 50,306.4, 7.6, 81.36mg kg^{-1}, respectively. Analysis variance of data was obtained using statistical software of MSTATC and treatment means were compared using LSD ($p<0.05$).

Table 1: Fertilizer treatments which were used in this study

	Treatments	Amount (per pot)
T_1	Foliar control	no fertilizer
T_2	Foliar nano iron fertilizer	1.08 g
T_3	Foliar EDDHA	1.55 g
T_4	Foliar $FeSo_4$	0.49
T_5	Foliar Fe-EDTA	1.16 g
T_6	Soil control	No fertilizer
T_7	Soil nano iron fertilizer	3.25 g
T_8	Soil EDDHA	4.66 g
T_9	Soil $FeSo_4$	1.47 g
T_{10}	Soil Fe-EDTA	3.5 g

RESULTS AND DISCUSSION

Effect of Fe fertilizers

Data presented in Table 2 shows that the simple effect of Fe treatments on all growth characteristics were significant. Based on data mean comparison (Table 3) $FeSo_4$treatment caused to the highest amount of height (3.71 cm)that didn't show significant difference with nano iron fertilizer, EDDHA and control treatment. but with Fe-EDTA (the lowest plant height) shows significant difference. these results are in agreement with results Ferrarezi *et al.*[18] on *Citrus* on all of the measured growth characteristics was significant ($p<0.05$). Data mean comparison (Table 3) shows that the best treatment for increasing the number of leaves was the control treatment (10.06) and Fe-EDTA caused to the lowest leaf number. Root stock. They showed that Fe-EDTA treatments caused to decrease the height in this plant in comparison to other Fe sources.

Highest root length (25.01 cm) obtained from the control treatment that shows significant difference to other treatments. Nano iron fertilizer, EDDHA and $FeSo_4$ treatments with 21.48, 21.73 and 23.01 cm respectively, didn't show significant difference with each other. But they had significant difference with Fe-EDTA (the lowest root length) (Table 3).

Table 2: The results of analysis of variance on some measured traits

Source of variance	Df	Mean squares							
		Number of leaves	height (cm)	Root length (cm)	Feresh weight of root (g)	Dry weight of root (g)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Chlorophyll content
Fctor A(method of use)	1	7.70^{ns}	1.58^{*}	0.43^{ns}	29.40^{ns}	4.80^{*}	0.004^{ns}	0.006^{ns}	217.08^{*}
Factor B(Fe fertilizers)	4	86.05^{*}	12.81^{*}	91.69^{*}	453.42^{*}	14.24^{*}	53.12^{*}	1.62^{*}	231.04^{*}
AB	4	23.73^{*}	0.89^{*}	3.01^{ns}	17.06^{ns}	2.02^{*}	4.15^{ns}	0.11^{ns}	41.23^{*}
Error	20	2.65	1.21	6.97	17.14	0.36	2.49	0.10	5.97
CV(%)	-	27.45	47.59	12.47	21.35	17.97	28.06	33.04	20.30

*ns Non significant, *significant at P<0.05*

In this Characteristic, Fe fertilization were in the low level from control treatment that these results are in agreement with results Rajab Beigi*et al.*[19] on *Ocimum basilicum* that the growth of the plants treatments with Fe declined sharply in comparison to the control treatment. As well as, in a study conducted by Turemis *et al.* [20] strawberry cultivars showed different responses to various doses and application types of EDDHA. Some varieties responded negatively to the Fe fertilization, and the yield decreased compared to the control. In the present experiment, root

length in nano fertilizer treatments decreased compared to the control treatment that this result is in agreemend with results peyvandi *et al.*[21]on *Sature jahortensis*.

Table 3 indicated that control treatment increased the fresh and dry weight of shoot of *Spathiphyllum* plant. Whereas it didn't show significant difference with nanoiron fertilizer, EDDHA and $FeSo_4$. On the other hand Lowest amounts of this traits was recorded from Fe-EDTA treatments that showed significant difference with the other treatments. Similar results about *Sature jahortensis* plant were reported by peyvandi *et al.*[21]. Also, Sajedi and ardakani[22]in the results of their research on Maize reported Micronutrients fertilizers influence on metabolic activities more and indirectly by increasing the speed of growth of the plant, absorption level, leaf durability and photosynthesis increases the dry weight of the plant and on the other the growth physiologic indexes Little influence.

Based on results (table 3) the highest amounts of fresh weight root with 27.78 g was recorded from control treatment. However, no significant statistical difference was observed in this treatment with EDDHA and nano iron fertilizer treatments with 23.45and 22.85 g respectively. The lowest amounts of this trait was recorded from Fe-EDTA with 5.23 g. Also, data mean comparison (Table 3) shows that the best treatment for increasing the was EDDHA treatment that didn't show significant statistical difference with control and nano iron fertilizer treatments. Fe-EDTA treatment caused to the least dry weight root with 0.76 g.

The effect of iron fertilizer was so that the highest chlorophyll content (20.7) was obtained from EDDHA treatment (Table 3). After EDDHA treatment, highest amounts of this index with the amounts of 14.86 and 12.43 was recorded from $FeSo_4$ and nano iron fertilizer respectively, that were on a higher level compared to the control treatment with the amount 6.61 and Fe-EDTA treatment with the amount 5.6.

In this index, the amount of chlorophyll of the nano iron fertilizer was on higher level from control treatment but no superior have than EDDHA treatment and was at the same level with $FeSo_4$ after the EDDHA. These results are disagreement with the results of the amount of chlorophyll in application of nano iron fertilizer on *Ocimum Basilicum* plant by peyvendi *et al.*[16].

Effect of use method from fertilizer

Analysis of variance results (Table 2) shows that the simple effect of use method of fertilizer on plant height (cm), dry weight root (g) and chlorophyll content was significant ($p<0.05$). data mean comparison (Table 4) shows that foliar method was superior than soil method in plant height index. Similar results about different plants were reported by Yarnia*et al.*[11], Keikha*et al.*[23] and Karp *et al.*[13].

In dry weight root index, soil method was superior compared to foliar method and leaded to increasing this index(Table 4). It seems that in the indexes of corresponding to the root such as fresh and dry weight of roots, soil method is better because of more activity of root for nutrient uptake from medium and increases this indexes. This matter can be useful for plants that their ground part is importance and economic. Also, foliar method increased plant chlorophyll content (Table 4). Haghighatnia and rajaee[24]reported that influence of amount and use methods of micronutrients especially Fe, show their positive role in increasing seed yield of *Brassica napus* and it's economic yield. Who believed Fe role is more in foliar method.

Interaction effect of Fe fertilizers and their use method

With attention to variance analysis results (Table 2), the interaction effect of Fe fertilizers and their use method showed significant influence on number of leaves, plant height, dry weight of root and chlorophyll content ($p<0.05$). Interaction effect of this two factor was so that the highest number of leaves (12.5) was obtained for foliar control treatment (Table 5).However, no significant difference was observed in this treatment with soil EDDHA (10.9).lowest number of leaves in this plant was recorded from soil and foliar Fe-EDTA.

El-Kassas[25] reported that application of iron to the soil or the foliage as chelate or sulphates improved the vegetative growth, gross yield and fruit quality of balady lime. Application of chelate iron Fe-EDDHA to the soil gave the highest response. these results are agreement with this experiment results.

Table 5 indicated that $FeSo_4$ as foliar increased the plant height. However, no significant difference was observed in this treatment with control, nano iron fertilizer, EDDHA treatments in both the methods and $FeSo_4$ in soil method. The lowest amount height was that of the Fe-EDTA in both methods foliar and soil application.

Based on results (Table 5) highest of dry weight of root with 5.53 g was recorded from EDDHA in soil method and lowest of this trait was recorded from Fe-EDTA in soil and foliar application with 0.9 and 0.63 g respectively. Based on data mean comparison (Table 5), the best treatment was EDDHA in foliar method (25.66) and Fe-EDTA in soil method (4.4) caused to the least chlorophyll content. .

Table 3: Data mean comparisons of simple effect of Fe fertilizers on characteristics

Treatments	Number of leaves	height (cm)	Root length (cm)	Fresh weight of root (g)	Dry weight of root (g)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Chlorophyll content
Control	10.06 a	2.66 ab	25.01 a	27.78 a	4.35 a	7.6 a	1.31 a	6.61 c
Nano iron fertilizer	6.20 bc	3.3 a	21.48 b	22.85 a	3.91 ab	6.83 a	1.18 a	12.43 b
EDDHA	8.10 b	1.9 b	21.73 b	23.45 a	4.56 a	7.4 a	1.23 a	20.7 a
$FeSo_4$	5.30 c	3.71 a	23.01 ab	17.66 b	3.2 b	5.86 a	1.03 a	14.86 b
Fe-EDTA	0.01 d	0.01 c	14.65 c	5.23 c	0.76 c	0.44 b	0.05 b	5.6 c

Means with similar letters in column are not significantly different at 5% probability level, (LSD)

Table 4: Data mean comparison of simple effect of fertilizers use method

Use method	height (cm)	Dry weight of root (g)	Chlorophyll content
Foliar	2.54 a	2.96 b	14.73 a
Soil	1.08 b	3.76 a	9.35 b

Table 5: data mean comparison of Interaction effect of Fe fertilizers and their use method

Treatments	Number of leaves	height (cm)	Dry weight of root (g)	Chlorophyll content
Foliar control	12.5 a	3.53 ab	3.6 c	7.86 c
Foliar nano iron fertilizer	5.76 bc	3.6 ab	4.4 bc	18.43 b
Foliar EDDHA	5.23 bc	1.8 bc	3.6 c	25.66 a
Foliar $FeSo_4$	3.663 c	3.8 a	2.56 d	14.9 b
Foliar Fe-EDTA	0.01 d	0.01 c	0.63 e	6.8 c
Soil control	7.63 b	1.8 bc	5.1 ab	5.36 c
Soil nano iron fertilizer	6.63 b	3 ab	3.43 cd	6.43 c
Soil EDDHA	10.96 a	2 ab	5.53 a	15.73 b
Soil $FeSo_4$	6.96 b	3.63 ab	3.83 c	14.83 b
Soil Fe-EDTA	0.01 d	0.01 c	0.9 e	4.4 c

NUTRIENTS CONCENTRATION INPLANT

Effect of Fe fertilizers

With the attention to variance analysis results (Table 6) the simple effect of Fe treatments on all of the measured nutrients concentration was significant ($p<0.05$). data mean comparison(Table 7) shows that the best treatment for increasing the leaf N concentration was the control treatment (2.25%) and Fe-EDTA caused to the lowest leaf N concentration (0.8%). In general, even in control plants had the highest of nitrogen concentration, N value in the optimum rate(3-4.5 %) which is required *Spathiphyllum* growth[26] was not.

Table 6: The results of analysis of variance on nutrients concentration in *Spathiphyllum* plant

Source of variance	Df	Mean squares						
		N (%)	P (%)	K (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Mg (ppm)
Fctor A(method of use)	1	0.06^{ns}	0.01^{*}	0.002^{ns}	174498^{*}	25386^{*}	5715^{*}	0.002^{*}
Factor B(Fe fertilizers)	4	1.63^{*}	0.008^{*}	0.004^{*}	129389^{*}	13701^{*}	8321^{*}	0.02^{*}
AB	4	0.54^{ns}	0.016^{*}	0.009^{*}	117188^{*}	7074^{*}	3359^{*}	0.01^{*}
Error	20	0.23	0.001	0.001	30.56	8.87	7.45	0.01
CV(%)	-	34.26	9.22	13.04	2.10	4.31	5.74	11.15

*ns Non significant, *significant at P<0.05*

data mean comparison (Table 7) shows $FeSo_4$ with 0.24% and 0.18% the most effective treatment to P and K content rising, respectively. Also, the lowest value P and K was recorded from Fe-EDTA with 0.15% and 0.12%, respectively. Concentration of K in all treatments was less than optimum range in *Spathiphyllum* plant (2-5%) that recorded by Chen*et al.*[26].

Highest of plant Fe value (454.5 ppm) was obtained from the $FeSo_4$ and Fe-EDTA with 91.17 ppm caused to the lowest Fe value (Table 7). Fe value in $FeSo_4$, EDDHA, iron nano fertilizer treatments was more than the optimum range (50-300 ppm) for *Spathiphyllum* plant [26].

Such a process by Erdal*et al*.[17] has also been reported that after treatment with Fe fertilizers, the Fe concentration increased and reached optimal levels in Strawberry, or under the optimal concentration [27].$FeSo_4$ and nano iron fertilizer which were the best treatments in plant Fe concentration, sat at similar level with the other treatments in plant Growth Characteristics and in more of this traits were on the lower level in comparison to the control treatment. This may be interpreted to mean that although the total leaf Fe concentration is high, it may not be used metabolically [28;29]. In experiments conducted under uncontrolled conditions in calcareous soils, it was found that the concentration of Fe in chlorotic leaves might be similar to or even higher than that in green leaves. These situations are partly related to the localization and binding properties of Fe in leaves. A portion of Fe might be precipitated in the apoplasm of leaves and not be physiologically active [30]. Nano iron fertilizer increased plant Fe concentration in comparison to the EDDHA. These results are in agreement with results khalaj*et al*. [31] on *Cucumis sativus*. They showed that nano iron fertilizer caused to increase the Fe concentration in Cucumbers.

As well as nano iron fertilizer increased plant Fe concentration to about 2.5 times. It has been reported that nano iron fertilizer was effective on Pistachiotrees and increased leaf Fe value of Pistachio trees to about 2 times [32]. These finding showed an agreement with the present results.

Data mean comparison (Table 7) shows nano iron fertilizer with 146.7 ppm the most effective treatment to Zn content rising and sat on upper level in comparison to control treatment. Lowest Zn content was recorded from EDDHA with 28.48 ppm. Zn concentration in all of treatments were in optimum range 20-200 ppm [26] for *spathyphyllum* plant.

Table 7 indicated that $FeSo_4$ (0.19 ppm) increased the Mg concentration, although no significant difference was observed in this treatment with EDDHA, nano iron fertilizer and control treatment. Lowest value Mg with 0.03 ppm obtained from Fe-EDTA. The optimum range for *spathyphyllum* growth is 0.4-1 ppm [26]. Mg concentration in all treatments, especially for Fe-EDTA was more lower than optimum range.
Among different sources of Fe fertilizer, nano iron fertilizer (108.2 ppm) recorded the highest of plant Mn concentration compared with other treatments. The lowest plant Mn concentration (14.78) observed in Fe-EDTA.

Based on required nutrient concentrations in leaves for *spathyphyllum* growth that are determined by Chen *et al*.[26] Mn concentration in nano iron fertilizer, $FeSo_4$ and control treatment was within optimum range (40-300 ppm).But in EDDHA and Fe-EDTA was lower than the optimum amount. Basar and Ozgumus[33] found a negative correlation between the total Fe concentration and Zn and Mn concentrations of peach trees. These results are disagreement with the present results. Of course these results due to the existence of Fe, Mn and Zn in the combination of nano iron fertilizer with special formulation was expected.

Effect of use method from fertilizer
Effect of use method from fertilizers (Table 6)had significant effects on P, Fe, Zn, Mn and Mg concentration ($p<0.05$).data mean comparison (Table 8) shows that the best treatment in this elements was obtained under foliar application of Fe fertilizers. Similar results about different plants for Fe concentration were reported by Koksal*et al*.[34]; Horesh and Levy[35]; Basar and Ozgumus[33]; Erdal*etal*.[36].

Interaction effect of Fe fertilizers and their use method
Results from the analysis of variance the effect of Fe fertilizers and their use method (Table 6) on all of the measured elements (except for N concentration) showed that there was a significant difference between the studied treatments ($p<0.05$).

Among interaction levels (Table 9), the highest plant P concentration was obtained from control treatment in soil application with 0.27 %. The lowest P concentration with 0.05 % was obtained from Fe-EDTA in soil application. This decrease in the concentration of the elements on this treatment can be due to low speed of iron intake and transmission from this fertilizer that causes disturb the balance of nutrients absorption such as P and K in soil and decreases concentrations of these elements in the plant that this problem been resolved in foliar method and plants

treated with this fertilizer had the highest concentrations of P and K. these results for adjustment of nutrients balance in plant by the foliar method are agreement with the obtained results from experiment of yarnia*et al*. [11].

Table 9 indicated that $FeSo_4$ as foliar increased the K concentration. However, no significant difference was observed in this treatment with the other treatments (except for Fe-EDTA). The lowest K concentration was that of the Fe-EDTA in soil application. Saleh[37], as well as the highest K concentration of leaves in his experiment on 'Lisbon' Lemon obtained from $FeSo_4$ in foliar application in comparison to the EDDHA (in three use method: soil, foliar and surface).

Interaction effect of this two factor was so that the highest Fe concentration (730 ppm) was obtained for $FeSo_4$ in foliar application (Table 9). After $FeSo_4$, nano iron fertilizer in foliar application with 475.7 ppm had the highest concentration of plant Fe that observed significant difference with the other treatments. Lowest concentration of plant Fe was recorded from Fe-EDTA in soil application. Erdal*et al.*[17] in their experiment on Strawberry cultivars reported that the effect of $FeSo_4$ on leaf Fe concentration was higher than that of Fe-EDTA. These findings showed an agreement with the present results.

Plants treated with $FeSo_4$ in foliar application, despite having the highest Fe content had yellow and sparse leaves in compared to other plants. probably because Fe was present in the form of non-reactive ferric ion (Fe3+), according to Pérez-Sanz and Lucena[38], not being easily used in photosynthesis reactions and formation of chlorophyll pigments [39]. Furthermore, Mohammad *et al*. [40] observed that the total Fe concentration was always higher in chlorotic leaves as compared to green leaves and was not related to the chlorosis degree. So it can be said that the high concentrations of Fe in $FeSo_4$ treatments had no effect on growth Characteristics and also having the green leaves and was accumulation in the form of non-reactive Fe in plant. Also, Musa [41] found that high level of Fe in the basal leaves of *Hibiscus sabdariffa* has no nutritional benefit.

Table 9 indicated that nano iron fertilizer in foliar application increased Zn concentration in *spathyphyllum* plant more than other treatments. Lowest concentration of plant Zn was recorded from Fe-EDTA in soil application with 8.66 ppm. Foliar Fe applications from two sources: Fe-EDTA and $FeSo_4$ resulted in significant increases in leaf Zn concentration on Strawberry cultivars [17]. The increase in leaf Zn concentration with Fe sprayings may be due to increasing plant growth and metabolism [42].

Data mean comparison (Table 9) shows control treatment in foliar application with 0.2 ppm the most effective treatment to Mg content rising. However no significant difference was observed in this treatment with EDDHA in foliar application, $FeSo_4$ in soil and foliar application and nano iron fertilizer and control treatments in soil application with 0.2, 0.2, 0.17, 0.15 and 0.19 ppm Mg in plant.

In total the process changes of Mg in plant is not regular and uniform so that can provide decisive interpretation, just to say that the concentration of Mg was lowest in Fe-EDTA treatment in soil application and this can be due to more accumulation of non-active Fe in this fertilizer and antagonistic effect of Fe on absorption and transport Mg in plant.

Based on results (Table 9) highest of Mnconcentration with158.3 ppm was recorded from nano iron fertilizer in foliar application and lowest of Mn content was recorded from Fe-EDTA in soil application with 3 ppm. Basar and Ozgumus[33] found that Fe-EDDHA applied Peach trees had significantly lower Mn levels than control and $FeSo_4$ applied Peach trees.

Table 7: Data mean comparisons of simple effect of Fe fertilizers on Nutrients concentration

Treatments	N (%)	P (%)	K (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Mg (ppm)
Control	2.25 a	0.24 a	0.17 a	142.3 d	54.58 c	43.32 c	0.18 a
Nano iron fertilizer	1.35 b	0.23 a	0.15 ab	322.8 b	146.7 a	108.2 a	0.13 a
EDDHA	1.35 b	0.23a	0.17 a	306.8 c	28.48 e	19.8 d	0.14 a
$FeSo_4$	1.35b	0.24 a	0.18 a	454.5 a	80.17 b	51.67 b	0.19 a
Fe-EDTA	0.8b	0.15b	0.12 b	91.17 e	35.42 d	14.87 e	0.03 b

Means with similar letters in column are not significantly different at 5% probability level, (LSD)

Leaf Mn concentration were negatively affected by foliar Fe application in Strawberry cultivars in comparison to the control treatment [17]. Except nano iron fertilizer, in this experiment also foliar Fe treatments decrease Mn

concentration in comparison to the control treatment. Iron nanofertilizer because of having Mn element in its structure, have the highest concentration of this element in plants.

Table 8: Data mean comparison of simple effect of fertilizers use method on Nutrients concentration

Use method	P (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Mg (ppm)
Foliar	0.24 a	339.8 a	98.15 a	61.36 a	0.14 a
Soil	0.2 b	187.2 b	39.97 b	33.76 b	0.12 b

Table 9: data mean comparison of Interaction effect of Fe fertilizers and their use method on Nutrient concentration

Treatments	P (%)	K (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Mg (ppm)
Foliar control	0.21 b	0.15ab	132.7 g	58.17 c	57.5 c	0.2 a
Foliar nano iron fertilizer	0.23 ab	0.13 b	475.7 b	231.7 a	158.3 a	0.08 bcd
Foliar EDDHA	0.25 ab	0.17 ab	228.3 d	27.1 e	28.6 e	0.2 a
Foliar $FeSo_4$	0.23 ab	0.2 a	730 a	111.7 b	35.6 d	0.17 ab
Foliar Fe-EDTA	0.26 ab	0.19 a	132.3 g	62.17 c	26.7 e	0.05 cd
Soil control	0.27 a	0.19 a	152 f	51 d	29.1 e	0.15 abc
Soil nano iron fertilizer	0.22 ab	0.18 ab	170 e	61.67 c	58 c	0.19 ab
Soil EDDHA	0.22 ab	0.17 ab	385.3 c	29.87 e	11 f	0.08 bcd
Soil $FeSo_4$	0.25 ab	0.17ab	179 e	48.67 d	67.67 b	0.2 a
Soil Fe-EDTA	0.05c	0.05 c	50 h	8.66 f	3 g	0.01 d

CONCLUSION

The results indicated that in between Fe fertilizers, Fe-EDTA treatment particularly with soil method caused to severe leaf absicion and growth decreasing and since in ornamental plants such as *spathyphyllum*, the beauty of the plant air organs mean leaf is important, so its use don't in both of methods "foliar and soil application" recommended particularly in primary stages of growth. Among tree fertilizers treatment $FeSo_4$, nano iron fertilizer and EDDHA that in most growth characteristics were on the similar surface, but nano iron fertilizer was significant superiority than other fertilizers particularly EDDHA, in the concentration of the plant nutrients. So use of nano iron fertilizer in addition to cost-effectiveness and cost much less than the imported fertilizer EDDHA, of terms reducing the harmful effects of chemical fertilizers such as $FeSo_4$ on the environment also has advantage. By employing nano iron fertilizer as alternative to common fertilizers, nutrients of the fertilizer are released in soil gradually and to be controlled and caused reduce the toxicity of the soil and to at least reach the negative effects due to excessive consumption of fertilizers. Method of foliar caused to increase of growth characteristics such as height and chlorophyll of leaves and nutrients concentration of leaves in this method increased a lot. If increasing of root yield is the purpose of fertilizing suggest soil method, and if increasing of nutrients concentration is the purpose, suggest foliar method.

Foliar method in addition to increased performance is a method for reducing the consumption of chemical fertilizers and their environmental risks. for in order to increase the performance of foliar, in addition to conditions of ideal absorption should be provide for the plant, with reducing cost of foliar should take high its economic justification. For this work, use of the material for increasing absorption values such as wax and or foliar in cool times of day, provide suitable moisture of soil and mixing fertilizer with allowed toxins recommended. Application of nano iron fertilizer and $FeSo_4$ in foliar method recommended and EDDHA to both methods 'foliar and soil application' can be useful.

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