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Nano Chelated Iron and Boron Effect on Their Rates of Absorption and Transport by Moringa Plant

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ABSTRACT: An experiment was carried out under a plastic house during 2019/2020 in Al-hindiya Herticaullare Station, Kerbala Province, Iraq. Seeds of Moringa Were sown in black polyethylene bags 5 kg soil capacity. Factorial experiment within Completely Randomized Design (C.R.D) with three replicates was adopted. The aim was to assess the effect of three Levels of the nano chelated Fe i.e. 0 ,180 and 360 mg. L-1, and Four Levels of B i.e. 0, 25 ,50 and 75 mg. L^{-1} spraying either once or twice – on the Fe and B rates of absorption and transport.

Results could be summarized as follow:

1- Iron significantly affected on the rates of its absorption and transport. where 360 mg. L^{-1} Fe gave the highest values of 0.30 and 0.19 mg. pL^{-1}. d^{-1} for Fe absorption and transport respectively compared with 0.08 and 0. 01mg.pL^{-1}. d^{-1} of the control treatment respectively. Iron also affected the rates of B absorption and transport, where Fe .at 360 mg. L^{-1}gave the highest values.

2-Boron at 75 mg. L^{-1} markedly affected on Fe and B rates of absorption and rates.The absorption and transport rates of were 0.23 & 0.15 mg.pL^{-1}.d^{-1} compared with 0.09 mg.$Pl^{-1}d^{-1}$. The control treatment respectively. The same conc. Of B gave 0.23 & 0.15 mg. pL^{-1}. d^{-1} of B absorption and transport rates compared with 0.06 and 0.05 respectively.

3-The interaction effect between Fe & B on the pervious traits was significant where 360 mg. L^{-1} Fe and 75 mg. L^{-1} B treatment was the best.

4- The interaction between studied factors was effective on the rates of Fe absorption and transport only. The interaction of 360 mg. L^{-1} Fe, 75 mg. L^{-1} B sprayed once gave the best values. Meanwhile, the control treatment in both sprayings gave the lowest values 0.04 and 0.05 mg. pL^{-1}. d^{-1}.

INTRODUCTION

Moringa (Moringa oleifera L.) is tropical and sub-tropical plant belonging to Moringaceae family. It has high nutritional value as well as medicinal application (Anwar, *et at*., 2007) suds of moringa contain about 80% unsaturated Fatty acids oleic acid represents 63-76% of their unsaturated fatty acids. Seeds oil of this plant is used as antioxidant substance, enters in a wide group of nutritional was and cosmetics and other industries (wu *et at*., 2018). leaves of Moringa are rich in vitamins carotenoids, amino acids and essential mineral nutrients necessary for human beings, these had physicians to prescribe it to overcome the malnutrition and vitamins deficiency (Zheug, *et at*., 2016). Nano-chelated Iron is considered important source for plant growth (Roosta, *et at*., 2015) Nano- fertilizers have a beneficial criterion because of their small particles size and large surface area leading to increase the surface of absorption. Consequently, the active ingredients and photosynthesis will be increased (Singh, *et at*., 2016) iron is an essential more nutrients which is needed in larger amount then other more nutrients (Amin, *et at*., 2014) it is also considered as a catalyst For more than 140 enzymes stimulating biochemical reactions (Mohamadipoor, *et at*., 2013) Boron in one of the essential micronutrients, it is essential for growth and development of plants .It enters in different physiological processes of plants .such as nucleotides, Carbohydrate and protein metabolism as well as protection of cell wall and plasma membranes and sugar translocation (Goldbach, et al.,2001 and Ahmed, et al., 2012) the deficiency of baron causes an effect on the reproductive system of plants.(Cakmak and Romhold 1997 and Rashid, et at., 2009)there are many factors cause deficiency of this element such as , drought , low organic matter content of soil , soil pH and leaching (Zheng, *et at* ., 2019).

Studies concerning Moringa plants inside lraq are very limited because this plant was recently introduced into lraq. Soil of middle and south parts of Iraq are classified ether calcareous or saline soil, therefore, micronutrients availability are facing Problems in these soil.so the experiment was applied to study the effect of different levels of Fe & B on the morphological and nutritional status

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(represented by absorption and transport rates of Fe and B) Properties of Moringa seedlings.

MATERIALS AND METHODS

Seeds of Moringa plants were sown on 28/11/2019 in 5kg soil capacity black plastic bags inside a plastic house during 2019/2020 growling season, in Alhindiya Herticaullare station, Kerbala province. The physical and chemical properties were EC: 0.5 $ds.m^{-1}$, pH:7.6, lron:14.6$mg.kg^{-1}$ and B:0.31$mg.kg^{-1}$.

The experiment was arranged in a factorial manner within completely Randomized Design (C.R.D.) with 3 replicates. The experiment included three factors i.e. .number of foliar application i.e. .either once or twice sprayings, nano chelated iron at 0,180and360 $mg.L^{-1}$and Boron at 0, 25, 50 and 75$mg.L^{-1}$.the lst spraying of Fe was adopted on 9/8/2020 and B was sprayed one day later .the 2nd spraying were applied 6/9/2020 and 7/9/2020 for Fe and B respectively .On 22nel, Sept.2020, plants were terminated, Sported into vegetable and root systems thoroughly washed by acidic distilled water. The dry weights ware received, grinded by mill and 0.2gm of each of leaves and roots were lateen for nutrients determination. Wet digestion was adopted

(Crassar and Parsons,1979) the concentrations of Fe and B were determined and their absorption and transport rates were.

Calculated as follow:

$$Im = \frac{Ln\ W_2 - Ln\ W_1}{T_2 - T_1} \times \frac{M_2 - M_1}{W_2 - W_1} \qquad \text{(William,1980)}$$

Im: absorption rate of the nutrient during the period of T2 to T1

W1: The initial wt. of plant (g), at T1.

W2: The Final wt. of plant (g), at T2.

M1: nutrient content of the plant at T1.

M2: nutrient content of the plant at T2.

T: Time in days.

Ln: natural logarithm.

$$V = \frac{Ln\ W_2 - Ln\ W_1}{T_2 - T_1} \times \frac{M_2 - M_1}{W_2 - W_1} \qquad \text{(Robson et al., 1970)}$$

The difference between This equation and the above one is that, M1 and M2 are the nutrients content in vegetative part only.

RESULTS

absorption rate of Fe:

Data in Table (1) revealed that the Fe absorption rate was the significantly influenced by the number of foliar sprayings where spraying twice excelled that of one spraying. The rates 0.20 and 0.17 mg. pL^{-1}. d^{-1} for once and twice, respectively the inurement percentage was 17.6%. Boron had significant effect on this trait. this trait was increased on Boron concentrations, increased the highest value (0.23) obtained from 75 mg. L^{-1}whoreas, the lowest value (0.14) associated the control treatment giving an increase percentage of 28.6, 35.7 and 64.3% for the concentrations of 25, 50 and 75 mg. L^{-1} B compared with the control treatment, respectively. The influence of Fe on thin trait was obvious where 180 and 360 mg. L^{-1} Fe gave 0.18 and 0.30 mg. pL^{-1}. d^{-1} compared mg. Plant $^{-1}$. Day $^{-1}$ for each. From the comparison with the control (0.08 mg. pL^{-1}. d^{-1}). giving an increase percentage reached 125 and 275 compared with the control respectively. It is worthy to mention that the deferent between 180 and 360 $mg.L^{-1}$ Fe was significant.

The interaction between Fe × B was significant where the control treatment gave lower values of 0.04 mg. $p^{-1}d^{-1}$, where, 75 $mg.^{-1}$ B and 360 mg. L^{-1} Fe treatment gave the highest value 0.38 mg. $p^{-1}d^{-1}$. The other interaction treatment came in between. interaction between these studied factors had a significant effect on this parameter where control treatment sprayed once gave the least value 0.04 $mg.p^{-1}d^{-1}$ where 75 mg. L^{-1} B and 360 mg. L^{-1} Fe sprayed twice gave the highest value

0.43 mg. $p^{-1}d^{-1}$. On the other hand, neither the interaction between no. of spraying and B no. spraying and Fe interaction were effective on thin characteristic.

Transport rate Fe

The same sprayed trend was found as with the rate of absorption. Table 2 showed that, plants sprayed twice gave higher value of Fe transport rate 0.12 mg. P^{-1}. d^{-1}, compared with one spraying (0.11 mg. p^{-1}. $d^{-1)}$ with an increase percentage of 9.1%, Boron also had

a prefaced effect on Fe transport rate. The control treatment gave 0.09 mg. $p^{-1}.d^{-1}$ compared with 0.15 mg. p^{-1}. $d^{-1}$the gained from 75 mg. L^{-1} B, the treatment percentages were 22.2, 33.3 and 66.7% compared with the control treatment, respectively .values of B concentration were significant different from each other.

The Iron had a marked effect on this trait .Its rate of transport increased with increasing its contraction The lowest value (0.05 $mg.pL^{-1}.d^{-1}$ Obtained for the control treatment where as higher value (0.19) obtained for 360mg.L^{-1} Fe treatment. The interaction between Fe & B had a significant effect on this parameter, where control treatment gave tower value (0.02$mg.pL^{-1}.d^{-1}$.) while higher value was obtained from 360mg. L^{-1} Fe and 75mg.L^{-1} B. giving 0.25 $mg.pL^{-1}.d^{-1}$ The tri-interaction had significant effect on Fe rate of absorption

,where control treatment sprayed one time gave lower value (0. 02$mg.pL_{-1}.d^{-1}$) while 360mg. L^{-1} Fe x 75mg.L^{-1} B sprayed twice gave the highest value (0. 029$mg.pL^{-1}.d^{-1}$). Nather spray x B nor spray x Fe treatment affected this trait .

The rate of B absorption.

It is appeared from table 3 that B had a significant effect on its rate of absorption by Moringa plants .the lowest value came from the control treatment (0.03$mg.pL^{-1}.d^{-1}$) whereas, higher value obtained from 75mg.L^{-1} B treatment (0.06 $mg.pL^{-1}.d^{-1}$) .the percentage increase were 66.7 and 100%compared with the control treatment respectively .Iron had significant effect where on the absorptions rate of B where the control treatment gave 0.04$mg.PL^{-1}.d^{-1}$while Fe at 360mg.L^{-1} gave 0.08 mg.L^{-1} i.e.100% increase. The interaction between Fe and B showed a significant effect on the rate of B absorption where the control treatment gave lower value 0.01mg.$PL.^{-1}.d^{-1}$ while the highest concentration .of Fe and B gave the highest value reached 0.12$mg.pL^{-1}.d^{-1}$

The rate of B transport: It is shown from table 4 that the concentrations of B significantly affected it's rate of transport within plant where the control treatment gave lower value (0.03mg.$pL.^{-1}.d^{-1}$) while 75mg.L^{-1} B gave the highest value (0.05mg) , with an increase reached 66.7%. the lron significantly effected on this trait when the control treatment gave lower value and 360 mg.L^{-1} Fe gave the highest.

The interaction between Fe & B had a significant effect on B rate of transport Boron at 25mg.L^{-1} without Fe showed lower value (0.01$mg.pL^{-1}.d^{-1}$) where 360mg.L^{-1} Fe with 75 mg.L^{-1} B gave the highest value (0.09$mg.pL^{-1}.d^{-1}$).

Table (1): Effect of different levels of Fe, B, number of foliar application and their interactions on the rate of absorption of Fe in (mg. $pL^{-1}.d^{-1}$) Moringa plant.

Interaction Between spray and boron	**Iron (Mg / L^{-1})**			**Boron (Mg / L^{-1})**	**The number of times Spraying**
	060	**080**	**0**		
0.12	0.24	0.09	0.04	0	1
0.17	0.26	0.15	0.09	25	
0.19	0.31	0.18	0.10	50	
0.21	0.33	0.21	0.10	75	
0.16	0.26	0.17	0.05	0	2
0.19	0.27	0.19	0.10	25	
0.19	0.29	0.20	0.09	50	
0.26	0.43	0.23	0.11	75	
	0.30	0.18	0.08		Average Iron
N.S		**0.0411 Triple**		**0.014 Iron**	**LSD 0.05**
Sprinkles average					**Interaction Number Sprinkles with Iron**
0.17	0.28	0.16	0.08	1	
0.20	0.31	0.20	0.09	2	
0.012	**N.S**				**LSD 0.05**
Average Boron					**Interaction Between Iron and boron**
0.14	0.25	0.13	0.04	0	
0.18	0.26	0.17	0.09	25	
0.19	0.30	0.19	0.10	50	
0.23	0.38	0.22	0.10	75	

Table (2): Effect of different levels of Fe, B, number of foliar application and their interactions on the rate of transport of Fe in (mg. $pL^{-1}.d^{-1}$) Moringa plant.

Interaction Between spray and boron	**Iron (Mg / L^{-1})**			**Boron (Mg / L^{-1})**	**The number of times Spraying**
	060	**080**	**0**		
0.09	0.16	0.08	0.02	0	

0.10	0.16	0.09	0.05	25	1
0.12	0.19	0.10	0.06	50	
0.13	0.21	0.13	0.06	75	
0.10	0.15	0.11	0.03	0	2
0.11	0.17	0.11	0.05	25	
0.12	0.18	0.12	0.05	50	
0.16	0.29	0.14	0.06	75	
	0.19	0.11	0.05		Average iron
N.S		**0.029 Triple**		**0.010 Iron**	**LSD 0.05**
Sprinkles average					**teraction number Sprinkles with Iron**
0.11	0.18	0.10	0.05	1	
0.12	0.20	0.12	0.05	2	
0.008	**N.S**				**LSD 0.05**
Average Boron					**nteraction Between Iron and boron**
0.09	0.16	0.10	0.02	0	
0.11	0.17	0.10	0.05	25	
0.12	0.19	0.11	0.06	50	
0.15	0.25	0.13	0.06	75	

Table (3): Effect of different levels of Fe, B, number of foliar application and their interactions on the rate of absorption of B in (mg. $pL^{-1}.d^{-1}$) Moringa plant.

Interaction Between spray and boron	**Iron (Mg / L-1)**			**Boron (Mg / L-1)**	**The number of times Spraying**
	060	**080**	**0**		
0.03	0.06	0.04	0.01	0	1
0.05	0.08	0.05	0.03	25	
0.05	0.05	0.06	0.05	50	
0.08	0.09	0.08	0.07	75	
0.04	0.05	0.06	0.02	0	2
0.05	0.09	0.05	0.02	25	
0.07	0.08	0.09	0.04	50	
0.12	0.15	0.13	0.08	75	
	0.08	0.07	0.04		Average Iron
N.S		**N.S Triple**		**0.005 Iron**	**LSD 0.05**
Sprinkles average					**teraction number Sprinkles with Iron**
0.04	0.07	0.04	0.01	1	
0.05	0.09	0.05	0.03	2	
N.S	**N.S**				**LSD 0.05**
Average Boron					**Interaction Between ron and boron**
0.03	0.04	0.06	0.01	0	
0.05	0.07	0.05	0.04	25	
0.05	0.06	0.08	0.03	50	
0.06	0.12	0.05	0.02	75	
0.005	**0.009**				**LSD 0.05**

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Table (4): Effect of different levels of Fe, B, number of foliar application and their interactions on the rate of transport of B in (mg. $pL^{-1}.d^{-1}$) Moringa plant.

Interaction Between spray and boron	**Iron (Mg / L-1)**			**Boron (Mg / L-1)**	**The number of times Spraying**
	060	**080**	**0**		
0.02	0.03	0.03	0.01	0	1
0.04	0.05	0.04	0.02	25	
0.03	0.04	0.05	0.01	50	
0.05	0.07	0.06	0.02	75	
0.03	0.03	0.04	0.01	0	

0.05	0.06	0.06	0.02	25	2
0.05	0.06	0.07	0.01	50	
0.05	0.09	0.05	0.02	75	
	0.06	0.05	0.02		Average Iron
N.S		**N.S Triple**		**0.00 Iron**	**LSD 0.05**
Sprinkles average					**teraction number Sprinkles with Iron**
0.03	0.06	0.03	0.01	1	
0.05	0.08	0.04	0.02	2	
0.003	**N.S**				**LSD 0.05**
Average Boron					**Interaction Between on and boron**
0.03	0.03	004	0.2	0	
0.03	0.05	0.03	0.01	25	
0.04	0.04	0.05	0.03	50	
0.05	0.09	0.06	0.01	75	
0.005	0.008				**LSD 0.05**

DISCUSSION

It is indicated from table 1,2,3,4 that , the number of sprayings had a significant effect on the absorption rate of Fe and on the transport rate of Fe & B within Moringa plant tissues. Both Fe and B had marked effects on the rates of absorption and transport of Fe & B. The interaction between these two nutrients had a significant effect on The rates of absorption and transport of Fe & B. Tri-interaction between studied factors significant affected rates absorption and transport of Fe only .The increase in the rate of absorption may be due to

growth of large root system and efficient for nutrients uptake from the soil in addition to the absorption of this nutrient by leaves (Sekhon, 2014). These results were accordance with those found by Alkhlefawi (2017) with Moringa plant , Aljuthery (2017) with Giant milk wood, Al-Rkabe (2019) with beans and Al-Hujayri (2020) with Moringa plants. Rate of Fe transport was also increased with increasing its concentration in The foliar solution. This is attributed to The increase in plant. Requirements due to increase in the growth such as no.of leaves and leaves area. These parameter were reflected in The increase in The dry weights of shoot & root systems .from physiological standpoint Fe increase the plant efficiency in terms of chlorophyll increase leading to increase the photosynthesis in other word increasing carbohydrate control. Increasing assimilates by shoot parts and there translocation into the roots cause an increase in roots parameter i.e. length, size, diameter which increase the absorption surface for nutrients uptake these results agreed with Knapp and Knapp (1978) with wheat and Alzabaidi (2004) with pepper plant .Boron was effective on the absorption and transport rate of Fe & B .It is well known that B enters in many biochemical activities mainly sugar translocation via forming borate-sugar complex. The interaction effect of Fe & B on these characteristics was positive . This was obvious from tables(1,2,3and4) which means that both of there had synergistic influence on the synthesis of protein and other biochemical substance (Soliman, *et al* .,2015) overall ,these results were in accordance with Al -Hujayri (2020)on the Moringa plants.

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