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THE EFFECT OF FOLIAR SPRAYING WITH BORON AND CHELATING IRON ON GROWTH AND YIELD OF BROAD BEAN (*VICIA FABA* L.)

Ahmed Hasan Fadhil and Jassim Jawad Jader
Al-Musaib Technical College, Al-Furat Al-Awsat Technical University, Iraq
Corresponding author: com.jas1@atu.edu.iq, com.ahmd44 @atu.edu.iq

Abstract

A field factorial experiment was conducted in one of the fields of Baghdad province for the season 2018-2019. Using the Randomized Complete Block Design (RCBD) with three replicates in order to study the effect of Foliar spraying with boron at concentrations (0, 25, 50 mg. L^{-1}) and chelated iron in concentrations (0, 50, 100, 150 mg. L^{-1}) and their interaction in plant height (cm), the number of branches per plant, the total number of leaves, the number of pods per plant, the length of the pods cm, the weight of the pod (g), the number of seeds per pod, the weight of 100 of seeds (g), and the total seed yield in tons.ha^{-1} for the Broad Bean. The Boron treatment 50 mg. Liters^{-1} results showed the highest average in all studied traits, On the other hand, spraying with chelated iron (150 mg. L^{-1}) resulted in the highest average in all traits and gave the lowest treatment average without spraying the lowest average for all traits. As for the interaction between boron and chelated iron sprayed on the vegetative part of the plant, it was significant for all studied traits. The interaction (boron 50 and iron 150 mg. L^{-1}) gave the highest average of all studied traits. As for the pod weight, the interference was not significant.

***Keywords*:** Broad Bean, Boron, chelated iron

Introduction

Vicia faba L belongs to the Leguminosae family, It is a basic food source for a large number of the world's population and is cultivated for the purpose of obtaining green pods, fresh or dry seeds with calcium and phosphorus content and rich in vitamins B1, B2 and C (Hassan, 2002). For animals, as It is also used as green fertilizer and its cultivation is not stressful to the soil, as it takes advantage of atmospheric nitrogen, which fixes Bacteria of Root Nodules(Rhizobia) that protocooperation with the plant (Al-Tamimi, 1998). Leguminous crops are rich in iron, so you must take into account the needs of these plants from this element when cultivated, and because Iraqi soil suffers from a reduced iron element in it due to the low levels of organic matter, especially in southern Iraq, and the high soil reaction pH and the lack of balance of the iron element with some Elements such as zinc and copper, by replacing iron with these elements, reduce the amount of iron that is transported through the roots. It also transforms it from an easily absorbed form by the plant to an unavailable form, that is, it changes from ferrous to ferric., so it is preferable to spray iron on the plant instead of adding it to the soil to treat its deficiency on the plant using chelated iron (Al-Rayes, 1982). Iron is essential and important for crop growth, as the plant cannot complete its life cycle in absence. It is involved in many physiological activities such as photosynthesis, increased building products, chlorophyll formation and enzymatic reactions (Al-Naimi, 2000). It is preferable to add chelated iron as a bribe to crops because processing it with nutrients through the vegetative system increases fertilizing efficiency and because it reduces the amount of loss and fixation to the added elements (Soliman, 1996) Boron has an important role in transporting carbohydrates from Source to Sink as well as protecting IAA and its transfer and increasing cell division in the growth center and its expansion which in turn, gives the greatest chance for growth and branch formation (Barker, 2006). Boron is a microelement of flowering and cell division processes and also helps in germination and growth of pollen tube (Anonymous, 1998). Crops differ in their response to the different concentrations of boron and chelated iron added as bribes on the vegetative system. Therefore, this study aims to influence the Foliar spraying with boron and chelated iron on the growth and yield of beans.

Materials and Methods

A field experiment was conducted during the 2018 agricultural season in a field in Baghdad. According to the randomized complete block design (RCBD) with three replications. Chelated iron was used in agriculture with concentrations (0, 50, 100, 150 mg.L^{-1}) and boron was used in concentrations (0, 25, 50 mg.L^{-1}). The seeds were cultivated on 10/1/2018, The soil and crop service operations were conducted and the research land was divided into 36 experimental units per unit area (2.5 x 3 m^2) The seeds were cultivated by four lines in one experimental unit and the distance between one line and another 60 cm and between a pit and another on the same line 25 cm, put three seeds in one pit and after the emergence of seedlings, the process of thinning was done and placing one plant in the pit. The weed control was conducted by hand three times and they were irrigation whenever needed. The spraying process was conducted in the early morning using a 16-litre big back sprayer, and when the crop reached full maturity, the following harvesting process was done and the following traits were studied: plant height (cm), number of branches, pod length, number of seeds per pod, weight of 100 gm seed, plant yield , total seed yield tons.ha^{-1}

Statistical analysis

Statistical analysis was performed using the Genstate statistic program and tested the significance of differences between the average of the treatments using the test of the Least Significant Difference (LSD) with a probability level of 5%.

Results and Discussion

Plant height (cm)

Table (1) indicated the significant effect of adding boron concentrations, Where the concentration 50 mg. L^{-1} excelled and gave the highest average amounted to 77.58 cm, compared to the non-spray treatment that gave the lowest

average amounted to 58.67 cm. It is understood that an increase in the concentration of IAA leads to increased cell elongation, which may affect the elongation of inter nods and then increase the plant height (Gharib, 2010). These results agree with (Al-Amiri, 2014) and (Mohammed, 2014). There was a significant increase in the average of the plant height of broad been. As for adding chelated iron concentration, it is noted from Table (1) that there were significant differences for the same trait, where the concentration 150 mg.L^{-1} gave the highest average 74.67 cm , compared to the non-addition treatment that gave the lowest average in these traits amounted to 60.11 cm. The reason is due to the effect of iron on all bioactivities in the plant through its effect on the activity of many enzymes and a role in the division of the activity of meristemic cells (Prakash and Gansesan, 1997). As for the interaction in the plant height trait, the interaction (boron 50 and iron 150 mg. L^{-1}) gave the highest average of 84.33 on the other interaction.

The number of branches (branch.plant^{-1})

The results in Table (2) showed the presence of significant differences in boron concentrations in the trait number of leaves per plant for the season 2019, where the Boron concentration 50 mg. L^{-1} gave the highest average amounted to 6.72(branch.plant^{-1}), compared to the non-spray treatment which gave the lowest average amounted to 4.71(branch.plant^{-1}). The reason is due to the positive role of boron in transporting carbohydrates from the source to the estuary and protecting the IAA and its transmission and then increasing cell division and expansion in the growth centers gave the highest opportunity for growth (Barry and Marentes, 2006). Agreed with (Sharaf *et al*., 2009), who observed that boron sprayed at a concentration of 75 mg. L^{-1} of the Broad Bean yield an encouragement in the number of branches. And the presence of a significant increase in this trait of Broad Bean amounted to 12.4 (branch.plant^{-1}) when sprayed with boron at a concentration of 25 mg. L^{-1}, compared to the non-spraying (Al-Amiri, 2014). The results in Table (2) showed significant differences between the adding of spraying with concentrations of chelated iron that the concentration of 150 mg. L^{-1} gave the highest average amounted to 6.72 (branch.plant^{-1}) on a non-addition treatment of 4.71 (branch.plant^{-1}). Results of the same table showed significant differences between (50 boron and 150 mg. L^{-1}), which gave the highest average amounted to 7.53 (branch.plant^{-1}) on the other interaction.

The total number of leaves (Leaf.pant^{-1})

The results in Table (3) showed the effect of boron was significant and the concentration 50 mg. Liters^{-1} gave the highest average amounted to 147.1 (Leaf.pant^{-1}) while the non-spray treatment gave the lowest average amounted to 119.4(Leaf.pant^{-1}).The results in Table (3) showed that there was a significant increase in this trait in chelated iron concentrations added, where the concentration 150 mg. L^{-1} gave the highest average amounted to 147.3(Leaf.pant^{-1}), compared to the no-adding treatment that gave the lowest average amounted to 121.1(Leaf.pant^{-1}). This is due to that iron enters the chlorophyll molecule composition necessary to increase the efficiency of photosynthesis and the formation of the amino acid Tryptophan, which is important for stem elongation and affects growth indicators (Cakmak *et al*., 1998). As for the interaction, the interaction between (Boron 5 and Iron 150 mg. L^{-1}) gave the highest rate of 172.7. (Leaf.pant^{-1}).

The number of pods per plant (pod. Plant^{-1})

The results in Table (4) showed the effect of boron concentration in the presence of significant differences in this trait and the concentration of 50 mg. L^{-1} was given the highest average amounted 15.50 pod. Plant^{-1} compared to the treatment of 25mg. L^{-1} which gave the lowest average amounted to 10.08 pod. Plant^{-1}. The results of the table showed the same significant increase in added iron concentrations excelled the concentration of 150 mg. Liter gave the highest average amounted to 16.78 pod. Plant^{-1} while the non-addition treatment gave the lowest average amounted to 8.56 pod. Plant^{-1} (Rashed and Ahmed, 1997) have mentioned that the role of iron in increasing plant hormones, including Auxin and gibberellins, It also increases carbohydrates, and this leads to an induction of the plant to flowering and prevent Dropping. As for the, it was significant in this trait, as the interaction (Boron 50 and Fe 150 mg. L^{-1}) gave the highest average amounted to 20.33 pod. Plant^{-1} compared to the other interaction.

The pod length (cm)

The results in Table (5) indicate the presence of significant differences between boron concentrations and chelated iron concentrations and their interaction. As for the concentration of 50 mg. L^{-1} gave the highest average amounted to 18.25 cm compared to the no-spray treatment that gave an average amounted to11.00 cm. As for the concentrations, the concentration of 150 mg. Liters^{-1} excelled and gave the highest average amounted to 18.33 cm on the other concentrations, and the non-adding treatment gave the lowest average amounted to 10.89 cm. The reason is due to the role of iron in increasing plant hormones, including Auxins and gibberellins, It also increases carbohydrates, and this leads to stimulation of the plant to flowering and prevents Dropping (Rashed and Ahmed, 1997). As for the interaction, it was significant, as the interaction between (B 50 and Fe gave 150 mg. L^{-1}) gave the highest amounted to 22.00 cm on the rest of the interventions.

The pod Weight (g)

Table (6) showed the presence of significant differences for the pod weight (g), Where the concentration 50 mg. L^{-1} was the highest average amounted to 23.50 g, while the non-spray treatment gave the lowest average amounted to 18.83 g. Table (6), showed there was a significant difference for this trait of the added concentrations of chelated iron, as the concentration 150 mg. L^{-1} gave the highest average amounted to 24.67 g, compared to the non-adding treatment which given the lowest average amounted to 17.00 g. The reason is due to the effect of iron on the increase in chlorophyll, which is reflected in the improvement of photosynthesis and the increase in products and their transfer to seeds. This leads to an increase in pod weight (g). Table (6) showed that there were no significant differences for interference in this trait.

The number of seeds per pod (seed. Pod^{-1}):

The results in Table (7) confirmed the presence of significant differences between concentrations B and Fe concentrations and the interaction between them in the average number of seeds per pod, as concentration B (50 mg. L^{-1}) achieved the highest average amounted to 6.17 seed.

Pod^{-1} and the non-spray treatment gave the lowest average amounted to 5.18 seed. Pod^{-1}. As for iron concentrations, the concentration 150 mg. L^{-1} gave the highest average amounted to 6.27 seed. Pod^{-1} and the non-spray treatment gave the least significant difference to this trait amounted to 5.17 seed. Pod^{-1}. The results in Table (7) showed that the interaction was significant, where the interaction between (B 50 and Fe 150 mg. L^{-1}) gave the highest average amounted to 6.76 seed. Pod^{-1} compared to the other interaction.

Weight of 100 seed (g)

Table (8) indicated that there were significant differences for B concentrations, Where the concentration 50 mg.L^{-1} gave the highest average amounted to 168.17 g, compared to the lowest average of non-spray treatment recorded 155.42 g.

The results in Table (8) indicated the presence of significant differences for chelated iron, as the concentration 150 mg. $Liters^{-1}$ excelled on the other concentrations and gave the highest average amounted to 169.56 g and the non-spray treatment gave the lowest average amounted to 155.67 g. The reason is due to the effect of iron on the increase in chlorophyll, which is reflected in the improvement of photosynthesis and the increase in products and their transfer to seeds. This leads to an increase in pod weight (g).

The results in Table (8) indicated the presence of significant differences for the interaction, Where the interaction between (B 50 and Fe 150 mg.L^{-1}) gave the highest average reached 178.00 g on the rest of the interaction.

Total plant yield ton. ha^{-1}

It was found in Table (9) that there were significant differences in the trait of the total plant yield, where the concentration boron spray 50 mg. L^{-1} gave the highest average reached 2.718 ton. ha^{-1}, while the non-spray treatment gave the lowest average amounted to 2.223 ton. ha^{-1}. The reason for this is due to the provision of the micronutrients that make up the nutrient solution during the growth that contributed to the improvement of growth and flowering from which the seeds are formed and then the total plant yield. In Table (9), it was found that there were significant differences in iron spraying, as the concentration of 150 mg. L^{-1} gave the highest average amounted to 2.878 ton.ha^{-1}, compared to the no-spray treatment that gave the lowest average amounted to 2.263 ton.ha^{-1}.

In Table (9), there were significant differences for the interaction, as the interaction between (B 50 and Fe 150 mg. L^{-1}) gave the highest average amounted to 3.237 ton.ha^{-1} compared to the other interaction.

We conclude that the boron concentration 50 mg. L^{-1} gave the highest average of traits, plant height, number of branches, the total number of leaves, number of pods, length of the pod, the weight of pod, number of seeds per pod, the weight of 100 seeds, total seed yield. The effect of spraying with chelated iron was at 150 mg. L^{-1} gave the highest average of traits, plant height, number of branches, the total number of leaves, number of pods, length of pods, the weight of pods, number of seeds per pod, the weight of 100 seeds, total seed yield. The interaction between the effect of spraying (with boron and chelated iron), Where the interaction between (B 50 and Fe 150 mg. L^{-1}) gave the highest average for traits plant height, number of branches, total number of leaves, number of pods per plant, length of pod and Number of seeds per pod, weight 100 seeds, total seed yield.

Therefore, we recommend using boron at a concentration of 50 mg. L^{-1} with chelated iron at a concentration of 150 mg. L^{-1} when cultivation.

Table 1 : Effect of Foliar spraying with boron and chelated iron and their interaction on average plant height, cm² for the season 2019.

Average effect of boron concentrations	Season 2019				Chelated iron concentration / Boron concentrations
	150	100	50	0	
58.67	65.00	61.33	57.67	50.67	0
66.75	74.67	68.33	66.67	57.33	25
77.58	84.33	78.00	75.67	72.33	50
	74.67	69.22	66.67	60.11	Average effect of chelating iron concentration
Interaction 4.897	Boron 2.449		Chelated iron 2.827		L.S.D. 0.05

Table 2 : Effect of Foliar spraying with boron and chelated iron and their interaction on The number of branches (branch.$plant^{-1}$) for the season 2019.

Average effect of boron concentrations	Season 2019				Chelated iron concentration / Boron concentrations
	150	100	50	0	
4.10	4.46	4.83	5.46	4.71	0
4.76	5.46	5.73	6.46	5.60	25
5.96	6.43	6.96	7.53	6.72	50
4.94	5.45	5.84	6.48		Average effect of chelating iron concentration
Interaction 0.355	Chelated iron 0.205		Boron 0.177		L.S.D. 0.05

Table 3 : Effect of Foliar spraying with boron and chelated iron and their interaction on The total number of leaves (Leaf. pant^{-1}) for the season 2019.

Average effect of boron concentrations	Season 2019				Chelated iron concentration / Boron concentrations
	150	100	50	0	
111.7	117.0	122.0	127.0	119.4	0
119.7	126.0	135.7	142.3	130.9	25
132.0	138.7	145.0	172.7	147.1	50
121.1	127.2	134.2	147.3		Average effect of chelating iron concentration
Interaction 10.73	Chelated iron 6.19		Boron 5.36		L.S.D. 0.05

Table 4 : Effect of Foliar spraying with boron and chelated iron and their interaction on The number of pods per plant (pod. Plant^{-1}) for the season 2019.

Average effect of boron concentrations	Season 2019				Chelated iron concentration / Boron concentrations
	150	100	50	0	
6.33	11.00	13.33	16.33	11.75	0
8.33	8.33	10.00	13.67	10.08	25
11.00	13.33	17.33	20.33	15.50	50
8.56	10.89	13.56	16.78		Average effect of chelating iron concentration
Interaction 2.913	Chelated iron 1.682		Boron 1.457		L.S.D. 0.05

Table 5 : Effect of Foliar spraying with boron and chelated iron and their interaction on The pod length (cm) for the season 2019.

Average effect of boron concentrations	Season 2019				Chelated iron concentration / Boron concentrations
	150	100	50	0	
8.00	8.67	11.33	16.00	11.00	0
10.00	11.67	14.00	17.00	13.17	25
14.67	17.00	19.33	22.00	18.25	50
10.89	12.44	14.89	18.33		Average effect of chelating iron concentration
Interaction 2.384	Chelated iron 1.376		Boron 1.192		L.S.D. 0.05

Table 6 : Effect of Foliar spraying with boron and chelated iron and their interaction on The pod Weight (g) for the season 2019.

Average effect of boron concentrations	Season 2019				Chelated iron concentration / Boron concentrations
	150	100	50	0	
15.00	18.67	19.00	22.67	18.83	0
16.67	19.00	21.67	23.67	20.25	25
19.33	22.33	24.67	27.67	23.50	50
17.00	20.00	21.78	24.67		Average effect of chelating iron concentration
Interaction N.S.	Chelated iron 1.991		Boron 1.725		L.S.D. 0.05

Table 7 : Effect of Foliar spraying with boron and chelated iron and their interaction on The number of seeds per pod (seed. Pod^{-1}): for the season 2019.

Average effect of boron concentrations	Season 2019				Chelated iron concentration / Boron concentrations
	150	100	50	0	
4.56	5.03	5.33	5.80	5.18	0
5.40	5.56	5.83	6.26	5.76	25
5.56	6.00	6.36	6.76	6.17	50
5.17	5.53	5.84	6.27		Average effect of chelating iron concentration
Interaction 0.322	Chelated iron 0.186		Boron 0.161		L.S.D. 0.05

Table 8 : Effect of Foliar spraying with boron and chelated iron and their interaction on Weight of 100 seed (g) for the season 2019 .

Average effect of boron concentrations	Season 2019				Chelated iron concentration / Boron concentrations
	150	100	50	0	
148.67	154.33	157.67	161.00	155.42	0
158.67	159.67	163.67	169.67	162.92	25
159.67	164.67	170.33	178.00	168.17	50
155.67	159.56	163.89	169.56		Average effect of chelating iron concentration
Interaction 3.549	Chelated iron 2.049		Boron 1.775		L.S.D. 0.05

Table 9 : Effect of Foliar spraying with boron and chelated iron and their interaction on Total plant yield $ton.ha^{-1}$ for the season 2019.

Average effect of boron concentrations	Season 2019				Chelated iron concentration / Boron concentrations
	150	100	50	0	
2.090	0.160	2.297	2.347	2.223	0
2.293	2.367	2.397	3.050	2.527	25
2.407	2.473	2.753	3.237	2.718	50
2.263	2.333	2.482	2.878		Average effect of chelating iron concentration
Interaction 0.1730	Chelated iron 0.0999		Boron 0.0865		L.S.D. 0.05

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