Physiological effect of iron on the growth and yield of two cultivars of broad bean

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Abstract A field experiment was conducted in Al-Husseinia, Holy Karbala govern during the winter season 2018 to investigate the effect of spraying the vegetative part with iron on growth and yield of two cultivars of broad bean (Vicia Faba L.). Randomized Complete Block Design (RCBD) of three replicates was used. The factorial experiment included two factors, the two cultivars (local and Spanish, Luzdeotono) and spraying three concentrations (10, 20, and 30 mg.l⁻¹) of iron on the vegetative parts in addition to the control treatment (spraying distilled water only). Results showed the superiority of the local cultivar giving the highest averages of the plant height (79.45 cm), 100-seeds weight (127.7 g), and seed yield (2583 kg.ha⁻¹) and the superiority of the concentration 20 mg.l⁻¹ giving the highest averages of the plant height (88.55 cm), number of pods (14.16 pods.plant⁻¹), 100-seeds weight (135.5 g), and seed yield (2705 kg.ha⁻¹); however, the effect of the interaction between the two factors was not significant.

1. Introduction
Broad bean is one of the most important legume crops in Iraq. Its seeds contain a high percentage of protein ranging between 25-40% [1]. The seeds also contain a high percentage of carbohydrates in addition to mineral elements, fibers, and vitamins [2]. Results of many studies showed a response of the most economic plants, especially, the legumes grown in a different type of soils, in particular, the calcareous soils for iron fertilization, whether chelated or mineral and added to the soil or as a foliar spray [3],[4]. Iron is a necessary element for most crop especially the legumes since it participates in constructing the Nitrogenase responsible for fixing the atmospheric nitrogen as well as for its contributing to the activity legume hemoglobin found in the crop root nodes, in addition to its other physiological effects such as delaying the senility in bean for instance and its role in increasing the plant hormones such IAA and gibberellin as well as increasing chlorophyll and carotene pigments that leads to stimulating flowering and preventing flower dropping, and consequently, increasing the yield[5]. It is known that the Iraqi soils since they are calcareous, the most plants suffer from a shortage of an available iron because of subjecting the iron to several reactions including deposition and adsorption caused by carbonate minerals [6], [7], [8]. In order to treat the shortage that the economic plants grown in calcareous soils suffer from as a result of lack of available iron, adding iron fertilizers whether mineral or chelated is one of the main methods to increase its availability and meet the plant need of iron. Iraqi soils have a high level of pH meaning a lack of iron, even if it exists, it is not available for plants. Therefore, the study aimed to evaluate the efficiency of spraying chelated iron on the vegetative parts of broad bean plants and how it affects the plant growth and yield.
2. Materials and methods
A field experiment was conducted in Al-Husseinia, Holy Karbala govern during the winter season 2018. Randomized Complete Block Design (RCBD) of three replicates was used. The factorial experiment included two factors, the two cultivars (local and Spanish, Luzdeotono) and spraying three concentrations (10, 20, and 30 mg.l⁻¹) of iron on the vegetative parts in addition to the control treatment (spraying distilled water only). The required soil service operations were performed and the seeds were planted on furrows in pits each contained two seeds at the beginning of the last third of October 2014, then after emergence, plants were thinned to one plant in each pit. Each experimental unit was sized 3x3 m divided into furrows separated from each other by 70 cm and the distances between plants were 30 cm. Phosphate fertilizer of 35 kg P.ha⁻¹ was added before planting and nitrogenous fertilizer of 50 kgN.ha⁻¹ was added as two batches the first at the planting and the second at the flowering and the commencing of pod formation stage[9]. Iron (Fe) concentrations were prepared as required and detergent was added, as a diffuser, and then they, in addition to the control treatment, were sprayed on the plant vegetative parts during the early morning till the full wetness.

The studied traits were as following:
1. Plant height (cm): measured from the soil surface to top leaf as an average of five plants selected randomly.
2. Number of branches (branches.plant⁻¹): calculated for the same five plants mentioned above as an average.
3. Number of pods (pods.plant⁻¹): calculated as an average of ten randomly selected plants.
4. Number of seeds (seeds.pod⁻¹): from the ten selected plants, 30 pods were taken randomly and seeds inside them were calculated as an average.
5. Weight of 100 seeds (g): from the former ten plants, the average weight of 100 seeds was calculated.
6. Seed yield (kg.ha⁻¹): estimated as an average of ten plants harvested randomly from the two middle furrows of each experimental unit multiplied by the plant density (40816 plant.ha⁻¹) and the resulted data convert into kg.ha⁻¹.

The data were statistically analyzed and compared based on the least significant difference (L.S.D) at the probability level of 5%.

3. Results and discussion:
Plant height (cm)
Results in Table 1 refer to significant differences in the pant height affected by the cultivar and by the Fe concentration, while the effect of the interaction between the two factors was insignificant. The local cultivar was superior producing plant height averaged 79.45 cm compared to the Spanish cultivar producing plants of 79.41 cm in height. The superiority of the local cultivar may be due to the genetic variances among cultivars that consistent with the findings of[2] who reported that broad bean cultivars differ in the trait of plant height. Concerning the iron concentration, it is observed in Table 1 that the concentration 20mg.l⁻¹ gave the highest values of the plant height averaged 88.55 cm, while the lowest plant height was 63.89 cm obtained from the control treatment. This superiority may be due to an iron role in contributing to other nutrients in increasing plant growth. This result is in agreement with those referred to by [2] that adding iron to peanut plants in creased the plant height significantly.
Table 1: effect of iron and the cultivar and the interaction between them on the plant height (cm)

| Iron concentration (mg.l⁻¹) | Cultivars | Control (distilled water only) | 10   | 20   | 30   | Mean |
|-----------------------------|-----------|--------------------------------|------|------|------|------|
|                             | Local     | 68.33                          | 88.66| 93.00| 76.81| 79.45|
|                             | Spanish   | 59.44                          | 81.99| 84.11| 71.22| 74.19|
|                             | Mean      | 63.89                          | 85.33| 88.55| 71.51| 74.19|
| L.S.D 5%                    | Cultivars | 3.58                           | Concentrations | 5.07 | Interaction n.s |

Number of branches (branches.plant⁻¹)

Results in Table 2 refer to no significant differences in the number of branches neither among the cultivars nor in the interaction between the cultivars and the iron concentrations, however, the iron concentration affected significantly the number of branches which was superior at the concentration 30 mg.l⁻¹ giving the highest number reached 10.66 branches.plant⁻¹ compared to the control treatment that gave the lowest number of branches (55.5 branches.plant⁻¹).

Table 2: effect of iron and the cultivar and the interaction between them on the number of branches.

| Iron concentration (mg.l⁻¹) | Cultivars | Control (distilled water only) | 10   | 20   | 30   | Mean |
|-----------------------------|-----------|--------------------------------|------|------|------|------|
|                             | Local     | 5.66                           | 6.77 | 8.77 | 10.44| 7.91 |
|                             | Spanish   | 5.44                           | 7.55 | 9.78 | 10.88| 8.41 |
|                             | Mean      | 5.55                           | 7.16 | 9.28 | 10.66|      |
| L.S.D 5%                    | Cultivars | n.s                            | Concentrations | 2.53 | Interaction n.s |

Number of pods (pods.plant⁻¹)

Results in Table 3 show no significant differences in the number of pods neither among cultivars nor in the interaction between the cultivar and iron concentrations where the significant difference was only among concentrations. Spraying iron at 20 mg.l⁻¹ was superior giving the highest number of pods (14.16 pods.plant⁻¹) compared to the control treatment that gave the lowest number of pods (8.33 pods.plant⁻¹).
pods.plant\(^4\)). This superiority may be attributed to the effect of iron on increasing the flowering and fertilization percentages since iron decrease the abortion, thus it leads to increasing pods per plant which consistent with the results of\[10],[11\] who referred that spraying iron increased the pods per plant significantly.

**Table 3:** effect of iron and the cultivar and the interaction between them on the number of pods

| Iron concentration (mg.l\(^{-1}\)) | Cultivars | Control (distilled water only) | 10 | 20 | 30 | Mean |
|-----------------------------------|-----------|--------------------------------|----|----|----|------|
|                                   | Local     |                                |    |    |    |      |
|                                   | 7.89      | 11.78                          | 14.33 | 10.33 | 11.08 |
|                                   | Spanish   |                                | 13.55 | 14.00 | 10.67 | 11.75 |
|                                   | Mean      |                                | 12.66 | 14.16 | 10.50 |
| L.S.D 5%                          | Cultivars | n.s                            |     |     |     |      |
|                                   | Concentrations | 2.59                        |     |     |     |      |
|                                   | Interaction | n.s                          |     |     |     |      |

**Number of seeds (seeds.pod\(^4\))**:  
Results in Table 4 illustrate no significant differences in the number of seeds among the cultivars, iron concentrations, or the interaction between them.

**Table 4:** effect of iron and the cultivar and the interaction between them on the number of seeds per pod

| Iron concentration (mg.l\(^{-1}\)) | Cultivars | Control (distilled water only) | 10 | 20 | 30 | Mean |
|-----------------------------------|-----------|--------------------------------|----|----|----|------|
|                                   | Local     |                                |    |    |    |      |
|                                   | 4.50      | 3.87                           | 4.33 | 3.70 | 4.10 |
|                                   | Spanish   |                                | 4.03 | 3.67 | 3.93 | 3.98 |
|                                   | Mean      |                                | 3.95 | 4.00 | 3.82 |
| L.S.D 5%                          | Cultivars | n.s                            |     |     |     |      |
|                                   | Concentrations | n.s                        |     |     |     |      |
|                                   | Interaction | n.s                          |     |     |     |      |

**100-seeds weight (g):**
Results in Table 5 show that the differences among the cultivars as well as of the interaction between cultivars and iron concentrations were not significant in the weight of 100 seeds, in contrary to the difference among iron concentrations which was significant as spraying 20 mg.l-1 of iron was superior to the other concentrations and produced the highest weight of 100 seeds reached 123.4 g compared to the treatment of spraying 10 mg.l-1 and the control treatment that gave the lowest weight of 100 seeds averaged 122.6 and 123.4 g respectively. This superiority may be due to the effect of iron on increasing the number of pods per plant (Table 3) as well as the number of branches (Table 2) that confirms the iron efficiency in enhancing the growth traits represented by the number of branches and plant height which in turn lead to increasing the dry matter in the seeds.

**Table 5**: effect of iron and the cultivar and the interaction between them on 100-seeds weight (g)

| Iron concentration (mg.l-1) | Control (distilled water only) | 10 | 20  | 30  | Mean |
|----------------------------|--------------------------------|----|-----|-----|------|
| Cultivars                  |                                |    |     |     |      |
| Local                      | 126.4                          | 116.4 | 138.7 | 129.4 | 127.7 |
| Spanish                    | 120.4                          | 128.8 | 132.2 | 126.0 | 126   |
| Mean                       | 123.4                          | 122.6 | 135.5 | 127.7 |
| L.S.D 5%                   | Cultivars n.s                  | Concentrations 8.30 | Interaction n.s |      |

**Seed yield (kg.ha⁻¹):**

Results in Table 6 demonstrate significant differences in the seed yield affected by the cultivars and iron concentrations, however, the interaction between the two factors was insignificant. The local cultivar was superior producing 2583 kg.ha⁻¹ while the Spanish cultivar produced an average of 2013 kg.ha⁻¹. The superiority of the local cultivar in this trait may be due to its efficiency in utilizing the photosynthesis products since it is adapted for the Iraqi environmental conditions. This is consistent with the results found by [2] who referred to differences among peanut cultivars in the seed yield. Concerning the iron concentrations, the treatment of spraying 20 mg.l-1 was superior producing the highest yield of seeds averaged 2705 kg.ha⁻¹ compared to the control treatment that produced the lowest seed yield averaged 1577 kg.ha⁻¹. The reason behind this increase may be due to the increase in the number of pods (Table 3) and in the 100-seeds weight (Table 5), i.e. iron increases the yield components leading to increasing the seed yield. This is consistent with the results of [12]and [2] who reported that spraying iron increases the seed yield significantly.
Table 6: effect of iron and the cultivar and the interaction between them on the seed yield (kg.ha-1)

| Iron concentration (mg.l-1) | Control (distilled water only) | 10 | 20 | 30 | Mean |
|----------------------------|--------------------------------|-----|----|----|------|
| Local                      | 1583                           | 2761| 3335| 2653| 2583 |
| Spanish                    | 1571                           | 2145| 2076| 2260| 2013 |
| Mean                       | 1577                           | 2453| 2705| 2456|      |
| L.S.D 5%                   | Cultivars                      | Concentrations | Interaction |
|                            | 342.2                          | 484.0|   | n.s |      |

References

[1] Natalia Gutierrez,C., M.T. Moreno and A.M. Torres. 2008. Development of SCAR markers linked to zt-2, one of the gens. Controlling absence of tannins in faba bean, Aust J of Agric. Res. 59: 6-68.

[2] Gao, Li, and Y. Shi. 2007. Genetic differences in resistance to iron deficiency chlorosis in peanut. J. Plant Nutr. 30: 37 – 52.

[3] Moraghan, J.T. 1987. Effect of phosphorus and iron fertilizers on the growth of two spybean varieties at two soil temperatures. Plant Soil. 104:121-127.

[4] Lucena,J., J.A. Garate and O. Carpena. 1988. Lolium multiflorum uptake of iron supplied as different synthetic chelates. Plant Soil. 112: 23-28.

[5] Rashed, M.H. and H.A. Ahmed. 1997. Physiological studies on the effect of iron and zinc supplies on faba bean plant. J. Agric. Sci. Mansoura Univ. 22(23): 729-743.

[6] FAO. 1973. Calcareous soils of Iraq. Bull. No. 21, FAO. Roma. Italy.

[7] AI-Uqaili, J., K.A. Al-Hadethi and A.K.A. Jarallah. 2001. Adsorption-desorption of iron in some calcareous soils. Basrah. J. Agric. Sci. Mansoura Univ. 22(3): 729-743.

[8] Sharama, B.M.D., H. Arora, R. Kumar and V.K. Nayyar. 2004. Relationships between soil characteristics and total and DTPA-extractable micronutrients in Inceptisols of Punjab. Commum. Soil Sci. Plant Anal. 35: 799-818. (abstract).

[9] Aguilera-Diaz, C. and M.L. Recald. 1995. Effect of plant density and inorganic nitrogen fertilizer on field bean (Vacia Faba L.) Agric. SeiCamb. 125(1): 87-93.

[10] Goos, R. J., B. Johnson, G. Jackson, and G. Hargrove .2004. Greenhouse evaluation of controlledrelease iron fertilizers for soybean. J. Plant Nutr. 27: 43 – 55. (Abstract).
[11] Naeve, S. L., and G.W. Rehm. 2006. Genotypes by environment within iron deficiency chlorosis tolerant soybean genotypes. Agron. J. 52:84 – 86.

[12] Havlin, J. L., J. D. Beaton, S. L. Tisdale, and W. L. Nelson. 1999. Soil Fertility and Fertilizers. An Introduction to Nutrient Management. Prentice-Hall, Inc., N.J.