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ORIGINAL ARTICLE

EFFECT OF FOLIAR FEEDING WITH NANO-BORON ON THE GROWTH AND YIELD OF TWO CULTIVARS OF FABA BEAN CROP (*VICIA FABA* L.)

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Abstract : A field experiment was carried out during the agricultural season 2017/2018 in one of the agricultural fields of the Governorate of AL-Muthanna, to study the effect of foliar feeding of Nano-boron with three concentrations (zero, 5, 10mg.liter^{-1}) in growth and yield of two varieties of faba bean crops (Aquadlegi, Aquadols). The experiment was applied according to split plot design used to complete randomized sectors (R.C.B.D) with three replicates. The varieties were put in the main plots and concentrations of Nano-boron in the secondary plots. The results show that spraying with Nano-boron with a concentration of 10 mg.l^{-1} had an increase in length of pod, number of pods per plant, weight of 100 seeds and total yield of seeds, which gave highest averages of 25.00 cm, 16.57 pods. plant^{-1}, 132.30 g and 5576 kg. ha^{-1}. Sequentially, while there were no significant differences for spraying with Nano-boron in plant height and number of seeds per pod. The results also indicated that the two cultivars differed significantly between them, as the cultivar Ecuador was higher in plant height and gave an average of 88.10 cm and a weight of 100 seeds at 134.20 g and 4921 kg. ha^{-1}, while no significant differences appeared between two cultivars in the length of pod, number of pods per plant and number of seeds in the pod. The interaction between varieties and spraying with Nano-boron showed a significant increase in number of pods per plant, cultivar Aquadollus gave the highest concentration of boron, highest average number of pods reached 17.97 pods.plant^{-1}.

Key words : Foliar feeding, Nano-boron, faba bean crop, Cultivars.

1. Introduction

Faba bean crop (*Vicia faba* L.) is one of the seed crops of legume belonging to Fabaceae family. It is a basic food source for a large number of the world's population, which is cultivated for purpose of obtaining green pods or soft or dry seeds. It contains a high percentage of protein 25-40% [Natalia *et al*. (2008)]. The percentage of carbohydrates reaches 56% and also it contains a mineral elements, fibers, oils and vitamins, especially B complex and a high percentage of phytic acid [Mahmoud (2010)]. In addition, its plants use green fertilizer for the soil, as it increases the productivity of crops that follow in the field because it fixes atmospheric nitrogen in the soil by bacterial nodes [Jasim (2007)]. The cultivation of this crop suffers from many problems that lead to reducing its production due to the primacy of cultivation and the failure to use modern methods in its cultivation.

The production of any crop depends on the availability of necessary macro and micro-nutrients in ideal quantities in harmony with the requirements of growing crops, adding foliar fertilizers by spraying on. The vegetative group of plants provides the plant's nutrient requirements during the critical and sensitive stages of its growth, which roots cannot provide [Martin (2002)]. The use of nanomaterial's is a modern technology that has been used in wide-ranging fields of life sciences, including agricultural fields, added to plants in order to increase their growth and improve their productivity because they work to increase the absorption of water and nutrients in addition to their low material costs and thus reduce the economic cost of the agricultural process [Parasd *et al*. (2014)].

Boron is one of the most important nutrients due to role it plays in controlling movement of sugars inside plant to places of its storage, in addition to its effect on

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absorption of nitrogen and potassium and its importance in formation of plant hormones such as oxides, and also helps in germination of pollen and growth of germination tubes. Need of it in plants is greater in stages flowering and Fruiting, therefore, it is important in formation of seeds and fruits. Boron is usually present in soil in limited quantities, therefore it is preferred to add sprinkles to vegetative system, as increase in calcium in soil is one of the most important reasons for the symptoms of this element deficiency on plant because of opposite relationship between these two elements [Leite *et al*. (2008)]. One of the important foundations in expanding cultivation of faba bean crops and raising the production is cultivating varieties with high production capacity and following important, effective field methods such as foliar feeding, also knowing the ability of the varieties to absorb nutrients to obtain latent energies, in addition to knowing the response of varieties to local conditions and extent of their adaptation to those conditions [AL-Hasany (2018)].

This experiment was aimed at identifying growth response and yield of two faba bean cultivars for foliar feeding by Nano-boron.

2. Materials and Methods

A field experiment was carried out during the agricultural season 2017/2018 in one of the agricultural fields of the Governorate of AL-Muthanna, to study the effect of foliar feeding in Nano-boron with three concentrations (zero, 5, 10 mg-1 liter) which symboled by (B0, B1, B2) on the sequence in growth and yield of two cultivars of faba bean are Aquadlegi and Aquadols and are symboled by (V1, V2) in succession. The experiment was applied according to split plot design experiments used to complete randomized sectors (R.C.B.D) with three replicates. The cultivars were put in the main plots and foliar of Nano-boron in the secondary plots.

A complex sample was taken to represent the experiment field randomly from different places from each replicate from a depth (0-30) cm and mixed together. A set of chemical and physical analysis were performed prior to planting for the experiment field shown in Table 1.

The process of plowing, smoothing and levelling was conducted. Experiment field was planned according to design used. Then the field is divided into three replicates that left a distance (1 m) between each one and another, also between an experimental unit and another, then experiment land was irrigated before date of planting for purpose of calibration and to determine the level of seeds on furrows. The planting process was completed on 10.15.2017, the area of experimental unit reached (2 x 3) m^2 and the distance between one and the other was 75 cm, each experimental unit contained 4 plants and seeds were planted with a distance of 20 cm between one plant and another by placing two seeds in the hill, when plant reached a height of 10-15 cm, it was reduced to one plant in the hill, it was rewarded fertilization process according to the fertilizer recommendation, it was nitrogen in amount of 60 kg $N.ha^{-1}$ at the rate of two batches one after 15 days for planting and the second after a month of the first batch and in the form of urea fertilizer 46% N. The process of phosphate fertilization was carried out in the amount of 80 kg $P.ha^{-1}$ and amount of a batch one before planting in form of triple superphosphate fertilizer 21% P, and potassium fertilizer in amount of 80 kg K_2O by one batch before planting in the form of potassium sulfate 42% K. Irrigation and weeding operations were carried out whenever needed. The process of spraying with Nano-boron in the morning was done to avoid high temperatures, and on the first two times at the beginning of flowering and second at 50% flowering, the spraying process was carried out with a dorsal spraying, a diffusion substance was added to solution to ensure complete wetness of the leaves and reduce the surface tension of the water in order to increase the efficiency of spray solution.

Table 1 : Physical and chemical characteristics of the experiment field before planting.

Feature	Value	Unit
pH	7.4	
E.C.	3.6	Desimines M^{-1}
CEC	24.6	Centimeter (+) kg^{-1}
Ready N.	20	mg kg^{-1} soil
Ready P.	8.2	mg kg^{-1} soil
Ready K.	160	mg kg^{-1} soil
Ready B.	1.1	mg kg^{-1} soil
Sand	19	kg^{-1}
Silt	44	
Clay	37	
Texture	Silty clay loam	

The data were analyzed statistically according to design by using genestat program. Mean data were compared according to the L.S.D test under the probability level of 5%.

3. Results and Discussion

3.1 Plant height (cm)

The results in Table 2 show that there was no significant effect of spraying of Nano-boron on the characteristic of plant height, while the varieties showed a significant effect of this feature, V1 cultivar recorded highest plant height of 86.10 cm, significantly outperforming than V2 cultivar, which recorded the lowest height of the plant 66.60. It may be due to the difference in genetic nature of varieties and this result was consistent with what obtained by Hassan (2019). The interference between the concentrations of Nano-boron and varieties had no significant effect on plant height characteristic (Table 2).

Table 2 : Effect of spraying of Nano-boron and varieties and their interaction on plant height (cm).

V \ B	B			Mean V
	B_0	B_1	B_2	
V_1	80.50	86.80	91.00	86.10
V_2	65.20	66.60	67.80	66.60
Mean B	72.80	76.70	79.40	
$L.S.D_{0.05}$	V	B	V × B	
	12.68	N.S	N.S	

3.2 Length of pod (cm)

The results of Table 3 showed the significant effect of spraying with Nano-boron on the length of pod, as the highest concentration of Nano-boron B2 gave highest average at 25 cm, outperforming than concentrations B1 and B0, while the non-addition treatment recorded lowest average of pod length feature was 19.25 cm. Perhaps the reason for increase when spraying with boron is due to its important role in increasing the efficiency of the photosynthesis process and producing dry matter in a manner that helps to increase length of pod and this result is agreed with Reda *et al*. (2014). About effect of faba bean varieties and the interaction between concentrations of Nano-boron and cultivars in the characteristic length of pod. The results showed that there was no significant effect in this characteristic (Table 3).

Table 3 : Effect of spraying of Nano-boron and varieties and their interaction on Length of pod (cm).

V \ B	B			Mean V
	B_0	B_1	B_2	
V_1	19.83	22.33	25.50	22.56
V_2	18.67	21.33	24.50	21.50
Mean B	19.25	21.83	25.00	
$L.S.D_{0.05}$	V	B	V × B	
	N.S	1.04	N.S	

3.3 Number of pods per plant (pods. plant^{-1})

The results of experiment showed a steady increase with an increase in concentration of Nano-boron, as B2 concentration recorded the highest mean of number of pods per, reached 16.57 pods. plant^{-1}, with a significant difference from concentrations B1 and B0, and the non-spraying treatment B0 gave the lowest average of this trait was 11.52 pods. plant^{-1}. The reason for increase may be due to the important role of boron in pollination process by stimulating reproductive and biological processes in the stages of growth and flowering, and this leads to increased fertilization and thus an increase in the number of pods per plant. These results are consistent with findings by Al-Hasany *et al*. (2019a). As for varieties effect, there were no significant differences in the characteristic of number of pods per plant (Table 4). Interaction between spraying of Nano-boron and varieties had a significant effect in this characteristic, as cultivar V1 which sprayed the highest concentration of Nano-boron B2 combination (B2 × V1) gave highest average of this feature reached 17.97 pods. plant^{-1}. Whereas, cultivar V2 with control treatment B0 (B0 × V2) gave the lowest mean was 11.50 pods. plant^{-1} (Table 4).

Table 4 : Effect of spraying of Nano-boron and varieties and their interaction on number of pods per plant (pods. Plant^{-1}).

V \ B	B			Mean V
	B_0	B_1	B_2	
V_1	11.53	13.60	17.97	14.37
V_2	11.50	12.37	15.17	13.01
Mean B	11.52	12.98	16.57	
$L.S.D_{0.05}$	V	B	V × B	
	N.S	1.02	1.60	

3.4 Number of seeds in pods (seed. pod^{-1})

From the results in Table 5 showed we note that there were no significant differences between the concentrations of spraying with Nano-boron and the varieties and their interaction in the number of seeds per pod.

Table 5 : Effect of spraying of Nano-boron and varieties and their interaction on number of seeds in pods (seed. pod^{-1})

V \ B	B			Mean V
	B_0	B_1	B_2	
V_1	4.50	4.52	4.68	4.56
V_2	4.65	4.95	5.30	4.96
Mean B	4.57	4.73	4.99	
L.S.D $_{0.05}$	V	B	V × B	
	N.S	N.S	N.S	

3.5 Weight of 100 seeds (g)

The results of Table 6 indicated that the increase in concentration of Nano-boron in the spray solution resulted in an increase in the weight of 100 seeds. B2 concentration recorded highest average for this trait of 132.30 g, which did not differ significantly from B1 concentration, which gave an average of 126.70 g, while the control treatment B0 gave less average was 113.70 g. This result was consistent with what found by Al-Hasany *et al*. (2019b). Results in Table 6 indicated that cultivar V1 recorded highest average for this feature was 134.20 g that was significantly superior to cultivar V2 which gave lowest average at 114.20 g. Perhaps the reason for increase in the seed weight of cultivar Aquadols is due to fact that this trait is genetically related to cultivars more than an effect external and environmental factors are influenced by them and these results are consistent with what obtained by Kubure *et al*. (2015). Also, there were no significant differences for interaction between Nano-boron concentrations and cultivars in this feature (Table 6).

Table 6 : Effect of spraying of Nano-boron and varieties and their interaction on weight of 100 seeds (g).

V \ B	B			Mean V
	B_0	B_1	B_2	
V_1	124.00	136.70	142.00	134.20
V_2	103.30	116.70	122.70	114.20
Mean B	113.70	126.70	132.30	
L.S.D $_{0.05}$	V	B	V × B	
	16.30	8.18	N.S	

3.6 Total seed yield (kg. ha^{-1})

We note from Table 7 that there was a significant increase in the total seed yield by increasing concentrations of Nano-boron, as B2 concentration exceeded both concentrations B0 and B. It gave the highest average characteristic of total seed yield amounted to 5576 kg. ha^{-1}. B1 concentration in turn significantly increased than control treatment B0 which gave lowest average yield of 3833 kg. ha^{-1}, perhaps due to superiority of spraying with boron in characteristic of number of pods per plant (Table 4) also increase in weight of 100 seeds (Table 6), which in turn led to an increase in total seed yield, this result agreed with what obtained by Al-Hasany *et al*. (2018). Table 7 also shows a significantly effect of varieties on total seed yield, cultivar V1 gave highest mean for this feature, amounting to 4921 kg. ha^{-1}, significantly outperforming cultivar V2, which gave lowest average of 4,512 kg. ha^{-1}. Perhaps the superiority of cultivar V2 in feature of yield was due to its superiority in characteristic of weight 100 seeds, which is one of the basic components of final grain yield (Table 6), which led to an increase in total seed yield, this outcome was consistent with what findings by Negash *et al*. (2015). There was no significant effect of interaction between Nano-boron concentrations and varieties in total seed yield (Table 7).

Table 7 : Effect of spraying of Nano-boron and varieties and their interaction on total seed yield (kg. ha^{-1}).

V \ B	B			Mean V
	B_0	B_1	B_2	
V_1	4113	4905	5745	4921
V_2	3552	4577	5407	4512
Mean B	3833	4741	5576	
L.S.D $_{0.05}$	V	B	V × B	
	291.5	239.8	N.S	

4. Conclusion

We find no significant differences appeared between two cultivars in the length of pod, number of pods per plant and number of seeds in the pod. The interaction between varieties and spraying with Nano-boron showed a significant increase in number of pods per plant, cultivar Aquadollus gave with highest concentration of boron highest average number of pods.

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