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# The role of spraying copper and zinc on the growth and yield of *Vicia faba* L.

Ali R. Alhasany, Ali H. Noaema and Hekmat B. Alhmadi\*

Department of Field crops College of Agriculture, Al-Muthana University,  
College of Medicine, Al-Muthana University,  
ali.algayashe@gmail.com

**Abstract .** A field experiment was conducted in Al-Rumaitha district 25 km north of Al-Muthanna governorate in winter season 2017/2018 to study the effect of spraying with three concentrations of copper (0, 10, 20 ) mg Cu L<sup>-1</sup>, and three concentrations of zinc (0, 40, 80) mg Zn L<sup>-1</sup> on the growth and yield of faba bean. The experiment was applied as a factorial experiment within randomized complete block design (RCBD) with three replicates. The results showed that copper spraying at concentration of 20 mg cu L<sup>-1</sup> resulted in an increase in most growth and yield characteristics, giving the highest nitrogen content in plant leaves (35.07g.kg<sup>-1</sup>), chlorophyll content in leaves (35.22 SPAD), plant height (81.01 cm), the number of branches (6.78 branch. Plant<sup>-1</sup>) and increased components of the yield by percentage of number of pods reached to (41.12%), the number of seeds by the pods (24.23%), and the number of total seed yield by (46.16%). There were no significant differences between the treatment of spray and the loss of the weight of 100 seeds. The results showed significant increase of zinc concentrations in the spray solution, where the concentration exceeded 80 mg Zn L<sup>-1</sup> in most studied traits such as content of nitrogen in plant leaves, leaf content of chlorophyll, plant height, the number of branches, and also some yield components, the pods were 15.32, the number of seeds by pods was 5.12, the total number of seeds was 4628 Kg<sup>-1</sup>, while the comparison treatment was higher in the weight of 100 seeds. The interaction between copper and zinc showed a significant effect on the content of nitrogen in plant leaves and leaf content of chlorophyll. The combination (20 mg Cu.L<sup>-1</sup> × 80 mg Zn.L<sup>-1</sup>) showed the highest mean of 37.50 g. kg<sup>-1</sup> and 37.17 SPAD for both respectively.

## 1. Introduction

Faba bean (*Vicia faba* L.) is a winter crop belonging to the Fabaceae family, its importance lies in being an important food source. Its seeds contain a high protein content of 28-38% as well as a good source of vitamins, minerals and fiber, as well as contain amino acids, starchy and sugary substances in good proportions in addition to the content of the seeds of carbohydrates, which reach in some varieties to 40-46% [1]. Faba bean crop, also contributes through its important role in stabilizing atmospheric nitrogen, also contributes to the improvement of the properties of chemical and physical soils to contain its roots on the root nodes that coexist with the rhizobium bacteria [2].

Paper feeding is a preferred method because it is easy, economical and quick. there is no soil problems with it, in addition to being positive with nutrients such as copper and zinc due to many problems of these elements when added to the soil, which reduces the plants readiness [3]. The copper which plays an important role in plant rooting, which has a positive effect on the absorption of water and nutrients [4], as



well as its important role in the process of photosynthesis and breathing through the transfer of electrons and also important in the formation of pollen and seed production [5].

Zinc is also considered one of the most important elements in the micro-nutrition of the plant as it has an important role in the building and growth of the plant by entering the formation of many enzymes and Protein materials. It directly contributes to the increase of photosynthesis by participating in the processes of metabolism of carbohydrates [6], also, it introduces the synthesis of some amino acids, hormones and many important enzymes in oxidation and reduction reactions, demolition and construction processes and also acts as a catalyst and promoter for plant growth regulators such as (IAA) [7]. This study was carried out to determine the effect of different concentrations of copper, zinc and their interaction on the growth and yield of faba bean.

## 2. Materials and methods

A field experiment was carried out during the agricultural season 2017/2018 In Al-Rumaitha district of Al-Muthanna governorate to study the effect of spraying with different concentrations of copper and zinc on the growth and yield of faba bean. The experiment was applied according to the design of the factorial experiments. The first factor included spraying with three concentrations of copper (0, 10 and 20) mg Cu L<sup>-1</sup>) using copper sulphate, its code by Cu 0, Cu 1 and Cu 2. The second factor was three concentrations of zinc (0, 40 and 80) mg Zn L<sup>-1</sup>) using EDTA (13%) Zinc fertilizer and Zn 0, Zn 1 and Zn 2 respectively using the complete RCBD design with three replicates.

Random samples were also taken from a depth of 0 - 30 cm from different places of each replicate and mixed to represent the experiment field. Prior to planting. Some chemical and physical analyses were required for the field of experiment described in (table1).

Table (1) some physical and chemical characteristics of the experiment field before planting

| Characteristic              | Value                  | Unit                                  |
|-----------------------------|------------------------|---------------------------------------|
| <b>pH</b>                   | <b>7.3</b>             |                                       |
| <b>E.C.</b>                 | <b>4.6</b>             | <b>Desimines M<sup>-1</sup></b>       |
| <b>CEC</b>                  | <b>22.6</b>            | <b>Centimeter (+) kg<sup>-1</sup></b> |
| <b>Available Nitrogen</b>   | <b>19</b>              | <b>mg kg<sup>-1</sup> soil</b>        |
| <b>Available Phosphorus</b> | <b>7</b>               | <b>mg kg<sup>-1</sup> soil</b>        |
| <b>Available Potassium</b>  | <b>150</b>             | <b>mg kg<sup>-1</sup> soil</b>        |
| <b>Sand</b>                 | <b>241</b>             | <b>kg<sup>-1</sup></b>                |
| <b>Silt</b>                 | <b>435</b>             |                                       |
| <b>Clay</b>                 | <b>324</b>             |                                       |
| <b>Texture</b>              | <b>Silty clay loam</b> |                                       |

The soil fertilization processes were carried out by plowing, tilling and settling. The soil was then divided according to the design used after the seeds were planted on 15 October [8]. Nitrogen fertilization was carried out with a quantity of 60 kg N ha<sup>-1</sup> in the form of urea fertilizer (46 % N) once 15 days after planting and the phosphate fertilization at 80 kg P ha<sup>-1</sup> in the form of triple superphosphate fertilizer (46% P) and Potassium fertilizer at 80 kg K<sub>2</sub>O in the form of potassium sulphate (42 % K) at a single

batch before planting [9]. Irrigation and weeding operations were carried out as needed, the cultivation was done on lines and the distance between the lines was 60 cm. The experimental unit is a panel ( $2 \times 3 = 6 \text{ M}^2$ ) in which four lines length 3 meters per line and planted the rest of the distance 20 cm between the plant and another by placing two seeds per hole then thinned to one plant per hole thus the plant density on (83333) plants  $\text{ha}^{-1}$  [10]. Spraying was carried out after the preparation of the concentrations used in the spray solution for both copper and zinc, based on the quantity of water (400 liters  $\text{ha}^{-1}$ ). The concentrations of copper and zinc were sprayed when the plant reached 50% flowering, the spraying was conducted mediated sprinkler dorsal, taking into account spraying times during the morning or evening to avoid high temperatures; a detergent solution was added to the solution to reduce the surface tension of the water and to ensure complete wetness of the leaves in order to increase the efficiency of the spray solution. Data were statistically analyzed using the program analysis (genstst) averages were compared by LSD test at the probability level of 5 % [11].

### 3. Results and discussion

#### 3.1. Content of nitrogen in plant leaves ( $\text{g kg}^{-1}$ )

The results of table (2) showed that there was a significant increase in the content of nitrogen in the leaves of the plant with a higher concentration of copper in the spray solution. The concentration of Cu 2 recorded the highest mean of this value was  $35.07 \text{ g N Kg}^{-1}$  while the comparison Cu 0 gave a mean average of  $31.56 \text{ g N Kg}^{-1}$ , this may be due to the fact that copper spraying improves root growth, which contributes to its efficiency in absorbing some nutrients from the soil, including nitrogen and thus increasing its content in the leaves of plants and agreed this result with Hussein and Rabie [12].

The results in Table (2) showed a significant increase in the content of nitrogen in plant leaves with increased concentration of zinc in the spray solution., Zn 2 gave the highest mean of  $35.06 \text{ g N Kg}^{-1}$  and significantly different from the Zn 0 comparison treatment, which gave the lowest mean of  $30.88 \text{ g N Kg}^{-1}$ , and may be due to the role of zinc in the activation of many enzymes that have an important role in the production of nuclear acids, which contribute to increase the absorption of nitrogen from the soil, which led to increased content in the leaves, this result agreed with Castrup et al., [13].

The highest content of cu 2 and zinc Zn 2 (Cu 2  $\times$  Zn 2 ) gave the highest mean of this characteristic to  $37.50 \text{ g N Kg}^{-1}$  while the (Cu 0  $\times$  Zn 0 ) combination of cooper comparison Zinc had a less mean average nitrogen concentration in leaves of  $29.36 \text{ g N Kg}^{-1}$ .

Table (2) The effect of spray copper and zinc and their interaction on the content of nitrogen in plant leaves ( $\text{g kg}^{-1}$ )

| Cu<br>Zn              | Cu              |                 |                 | Mean  |
|-----------------------|-----------------|-----------------|-----------------|-------|
|                       | Cu <sub>0</sub> | Cu <sub>1</sub> | Cu <sub>2</sub> | Zn    |
| Zn <sub>0</sub>       | 29.37           | 30.37           | 32.90           | 30.88 |
| Zn <sub>1</sub>       | 31.97           | 34.00           | 34.80           | 33.59 |
| Zn <sub>2</sub>       | 33.33           | 34.33           | 37.50           | 35.06 |
| Mean Cu               | 31.56           | 32.9            | 35.07           |       |
| L.S.D <sub>0.05</sub> | Zn              | Cu              | Cu $\times$ Zn  |       |
|                       | 0.63            | 0.63            | 1.09            |       |

### 3.2. Chlorophyll content in leaves

The results showed that content of chlorophyll in a leaves increased significantly with all the increase in the Concentration of copper in solution spraying, as it was average this attribute 29.74 and 32.53 and 35.22 spad to relay (table 3), and possibly due to the role of copper in increasing content of nitrogen in plant (table 2), which was reflected to increase the content of chlorophyll in the leaves, this result agreed with Korzeniowska and Glubiak [14].

As the impact of spray zinc significantly in the content of chlorophyll content in leaves, with more than focusing top Zn 2 gave the highest average the content of chlorophyll in the leaves was 33.83 SPAD while gave the control treatment Zn 0, Lower average of this trait was 31.07 (table 3), has come back the cause of the increase in the content of the leaves of chlorophyll to the role of zinc in activating of enzymes, in particular, the enzymes that responsible for the building and configure the molecule Chlorophyll increased its content in the leaves, these results agreed with Issawi [6].

The impact of interaction between copper and zinc ( $Cu\ 2 \times Zn\ 2$ ) were 37.50 SPAD, at ( $Cu\ 0 \times Zn\ 0$ ) gaves lower value 28.80 SPAD (table 5), this could be due to the increase of spraying in copper and zinc leading to increase the many of enzymes involved in the processes which contributed to increase the content of the leaves of chlorophyll.

Table (3) The effect of spray copper and zinc and their interaction on leaf content of chlorophyll (SPAD)

| Cu<br>Zn              | Cu              |                 |                 | Mean<br>Zn |
|-----------------------|-----------------|-----------------|-----------------|------------|
|                       | Cu <sub>0</sub> | Cu <sub>1</sub> | Cu <sub>2</sub> |            |
| Zn <sub>0</sub>       | 28.80           | 31.07           | 33.33           | 31.07      |
| Zn <sub>1</sub>       | 29.92           | 32.70           | 35.17           | 32.59      |
| Zn <sub>2</sub>       | 30.50           | 33.83           | 37.17           | 33.83      |
| Mean Cu               | 29.74           | 32.53           | 35.22           |            |
| L.S.D <sub>0.05</sub> | Zn              | Cu              | Cu $\times$ Zn  |            |
|                       | 0.76            | 0.76            | 1.3             |            |

### 3.3. Plant height (cm)

The plant height was significantly increased due to increasing concentration of copper in solution spraying as register focus supreme copper Cu 2 highest average was 81.01 Cm compared with lower average was 72.72 cm in the control treatment (table 4). The reason for this may be due to the spraying of copper contributes to the growth of elongation roots, which helps to configure the sum of radical capable of exploitation and optimization of water and nutrients and this, in turn, leads to an increase in plant height, this result agreed with what pointed out by [15].

The results showed that the spray of zinc focusing supreme Zn 2 led to increase the plant height giving 81.37 cm, when the control treatment Zn 0 and Zn 1 gave less average 73.30 and 77.73 cm respectively. The reason of increase the plant height with increasing concentration of zinc to positive role of these elements, which contributes to improve the growth and increase the efficiency of the process of photosynthesis, and thus increasing the production of dry matter, which lead to increase of plant growth, in general, this result agreed with [16].

No significant differences were observed between copper and zinc interaction on plant height.

Table (4) The effect of spray copper and zinc and their interaction on a height plant (cm)

| Cu<br>Zn              | Cu              |                 |                 | Mean<br>Zn |
|-----------------------|-----------------|-----------------|-----------------|------------|
|                       | Cu <sub>0</sub> | Cu <sub>1</sub> | Cu <sub>2</sub> |            |
| Zn <sub>0</sub>       | 68.07           | 75.50           | 76.33           | 73.30      |
| Zn <sub>1</sub>       | 73.17           | 77.83           | 82.20           | 77.73      |
| Zn <sub>2</sub>       | 76.93           | 82.67           | 84.50           | 81.37      |
| Mean Cu               | 72.72           | 78.68           | 81.01           |            |
| L.S.D <sub>0.05</sub> | Zn              | Cu              | Cu × Zn         |            |
|                       | 2.01            | 2.01            | N.S             |            |

### 3.4. Number of branches per plant (branch. plant<sup>-1</sup>)

The concentration of the highest copper Cu 2 had a significant effect of the two concentrations Cu 1 and Cu 0 in the number of plant branches, giving the highest average 6.78 branches of plant<sup>-1</sup> while the treatment of non-spray gave less average of this trait to 5.46 branches. Plant<sup>-1</sup> (table 5). The reason for this is due to the sprayed copper on plants helps roots to do its functions, which is reflected positively on the water and nutrient absorption, which leads to increased vegetative growth in plant, including the number of branches per plant [4], this result agreed with Korzeniowska and Glubiak [14].

Results in table 5 showed Zn treatment of Zn 2 affected on the number of branch Plant, as it has given above average was 6.60 branches. Plant<sup>-1</sup> while the control treatment Zn 0 gave lower average 5.67 branches. Plant<sup>-1</sup> (Table 5). This probably due to the composition of the branches and the buds need to carbohydrate which depends basically on process synthesis and this process is increased by increasing the supply of zinc, which led to an increase in the number of branches. This result agreed with Reda et al. [17]. The interaction between Cu × Zn was not significant on the number of branches per plant (Table 5).

Table (5) Effect of Spraying Copper and Zinc and interaction on (plant branch<sup>-1</sup>)

| Cu<br>Zn              | Cu              |                 |                 | Mean<br>Zn |
|-----------------------|-----------------|-----------------|-----------------|------------|
|                       | Cu <sub>0</sub> | Cu <sub>1</sub> | Cu <sub>2</sub> |            |
| Zn <sub>0</sub>       | 5.00            | 5.73            | 6.30            | 5.67       |
| Zn <sub>1</sub>       | 5.56            | 6.33            | 6.83            | 6.24       |
| Zn <sub>2</sub>       | 5.83            | 6.73            | 7.23            | 6.60       |
| Mean Cu               | 5.46            | 6.26            | 6.78            |            |
| L.S.D <sub>0.05</sub> | Zn              | Cu              | Cu × Zn         |            |
|                       | 0.15            | 0.15            | N.S             |            |

### 3.5. Number of pods per plant (pods/plant<sup>-1</sup>)

It was clear from Table (6) that the spraying of copper led to a significant increase in the number of pods in the plant and record the highest average reached 16.37 pods/ plant<sup>-1</sup> at focus Cu 2. While the comparison treatment Cu 0 was gave the lowest average of this characteristic 11.60 pods/plant<sup>-1</sup>. Probably this is to positive role of copper in increasing the process of photosynthesis, which led to increase the transmission of outputs of the process of the source to downstream thus increasing the number of pods. This result was in accordance with Hussein and Rabea [12].

The results present in the table (6) reveal the existence of a significant effect of zinc on the number of pods per plant. The treatment of Zn 2 gave the highest mean of pods.plant<sup>-1</sup> 15.32, while the control treatment Zn 0 gave lower average number of pods per plant reached 12.74 pods/ plant<sup>-1</sup>. It may be attributed to the fact that zinc affects the proteins and metabolism of carbohydrates and this effect is directly related to the processes of sugar conversion and also affects the process of photosynthesis and this has an important role in providing carbohydrates and proteins necessary for the process of growth of vegetative parts and production of reproductive parts [18]. These findings were agreed with Alek et al. [19].

The results showed no significant differences between copper and zinc interaction on the number of pods per plant.

Table (6) Effect of Spraying Copper and zinc and interaction in the number of pods in the plant (Pods/plant<sup>-1</sup>)

| Cu<br>Zn              | Cu              |                 |                 | Mean<br>Zn |
|-----------------------|-----------------|-----------------|-----------------|------------|
|                       | Cu <sub>0</sub> | Cu <sub>1</sub> | Cu <sub>2</sub> |            |
| Zn <sub>0</sub>       | 10.73           | 12.97           | 14.53           | 12.74      |
| Zn <sub>1</sub>       | 11.53           | 14.37           | 16.77           | 14.22      |
| Zn <sub>2</sub>       | 12.53           | 15.63           | 17.80           | 15.32      |
| Mean Cu               | 11.6            | 14.32           | 16.37           |            |
| L.S.D <sub>0.05</sub> | Zn              | Cu              | Cu × Zn         |            |
|                       | 0.75            | 0.75            | N.S             |            |

### 3.6. Number of seeds in pods (seed/pod-1)

Shows the results of table (7) the effect of spray copper significantly in this trait, as giving the highest concentrate of copper Cu 2 top average number of the seeds by 5.28 seed/pods<sup>-1</sup>, while the control treatment Cu 0 gave the lower average for this adjective was 4.25 seed/pods<sup>-1</sup>. The spraying with top copper may be due to its role in facilitating the movement of carbohydrates from the source to the downstream through the revitalization of many important enzymes, leading to pods filled with and then increase the number of seeds, these results agreed with Bhakuni et al. [20].

The results indicated to presence of the significant effect of sprinkling with zinc on the number of seeds per pod, as giving the highest concentrations of zinc Zn 2 in average number of seeds of pods was 5.12 seed/pods<sup>-1</sup>, while the control treatment Zn 0 gave the lower average for this characteristic 4.50 seed/pods<sup>-1</sup> (table 7). Probably the cause of this increase In the number seeds per pod when spraying Zinc due to its contribution in increasing proteins and carbohydrates and some organizations of growth Inside the plant which is reflected positively on the increase in the number of seeds of pods, this result agreed with Issawi [6].

The interaction between Cu and Zn was not significant.

Table (7) Effect of Spraying Copper and zinc and interaction on the number of seeds of pods (seed/ pods<sup>-1</sup>)

| Cu<br>Zn              | Cu              |                 |                 | Mean<br>Zn |
|-----------------------|-----------------|-----------------|-----------------|------------|
|                       | Cu <sub>0</sub> | Cu <sub>1</sub> | Cu <sub>2</sub> |            |
| Zn <sub>0</sub>       | 3.96            | 4.55            | 5.00            | 4.50       |
| Zn <sub>1</sub>       | 4.26            | 4.93            | 5.28            | 4.82       |
| Zn <sub>2</sub>       | 4.54            | 5.25            | 5.58            | 5.12       |
| Mean Cu               | 4.25            | 4.91            | 5.28            |            |
| L.S.D <sub>0.05</sub> | Zn              | Cu              | Cu × Zn         |            |
|                       | 0.16            | 0.16            | N.S             |            |

### 3.7. Weight of 100 seeds (g)

Results indicated in table (8) that the treatment Zn 0 gave the highest average of 100 seeds weight (130.10 g) on the other hand, Zn 2 gave the lowest average of 100 seeds weight giving (114.40 g). Neither Cu nor the interaction between Cu and Zn had a significant influence on 100 seeds weight. Some statement was mentioned by [19].

Table (8) Effect of Spraying Copper and zinc and interaction on 100 seeds weight (g)

| Cu<br>Zn              | Cu              |                 |                 | Mean<br>Zn |
|-----------------------|-----------------|-----------------|-----------------|------------|
|                       | Cu <sub>0</sub> | Cu <sub>1</sub> | Cu <sub>2</sub> |            |
| Zn <sub>0</sub>       | 139.00          | 125.30          | 126.00          | 130.10     |
| Zn <sub>1</sub>       | 131.30          | 128.00          | 118.70          | 126.00     |
| Zn <sub>2</sub>       | 119.30          | 114.70          | 109.3           | 114.40     |
| Mean Cu               | 129.9           | 122.7           | 118.0           |            |
| L.S.D <sub>0.05</sub> | Zn              | Cu              | Cu × Zn         |            |
|                       | 13.8            | N.S             | N.S             |            |

### 3.8. Yield (kg ha<sup>-1</sup>)

The treatment of Cu 2 gave the highest yield 5070 kg ha<sup>-1</sup>. Whereas, the control treatment which gave 3469 Kg ha<sup>-1</sup> (table 9). This could be due to increasing two of the yield components i.e. number of pods per plant and number of seeds per pods (Table 6, 7). This result was in agreement with Jasim [15].

The same trend was found with zinc. The treatment Zn 2 gave the highest yield 4628 kg ha<sup>-1</sup>. Meanwhile, the control treatment i.e. 4394 Kg ha<sup>-1</sup>, the reason was due to increase no. of seeds per pod (table 6, 7); some findings were found by [21].

No market effect was found due to the interaction between Cu and Zn on the previous mentioned trait.

Table (9) Effect of spraying copper and zinc and interaction on total seed yield (kg ha<sup>-1</sup>)

| Cu<br>Zn              | Cu              |                 |                 | Mean |
|-----------------------|-----------------|-----------------|-----------------|------|
|                       | Cu <sub>0</sub> | Cu <sub>1</sub> | Cu <sub>2</sub> | Zn   |
| Zn <sub>0</sub>       | 3177            | 4042            | 4613            | 3944 |
| Zn <sub>1</sub>       | 3466            | 4463            | 5253            | 4394 |
| Zn <sub>2</sub>       | 3765            | 4774            | 5344            | 4628 |
| Mean Cu               | 3469            | 4427            | 5070            |      |
| L.S.D <sub>0.05</sub> | Zn              | Cu              | Cu × Zn         |      |
|                       | 243.5           | 243.5           | N.S             |      |

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