Effect of Spraying Nano Fertilizers of Potassium and Boron on Growth and Yield of Wheat (*Triticum aestivum* L.)

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1. Abstract

The experiment was carried out in one of the agricultural fields during the agricultural season 2018/2019 of Al-Rumaytha city 25 km north of Almuthanna province, to know the effectiveness of spraying Nano fertilizers of potassium and boron on the yield and growth of wheat crop. The experiment was laid out as split-plot within R.C.B.D. with three replicates were fertilizer of Nano potassium placed in the main plates with three concentrations (zero, 4, 8 gm⁻¹) which symbolized by the symbol (K₀, K₁, K₂) on the sequence, while Nano boron fertilizer was placed in the sub-plates with three concentrations (0, 1.5, 3 mg.L⁻¹) were symbolized by (B₀, B₁, B₂) on the sequence by using the full random sectors R.C.B.D with 3 replicates.

Results indicated that spraying by potassium nanoparticles with highest concentration of 8 m. L⁻¹, showed a significant increase in many features of growth and yield, giving the highest mean of chlorophyll content (194.56 mg. m²), and plant height (98.24 cm). In addition, some of the components of the crop and the yield was increased the number of spikes (16.41%), the number of grain spike (8.29%), the grain yield (17.94%) and biological yield (14.31%). There was no significant effect between spray treatment and lack of weight on 1000 grains. In addition, the results showed that there were significant differences when increasing the concentrations of Nano boron in the solution, where concentration about 3 ml. L⁻¹ in content of chlorophyll in leaves and the plant height. In addition, there were significant differences in some traits; the highest concentration (3 ml.L⁻¹) gave the highest average number of spikes (395.90 spikes. m²), the number of grains per spike (56.64 grains.spike⁻¹), total yield of seed (6761 kg.ha⁻¹) and the biological yield (14533 kg. ha⁻¹). While no significant due to boron treatment in the number and weight of 1000 grains.

The interaction between spraying Nano potassium and boron showed a significant effect on leaf chlorophyll content and the number of spikes per square meter only.

2. Introduction

The wheat (*Triticum aestivum* L.) is one of the winter cereal crops belonging to family of Poaceae, as its important and economic role in food security; as its grains have the first number in list of consumers food commodities because it’s give adult persons about 25% and 50% of their energy and protein needs. The sequence in addition to containing some mineral salts, vitamins and amino acids [1]. One of the modern means of crop development and increasing its growth and production on a large scale is nanotechnology as it is one of the promising applications to improve plant growth and increase its production because it works to increase the absorption of water and nutrients and thus improve the quantity and quality of production, and nanotechnology applications in the agricultural field contribute to reducing economic costs through increase fertilizer efficiency with less material cost [2]. Spraying nutrients on leaves is a positive method with micro and large macronutrients as well as being economical, easy and fast, and there are no soil problems in them and a rapid response is achieved in the plants obtaining their nutrient needs during the growth stages [3].

Potassium is one of the major nutrients and important in plant nutrition as it helps plant roots to grow and plays important roles in the stages of growth and reproduction as well as its effective effect in many vital activities such as cell division and expansion and activation of many important enzymes in carbohydrate metabolism, nitrate reduction,
pollen tube growth and works to increase the nutritional value of plants increases the seed weight and size as well as improves yield quality and leads to increased production [4]. Boron has a place of the essential elements, it has an importance role in the contract process by stimulating it to many vital processes in the stages of plant growth and flowering as it contributes to the growth of pollen tube, pollen germination and increased fertilization [5]. This study was carried out with the aim of knowing the effect of spray Nano- fertilizers of potassium and boron on the yield and growth of wheat.

3. Materials and methods
The experiment was carried out in the agricultural fields during the agricultural season 2018/2019 of Rumaytha city 25 km in the north of Al-Muthanna province, to study the effectiveness of spray Nano fertilizers of potassium and boron on the yield and growth of wheat. The experiment was applied according to split-plot design, whereas fertilizer of Nano potassium placed in the main plots with three concentrations (0, 1, 2 K. L⁻¹) which symbolized by the symbol (K0, K1, K2) on the sequence, while Nano boron fertilizer was placed in the sub-plates with three concentrations (0, 1.5, 3 mL⁻¹) were symbolized by (B0, B1, B2) on the sequence by using randomized complete block design R.C.B.D with three replicates. Soil service operations were carried out by ploughing, smoothing and levelling, and then the field was divided according to the design used, seeds of wheat cultivar Ebaa 99 were planted on (15/11/2018) [6] with a seed amount of 120 kg. ha⁻¹ [7] and cultivation was carried out on lines with a length of 2 m and the distance between 1 line and another 20 cm, the unit of experiment was (2 x 2 = 4 m²).

The nitrogen fertilization process was carried out according to the fertilizer recommendation in the amount of 120 kg N.ha⁻¹ by used urea fertilizer (46% N) and by the two times, the first one 15 days after planting and the second was after 45 days from the first batch, and the phosphorus was added before planting 80 kg.P₂O₅ ha⁻¹, by used triple superphosphate fertilizers (46% P) [8]. Weeding and irrigation were carried out whenever required. The spraying process was carried out with Nano- fertilizers of potassium and boron in the flowering stage, the spraying process was carried out in the evening with a dorsal sprinkler, and a diffuser was added. In order to increase the efficiency of the spray solution and to decrease the surface tension of water and ensure that full of fresh leaves. The data were statistically analyzed according to the design used by the statistical program (Genestat) and the averages were compared according to the L.S.D test under the probability level of 5% [9].

Random samples were taken from the field soil from different places from each repeater and mixed together to form a complex sample and from a depth of (0- 30) cm before planting. Some physical and chemical properties were required in the experiment field and shown in (Table 1).
Table (1) some of the chemical and physical features of the experiment field

| feature                | Amount | The unit           |
|------------------------|--------|--------------------|
| PH                     | 7.2    |                    |
| E.C                    | 2.8    | desimines M⁻¹      |
| C.E.C                  | 21.8   | centimeter (+) kg⁻¹|
| Available nitrogen     | 25     | mg.kg⁻¹.soil       |
| Available Phosphorus   | 9.3    | mg.kg⁻¹.soil       |
| Available Potassium    | 180    | mg.kg⁻¹.soil       |
| Sand content           | 180    | g                  |
| Silt content           | 530    |                    |
| Clay content           | 290    |                    |
| Soil texture           |        | silty clay loam    |

4. The results and Discussion

4.1 The content of leaves from chlorophyll (mg.m²)

in Table (2) the results indicated a significant increase in the content of leaves from chlorophyll with an increase of potassium nanoparticles in the foliar fertilization solution, as the concentration K2 gave the highest average of 194.56 mg. m² while the non-spray treatment (control) K0 gave the lowest average of 165.67 mg. m², it may be the reason for the increase in chlorophyll content is the role of potassium in the activity of many important enzymes in addition to increasing the plant's ability to photosynthesis lead to increase the content of leaves from chlorophyll, this result was consistent with its findings [10].

The results showed in Table (2) that the concentrations of spraying with nanoparticles led to an increase content of chlorophyll, as it exceeded the highest concentration B2, which recorded a highest mean for this features was 193.00 mg. m² compared with control treatment B0, that had a lowest mean of the chlorophyll content which at 170.89 mg.m², and this increase content of chlorophyll when increasing concentrations of spraying with boron may be due to its role in the activity of many important enzymes in the process of photosynthesis, which led to increase the content of leaves from chlorophyll, and this result is consistent with what indicated by Baqer, [11].

interaction between potassium and boron spray had a significant effect in this feature, as the combination (B2 × K2) gave the highest average was 210.33 mg. m², while the combination (V2 × S0) gave the lowest average amounted to 153.33 mg. m² (Table 2).

Table (2) Effect of spraying Nano fertilizers of potassium and boron and their interaction on chlorophyll content in leaves (mg.m²)
4.2. Plant height (cm)

Table (3) showed the significant increase in height of plant and an increase due to potassium concentration in the foliar solution as the highest concentration K2 gave the highest mean of 98.24 cm compared with control treatment K0, that gave the lowest mean height of the plant reaching 91.77 cm, and the reason may be due to the role of potassium in the strength of growth of the root system, which contributes to increasing the plant's ability to absorb nutrients, which in turn leads to increased products of photosynthesis and its accumulation in the plant, which reflects positively on increase in height of plant, and that result is consistent with Kumar [12].

The results in Table (3) showed a significant difference when spraying boron in the average height of the plant, as the highest concentration exceeded B2 by giving the highest mean of this features of 99.16 cm while the control treatment gave the lowest mean about 91.39 cm, and this increase may be due to the role of boron in Increased activity of growth rates in plants due to the increase in the efficiency of roots to absorb other nutrients and move them into the plant, this agreed with result found by [13].

No any significant difference was showed for the interaction among potassium and boron spray on plant height (Table 3).

|       | B0  | B1  | B2  | Mean K | L.S.D 0.05 | K | B | K × B |
|-------|-----|-----|-----|--------|-------------|---|---|-------|
| K0    | 87.83 | 92.33 | 94.00 | 91.77 | 4.56 | N.S |
| K1    | 91.67 | 96.27 | 98.70 | 95.53 | 1.38 |
| K2    | 95.80 | 99.00 | 102.67 | 99.16 |     |

Table (3) Effect of spraying Nano fertilizers of potassium and boron and their interaction between them on height of plant, cm

4.3. Number of spikes in m2 (spike m2)
The potassium concentration of K2, which did not differ significantly from K1, which resulted the highest average about 395.90 spikes.m² and differed significantly on the concentration of K0, which recorded a lowest mean of 346.30 spikes.m² in relation to spikes number in m² (Table 4). The reason may be due to the important role of potassium in the hormonal balance process between auxins and cytokinins. This contributed to creating an opportunity towards reducing apical dominance and thus increasing the plant's ability to produce branches and then ensuring natural growth for these branches to produce the largest number of spikes that agreed with what recorded by Aboudahi et al [14].

The results are shown in Table (4) the significantly effect of spraying with Nano boron on the characteristic number of spikes in m², as concentration B2 gave a significant superiority over the concentrations B1 and B0 with a percentage increase in succession, the reason may be due to the important role of boron in stimulating many vital processes and its role in the flowering and contract stage, in addition to its important role in increasing the fertility rate, which reflects positively increase number of spikes in m², these result agreed by Zoz et al. [15].

No significant differences were observed for the interaction between potassium and boron spray in the number of spikes in m² (Table 4).

Table (4) Effect of spraying Nano fertilizers of potassium and boron and their interaction between them on Number of spikes in m² (spike. m²)

|        | K0         | K1         | K2         | Mean         |
|--------|------------|------------|------------|--------------|
| B      | K          |            |            |              |
| B0     | 310.70     | 373.30     | 335.00     | 339.70       |
| B1     | 348.30     | 378.30     | 416.70     | 381.10       |
| B2     | 380.00     | 403.30     | 436.00     | 406.40       |
| Mean K | 346.30     | 385.00     | 395.90     |              |
| L.S.D 0.05 | K         | B         | K × B      |              |

4.4. Number of grains per spike (spike. m²)

The results in Table (5) indicate that there was a significant effect of spraying with Nano fertilizer of potassium on increasing the number of grains in the spike, as the concentration of K2 gave the highest average for this trait was 56.64 spike⁻¹ grain, which did not differ significantly from the concentration K1, which gave an average of 54.72 spike⁻¹ grain while (K0) the control treatment gave a lowest mean of number of grains in the spike at 51.94 spike⁻¹. Perhaps the reason is due to its contribution to increasing the efficiency of transferring the photosynthesis process from the source to the rest of the plant parts in general and the spike in particular, that help to an increase number of grains. This result was agreed and with that recorded by Khan and Aziz [16].

Table (5) showed that spraying by Nano fertilizer of boron resulted in a significant increase in the number of grains in the spike, as it recorded the highest average of 57.33 spike⁻¹ for K2 while K0, the control treatment gave a lower mean for this trait was 50.59 spike⁻¹, and perhaps the reason is due to the direct influence of boron on the growth of reproductive parts of the plant, and these results are consistent with Mandal and Sharma [17].

There is no significant differences were observed for the interaction between spray Nano fertilizers of potassium and boron in the number of pills per spike (spike⁻¹), (Table 5).
Table (5) the effect of spraying Nano fertilizers of potassium and boron and their interaction between them on number of grains per spike. (spike. m²)

| K   | B   | Mean |
|-----|-----|------|
|     |     |      |
| K₀  | 48.00 | 51.83 | 51.93 | 50.59 |
| K₁  | 52.83 | 55.33 | 58.00 | 55.39 |
| K₂  | 55.00 | 57.00 | 60.00 | 57.33 |
| Mean K | 51.94 | 54.72 | 56.64 |
| L.S.D 0.05 | 3.34 | 1.06 | N.S |

4.5. The weight of 1000 grains. (g)
Table (6) showed that there was no significant difference for spraying with Nano fertilizers of potassium and the interaction between them on the characteristic of weight 1000 grains.

Table (6) Effect of spraying Nano fertilizers of potassium and boron and their interaction between them on the weight of 1000 grains. g

| K   | B   | Mean |
|-----|-----|------|
|     |     |      |
| K₀  | 39.67 | 37.20 | 40.53 | 39.13 |
| K₁  | 38.67 | 39.87 | 37.60 | 38.71 |
| K₂  | 38.67 | 36.93 | 38.13 | 37.91 |
| Mean K | 39.00 | 38.00 | 38.76 |
| L.S.D 0.05 | n.s | n.s | n.s |

4.6. Yield of grain (kg. ha⁻¹)
Yield grains recorded a significant increase in its averages with an increase in the potassium Nano fertilizer in the spray solution, as the higher concentration K₂ gave the highest mean for this feature was 6761 kg.ha⁻¹, recording a significant superiority over the comparison treatment, that gave 6175 kg ha⁻¹ (Table 7) Perhaps the reason is because the important function of potassium in accelerating the transport of the photosynthesis process from the places of manufacture to the estuary from source to sink, that had increased in number spikes per m² (Table 4) and also an increase in the number of grains in spike Table (5), which led to an increase of the yield grains, this result agreed with Al-Juthery et al. [18].
Table (7) showed that there was a significant increase in the yield of grain with an increase in the Nano boron concentration in the foliar solution, as the highest B2 concentration recorded the highest average for this feature was 7044 kg ha^{-1}, while B0 gave the lowest mean of grain yield, reached 5780 kg ha^{-1}, the reason for this increase of yield of grain when spraying with boron may be due to the increase in the components of yield, which are the number of spike per m^{2} (Table 4), also the increase in the number of grains in the spike (Table 5), which led to an increase in the total grain yield, these results were agreed with Baqer [19].

No significant difference was observed for the interaction among potassium and boron in Nano fertilizers in this characteristic (Table 7).

### Table (7) Effect of spraying Nano fertilizers of potassium and boron and their interaction on grain yield (kg ha^{-1})

|         | K_0 | K_1 | K_2 | Mean B |
|---------|-----|-----|-----|--------|
| B_0     | 5224| 6017| 6100| 5780   |
| B_1     | 6567| 6533| 6833| 6644   |
| B_2     | 6733| 7050| 7350| 7044   |
| Mean K  | 6175| 6533| 6761|         |
| L.S.D 0.05 |     |     |     |        |
| K       | 213.80 |     |     |        |
| B       | 201.50 |     |     |        |
| K × B   | N.S     |     |     |        |

4.7. Biological yield (kg ha^{-1})

Results of Table (8) revealed that the biological yield took a significant increase in its averages with an increase in the potassium Nano fertilizer concentration in foliar fertilizers solution, as the higher concentration K2 gave the highest mean average of 14533 kg ha^{-1}, while control treatment K0 gave 12452 kg ha^{-1}, the increase in the biological yield perhaps because of an increase in height of plant (Table 3), also increase in grain yield (Table 7), which reflected positively on the increase in the biological yield, and this result agreed with findings of Gomaa, et al. [20].

The effect of spraying with Nano fertilizers of boron was significantly affected in this characteristic, as the highest concentration B2 exceeded in giving highest mean of the biological yield amounted to 14328 kg ha^{-1}, than B0 gave the lowest mean for this feature amounting to 12747 kg ha^{-1} (Table 8). The result agreed with Khan, et al. [21].

No significant differences were observed for the interaction between potassium and boron Nano fertilizers in the feature of biological yield (Table 8).

### Table (8) Effect of spraying Nano fertilizers of potassium and boron and their interaction on biological yield (kg ha^{-1})

|         | K_0 | K_1 | K_2 | Mean B |
|---------|-----|-----|-----|--------|
| B_0     |      |     |     |        |
| B_1     |      |     |     |        |
| B_2     |      |     |     |        |
| Mean K  | 213.80| 201.50| N.S |        |
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