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## The Role of Nano Potassium and Boron In Increasing Wheat Yield

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### Abstract:

In the 2022-2023 growth season, a field experiment was conducted at a field in Hamza Al-Sharqi district, Al-Qadisiyah Governorate. The main aim of the experiment was to study the effect of applying potassium nano and boron foliar (foliage) on some growth and yield characteristics of bread wheat (*Triticum aestivum* L.) Ibaa 99 cultivar. The experiment was laid out as a factorial experiment using randomized complete block design (RCBD) with three replications. The experiment structure included two factors: the first factor was potassium nano-foliar application at three concentrations (0, 2, and 3 gm L<sup>-1</sup>), and the second factor was boron foliar application at two concentrations (0 and 300 mg L<sup>-1</sup>) during flowering. The results indicated that potassium (3 gm L<sup>-1</sup>) was the best for all the traits examined, including plant height (101.59 cm), spike length (13.40 cm), spikes number (424.8 spikes m<sup>2</sup>), grain number (62.87 grains spike) and total yield (5.503 Mg ha<sup>-1</sup>). All the previous traits (plant height, spike length, spikes number, grain number and yield) have lower average values than the control. Likewise, the best results, for all traits we examined, were for boron (300 mg L<sup>-1</sup>) compared to the unsprayed control. For boron the plant height was 101.23 cm, spike length was 13.30 cm, spikes number was 445.4 spikes m<sup>2</sup>, grain number was (58.66 grains spike) and total yield was (5.171 Mg ha<sup>-1</sup>). All the previous traits were lower in average values of the treatment which was not sprayed for boron.

**Keywords:** nano potassium, boron, wheat.

## **Introduction:**

Wheat, known scientifically as *Triticum aestivum* L., is a cereal crop from the Poaceae family that holds great importance especially in terms of food security and economic importance as a crop as wheat is ranked one of the staple food crops of daily diets. Each year it holds first place among staple food crops because it supplies adults on average 26% of their daily energy and 46% of their daily protein needs with the added benefit of various vitamins, minerals, and essential amino acids (Saudi, 2013).

Nanotechnology is one of the current methods of improving crops and helping them grow and yield benefits. It is a promising technology for improving plant growth and increasing productivity because nanoparticles can better facilitate plant uptake water and nutrients. Nanoparticles size gives improved crop yield and quality properties simply because their small size facilitates absorption. Additionally, nanotechnology also helps agriculture reduce economic costs by improving fertilizer uptake and lowering production costs (Al-Ramadi et al. 20116).

When applied via foliar spray, nutrients are a useful method for supplying macro and micro-nutrients to plants. Furthermore, it is an economical, easy, and rapid means of application that does not adversely affect soil, and allows rapid plant uptake of nutrients needed during numerous growth stages (Ali et al., 2014).

Potassium, is an essential nutrient for plants in that it provides root development and is important for a plant's growth cycle and reproduction. Furthermore, potassium is important for thousands of biochemical processes, such as, division and expansion of cells, promotes the extension of pollen tube growth and increase plant nutritional value, seed size and weight which promotes yield increase and crop quality (Malvi, 2011).

Boron is a required element that facilitates important processes in plants because of its essential functions, especially for fruit set, stimulating many vital processes as part of growth and flowering, pollination nucleus tube growth and germination (Shireen et al. 2018).

This study was completed to determine the effect of foliar applied potassium and boron nano-fertilizer on wheat yield.

## **Materials and Methods**

An experiment was conducted in agricultural fields during the 2023-2024 growing season at Hamza Al-Sharqi district, Al-Qadisiyah Governorate, 55 km north of Muthanna Governorate to investigate the influence of foliar application of potassium and boron nano-fertilizers on yield and growth of wheat. The experiment was designed with a 2 x 3 factorial design with two factors of potassium nano-fertilizer in three concentrations (0, 2 and 3 gm L<sup>-1</sup>, designated as K1, K2 and K3 respectively), and boron fertilizer in

two concentrations (0 and 300 mL L<sup>-1</sup>, designated as B1 and B2 respectively). The experimental design was a randomized complete block design (RCBD) with three replications. Soil preparation included chisel plowing, leveling and all other operations for planting crops. The field was divided according to the experimental design. Seed of Ibaa 99 wheat variety were planted on November 15, 2023 (Al-Asseel et al., 2018) with rate of sowing of 120 kg ha<sup>-1</sup> (Al-Maeini and Mohsin, 2016). The seeds were planted in rows of 3 meters long, with 25 cm space between rows. The experimental unit was 6 m<sup>2</sup> (3x2).

Fertilization of nitrogen, to the recommendation of 120 kg N/ha, applied in two applications of urea fertilizer (46% N). The first 2 weeks after planting and again 40 days after planting the first application. Phosphorus was also applied at the rate of 80 kg P ha<sup>-1</sup> just before planting (Al-Abedi, 2011) using triple superphosphate (46% P). Weeds and

irrigation were carried out as necessary. Foliar applications of nano-potassium and boron fertilizers were made while the plants were in the flowering stage. The time in the morning before the sun was the optimal time for spraying using a hand-held sprayer. A surfactant was added to the spray mixture to aid in increasing the efficacy of the spray and decrease surface tension to allow total coverage on the leaf surface.

The data was analyzed statistically with the Genestat statistical software package. Mean values were compared using the Least Significance Difference (LSD) test at a 5% probability level (Al-Rawi and Khalaf Allah, 2000).

Random soil samples were collected from areas throughout the field, and thoroughly mixed together to form a composite soil sample before planting. Soil samples were taken down to a depth of 30cm. A laboratory analysis of the physical and chemical properties of the soil were conducted (Table 1).

**Table (1) Some essential chemical and physical properties measured for the experimental soil.**

Item	Amount	The unit
<b>pH</b>	7.3	
<b>C.E.C</b>	22.5	centimeter (+) kg <sup>-1</sup>
<b>E.C</b>	3.1	desimines M <sup>-1</sup>
<b>Available nitrogen</b>	27	mg.kg <sup>-1</sup> . soil
<b>Available Phosphorus</b>	9.2	mg.kg <sup>-1</sup> .soil
<b>Available Potassium</b>	185	mg.kg <sup>-1</sup> . soil
<b>Sand content</b>	170	gm
<b>Silt content</b>	435	
<b>Clay content</b>	385	
<b>Soil texture</b>	salty clay loam	

## Results and Discussion

### Plant Height (cm):

Table (2) indicated that an increase in plant height as a result of foliar application of nano-potassium could be statistically noted. The highest nano-K combination (K3) had the highest average plant height (101.59 cm), whereas the lowest combination (K1) had the lowest plant height average (98.49 cm). An increase in plant height could have been due to the effect of potassium on root growth resulting in increased nutrient uptake from the soil. Increased nutrient uptake could result in an increase in the total photosynthetic products and accumulation of these products in the plant, resulting in increased overall plant growth and thus plant height, which is consistent with Kumar et al . (2016)

Similarly, the results showed a significant difference in plant height

**Table (2) Effect of foliar application of nano-potassium and boron, and their interaction, on plant height (cm).**

Potassium (k)	Boron (B)		Mean
	B1	B2	
K1	95.42	101.56	98.49
K2	98.83	102.31	100.57
K3	100.36	102.82	101.59
Mean	98.21	101.23	
L.S.D <sub>0.05</sub>	B	L	Interaction
	0.901	1.103	1.560

### Spike Length (cm):

The results presented in Table (3) reveal a noteworthy enhancement in spike length associated with higher concentrations of nano-potassium in the foliar application. The spike length reached its highest mean length of

when boron was applied. The B2 concentration resulted in the highest average plant height (101.23 cm), whereas the control treatment had the average plant height of 89.21 cm. This increase could have been due to the effect of boron on plant growth rates, which might have been due to its stimulating effect on root efficiency in absorbing and transporting other nutrients, plus its role in cell elongation. This is consistent with Al-Hilfy and Zeboon.(2016)

In terms of the interaction effect between the nano-potassium and boron, the interaction effects were significant. Plant height increased with the increase of both I.P.s. The combination(K3B2) had the highest height average (101.23 cm) while the other combination had a lowest height average (K1B1) for plant height of 95.42 cm.

13.40 cm for the applicant that contained 0.5% potassium (K3), while control treatment (no nano potassium applied) had lowest mean spike length of 12.48 cm .

An increase in spike length was also reported with increasing concentrations

of boron in the foliar solution; B2 had the highest mean spike length of 13.30 cm and B1 had the lowest mean spike length of 12.48 cm .

The benefits associated with boron could possibly be due to its role in promoting cell division and enlargement. Boron also increases cytokinin activity (a growth hormone) which may help to maintain chlorophyll levels, prolong greenness in leaves, delay senescence, and increase photosynthesis time to allow for the building of the products of

photosynthesis which in turn promotes plant growth, and subsequently support spike length (Al-Maeini and Mohsin, 2016).

In terms of nano-potassium and boron interaction effect, the B2K3 combination performed best resulting in average spike length of 13.81 cm, while B1K1 had the lowest average spike length 11.96 cm together with the control treatment K1B1 also producing the same lowest average spike length of 11.96 cm.

**Table (3) Effect of foliar application of nano-potassium and boron, and their interaction, on spike length (cm).**

Potassium (k)	Boron (B)		Mean
	B1	B2	
K1	11.96	12.99	12.48
K2	12.49	13.10	12.80
K3	12.98	13.81	13.40
Mean	12.48	13.30	
L.S.D <sub>0.05</sub>	B	L	Interaction
	0.453	0.554	0.784

**Spike number (spikes m<sup>2</sup>):**

Table (4) shows a highly significant increase in spike number per square meter as a result of the application of each of the nano-potassium treatments. Of the nano-potassium treatments, the K3 treatment produced the highest average number of spikes (424.8 spikes m<sup>2</sup>) while the K1 treatment produced the lowest (98.49 spikes m<sup>2</sup>). This outcome is likely due to potassium's significant role in regulating hormonal accumulation of auxins and cytokinins which reduces apical dominance increasing the plants ability to produce branches.

Additionally, this promotes normal branch growth and ultimately production spikes. The results are in line with work done by Abu Dahi et al . (2009)

The results also showed a significant effect of boron foliar application. The B2 treatment significantly had a higher average number of spikes per square meter (445.4 spikes m<sup>2</sup>) than that of the B1 (325.1 spikes m<sup>2</sup>). This can be explained by the importance boron has in stimulating various physiological processes especially during flowering and grain set, and its ongoing importance to increase fertility

ultimately increasing spike number per square meter. These results were echoed by the findings of Zoz et al . (2016)

potassium and the boron, the K3B2 combination had the highest value (480.1 spikes m<sup>2</sup>) while the K1B1 had the lowest value (255.5 spikes m<sup>2</sup>).

When looking at the effect of the interaction between the nano-

**Table (4) Effect of foliar application of nano-potassium and boron, and their interaction, on the spikes number (spikes m<sup>2</sup>).**

Potassium (k)	Boron (B)		Mean
	B1	B2	
K1	255.5	416.4	335.9
K2	350.1	439.7	394.9
K3	369.7	480.1	424.8
Mean	325.1	445.4	
L.S.D <sub>0.05</sub>	B	L	Interaction
	38.90	47.64	67.38

**Number of grains per spike:**

The data presented in Table 5 indicate an appreciable enhancement in the quantification of grains per spike, which can be linked to the employment of nano-potassium fertilizer on the plants. The treatment K3 revealed the elevated average number of grains per spike (62.87), whilst the control treatment K1 achieved the lowest average (48.31 grains per spike) .

In the context of boron (B2) treatment, this also had a significant effect on this trait with B2 recording the highest

average (58.66 grains per spike) compared to (B1) achieving the lowest (55.49 grains per spike). This difference could be explained by the significant role of boron in activating various physiological processes and its most important role during flowering and grain setting, as well as its significant effect on grain fertility .

In regard to nano-potassium and boron treatment interaction, it was seen that K3B2 achieved the highest average grains per spike (64.62 grains spike) whilst K1B1 achieved the lowest (47.93 grains spike).

**Table (5) Effect of foliar application of nano-potassium and boron, and their interaction, on the number of grains per spike (grains spike).**

Potassium (k)	Boron (B)		Mean
	B1	B2	
K1	47.93	48.70	48.31
K2	57.42	62.67	60.04
K3	61.13	64.62	62.87
Mean	55.49	58.66	
L.S.D <sub>0.05</sub>	B	L	Interaction
	1.251	1.532	2.167

### Grain yield (ton ha<sup>-1</sup>):

Table (6) indicates a marked increase in average grain yield associated with the concentration of nano-potassium fertilizer applied as foliar spray, with K3, the highest concentration of nano-potassium, leading to the greatest average grain yield of 5.503 ton ha<sup>-1</sup>. In K3, average grain yield was significantly greater than the control treatment, which achieved 4.383 ton ha<sup>-1</sup> and may be partially due to the importance of potassium in increasing the rate of photosynthesis and improving the transfer of photosynthate from the source to the sink, which increased the spike number (Table 4), increased the number of grains per spike (Table 5), and

contributed to increasing grain yield at harvest .

Similarly, the results also showed a marked increase in average grain yield as boron concentration in the foliar spray solution increased, with the highest concentration of boron (B2) reaching the highest average of grain yield (5.171 tons ha<sup>-1</sup>) while the lowest boron concentration (B1) gave the lowest average grain yield (4.821 tons ha<sup>-1</sup>). Boron application increases grain yield likely due to increased yield components, such as the number of spikes per square meter (Table 4) and the number of grains per spike (Table 5). Overall, application of boron increased total grain yield. This is consistent with Baqer (2014).

**Table (6) Effect of foliar application of nano-potassium and boron, and their interaction, on grain yield (ton ha<sup>-1</sup>).**

Potassium (k)	Boron (B)		Mean
	B1	B2	
K1	4.417	4.350	4.383
K2	4.707	5.497	5.102
K3	5.340	5.667	5.503
Mean	4.821	5.171	
L.S.D <sub>0.05</sub>	B	L	Interaction
	0.2174	0.2662	0.3765

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