Impact of mineral ferlizater and Nano Potassium on Wheat (*Triticum aestivum L.*) growth Traits

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Abstract

Worldwide, wheat (*Triticum aestivum* L.) is a fundamental crop, critical as a primary food source for the original population. In the harvest season, 2023-2024, a series of out-of-door pot trials were conducted to estimate the identical urea fertilization combined with various levels of nano-potassium (K NPs) on wheat growth treats. The experiment was designed with three different treatments as the control group, a group recommended urea amount, and groups treated with K NOs at 500, 1000, 1500, and 2000 ppm with three replicates, The findings result revealed that the average plant height (cm) recorded 68.4 cm for the 1000 and 1500 ppm of K NPs treatment. The average number of leaves per plant was highest and recorded 10.6 leaves per plant for the treatment of K NPs 1500 ppm, followed by 1000 ppm, which recorded 9.38. For fresh weight (g), the plant normal was 75.75 g, with K NPs at 1500 ppm and recommended urea dose, followed by 1000 ppm, which recorded 67.8 g; in terms of dry weight (g) the heights average was 47.35 g by using 1500 ppm K NPs with recommended urea level, followed by 1000 ppm, which recorded 41.8 g. The average chlorophyll content were 1.96 µg/g for the 1500 ppm K NPs and recommended urea and 1.66 µg/g for the 1000 ppm K NPs treatment, the average relative growth rate was 0.814 for K NPs at 1500 ppm with recommended urea and 0.762 for 1000 ppm K NPs and recommended urea. Likewise, spike length, number of grains per spike recorded 17.4, 20.4 cm; 44.2 and 48.8, respectively.. Overall, the results indicated that the most effective treatments were the combination of recommended urea with K NPs at the rate of 1500 ppm, followed by the treatment at 1000 ppm of K NPs treatment.
Keywords: Wheat; chlorophyll content; K NPs; urea; pots; morphological characters

Introduction

Wheat (*Triticum aestivum L*) is one of the most important crops in the world, and 50% of the world's population relies on it mainly to feed. Its essential proteins and salutary filaments are vital for mortal nutrition. Wheat and durum wheat have been cultivated in the West for centuries to give food and energy. For over a century, plant breeders have concentrated on enhancing wheat kinds to boost grain yields **(Aljenaby *et al*., 2022). Alghargan and Almubarak (2024); (Bernela *et al*., 2021)** stated that the operation of nano fertilizers in fertilization programs are regarded as an effective volition to traditional conditions. It offers numerous advantages due to its use in lower quantities and its high stability under various conditions. This enhances the capability to store it for longer periods, thereby furnishing multiple benefits for both shops and the terrain, as well as supporting the agricultural economy in current circumstances

Kazem *et al*. (2024) indicated that different quantities of nano-NPK and biochar significantly influenced plant height, leading to improved growth. The chlorophyll indicator increased, suggesting enhanced photosynthesis and a greater number of tillers per plant. Significant differences in grain yield were observed, with measurements and lengths of wheat grains recorded as (78.633 kg hl^{-1}, 3.240 mm, 3.380 mm, and 6,500 mm) from the combinations of (Aras x booting x 300 mg L^{-1}) and (Aras x booting x 150 mg L^{-1}) **(Mahmood *et al*., 2024)**. Wheat cultivars significantly influenced plant height, total tiller count, effective tiller count, spike length, kernels per spike, biomass yield, grain yield, 1000-kernel weight, and straw yield. As a result, the application of 150 kg ha^{-1} of composite NPSB with the Shorima variety achieved the highest grain yield (5,952.38 kg ha^{-1}) and a notable net benefit (122,267 ETB ha^{-1}) with a low rate of return. Correlation analysis also indicated positive values for all parameters, except for the crop index, according to(**Hajigame *et al*. 2023).**

Singh *et al*. (2023) Noted that Wheat treated with 75 NPK combined with Nano N and Nano P at 30 and 45 days of growth showed significantly improved growth metrics, Plant Height was 91.23 cm, Tillers per Square Meter was 322.5, Leaf Area Index(LAI) was 0.83, Dry Matter Accumulation per Square Meter was 1532.7 g,The combination of 50 compound fertilizer, 50 biofertilizers, and 50 nano fertilizer yielded the stylish results, including Number of spikes 428.4 m^2, Weight of 1000 grains 41.66 g, Seed yield 5.15 tons ha^{-1}, Biological yield 15.89 tons ha^{-1} (**Al- Ghazali and Al- Zubaidy ., 2023)**, meanwhile tht treating wheat with nanofertilizers, was observed that there are Significant differences were found among NPK levels, with 4 mg L^{-1} showing superior results across all traits consistent with **(Al- Jibouri and Mohammed , 2022).**

In the interim the combination of 100% Recommended Dose of Fertilizers (RDF) + Soil Treatment (ST) with nano DAP and two foliar sprays of nano urea at 35 and 55 days after sowing (DAS) resulted in the highest dry matter accumulation and crop growth rate (CGR) across various growth stages. This treatment also yielded the highest grain yield **(Noaema *et al*., 2020).**

Along with **Hussein *et al*. (2023),** significant differences were observed in most parameters due to potassium treatments, wheat cultivars, and their interactions. The application of 2 g/L of potassium led to increases in grain yield (5.51 t/ha), protein content (10.52), and plant height (95.60 cm). Grain weight was significantly influenced by the interaction between swab stress and the application of either nano-fertilizer or potassium citrate. Both treatments showed potential benefits in enhancing wheat yield and mineral content under varying salinity levels. The booting stage with a 2 g/L concentration of nano potassium yielded the best results, including the highest number of grains per spike (44.43 and 44.88) and gluten percentage (16.59 and 16.71), as noted by **(Al-Ajili and Al-Saeedi 2023).**

Najm and Juthery (2023) indicated that the combination of nano-phosphorus, nano-potassium, carbon nanotubes, and Sepehr 4 resulted in the highest plant height (134.5 cm), biological yield (20.710 Meg ha), grain yield (6.067 Meg ha), nitrogen concentration in grains (1.40), and protein percentage (8.331). This combination also achieved the highest chlorophyll index (42.63 SPAD) and significant increases in concurrence chance (68.780 and 68.670). The highest grain yields for maize (52.9 q/ha) and wheat (33.4 q/ha) were recorded when 100 RDF was applied through conventional sources along with foliar applications of bio-nano P and K (**Baghla and Sharma, 2023).**

Using of 2000 mg/L K NPs treatment in wheat by **Alshatb and Alamery, (2022)** improved the highest traits, except for observance and stem periphery, where it was similar to the 1000 mg/ L treatment. Also, the 100-ppm cure of K NPs fertilizer redounded in the highest biomass accumulation, increased nitrate reductase exertion, enhanced photosynthetic exertion, SPAD values, and total chlorophyll content. Meanwhile, the 200-ppm cure led to a significant increase in yield **(Marquez *et al*., 2022).**

Along with **Rostami *et al*. (2022),** who concluded that the effects of K NPs failure stress at all irrigation stages. The high yield (3.17 tons/ ha), along with better morphological characteristics and water use effectiveness (0.112 kg. Mm $^{-1}$), was achieved with the operation of 3 kg ha-1 of K NPs under normal irrigation. Likewise, this treatment reduced the impact of water deficiency on yield and morphological traits by roughly 25%, especially during the seed-filling stage, The highest concentration (8 mL/L) of K NPs significantly increased chlorophyll content (194.56 mg/m^2) and plant height (98.24 cm). It also enhanced spikes (16.41%), grains per spike (8.29%), and grain yield (17.94%). **(Noaema and Alhasany , 2020)**

Freshwater resources in Libya negatively affect wheat productivity and increase irrigation costs. Also, soil that lacks water suffers from a lack of organic nutrients, which prompts us to use some modern methods to raise soil fertility. It is also noted that recent climate changes, including very high temperatures and low rainfall, increase the postponement of wheat production, which is a reason for reducing the country's food security and increasing dependence on imports, which in turn affects the local economy. To overawe these worries, we have followed the latest methods for the purpose of indorsing growth and plant development and for the purpose of establishment the plant’s resistance and its tolerance to unsuitable conditions resulting from environmental conditions and various agricultural pests. Therefore, the primary object of the current experiment is to determine the impact of K NPs combined with urea on vegetative growth and yield traits in wheat.

Material and methods

An experiment was conducted in pots at the Herbarium of the Faculty of Science, University of Sebha, Libya. The wheat variety" Dhahab" was planted in 30 pots, with 20 seeds in each pot. After the complete germination, thinning was carried out to retain only 10 plant/ pot. The soil used was a mixed type inclined towards flaxen. The data were analyzed using a Complete Randomized Block (CRB) with 5 replications. The treatments comprised of the recommended urea for wheat, which is 150 Kg/feddan, applied according to the pot area incontinently after planting, along with four different attentions of K NPs. K NPs was added at the following periods 15, 30, 45, and 60 days, using the different levels at 500, 1000, 1500, and 2000 ppm beside the control group without treatment.

The following measures were taken: Plant height (cm) measured from the soil position to the tip of the spike (banning the top), and the average height for each experimental unit was calculated, as mentioned by **(Alqasima and Al- Ghazal., 2024);** number of leaves (leaves/plant) as commented by (**Al-Tamimi *et al*., 2023);** fresh weight (g); dry Weight (g) was measured after placing the plant in a roaster at 70 °C for 24 hours. according to **(Al-Tamimi *et al.*, 2023);** spike length (cm) measured from each experimental unit, from the base to the tip of each spike, and equaled, as suggested by (**Alqasim and Al- Ghazal., 2024);** number of grains per spike (grain/spike). was determined by comprising the number of grains from ten aimlessly named harpoons in each experimental unit, as reported by **(Alqasim and Al- Ghazal. (2024);** relative growth rate computation was calculated according to the following equation i.e. RGR = (Final dimension - original dimension)/(original dimension) * 100 According to **(Atkin *et al*., 1996)** and - Chlorophyll Content of leaves (SPAD) content was assessed using a SPAD-502 chlorophyll cadence, with readings taken from three leaves of each seedling and equaled for each treatment, as stated by **(Al-Tamimi *et al.*, 2023).** The data were anatomized using a complete Randomized Block, and means were compared using (L.S.D) at 0.05%.

Table (1) Soil Physical and Chemical parcels of the Soil Used in the Pots

Soil Properties	
A) Mechanical Analysis	
Clay %	25.00
Sand %	70.00
Silt %	30.00
Soil Texture	
B) Chemical Properties	
Ph (1: 1)	7.8
Ec (Ds/M)	2.2
1) Soluble Cations (1:2) (Cmol/Kg Soil)	
K+	1.2
Ca++	8.0
Mg++	3.5
Na+	1.2
2) Soluble Anions (1 : 2) (Cmol/Kg Soil)	

Co3--+ Hco3-	2.6
Cl-	1.6
So4—	2.0
Calcium Carbonate (%)	4.0
Total Nitrogen %	0.12
Available Phosphate (Mg/Kg)	30
Organic Matter (%)	2.5

Results and discussion

Data in Table 2 presents that reveals significant differences among the interesting treatments across several characters. The treatment involved K NPs1500 ppm+ 150 kg urea, which had the haughtiest average for plant height (68.4 cm), followed by K NPs 1000 ppm with urea, which reached the same value (62.4 cm). The control group had the smallest plant height was (48.75 cm).The height average number of leaves per plant was recorded for the K NPs at 1500ppm + urea treatment by 10.6, and with K NPs 1000 ppm + urea were 9.38 leaves (Table 2). The smallest normal was noted in the K NPs at 2000ppm + urea treatment, which had 4.16 leaves.

In terms of fresh weight, K NPs (1500ppm) with urea led to a normal of 75.75 g, while KNPs at 1000ppm+ urea showed 67.8 g The smallest fresh weight was associated with kNPs at 2000ppm + urea. For the dry weight, K NPs 1500 ppm + urea achieved the proudest normal 47.35 g, followed by K NPs1000ppm+ urea (41.8 g). The treatment of K NPs 2000ppm + urea recorded the smallest average dry weight, which was 21.52 g as presented in Table 2. K NPs at 1500ppm + urea also had the best average chlorophyll content at 1.96, with K NPs 1000ppm + urea following at 1.66. The treatment of K NPs 2000ppm + urea showed the smallest average chlorophyll content at 0.88. The relative growth rate was the highest for K NPs 1500 ppm + urea at 0.814, while K NPs 1000 ppm urea recorded a normal of 0.762. The treatment of K NPs 2000ppm+ urea had the smallest relative growth rate at 0.568.

The data in Figure 1 expressions that in terms of spike length, K NPs 1500ppm+ urea stands out with the haughtiest normal of 20.4 cm, demonstrating its effectiveness in promoting high spike growth. K NPs 1000ppm + urea follows nearly with an average length of 17.4 cm, indicating that it also supports good growth, although not as prominently as K NPs 1500ppm + urea. On the other hand, K NPs 2000ppm + urea shows a significantly lower average spike length at 10.2 cm, suggesting that this treatment may not be as effective in enhancing spike length.

While the data for spike weight, showed that K NPs at 1500pm K NPs and urea leads to an emotional normal of 4.4 g, nearly chased by K NPs 1000ppm at 4.3 g. This slight difference indicates that both treatments give substantial benefits in terms of spiking weight. In discrepancy, K NPs 2000ppm recorded the smallest average spike weight at 1.9 g, showing an implicit insufficiency in this treatment's capability to enhance spike weight (Figure 1). The data in Figure 1 displayed incipiently, regarding the average number of grains per spike, K NPs 1500 ppm urea excels formerly further with a normal of 48.8 grains, which is reflective of its effectiveness in maximizing grain product. K NPs 1000 ppm with recommended urea, also showed strong performance with a normal of 44.2 grains, while K NPs 2000ppm urea significantly lags before with only 23.4 grains per spike. This lower count suggests that K NPs 2000ppm urea may not be suitable for achieving optimal grain yield. Overall, these values showed the clear advantages of K NPs 1000,1500 ppm K NPs + urea in enhancing spike length, weight, and grain count, while K NPs 2000 ppm+ urea appear less effective across all measured parameters.

Data in table (2) indicates that there was a significant effect on interesting parameters, including plant height, number of leaves, fresh weight, dry weight, chlorophyll content, and relative growth rate when treated with K NPs at a rate of K NPs 1500 ppm +urea. This comprehensive analysis easily illustrates the multifaceted benefits of this treatment on plant development and productivity. This treatment is considered optimal for achieving the high values in all the forenamed studied traits, reflecting its effectiveness in enhancing overall plant health and growth. The treatment with nano-potassium at 1000 ppm + recommended urea recorded the alternate highest value for these traits, indicating that, indeed, at a lower level, K NPs can still appreciatively influence plant characteristics and yield eventuality. In discrepancy, the smallest rates were generally observed in the treatment with K NPs at 2000 ppm + recommended urea, which had a negative impact on the utmost of the measured traits. This suggests that while K NPs can be salutary, inordinate attention may lead to mischievous goods, increasing the significance of lozenge in agricultural practices. Overall, the findings emphasize the critical part of the balanced nutrient operation in optimizing plant growth and maximizing agrarian affairs.

Table (2) the average values for vegetative growth and yield on wheat

Treatment	Plant height (cm)	number of leaves/ plants	Fresh wight (gm)	Dry wight(gm)	RGR g/g/day	Chlorophyll (µg/g)
Control	48.75 e	5.13 e	46.6 e	26.45 e	0.612 e	1.138 d
Uria	51.6 d	6.17 d	53d	31.8 d	0.664 d	1.16 d
K NPs 500 ppm+uria	56.2 c	7.8 c	60.8 c	36.5 c	0.712c	1.46 c
K NPs 1000 ppm+uria	64.4 b	9.38 b	67.8 b	41.8 b	0.762 b	1.66b
K NPs 1500 ppm+uria	68.4 a	10.6 a	75.75 a	47.35 a	0.814a	1.96 a
K NPs 2000 ppm+uria	49 e	4.16 f	38.6 f	21.52 f	0.568 f	0.88 e
Mean	56.392	7.207	57.092	34.237	0.689	1.376
LSD at 0.05	1.204	0.574	2.368	1.279	0.012	0.086

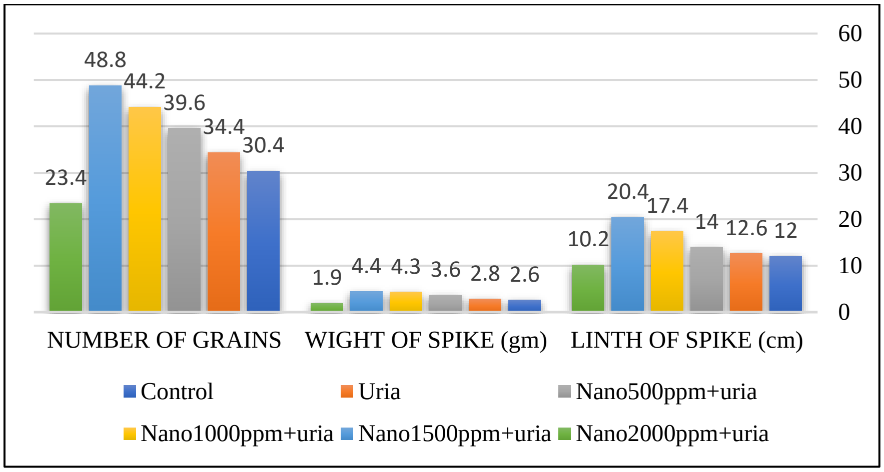

Fig. 1. Graphical representation of average values for number of grains and the wight of spike(gm), linth of spike (cm).

Data showed that the plant height displayed the haughtiest value for plant height in the mentioned K NPs treatment, aligning with the findings of **Al- Fahdawi and Allawi. (2019); Saedi *et al*. (2020); Al- Sultani *et al*. (2023) and Najm *et al*. (2023)**. The number of leaves also recorded the highest value in the same treatment, as preliminarily noted **(Al-Fahdawi and Allawi, 2019).** This indicates a clear correlation between the operation of nano-potassium and bettered leafage development. Regarding the fresh weight of the plant, the highest value was recorded in this same treatment, as demonstrated by **Saedi *et al*., (2020)**, suggesting that the treatment significantly enhances overall biomass accumulation. for dry weight, the highest value was also noted in this treatment, as clarified by **Saedi *et al*., (2020)** and **Mohammed *et al.* (2021)**, further buttressing the positive impact of nano potassium on plant health.

The highest value of chlorophyll content was recorded in the same treatment, showing the positive effect of K NPs, as mentioned by **(Afify *et al*., 2019), (Alshatb and Alamery., 2022), (Saedi *et al*., 2020), (Al- Sultani *et al*.,2023)** and **(Najm *et al*. 2023),** This increase in chlorophyll situations is critical for effective photosynthesis and energy product. Also, a significant impact was observed on the relative growth rate, showing a conspicuous increase in this treatment, as recorded by **(El-Attar *et al*., 2023)**, (**Verma *et al*., 2022),** which indicates accelerated growth dynamics, **Figure (1)** showed that for the spike length, the highest value rate was also noted, as mentioned by **(Sheoran *et al*., 2021),** demonstrating the treatment's effectiveness in enhancing reproductive structures. There was also a significant increase in spike weight, which aligned with the findings **(Sheoran *et al*., 2021),** suggesting a bettered yield eventuality. furthermore, a conspicuous increase in the number of grains per spike was observed, as noted by **(Al-Sultani *et al*., 2023),** indicating enhanced productivity, attesting that the treatment not only affects volume but also the quality of grain products.

Conclusion

Predicted on the data from this experiment, we can conclude that the Swish treatment is the recommended K NPs 1500 ppm+ urea combination, reaching the haughtiest values in all measured parameters. It rebounded by the altitudinous plant height, the proudest number of leaves, and the lordliest fresh and dry weights. Also, it recorded the Highest value chlorophyll content and relative growth rate, as well as leading values for spike length, weight, and number of grains. Therefore, using this treatment in unborn crop civilization is anticipated to yield the highest possible yield.

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