Alqalam Journal of Medical and Applied Sciences. 2026;9(6):1724-1728
https://doi.org/10.54361/ajmas.26937

Original Article

Influence of Urea and Nano-Potassium Interaction on Grain Quality and Protein Content of Wheat (*Triticum aestivum* L.)

Abusif Sonousi[1], Bilkess Salim[1]*, Khalid Alghannay[2]

[1]*Department of Crops, Faculty of Agriculture, University of Sabha, Sabha, Libya*
[2]*Department of Biology, Faculty of Education, University of Wadi Alshatti, Wadi Alshatti, Libya*
Corresponding Email. bil.salim@sebhau.edu.ly

Abstract
Wheat (*Triticum aestivum* L.) is one of the most important cereal crops worldwide and represents a major source of food and nutrition for the global population. Improving fertilization practices to increase wheat productivity and grain quality has become an important objective in modern agriculture. The objective of the study was to compare the impact of urea fertilization with various levels of nano-potassium (Nano K) on grain production and other quality characteristics of wheat under pot conditions of the 2025 to 2026 growing season in the experimental garden of the plant department, Faculty of Science, Sebha University. The experiment involved six treatments: a control, recommended urea fertilization, and urea combined with nano-potassium at levels of 500, 1000, 1500, and 2000 ppm. The treatments were arranged in five replicates under controlled pot conditions. The results revealed significant differences among the treatments. The Nano K 1500 ppm + Urea treatment exhibited the highest performance, recording the maximum values for Fibers (0.028 g/100 g DW), Gluten (0.278 g/100 g DW), and Protein (0.153 g/100 g DW). Regarding mineral content, the Nano K 1000 ppm + Urea treatment excelled in Potassium content (0.0054 g/100 g DW), whereas the 1500 ppm concentration recorded the highest Phosphorus (0.004 g/100 g DW). For Nitrogen accumulation, the sole Urea treatment achieved the maximum value of (0.936 g/100 g DW). These parameters positively influenced the final yield, with the 1500 ppm concentration achieving the highest dry weight of grains per spike (9.1 g). Conversely, increasing the Nano K concentration to 2000 ppm led to a sharp decline across all measured traits, while the control treatment recorded the lowest values for most parameters. These findings demonstrate the potential of nano-fertilizers to enhance wheat productivity, grain quality, and nutrient use efficiency under controlled conditions, with promising implications for sustainable crop production in arid and semi-arid environments.
Keywords. Grain Quality; Nano-potassium; Pot Experiment; Weight of Grain Per Spike.

Introduction

Wheat (*Triticum aestivum* L.), as an inexpensive staple food, is an important component of world food security, serving millions of people with much-needed calories and proteins. Wheat grains are the source of protein, fiber, and essential minerals, and thus the crop is the core of human food and food security. Wheat has continued to play a major role in agricultural systems, especially in arid and semi-arid areas where the factors of production may be restricted because of environmental stress and nutrient density [1]. Wheat growth requires potassium (K), a key macronutrient that plays a vital role in various physiological activities. It helps in enzyme activation, photosynthesis, protein synthesis, osmotic regulation, and stress tolerance. The nutrient requirement is particularly high during the critical development phases of booting and grain filling, and a proper supply of potassium is particularly critical. It has been reported in a previous study that foliar potassium application at the booting stage enhanced the grain yield, protein content, and height of the plants, and therefore, potassium management was considered important [2]. On the same note, potassium fertilization was found to enhance grain protein ratio as well as dough qualities, which emphasizes its significance to yield and technological quality [3].

The recent developments in nanotechnology have brought with them the use of nano fertilizers as a new way of enhancing the efficiency of nutrient use of nutrients and the productivity of crops. Nano potassium fertilizers have drawn a lot of attention because they are more reactive, their surface area is greater, and they are more efficient in the absorption process compared to traditional fertilizers. Several studies have indicated a positive impact of nano-potassium on the growth and productivity of plants. An example of the advances in seed weight and nutrient accumulation is provided after the application of nano-K in stress cases [4].

Equally, the addition of potassium was reported to improve the yield and mineral content under salinity stress [5], whereas the addition of nano-K was also reported to significantly improve the chlorophyll content and the number of spikes [6]. Moreover, the use of bio-nano fertilizers on the foliage has been linked with enhanced nutrient absorption and augmented 1000-grain weight [7,8]. Similar positive reports have also been observed in other crops like quinoa and rice [9]. Although these encouraging results were obtained, the reactions of the nano-potassium fertilization are still inconsistent, and the most appropriate concentration in the real growing conditions is yet to be determined. Moreover, very little information exists on the synergistic use of nano-potassium and traditional nitrogen fertilization and its effect on wheat output parts and grain quality features. Thus, the current experiment was performed to assess the impact of various doses of nano-potassium, used in concert with the prescribed urea application rate, on the production

***Received**: 20-04-2026 - **Accepted**: 19-06-2026 - **Published**: 24-06-2026*

https://doi.org/10.54361/ajmas.26937

aspects of wheat, the grain composition of protein, and the general grain quality in a pot assay. The research will maximize the nano-potassium fertilization practice and promote viable nutrient management practice in wheat systems.

Material and methods

A pot experiment was conducted at the experimental garden of the Faculty of Science, University of Sebha, Libya, during the 2025-2026 growing season, air temperature ranged from approximately 18 to 32 °C, while relative humidity varied between 25 and 55%. Plants were grown under natural daylight conditions and were irrigated as required to maintain adequate soil moisture throughout the experimental period.

Plant Material and Experimental Design

The wheat variety 'Dhahab' was used in this study. It was obtained from a local farm in southern Libya, where it is widely cultivated and well known among farmers. The cultivar is commonly grown in the region and is considered a well-adapted and established variety in southern Libyan agricultural systems. A preliminary germination test was conducted prior to sowing to ensure seed viability. 30 plastic pots were prepared and filled with mixed soil, predominantly sandy. Twenty seeds were sown per pot, and after complete germination, seedlings were thinned to maintain ten uniform plants per pot.
The experiment was arranged in a completely randomized design (CRD) with five replications.

Treatments

The treatments consisted of:

1. Control
2. Recommended urea dose
3. Urea + 500 ppm nano-K
4. Urea + 1000 ppm nano-K
5. Urea + 1500 ppm nano-K
6. Urea + 2000 ppm nano-K

Nano-K was applied as a foliar spray until complete coverage of the vegetative parts. Applications were performed at 15, 30, 45, and 60 days after sowing.

Sampling Procedure

Measurements were conducted at four intervals:

- 15 days after the first application
- 15 days after the second application
- 15 days after the third application
- 15 days after the fourth application

Samples were collected one day before each subsequent fertilizer application. Two plants were randomly uprooted from each pot at every sampling date, including the root system.

Soil Analysis

Soil samples were analyzed prior to planting to determine physical and chemical characteristics using standard procedures [10]. Particle size distribution was determined using the hydrometer method; soil pH was measured in a 1:1 soil-water suspension; and electrical conductivity (EC) was determined in a soil extract as showed in (Table 1).

Measured Traits

Fiber Content (g/100 g DW)

Total dietary fiber was determined using the enzymatic–gravimetric method [14].

$$Fiber\ (\%) = (Weight\ of\ dried\ residue\ /\ Original\ sample\ weight) \times 100$$

Gluten Content (g/100 g DW)

Wet gluten content was determined according to International Method 38-12. Flour samples were mixed with water to form dough, washed to remove starch, and the remaining gluten mass was weighed.

$$Gluten\ (\%) = (Weight\ of\ wet\ gluten\ /\ Original\ sample\ weight) \times 100$$

Protein Content (g/100 g DW)

Crude protein percentage was calculated from total nitrogen using the conversion factor 6.25:
$Protein\ (\%) = Nitrogen\ (\%) \times 6.25$

Potassium Content (g/100 g DW)

Potassium was determined by flame photometry using the method [13].

***Received**: 20-04-2026 - **Accepted**: 19-06-2026 - **Published**: 24-06-2026*

Phosphorus Content (g/100 g DW)
Phosphorus concentration was determined calorimetrically using the vanadomolybdate yellow method [12].

Nitrogen Content (g/100 g DW)
Total nitrogen was determined using the Kjeldahl digestion, distillation, and titration method [11]. Results were expressed as a percentage of dry weight.

Grain Weight (g)
Grains were harvested at maturity and dried to constant weight. Grain weight was measured using an analytical balance and expressed in grams (g).
Chemical constituents were expressed on a dry weight basis (g/100 g sample), and data were subjected to analysis of variance (ANOVA) using CoStat statistical software. Treatment means were compared using the Least Significant Difference (LSD) test at the 0.05 probability level.

Table 1. Some physical and chemical properties of the experimental soil in the pots. Particle size distribution (gm kg-1 soil)

Particle size distribution (gm kg-1 soil)	
Clay Sand Silt	23.0% 60.0% 17.0%
Ph. (1: 1) Ec	7.8 2.2 dS m^{-1}
Available Ca Mg Available Na Available	8.0 meq L^{-1} 3.5% 1.2%
Co3--+ Hco3- Cl- So4— Calcium Carbonate N Available p Available K Available Organic Matter (%)	2.6 % 1.6 meq L^{-1} 2.0 meq L^{-1} 4.0% 0.12 % 30mg kg^{-1} 1.2mg kg^{-1} 25%

Results and Discussion
The analysis of variance (ANOVA) revealed significant differences ($p \leq 0.05$) among treatments for all measured traits.

Fiber and Gluten Content (g/100 g DW)
Nano-potassium application significantly affected fiber and gluten contents (Figure 1.A, B). The highest fiber and gluten contents were recorded under the 1500 ppm nano-K + urea treatment (0.028 and 0.278 g/100 g DW, respectively), followed by the 1000 ppm treatment, whereas the lowest values were observed in the control treatment.
The increase in fiber content may be attributed to enhanced carbohydrate metabolism and improved assimilate partitioning during grain development [4,15]. Moreover, potassium nutrition plays an important role in enzyme activation and protein synthesis, thereby contributing to gluten formation and improved dough quality [2,3].

Protein Content (g/100 g DW)
Protein content was significantly influenced by nano-potassium levels (Figure1.C). The highest protein content was recorded under the 1500 ppm nano-K + urea treatment (0.153 g/100 g DW), followed by the 1000 ppm treatment, while the control treatment recorded the lowest value.
The improvement in protein content may be attributed to enhanced nitrogen assimilation and increased efficiency of protein biosynthesis under adequate potassium supply. Potassium is known to activate several enzymes involved in nitrogen metabolism, leading to increased protein accumulation in wheat grains. [2,3,4,6]. In addition, similar responses to grain protein concentration to nitrogen availability have also been observed [19,20].

Potassium Content (g/100 g DW)
Potassium content differed significantly among treatments (Figure1.D). The highest value (0.0054 g/100 g DW) was recorded under the 1000 ppm nano-K + urea treatment, followed by the 1500 ppm treatment, whereas the control treatment showed the lowest value.

***Received**: 20-04-2026 - **Accepted**: 19-06-2026 - **Published**: 24-06-2026*

https://doi.org/10.54361/ajmas.26937

The increased potassium concentration reflects the effectiveness of foliar nano-potassium application in enhancing nutrient uptake and translocation within plant tissues. Nano-sized particles possess high surface area and reactivity, which improve nutrient absorption efficiency [5,17,18].

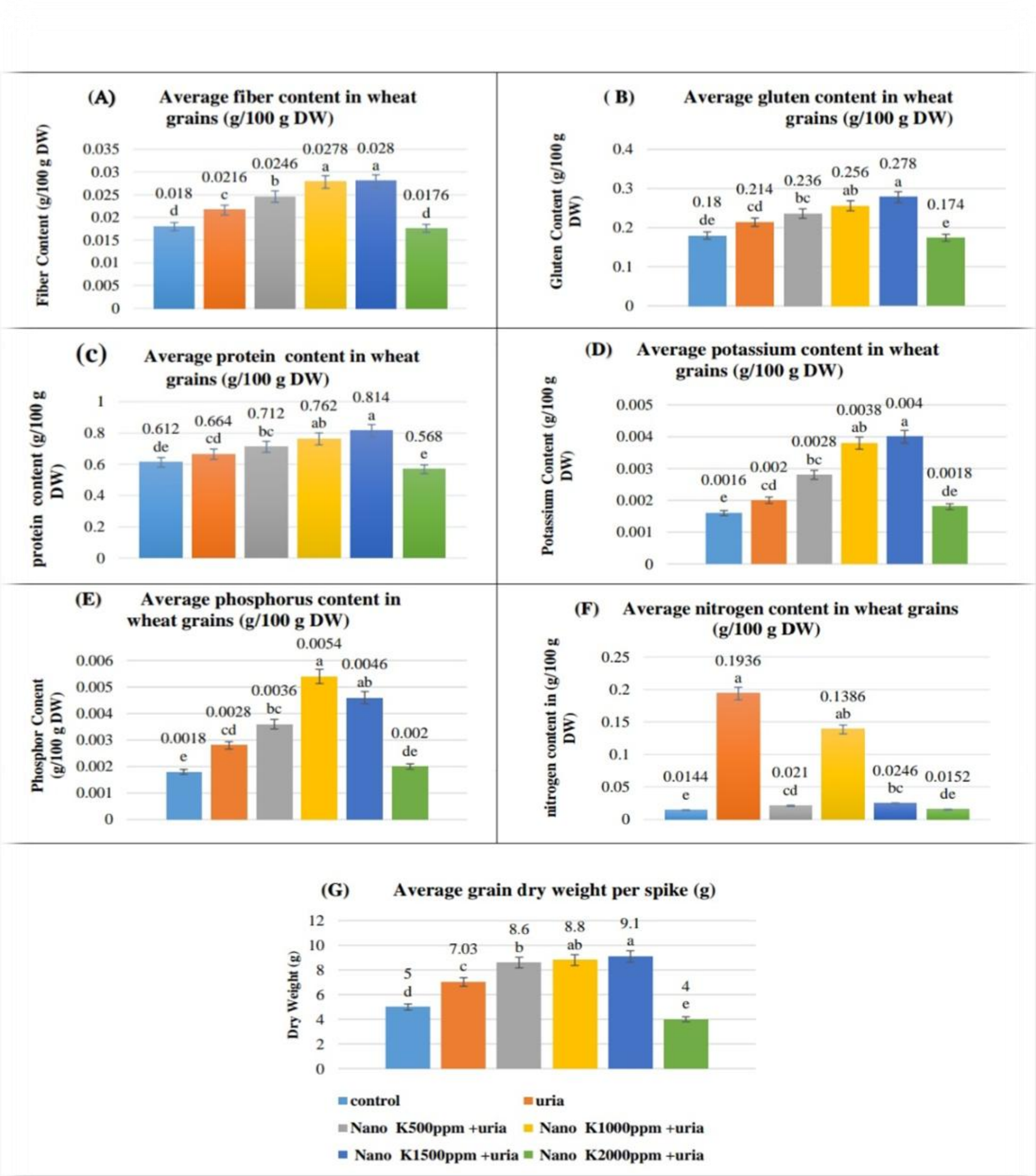

Figure 1. Effect of different potassium fertilization treatments on grain quality traits and grain dry weight per spike of wheat. Values are expressed as means ± SE (n = 5). Different letters above the bars indicate significant differences among treatments according to the LSD test at P ≤ 0.05.

Phosphorus Content (g/100 g DW)

Phosphorus content was significantly affected by the different treatments (Figure1.E). The highest phosphorus content (0.004 g/100 g DW) was observed under the 1500 ppm nano-K + urea treatment, followed by the 1000 ppm treatment, while the control treatment recorded the lowest value.

The increase in phosphorus concentration may be associated with improved nutrient balance and enhanced root activity resulting from potassium application. Adequate potassium supply promotes energy transfer processes and nutrient mobility during grain development [9,7,17].

Nitrogen Content (g/100 g DW)

Nitrogen content varied significantly among treatments (Figure1.F). The highest nitrogen content (0.936 g/100 g DW) was obtained under the sole urea treatment, whereas the control treatment exhibited the lowest value. Among the combined treatments, the 1000-ppm nano-K + urea treatment showed higher nitrogen accumulation than the other nano-potassium concentrations.

The superior nitrogen accumulation under urea application can be attributed to the direct supply of available nitrogen. The relatively lower values observed under combined nano-potassium treatments may

***Received**: 20-04-2026 - **Accepted**: 19-06-2026 - **Published**: 24-06-2026*

https://doi.org/10.54361/ajmas.26937

be due to a dilution effect associated with enhanced biomass production and carbohydrate accumulation [19,20,21].

Grain Dry Weight per Spike (g)

Treatments significantly affected grain dry weight per spike (Figure1.G). The highest grain dry weight (9.1 g) was recorded under the 1500-ppm nano-K + urea treatment, followed by the 1000-ppm treatment (8.8 g), whereas the 2000-ppm treatment produced the lowest value (4.0 g), even lower than that of the control treatment. The superiority of the 1500-ppm treatment indicates that this concentration represents an optimum level for improving assimilate partitioning and grain filling. However, increasing the concentration to 2000 ppm adversely affected grain development, possibly due to physiological disturbances caused by excessive nutrient levels [4,5,6, 7,18].

Conclusion

The results of this study suggest that foliar application of nano-potassium can significantly enhance grain quality and yield-related attributes in wheat. Among the tested treatments, the combined application of 1500-ppm nano-K with the recommended urea dose produced the highest values for fiber, gluten, protein, nutrient content, and grain dry weight per spike. These results highlight the potential of nano-potassium as an effective strategy for improving wheat productivity and grain quality. More field studies are suggested to optimize nano-potassium application rates and evaluate its long-term agronomic and environmental effects.

Conflict of interest. Nil

References

1. El-Sonbaty AE. Effect of foliar application of NPK nanoparticle fertilization and soil addition of mineral NPK fertilization as combined treatments on soil fertility and wheat plant performance. J Soil Sci Agric Eng. 2021;12(8):567-72.
2. Al-Ajili HDM, Al-Saeedi MAH. Response of some yield and quality indicators of different cultivars of bread wheat to spraying with nano-potassium fertilizer. IOP Conf Ser Earth Environ Sci. 2023;1262(3):032042.
3. Gu X, Liu Y, Li N, Liu Y, Zhao D, Wei B, et al. Effects of the foliar application of potassium fertilizer on the grain protein and dough quality of wheat. Agronomy. 2021;11(9):1749.
4. Mirtayebi M, Bostani A, Diyanat M, Azadi A. Effect of drought stress, biofertilizer and potassium nano fertilizer on leaf area index, 1000-seed weight, harvest index and quality of quinoa (*Chenopodium quinoa* Willd.) seed. J Crop Prod Process. 2022;12(1):133-49.
5. Hussein MM, El-Saady AM, El-Dahshouri MF. Response of wheat plants grown under salinity to nano fertilizers application. Egypt J Chem. 2023;66(7):465-77.
6. Al-Zubade A, Al-Ubori RN. Impact of nano-potassium foliar application on bread wheat cultivars for enhanced sustainable production. Res Crops. 2024;25(3):388-93.
7. Baghla D, Sharma VK. Impact of foliar application of bio nano P and K and their conventional sources on yield of maize and wheat in an acid Alfisol. Himachal J Agric Res. 2023;49(1):55-61.
8. Noaema AH, AlKafaji MH, Alhasany AR. Effect of nano-fertilization on growth and yield of three varieties of wheat bread (*Triticum aestivum* L.). Int J Agric Stat Sci. 2020;16:1269.
9. Younas A, Yousaf Z, Riaz N, Rashid M, Aftab A, Fiaz S, et al. Effect of Qiangdi 863 nanos synergids treated water, nitrogen, phosphorus and potassium fertilizers on rice growth physiology and grain quality. Front Plant Sci. 2022;13:916949.
10. Page AL, Miller RH, Keeney DR. Methods of soil analysis. Part 2: Chemical and microbiological properties. 2nd ed. Madison (WI): American Society of Agronomy; 1982.
11. Bremner JM. Total nitrogen. In: Sparks DL, editor. Methods of soil analysis. Part 3: Chemical methods. Madison (WI): Soil Science Society of America; 1996.
12. Murphy J, Riley JP. A modified single solution method for determination of phosphate in natural waters. Anal Chim Acta. 1962;27:31-6.
13. Chapman HD, Pratt PF. Methods of analysis for soils, plants and waters. Berkeley (CA): University of California, Division of Agricultural Sciences; 1961.
14. AOAC International. Official method 985.29: Total dietary fiber. Gaithersburg (MD): AOAC International; 2000.
15. Sharma V, Singh A, Nautiyal N. Effect of nano fertilizer on growth and yield in wheat (*Triticum aestivum* L.) under Dehradun conditions. Int J Res Agron. 2025;8(5):1-7.
16. Pop RI, Vidican R, Puşcaş A, Seştraş AF. Foliar application of calcium, silicon, and potassium nanoparticles improves drought stress tolerance in cereals. Not Bot Horti Agrobot Cluj Napoca. 2024;52(1):12936.
17. Gopinath KA, Kumari VV, Singh VK, Shanker AK, Reddy KS, Kundu S, et al. Impact of conventional and nano fertilizers on rainfed maize yield, profitability and soil nitrogen. Front Nanotechnol. 2025;7:1617500.
18. Sheoran P, Chouhan RS, Kumar A, Bahuguna A. Biogenic synthesis of potassium nanoparticles and their growth-promoting effects in wheat (*Triticum aestivum* L.). Environ Technol Innov. 2021;23:101575.
19. An HY, Han JJ, He QN, Zhu YL, Wu P, Wang YC, et al. Influence of nitrogen application rate on wheat grain protein content and composition. Agronomy. 2024;14:1164.
20. Giordano N, Sadras VO, Lollato RP. Late-season nitrogen application increases grain protein concentration and is neutral for yield in wheat: a global meta-analysis. Field Crops Res. 2023;290:108740.
21. Boulelouah N, Berbache MR, Bedjaoui H, Selama N, Rebouh NY. Influence of nitrogen fertilizer rate on yield, grain quality and nitrogen use efficiency of durum wheat. Agriculture. 2022;12(11):193.

***Received**: 20-04-2026 - **Accepted**: 19-06-2026 - **Published**: 24-06-2026*