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EVALUATION OF THE EFFICIENCY OF NANO-FERTILIZER NPK IN IMPROVING YIELD COMPONENTS AND CHEMICAL CONTENT OF SEEDS IN BARLEY CROP

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Abstract

This study was conducted in Al-Alam district - Tikrit during the agricultural season 2021-2022, to study the efficiency of spraying Nano-fertilizers on the yield components and chemical content of seeds of barley plants grown in plastic pots. In this study, the NPK fertilizer was used after converting it into nanoparticles. Statistical analysis was conducted at ($P \leq 0.05$) level, and the results were as follows: The effect of the interaction between different concentrations of NPK and the number of times of spraying varied in the yield constituent traits. The characteristic of the number of spikes was not significantly affected by the concentrations and the number of sprinkles, while the weight of the spike and the weight of 100 grains, was affected, giving 0.26 and 5.15 grams, respectively. The results confirm the existence of a significant difference between the different concentrations of NPK Nano fertilizer and the number of times of spraying, as the concentration exceeded 2 gm with spraying twice in giving the highest percentages of each of N, P, K, Na, Ca, protein and carbohydrates in the seeds amounted to 1.47, 19.95, 0.21, 0.07, 9.18 and 4.67%, respectively.

Keywords: Nano-Fertilizer, Chemical Content of Seeds, Barley, NPK

Introduction

The barley crop is one of the oldest crops that humans have known, and it was the main source of bread in the ancient world, as its grains contain amino acids and important proteins to feed humans as well as high levels of fiber, selenium and vitamins, especially vitamin B (Gani and Salman, 2011). There is an important historical and archaeological evidence documenting the role of barley as a source of sustainable food in human development, as barley was one of the most important food pills and a source of alcoholic beverages from ancient times until the beginning of the twentieth century (Newman and Newman, 2008). On the global level, barley pills are of great importance today, and are ranked fourth in terms of the amount produced and in the field of growing grain crops in the world after wheat, rice and corn. During the agricultural season 2018/2019, the annual global harvest of barley reached about 140,602 thousand metric tons of an area of about 47,009,175 hectares (USDA, 2019). Barley is a multi -use crop, withstand a wide range of growth conditions from dry conditions in the Middle East to the cold of the Andes region. It is more productive and less changed in yields than most other small grain crops such as wheat. Consequently, it is widely used among farmers with limited and poor resources under climate conditions and less suitable for the rest of the crops (Newton *et al*., 2011).

Foliar fertilizers are able to provide the total elements and nutrients needed for different apparent patterns in time for crop plants (Hall and FUNT, 2017). In the event of a lack of minerals due to climate, technological factors or soil conditions, the application of fertilizers to the leaves is a relatively fast correction method, although soil fertilization is still the main entrance to absorb the nutrients of the plant (Noroozlo *et al*., 2019). Plants need a constant and balanced presence of the basic minerals in the root area that is simple to absorb and transport the roots (Souri and Bakhtiarizade, 2019). The paper fertilizers act as a dietary supplement for the chemical elements necessary for plants. At the present time, paper fertilization is an effective way to correct mineral deficiency, and to increase the yield of crops and their quality under the climatic conditions or the opposite management (Souri and Tohidlooo, 2019). Paper fertilization has many advantages compared to soil fertilization, including reducing pollution rates, rapid correction of shortages, reducing the amounts of fertilizers used and increasing efficiency (Souri and Hatamian, 2019).

Nanosomic fertilizers are nutrients with accurate dimensions ranging from 1 to 100 nanometers, and they have the ability to keep nutrient ions with great availability due to the high surface area and slow launch according to the demand of crops (Subramanian and others, 2015). It leads to providing nutrients for plants and helps to increase the efficiency of mineral fertilizers, and replace nanoparticles with mineral fertilizers is useful in terms of adding nutrients to the soil in a controlled way and thus preventing pollution (Singh and others, 2015).

Nanosomic fertilizers are designed to provide an effective new alternative to traditional fertilizers, as the properties of nanoparticles (the growing surface area) allow these nanoparticles to increase their reaction points, causing changes in plant absorption of these fertilizers (Fraeto *et al*., 2016). This technology is promising to improve basic agricultural processes by improving the management, maintenance and sustainability of inputs in the field of agricultural production (Monreal *et al*., 2015). Nanoparticles (NPS) apply fertilizers in soil or leaves in small quantities, which increases the growth and productivity of some crops compared to the high amount of traditional fertilizer for the same elements, as it was found that the efficiency of the use of fertilizers is almost better due to the best penetration and the ability to move in the parts of the plant (Ghorbanpour *et al*., 2017). Nanosomic fertilizers or nutrients coated with Nano may have effective characteristics of crops by launching nutrients at the stages of the plant's need; These molecules control the release of chemical fertilizers that regulate plant growth and enhance targeted activity (Naderi and Abedi, 2012).

The current study aims to assess the efficiency of leaf spraying with NPK nanopolitan fertilizer at the concentrations and number of different sprinkles in improving the yield components of the barley crop and its content of basic chemical elements and compounds.

Materials and methods

The study was conducted in the Biology Department Laboratories/ College of Education for Women/ Tikrit University, with the aim of studying the effect of Nano fertilizer in the traits of the yield component and seed content of elements and basic chemical compounds of the barley plant *H. Volger*. In the study, the certified variety (Hadhur), a local black barley, was obtained from the Agricultural Research Department of the Ministry of Agriculture in Baghdad. The soil

brought from the Al-Aali area to the Al-Alam District/ Salah Al-Din Governorate, at a depth of 0-30 cm, and dried up and blessed and spared the sieve of dimeter its holes are 2 mm.

Preparing pots and planting seeds: 18-liter water bottles with a diameter of 24 cm were reused as plastic pots that hold 17 kg of soil, filled with previously prepared soil, and the seeds of local black barley (Hadhur) were sown on 5/11/2021, as ten seeds were sown in per pot, and the germination rate reached 98%. The dilution was made to five plants per pot, 20 days after planting, in order to give suitable conditions for the plants. Crop service operations were carried out, including irrigation and pest control, as needed. The plants were harvested on 26/4/2022 after reaching the stage Full maturity.

Preparation of Nano-fertilizer: The balanced NPK fertilizer was brought in at a concentration of 20-20-20 from the Agricultural Office in Al-Alam district, and it was ground and sifted with a Nano-sieve in the laboratory of the Biology Department/ College of Education for Women, and the fertilizer was dissolved according to the required concentrations, where 2 gm of fertilizer was dissolved powder and sieved in 1 liter of water to obtain a high concentration of 2 gm / liter, and by diluting it, other concentrations were prepared.

Studied treatments: The study treatments included three concentrations of NPK Nano-fertilizer: (0.5, 1, and 2 gm/l) at two levels. The first level included spraying the plants with the three concentrations only once after 50 days of planting on 25/12/2021, while the second level included Spraying the plants with the three concentrations for two times, the first spray after 50 days of planting on 25/12/2021, and the second spray after 85 days of planting on 1/2/2022, in addition to the control treatment (without spraying), and according to the description mentioned in Table (1).

Table (1): Treatments used in the study.

No.	Treatments
1	without spraying
2	Spraying once at a conc. of 0.5 gm after 50 days of planting
3	Spraying once at a conc. of 1 gm after 50 days of planting
4	Spraying once at a conc. of 2 gm after 50 days of planting
5	Spray twice at a concentration of 0.5 gm
6	Spray twice at a concentration of 1 gm
7	Spray twice at a concentration of 2 gm

Experimental design: A factorial experiment was carried out according to the randomized complete block design (RCBD), and it included two factors, the first being the number of sprays and the second the concentration of fertilizer, and it included the seven treatments shown in Table (1), and the treatments were distributed on pots with three replicates for each treatment.

The studied traits: The five plants were taken from each experimental unit, and the traits constituting the yield and the seed content of the following chemical elements and compounds were measured on them:

1- The number of spikes
2- The weight of the spike (gm)
3- Weight of 100 grains (gm)

4- The percentage of nitrogen in the seeds (%N): - The nitrogen was determined using the Micro kjeldahl apparatus as mentioned in Jackson (1958).
5- Percentage of Phosphorus in Seeds (%P): - Phosphorus was determined using ammonium molybdate and ascorbic acid using a UV-VIS Spectrophotometer Model 80D, at a wavelength of 662 nm (Olsen and Sommers, 1982).
6- Percentage of Potassium in Seeds (%K): - Potassium was estimated using a flame photometer as mentioned in Al Sahhaf (1989).
7- Percentage of Calcium (% Ca) and sodium (% Na) in seeds: - The percentage of calcium and sodium in plant samples was estimated using a flame photometer according to the method described in Page *et al*. (1982).
8- The percentage of protein (%Protein): - The percentage of protein was measured as a percentage using the following equation (Haynes, 1980):

Protein % = Nitrogen % * 6.25

9- Percentage of carbohydrates in seeds (% Carbohydrate): - Joslyn (1970) method was used to estimate the total amount of carbohydrates in seeds using a spectrophotometer at a wavelength of 490 nm. The percentage of total carbohydrates was calculated from the following equation: -

Total carbohydrates % = dilutions x concentration / sample weight x 100

Statistical analysis: After collecting data on the studied traits, it was entered into the computer and organized using the Microsoft Office Excel program, then it was analyzed statistically and the different averages were compared using the Statistical Analysis System (SAS) according to the experimental design used as explained by Al-Zubaidi and Al-Jubouri (2016).

Results and discussion

The traits constituting the yield

1- Number of spikes/plant: Table (2) shows the average effect of the concentration and the number of times of spraying with NPK Nano fertilizer on the characteristic of the number of spikes per plant during the full growth phase. Spraying and interfering with only one spike.

Table (2): The average effect of concentrations and number of sprays with NPK Nano fertilizer on the number of spikes/plant.

Times of spraying / Concentration (gm/L)	One spray	Two sprays	Mean of Concentration
Control	1.00 a		
0.5	1.00 a	1.00 a	1.00 a
1	1.00 a	1.00 a	1.00 a
2	1.00 a	1.00 a	1.00 a
Mean of spraying	1.00 a	1.00 a	

Means with the same letter are not significantly different.

2- Spike weight (gm): The results of Table (3) showed that a significant effect was obtained by increasing the concentrations and the number of times of spraying with NPK Nano-fertilizer on the characteristic of the spike weight during the full growth phase, as it appeared for the average

concentrations that the concentration exceeded 2 gm / L in achieving the highest spike weight. Significantly, it reached 0.58 gm, compared to the lowest rate of 0.49 gm at a concentration of 0.5 g/L. The number of sprays also had a significant effect on the weight of the spike by recording the highest rate when spraying twice, which amounted to 0.58 gm, compared to spraying once, which amounted to 0.49 gm. The interaction between the concentrations and the number of sprays, the spike weight increased significantly for all the interactions by increasing the concentration and spraying compared to the control treatment, except for the interaction of concentrations 0.5 and 1 gm/L with spraying once. With an increase of 30.65% compared to the control treatment, which recorded 0.43 gm.

Table (3): Mean effect of concentrations and number of sprays with NPK Nano fertilizer on the characteristic of spike weight (gm).

Times of spraying / Concentration (gm/L)	One spray	Two sprays	Mean of Concentration
Control	0.43 e		
0.5	0.45 de	0.53 bcd	0.49 b
1	0.49 cde	0.59 ab	0.54 a
2	0.54 bc	0.62 a	0.58 a
Mean of spraying	0.49 b	0.58 a	

Means with the same letter are not significantly different.

3- Weight of 100 grains (gm): The weight of 100 grains / gm was positively affected by the concentration and number of times of spraying with NPK Nano fertilizer, as the results of Table (4) showed that there were significant differences between the factors' averages and their interactions. The highest grain weight was significantly 5.05 gm/100 grains compared to the lowest weight of 4.20 gm/grain at a concentration of 0.5 gm/L. The number of sprays also affected significantly the weight of 100 grains by recording the highest rate when spraying twice, which amounted to 4.96 gm, compared to spraying once, which amounted to 4.42 gm. For the interaction between the concentrations and the number of sprays, the weight of 100 grains increased significantly for all interactions by increasing the concentration and spraying compared to the control treatment, except for the interaction of concentration 0.5 with spraying for one time, as the interaction concentration of 2 gm/ L with spraying twice achieved the highest significant grain weight of 5.19 gm/ 100 grains, with an increase it was 35.65% compared to the control treatment, which recorded 3.34 gm/100 grains.

Table (4): Mean effect of concentrations and number of sprays with NPK Nano fertilizer on the weight of 100 grains (gm).

Times of spraying / Concentration (gm/L)	One spray	Two sprays	Mean of Concentration
Control	3.34 c		
0.5	3.67 c	4.72 b	4.20 b
1	4.69 b	4.97 ab	4.83 a

2	4.90 ab	5.19 a	5.05 a
Mean of spraying	4.42 b	4.96 a	

Means with the same letter are not significantly different.

Spraying with NPK Nano fertilizer once or twice had a positive effect on the yield characteristics of the barley plant, as it worked on keeping the vegetative system effective in supplying the spikes with their needs of the nutrients that were represented and reducing the competition among them for these outputs, it has an important role in maximizing the components of the yield (Burhan and Ahmed 2019). The results of tables (2, 3, and 4) showed that the high concentration of Nano fertilizer 2 gm/L and the frequency of spraying were superior in raising the average components of the yield, which may be attributed to the nature of nanomaterials represented by their small size and large surface area, which helps them penetrate tissues and increase their absorption rates, thus stimulating plants. To increase the averages of the traits that make up the yield (Al-Obaidi, 2021). The reason for the superiority of the spray treatment at 2 gm/L was due to the fact that the effect was positive on most of the studied growth characteristics, which was naturally reflected on the components of the yield (Zaboun, 2013).

The reason for the superiority of the high concentration treatment and spraying twice is attributed to the absorption of phosphorus by the plant by the stomata, which led to increased plant growth and development, as well as the role of nanomaterials by contributing to the activation of the transport system, which helps in transporting processed food from its sources to the estuaries (Burhan and Ahmed, 2019). Also, the effective role of Nano-fertilizers in delivering nutrients to the plant by spraying them on the vegetative system increases the efficiency of fertilizer use and reduces the loss of nutrients, and this increases the pollination and fertilization process, and thus increases the grain in the spike (Al-Shammari, 2021). These increases are also attributed to the positive role of Nano-nitrogen in tissue development and its role in cell division, and its presence is necessary to build amino acids such as tryptophan, which forms the basis for building auxin, which has a role in cell division (Al-Sabahi *et al*., 2015).

The reason for the increase in the weight of the spike is due to the action of the superior fertilizer treatment in raising the efficiency of the photosynthesis process during the period of emergence, growth and development of the spike extending from the branching stage to the lining stage, which reduced the intensity of competition between it and other parts of the plant for processed food, which allowed its cells to divide and grow. (Muhammad, 2021). This is also explained on the basis that the treatment with NPK Nano fertilizer led to an increase in the efficiency of the photosynthesis process and an increase in the percentage of dry matter and its transfer from leaves to grain, which reflected positively on the spike weight and yield components (Mir and Shirmohammadi, 2015). These results agree with what was reached (Abdel-Aziz *et al*., 2016).

The high efficiency of Nano-fertilizers in entering into metabolic reactions efficiently and effectively contributed to achieving the necessary requirements of phosphorus, which directly contributed to the increase in grain weight (Rezaei and Abbasi, 2014; Janmohammadi *et al*., 2016). The reason for the increase in the weight of 100 grains may be due to the role of the high leaf area

as a result of the use of NPK Nano fertilizer in supplying the nodule florets with the requirements of growth and storage of processed food (Abdel-Aziz *et al*., 2016; Burhan and Ahmed, 2019). In addition to the role of Nano-fertilizers in managing nutrients and making them more available to the plant, which helped increase vegetative growth, which had a major role in increasing yield components, including the weight of the spike, the weight of 100 grains (Al-Saedan, 2019; Zaboun, 2013; Al-Shammari, 2021). As for the characteristic, the number of spikes, their lack of response to fertilization and the number of times of spraying was attributed to the high genetic control, which is linked to the genotype (variety), as well as being affected by other characteristics such as plant height, number of leaves, leaf area, and the length of the growth period of the shoots and their formation (Al-lela, 2015; Burhan and Ahmed, 2019).

grain chemical content

1- Nitrogen concentration in grains (%): Table (5) indicates that there are significant effects of the concentration and the number of times of spraying with NPK Nano fertilizer and their interactions in the percentage of nitrogen in grains. In average concentrations, the concentration of 2 gm/L was superior in achieving the highest concentration of nitrogen, which was 1.348%, compared to the lowest concentration of 0.898% at a concentration of 0.5 gm/L. The number of sprays also affected the nitrogen concentration significantly by recording the highest rate when spraying twice, which amounted to 1.28%, compared to spraying once, which reached 1.01%. For the interaction between the concentrations and the number of sprays, the nitrogen concentration increased significantly for all the interactions by increasing the concentration and spraying compared to the control treatment, as the interaction concentration of 2 gm/ L with spraying twice achieved the highest significant concentration of 1.470%, an increase of 50% compared to the control treatment, which recorded 0.735%.

Table (5): Mean Effect of Concentrations and number of sprays with NPK Nano Fertilizer on Nitrogen Concentration in Grains (%).

Times of spraying / Concentration (gm/L)	One spray	Two sprays	Mean of Concentration
Control	0.735 f		
0.5	0.833 e	1.127 c	0.898 c
1	0.980 d	1.228 b	1.104 b
2	1.225 b	1.470 a	1.348 a
Mean of spraying	1.01 b	1.28 a	

Means with the same letter are not significantly different.

2- Cereal phosphorus concentration (%): The results of table (6) showed that there were significant effects of the study factors on the percentage of phosphorus, as it appeared for the average concentrations that the concentration exceeded 2 gm / L in achieving the highest significant concentration of 17.36% compared to the lowest rate of 6.03%. At a concentration of 0.5 gm/L. The number of sprays also had a significant effect on the phosphorus concentration, by recording the highest rate when spraying twice, which amounted to 16.79%, compared to spraying

once, which amounted to 10.02%. For the interaction between the concentrations and the number of sprays, the phosphorus concentration increased significantly for all the interactions by increasing the concentration and spraying compared to the control treatment, as the interaction concentration of 2 gm/ L with spraying twice achieved the highest significant concentration of phosphorus, which reached 19.95%, with an increase of 91.63% compared to the control treatment, which recorded 1.67%.

Table (6): Mean effect of concentrations and number of sprays with NPK Nano fertilizer on cereal phosphorus concentration (%).

Times of spraying / Concentration (gm/L)	One spray	Two sprays	Mean of Concentration
Control	1.67 g		
0.5	4.40 f	12.03 d	6.03 c
1	10.88 e	18.37 b	14.63 b
2	14.77 c	19.95 a	17.36 a
Mean of spraying	10.02 b	16.79 a	

Means with the same letter are not significantly different.

3- Concentration of potassium in grains (%): The results of table (7) showed that there was a significant effect of increasing the concentration of Nano fertilizer NPK in the percentage of potassium in the seeds, in which the concentration exceeded 2 gm/ L significantly in achieving the highest concentration of potassium, which reached 0.193%, compared to the lowest concentration of 0.103% at 0.5 gm/L. The number of sprays also had a significant effect on the percentage of potassium in the grains, by recording the highest rate when spraying twice, which amounted to 0.168% compared to spraying once, which amounted to 0.125%. For the interaction between the concentrations and the number of sprays, the potassium concentration increased significantly for all the interactions by increasing the concentration and spraying compared to the control treatment, as the interaction concentration of 2 gm/ L with spraying twice achieved the highest significant concentration of 0.215%, an increase of 57.21% compared to the control treatment, which gave 0.092%.

Table (7): Mean Effect of concentrations and number of sprays with NPK Nano Fertilizer on Potassium Concentration in Cereals (%).

Times of spraying / Concentration (gm/L)	One spray	Two sprays	Mean of Concentration
Control	0.092 f		
0.5	0.100 e	0.118 c	0.103 c
1	0.105 d	0.170 b	0.138 b
2	0.170 b	0.215 a	0.193 a
Mean of spraying	0.125 b	0.168 a	

Means with the same letter are not significantly different.

4- Sodium concentration in grains (%): Table (8) shows the average effect of the two study factors, concentrations and number of sprays, and the interaction between them on the sodium concentration in grains. For the average concentrations, it is noted that there is a significant effect on the sodium percentage by increasing the concentration, as the concentration exceeds 2 gm/ L of Nano-fertilizer achieved the highest significant concentration of 0.070% compared to the lowest sodium concentration of 0.068% at a concentration of 0.5 gm/L. The number of sprays also affected significantly the sodium concentration by recording the highest rate when spraying twice, which amounted to 0.069%, compared to spraying once, which amounted to 0.068%. For the interaction between the concentrations and the number of sprays, the sodium concentration increased significantly for all the interactions by increasing the concentration of fertilizer and spraying compared to the control treatment, as the interaction of the concentration of 2 gm/ L with spraying twice achieved the highest significant sodium concentration of 0.070%, an increase of 2.86% compared to the control treatment, which recorded 0.068.

Table (8): Mean effect of concentrations and number of sprays with NPK Nano Fertilizer on Sodium Concentration in Cereals (%).

Times of spraying / Concentration (gm/L)	One spray	Two sprays	Mean of Concentration
Control	0.068 c		
0.5	0.068 c	0.068 c	0.068 c
1	0.068 c	0.069 b	0.069 b
2	0.069 b	0.070 a	0.070 a
Mean of spraying	0.068 b	0.069 a	

Means with the same letter are not significantly different.

5- Calcium concentration in grains (%): The effect rates of NPK Nano fertilizer concentrations shown in Table (9) showed a significant increase in the concentration of calcium in grains of barley plants with an increase in the concentration of fertilizer, as the concentration exceeded 2 gm/ L in achieving the highest concentration of calcium significantly. 0.024% compared to the lowest concentration of 0.018% when the concentration was 0.5 gm/L. The number of sprays also had a significant effect on the percentage of calcium, by recording the highest rate when spraying twice, which amounted to 0.022%, compared to spraying once, which amounted to 0.020%. For the interaction between the concentrations and the number of sprays, the calcium concentration increased significantly for all interactions by increasing the concentration and spraying compared to the control treatment, as the interaction concentration of 2 gm/ L with spraying twice achieved the highest concentration of calcium, which was significant at 0.027%, with an increase of 48.15% compared to the control treatment, which recorded 0.014%.

Table (9): Mean Effect of Concentrations and Number of sprays with NPK Nano Fertilizer on Calcium Concentration in Cereals (%).

Times of spraying / Concentration (gm/L)	One spray	Two sprays	Mean of Concentration
Control	0.014 c		
0.5	0.02 b	0.02 b	0.018 c
1	0.02 b	0.02 b	0.020 b
2	0.02 b	0.027 a	0.024 a
Mean of spraying	0.020 b	0.022 a	

Means with the same letter are not significantly different.

6- Protein concentration in grains (%): For the effect of the concentration and the number of times of spraying with NPK Nano-fertilizer on the protein concentration, the results of Table (10) showed that there were significant differences between the average factors and their interactions in the percentage of protein in the grains in achieving the highest protein concentration significantly amounted to 8.42% compared to the lowest concentration amounted to 5.61% at a concentration of 0.5 gm/ L. The number of sprays also had a significant effect on the protein concentration, by recording the highest rate when spraying twice, which amounted to 7.96%, compared to spraying once, which reached 6.33%. For the interaction between the concentrations and the number of sprays, the protein concentration increased significantly for all the interactions by increasing the concentration and spraying compared to the control treatment, as the interaction concentration of 2 gm/ L with spraying twice achieved the highest protein concentration significantly of 9.187%, an increase of 50% compared to the control treatment, which recorded 4.593%.

Table (10): Mean Effect of Concentrations and Number of Sprays with NPK Nano Fertilizer on Protein Concentration in Cereals (%).

Times of spraying / Concentration (gm/L)	One spray	Two sprays	Mean of Concentration
Control	4.593 f		
0.5	5.206 e	7.043 c	5.61 c
1	6.125 d	7.656 b	6.89 b
2	7.656 b	9.187 a	8.42 a
Mean of spraying	6.33 b	7.96 a	

Means with the same letter are not significantly different.

7- Concentration of carbohydrates in grains (%): The results of Table (11) showed significant effects of the concentration and the number of times of spraying with NPK Nano fertilizer on the concentration of carbohydrates, as it was shown with regard to the average concentrations that the concentration exceeded 2 gm/ L significantly in achieving the highest concentration of carbohydrates, which reached 4.27% compared to the lowest concentration was 3.02% at a

concentration of 0.5 gm/L. The number of sprays also affected significantly the concentration of carbohydrates by recording the highest rate when spraying twice, which reached 4.13%, compared to spraying once, which reached 3.32%. For the interaction between the concentrations and the number of sprays, the concentration of carbohydrates in the grains increased significantly for all interactions by increasing the concentration and spraying compared to the control treatment, as the interaction of concentration 2 gm/ L with spraying twice achieved the highest significant concentration of 4.672%, an increase of 41% compared to the control treatment that gave 2.756%.

Table 11: Mean effect of concentrations and number of sprays with NPK Nano fertilizer on the concentration of carbohydrates in grains (%).

Times of spraying / Concentration (gm/L)	One spray	Two sprays	Mean of Concentration
Control	2.756 g		
0.5	2.953 f	3.346 d	3.02 c
1	3.136 e	4.357 b	3.75 b
2	3.858 c	4.672 a	4.27 a
Mean of spraying	3.32 b	4.13 a	

Means with the same letter are not significantly different.

The reason for the superiority of the treatment of the high concentration of 2 gm/L and the frequency of spraying is due to the role of the Nano fertilizer particles in stimulating the enzymes that lead to the acceleration of the transfer of mineral nutrients from their absorption sites to the newly grown parts as a result of its association with protein carriers and the penetration of cell walls encouraging an increase in the transfer of substances represented by (Burhan And Ahmed, 2019), and an increase in the percentage of protein in plants and grains is linked to an increase in the readiness of the nitrogen element for the plant, if the plant, through metabolic activities, converts nitrogen into amino acids, which, through their association with each other in peptide bonds, form peptides that bind with each other to produce protein (Burhan and Ahmed, 2019).

The reason for the increase in the concentration of chemical elements and compounds is attributed to the possession of Nano-fertilizers more physical and chemical activity than conventional fertilizers as a result of the increase in the surface area of its particles and the presence of a large number of its atoms on the outer surface of the Nano-fertilizer material, which is reflected in the improvement of vital activities and the increase in the speed of enzymatic activities of the photosynthesis process and to increase the concentration of chlorophyll, it increases the ability of green pigments to absorb light and convert it into stored chemical energy in the form of organic substances that are transmitted to plant parts to benefit from it in various plant functions (Mir *et al*., 2015). Increasing the uptake of nutrients, especially nitrogen, has a role in increasing the rates of carbon fixation, thus increasing the plant's ability to supply the carbon structures required for the biosynthesis of the chlorophyll molecule (Rezaei and Abbasi, 2014). In addition to the importance of nitrogen and great potassium in building carbohydrates and transporting them to the rest of the plant parts, which causes the accumulation of carbohydrates in the plant (Cheng *et al*.,

2010). Also, the fact that the fertilizer contains phosphorous has an important role in forming a strong root system, which increases the ability to absorb nutrients, and thus increases their concentration in the plant (Barad *et al*., 2010).

The foliar spraying of fertilizer containing nitrogen increases the efficiency of the photosynthesis process and thus increases the accumulation of carbohydrates in the plant, while phosphorus plays an important role in building amino acids, chloroplasts and proteins, or this may be attributed to the role of potassium, which contributes to the activation of a number of enzymes responsible for the synthesis of Chlorophyll, which helps in the formation of chloroplasts and its role in activating the enzymes responsible for the manufacture of carbohydrates and energy, which leads to an improvement in the nutritional status of the plant, as potassium is known for its high ability to open and close stomata, which leads to an increase in the efficiency of photosynthesis, an increase in cell division, the growth of leaves, and the encouragement of vegetative growth, so it increases Thus, some chemical characteristics such as carbohydrates and chlorophyll in the plant, as when fertilizers are added, the reaction zone density around the roots increases, which leads to an increase in phosphorus absorption, and thus the plant content of chlorophyll and nutrients increases (Dhiraj and Kumar, 2012).

The effectiveness of the NPK Nano fertilizer and its containment of the elements accumulated in the leaves when added to the plant led to an increase in chlorophyll and thus to an increase in other growth indicators, as these elements are involved in vital activities and the synthesis of chlorophyll, enzymes, proteins, amino acids and all important substances in the division and elongation of cells, which leads to improvement Vegetative growth and increase their content in the plant (Kumar *et al*., 2015). Also, the frequency of spraying led to an improvement in the vegetative growth coefficient in general, which contributed to an increase in the accumulation of nutrients and nutritional compounds in the plant (Aziz and Zrar, 2021; AlJuthery *et al*., 2018).

Conclusions and Recommendations: We conclude from the foregoing that there are differences between the concentrations of NPK Nano fertilizer used on the traits constituting the yield and the chemical content of the seeds. The results also showed a clear response to increasing the concentration of NPK Nano fertilizer in improving all studied traits. The interaction between high concentrations of Nano-fertilizer and frequency of spraying enhanced the yield-forming traits and the chemical content of the seeds. Thus, this study recommends the use of NPK Nano fertilizer at a concentration of 2 gm/ L. The application of the process of spraying fertilizer in two full batches, and the use of higher concentrations of Nano fertilizer NPK to learn more about the role of this fertilizer in raising the performance of the studied characteristics, and expanding the use of other types of Nano fertilizers, and conducting studies using other characteristics and criteria and tracking the physiological effects of these fertilizers.

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