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# Effect of adding some macro- and microelements and spraying with the growth regulator Brassinolide on the chemical content of date palm leaves, Barhi Cultivar

**Qahtan Muhammad Abdelmawla*, Harith Mahmoud Aziz Al-Tamimi**

**Department of Horticulture and Landscape Engineering, College of Agriculture, University of Kerbala, Karbala, Iraq.**
**Corresponding author e-mail: kahtanalmwla@gmail.com**
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## Abstract

A field experiment was carried out on February15, 2023 in the Orchard Development Project / Kerbala Agriculture Directorate, located in the Um Gharagher area / Al-Husseiniyah district / Kerbala governorate during the 2023 growing season, with the aim of studying the effect of some micronutrients and spraying with the growth regulator Brassinolide on the chemical content of the Barhi date palm, at the age of 16 years, the experiment was implemented according to a randomized complete block design (R.C.B.D) in the order of factorial experiments and with three replications. The study included two factors, the first factor was adding some macro- and micro-nutrients at three levels (0, 1000, and 1500 g palm$^{-1}$), while the second factor included four concentrations of spraying with a regulator. Growth Brassinolide (0.0, 0.3, 0.6 and 0.8 mg L$^{-1}$). The results showed that treatment with chemical compound fertilizer at the level of 1500 g palm$^{-1}$, significantly affected the chemical content of the leaves by giving them the highest average content of chlorophyll, carbohydrates, nitrogen, phosphorus, potassium and iron (0.893 mg g$^{-1}$, 12.129%, 1.001%, 0.464%, 1.303% and 168.720 mg kg$^{-1}$ respectively), while the spraying treatment with brassinolide at a concentration of 0.8 mg L$^{-1}$ recorded the highest average leaf content of chlorophyll, carbohydrates, nitrogen, phosphorus, potassium and iron (0.943 mg L$^{-1}$, 12.420%, 1.066%, 0.497%, 1.366% and 171.880 mg kg$^{-1}$, respectively). As for the interaction between the two factors, it was noted that the treatment (1500 g palm$^{-1}$ + 0.8 mg L$^{-1}$) was superior by giving it the highest average for all the traits under study.

**Keywords**: *Phoenix dactylifera* L., Brassinolide, Macro and micro nutrients, Qualitative traits.

## Introduction

Date palm (*Phoenix dactylifera* L.) belongs to the palm family Arecaceae and is one of the most important permanent fruit trees in Iraq. Its cultivation is widespread in subtropical regions between latitudes (10 - 39°) north and south of the equator [1]. Southern Iraq and the Arabian Gulf region are among the oldest places for palm tree cultivation, from where they spread to other countries of the world [2]. The number of palm trees produced in Iraq estimate at about 11018783 palm, with a production rate of 735353 ton annually [3].

There are many varieties of palm trees, as there are approximately 2600 species in the world, but in Iraq there are more than 600 varietie, the most prominent of which is the Barhi variety, which represents one of the most important commercial varieties and is widely cultivated in the central and southern regions of Iraq, and its fruits are characterized by their absence of the substance (Tanninism) are astringent from the khalal stage to the date stage, which distinguishes them from other varieties, as they are eaten with khalal, tamr, and rutab [4]. Barhi is a late-flowering and maturing variety. The production of one palm tree is estimated at about 80-120 kg palm$^{-1}$ and it can produce 6-8 offshoot during its life cycle [5].

Most palm orchards in Iraq suffer from a lack of interest in agricultural service operations, especially fertilization, as signs of nutrient deficiency have been observed on palm fronds, which has had a negative impact on date productivity [6]. Therefore, chemical fertilization at specific rates and times can improve the growth of palm trees through the roots absorbing nutrients and increasing the chemical content of leaves, as it was found [7]. Fertilizing palm trees of the Khastawi variety with the third fertilizer combination (urea 900 g + 450 g DAP + 600 g potassium sulfate) caused a significant increase in the leaf content of chlorophyll, carbohydrates, nitrogen, phosphorus, potassium and protein. [8] also found that chemical fertilization had a significant effect on the characteristics of vegetative growth and the chemical content of leaves, as the third fertilizer level (600 g urea + 375 g DAP + 450 g potassium sulfate) gave the highest average for all the characteristics of vegetative growth and the leaves' content of chlorophyll, carbohydrates and nutrients.

It has become clear at the present time, as a result of scientific progress in the agricultural field, that plant growth is not limited to water, light, $CO_2$, and mineral elements only, but rather it needs plant hormones, which are considered a source of vital activities that control the physiological processes necessary for plant growth, such as Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene, and Brassinolide [9]. In view of the importance of plant growth regulators in activating the structural and biological activities of the plant, it was necessary to experiment with using the growth regulator Brassinolide with chemical fertilizers and to study their effect on the chemical content in leaves of date palm trees of the Barhi variety. Brassinosteroid (BR) is considered a new class of hormones that can be used in relatively low concentrations. With many plants in different stages of growth, it plays key roles in a wide range of plant structural processes, including cell division and stems elongation and roots, and the activation of many vital activities to improve growth and production [10]. In a study conducted on several concentrations of spraying with the growth regulator Brassinolide on date palm trees of Khastawi variety, it was noted that the concentration of 0.6 mg L$^{-1}$ recorded the highest average in the chemical content of leaves, including chlorophyll, CHO, N, P, and K [11]. Therefore, the current study aimed to know the effect of several levels of complex chemical fertilizer, as well as to know the best concentration of the growth regulator Brassinolide, in addition to knowing the effect of the interaction between them on the chemical content of leaves of Barhi date palm.

## Materials and Methods

A field experiment was carried out on February15, 2023 in the Orchard Development Project / Kerbala Agriculture Directorate / Iraqi Ministry of Agriculture / Um Gharagher area / Al-Husseiniyah District / Kerbala Governorate, where (36) date palms of Barhi variety, 16 years old, were selected, almost uniform in size and shape. Planted on lines with dimensions of (8 x 8 m), it is irrigated by creating a circular basin with a radius of (1.5m) around the trunk of the palm tree with a depth of (20 cm). The pollination process was also carried out manually using pollen of the red sheep variety on 18/ 3/2023 All agricultural service operations were also performed on the selected trees, including pruning, cleaning, removing thorns, and unifying the stems, by leaving 8 fruit bunch, for each palm tree, distributed evenly around the trunk. Samples of the orchard's soil were taken randomly at depths of (0-30 cm) and (30-60 cm) for analysis. It was dried, ground, and sieved with a sieve with 2 mm holes, after which some physical and chemical soil properties were estimated, Table (1).

The experiment was carried out according to a randomized complete block design (R.C.B.D) as a factorial experiments with three replications. Each replicate included 12 palm, one palm for each experimental unit, so the number was 36 palm. The experiment included two factors. The first factor was adding some macro- and micronutrients at three levels (0, 1000, 1500 g palm$^{-1}$), it was added in four installments, 30 days between one batch and the other, starting from 15/2 - 15/5/2023, the compound chemical fertilizer consists of the following elements: N, P, K, Mg, Fe, Zn, Mn and Cu, different proportions which are as follows 23, 8.1, 14, 0.27, 0.25, 0.09, 0.07 and 0.0125 respectively.While the second factor included four concentrations of spraying with the growth regulator Brassinolide (0.0, 0.3, 0.6, and 0.8 mg L$^{-1}$), spraying was done early in the morning in three stages (Hababouk Stage, Kimri Stage and Khalal Stage), using a 100 L sprinkler with the addition of Al-Zahi at a concentration 0.5 ml L$^{-1}$ to reduce the surface tension of water and increase absorption. The experiment ended in the second half of October 2023.

**Table (1): Some physical and chemical traits of orchard soil**

| Trait | | Unit | Value |
|---|---|---|---|
| **E.C** | | ds m$^{-1}$ | 4.27 |
| **pH** | | ----- | 7.9 |
| **Ready P** | | mg kg$^{-1}$ | 12.20 |
| **Ready K** | | mg kg$^{-1}$ | 124.08 |
| **Ready N** | **$N-NH_4$** | mg kg$^{-1}$ | 15.92 |
| | **$N-NO_3^-$** | mg kg$^{-1}$ | 14.17 |

| | | | |
|---|---|---|---|
| **Ready Zn** | | mg $kg^{-1}$ | 0.32 |
| **Ready Fe** | | mg $kg^{-1}$ | 0.46 |
| **Soil texture** | | Loamy Sand | |
| **Soil isolates** | **Clay** | % | 9.5 |
| | **Sand** | % | 69 |
| | **Silt** | % | 21.5 |

## Data recorded

**Chlorophyll content (mg $g^{-1}$):** The method mentioned by [12] was adopted. In calculating the total chlorophyll content of leaves, a weight of 0.2 g of leaves (wicker) was taken, cut using scissors into several small pieces, then placed in a ceramic mortar and ground by adding 20 ml of acetone 80% until the color of the precipitate became free of green dye, and then it was separated. The filtrate was separated from the precipitate using a centrifuge at 3000 rpm for 10 minutes. The extract was then placed in volumetric tubes and covered with opaque paper in order to avoid photooxidation of the dye. The volume was completed by adding acetone, and the optical density of the filtrate was measured using a spectrophotometer, type UV – 1700, at wavelengths (645 and 663) nm. The total chlorophyll content of leaves was calculated by the following equation:

$$\text{Total Chlorophyll} = [\,20.2\ (\text{D } 645)\ +\ 8.02\ (\text{D } 663)]\ \frac{\text{V}}{1000 * \text{W}}$$

So:

V: The final volume of the filtrate after completing the separation process by the centrifuge.

D: Reading of the optical density of the extracted chlorophyll.

W: fresh weight (g).

**Percentage of carbohydrates in leaves (%):**Total carbohydrates were estimated following method [13] by taking 0.2 g of the dried and ground sample for each experimental unit and placing it in a test tube and adding 1 of perchloric acid to it. Then it was placed in a water bath at 60°C for 60 min. The process was repeated three times and each time it was placed in the centrifuge. Central for 15 minutes at 3000 revolutions. 1 min, after which the clear solution was extracted and collected and added to 100 ml by adding distilled water. Then take 1 ml of the solution and add 1 ml of 5% phenol with 5 ml of sulfuric acid until the brown color appears, and then the measurement was made using a spectrophotometer at a wavelength of 490 nm, and the percentage of carbohydrates was estimated using the following equation:

$$\text{Percentage of carbohydrates} = \frac{\text{dilutions x concentration}}{1000 * \text{W}} * 100$$

**Concentration of nitrogen, phosphorus and potassium (%):** The samples were dried in an electric oven at a temperature of 70°C until the weight was stable, then they were ground. 0.2 g of the dried, ground sample were taken for each treatment and digested in a mixture of acid (concentrated sulfuric 96%) and (perchloric concentration 4%) with heating according to the described method by [14] After that, a clear solution was obtained and the volume was increased to 50 ml with distilled water, after which it was ready to estimate the mineral elements in it. Total nitrogen in plant samples was measured using a steam distillation device (Kjeldahl), according to [15]Phosphorus was measured after adjusting the acidity of the mixture using ammonium molybdate and ascorbic acid using a spectrophotometer at a wavelength of 400 nm according to the method described by [16] As for potassium, it was determined using a flame emission device according to the method [14]

**Iron content in leaves (mg kg$^{-1}$):** Iron content in leaves was estimated using an atomic emission device (atomic absorption) according to the method described in [17]

**Statistical analysis**

The results were statistically analyzed according to the analysis of variance (ANOVA) in randomized complete block design (R.C.B.D ) [18]. The least significant difference (L.S.D $_{0.05}$) test was used to compare and separate the means, this is done using statistical analysis software GenStat12.

**Results and Discussion**

**Chlorophyll content (mg g$^{-1}$)**

The results in Table (2) indicate that there are significant differences in the total chlorophyll content of leaves as a result of adding the compound chemical fertilizer. The treatment (1500 g palm$^{-1}$) excelled by giving it the highest average of 0.893 mg g$^{-1}$, while the control treatment gave the lowest average of 0.758 mg g$^{-1}$. This may be due to the macro- and micro-nutrients the fertilizer contains (N, P, K, Mg, Fe, Mn, Cu), which contribute to building the chlorophyll pigment. Nitrogen contributes with magnesium to building the chlorophyll molecule, where zinc enters indirectly. In building the chlorophyll molecule through its effect on regulating the pH inside the chloroplasts, in addition to its role in protecting proteins from losing their biological nature [19], iron also plays an important role in building the chlorophyll pigment by activating the effectiveness of the enzymes responsible for building green pigments, as well as Its contribution, along with zinc and copper, in protecting the chlorophyll molecule from premature catabolism [20].

The results of the same table showed that spraying with the growth regulator Brassinolide caused an increase in the total chlorophyll content of leaves, as the treatment (0.8 mg L$^{-1}$) gave the highest average of 0.943 mg L$^{-1}$, while the control treatment (0.0 mg L$^{-1}$) recorded the lowest average of 0.756 mg g$^{-1}$. The increase in chlorophyll content may be due to the role of Brassinolide, as it contains vitamins, amino and organic acids, and some synthetic growth regulators, which play an important role in increasing the activity of vital processes within the plant, the most important of which is the process of carbon metabolism, which works to increase the chlorophyll content of leaves [21]. It also works (Brassinolide) to protect chlorophyll from decomposition through its role in inhibiting the activity of the chlorophyllase enzyme, which increases when the plant is exposed to drought [22].

The results also showed that there was a significant interaction between the study factors in the total chlorophyll content of leaves, as the treatment gave (1500 g palm$^{-1}$+ 0.8 mg L$^{-1}$) the highest interaction amounted to an average of 1.047 mg g$^{-1}$, while the control treatment for both agents recorded the lowest average of 0.727 mg g$^{-1}$.

**Table (2): Effect of adding a compound chemical fertilizer, spraying with the growth regulator brassinolide and their interaction on the total chlorophyll content of leaves (mg g$^{-1}$)**

| Compound chemical fertilizer (g palm$^{-1}$) | Brassinolide (mg L$^{-1}$) | | | | Average |
|---|---|---|---|---|---|
| | 0.0 | 0.3 | 0.6 | 0.8 | |
| 0 | 0.727 | 0.733 | 0.743 | 0.830 | 0.758 |
| 1000 | 0.740 | 0.744 | 0.782 | 0.953 | 0.805 |
| 1500 | 0.801 | 0.828 | 0.895 | 1.047 | 0.893 |
| Average | 0.756 | 0.769 | 0.807 | 0.943 | |
| $L.S.D_{0.05}$ | Fertilizer | Brassinolide | | Interaction | |
| | 0.019 | 0.022 | | 0.038 | |

**Percentage of carbohydrates in leaves (%)**

The results in Table (3) showed that adding the compound chemical fertilizer had a significant effect on the carbohydrate content of leaves, as the treatment (1500 g palm$^{-1}$) recorded the highest average of 12.129%, while the control treatment gave the lowest average of 10.611%. The increase in the percentage of carbohydrates may be due to the role of added fertilizers and the basic nutrients they contain. For example, nitrogen contributes to the formation of proteins, which form an important part of plant cells and play a role in the process of photosynthesis, which contributes to increasing the representation of dry matter. Phosphorus helps in the formation of acids. Nuclear energy, carbohydrates, and sugars, while potassium contributes to regulating the processes of photosynthesis and transporting sugars within the plant. Zinc and magnesium also play an essential role in transporting and storing carbohydrates. Therefore, when these nutrients are sufficiently available, the plant can increase the production of carbohydrates and store them in the form of starch or sugars[23].

The results of the same table also indicated that there were significant differences between the spraying treatments with the growth regulator Brassinolide, as the treatment (0.8 mg L$^{-1}$) recorded the highest average of 12.420%, while the control treatment recorded the lowest average of 10.390%. This may be due to the effect of Brassinolide in stimulating the photosynthesis process, which led to an increase in net

$CO_2$ in leaves, which represents the basic unit for building carbohydrates, and thus increased their accumulation in the leaves [24].

The results also showed that there were significant differences as a result of the interaction between the two study factors in the concentration of carbohydrates in leaves, as the highest interaction was in the treatment (1500 g palm$^{-1}$ + 0.8 mg L$^{-1}$) with an average of 13.303%, while the control treatment for both factors recorded the lowest average of 9.955%.

**Table (3): Effect of adding a compound chemical fertilizer, spraying with the growth regulator brassinolide and their interaction in carbohydrate content of leaves (%)**

| Compound chemical fertilizer (g palm$^{-1}$) | Brassinolide (mg L$^{-1}$) | | | | Average |
|---|---|---|---|---|---|
| | 0.0 | 0.3 | 0.6 | 0.8 | |
| 0 | 9.955 | 10.239 | 10.443 | 11.807 | 10.611 |
| 1000 | 10.033 | 10.671 | 11.275 | 12.149 | 11.032 |
| 1500 | 11.182 | 11.740 | 12.290 | 13.303 | 12.129 |
| Average | 10.390 | 10.883 | 11.336 | 12.420 | |
| $L.S.D_{0.05}$ | Fertilizer | Brassinolide | | Interaction | |
| | 0.073 | 0.085 | | 0.147 | |

**Nitrogen percentage in leaves (%)**

The results in Table (4) indicate that there are significant differences in the nitrogen content of leaves when adding compound chemical fertilizer, as the treatment (1500 g palm$^{-1}$) excelled by giving it the highest average of 1.001%, while the control treatment recorded the lowest average of 0.861%. The increase in nitrogen content in the leaves may be due to the nitrogen element, being one of the most important components of the chemical fertilizer added to the soil, which led to an increase in the concentration of nitrogen in the area surrounding the roots, which increased the plant's ability to absorb larger quantities of it, causing an increase in its concentration in the plant tissues, especially the leaves [25]. In addition, nitrogen plays an important role in increasing vegetative growth by increasing the products of photosynthesis and biological processes. Thus, root activity increases and they are more efficient in absorbing nitrogen from the soil, thus increasing its concentration in plant tissues [26].

The same results showed that there were significant differences between the spraying treatments with the growth regulator Brassinolide in the nitrogen content of leaves, as the treatment (0.8 mg L$^{-1}$) gave the highest average of 1.066%, while the control treatment recorded the lowest average of 0.859%. The increase in the nitrogen content of leaves may be due to the effect of Brassinolide on some physiological processes, including increasing the absorption of water and mineral elements, and thus it contributes to the transfer and then to the accumulation of nutrients and their assembly in the leaves [27].

It is also noted from the same table that the interaction between the two study factors had a significant effect on the average concentration of nitrogen in leaves, as the highest interaction reached in the treatment (1500 g palm$^{-1}$ + 0.8 mg L$^{-1}$) with an average of 1.220%, while the lowest interference was achieved in the control treatment for both factors as well, with an average of 0.806%.

**Table (4): Effect of adding a compound chemical fertilizer, spraying with the growth regulator brassinolide and their interaction in nitrogen content of leaves (%)**

| Compound chemical fertilizer (g palm$^{-1}$) | Brassinolide (mg L$^{-1}$) | | | | Average |
|---|---|---|---|---|---|
| | **0.0** | **0.3** | **0.6** | **0.8** | |
| **0** | 0.806 | 0.815 | 0.870 | 0.951 | 0.861 |
| **1000** | 0.864 | 0.887 | 0.890 | 1.027 | 0.919 |
| **1500** | 0.906 | 0.924 | 0.985 | 1.220 | 1.001 |
| **Average** | 0.859 | 0.875 | 0.917 | 1.066 | |
| **L.S.D$_{0.05}$** | Fertilizer | Brassinolide | | Interaction | |
| | 0.033 | 0.038 | | 0.066 | |

**Phosphorus percentage in leaves (%)**

The results in Table (5) showed that there were significant differences between the chemical fertilizer treatments in the percentage of phosphorus in leaves, where the treatment (1500 g palm$^{-1}$) gave the highest average of 0.464%, while the control treatment recorded the lowest average of 0.371%. The reason for the increase in the phosphorus content of leaves may be attributed to the chemical fertilizer added to the soil containing phosphorus, which increased its concentration in the soil and facilitated its absorption by the roots, in addition to the high level of added nitrogen working to lower pH of the soil, which caused an increase in availability of phosphorus and increased its absorption by the plant [28]. Or perhaps the reason is due to the fact that phosphorus is involved in the formation of nucleic acids, proteins, and energy compounds [29], which had a positive effect on increasing its concentration in the leaves.

The results of the same table showed that there were significant differences between the spray treatments in the phosphorus content of the leaves, as the treatment (0.8 mg L$^{-1}$) recorded the highest average of 0.497%, while the control treatment gave the lowest average of 0.370%. The increase in phosphorus content in leaves may be due to the interaction of Brassinolide with other internal plant hormones that stimulate growth, which includes a cooperative response with auxins and a complementary effect by gibberellins [30], and thus it positively affects the process of absorption and transfer of nutrients from the soil to the plant, which is reflected in the Increased leaf content of nutrients, including phosphorus, these results agreed with what was found by [11,12].

Table (5) also indicates that there are significant differences in the percentage of phosphorus in leaves as a result of the interaction between the two factors of the study, as the treatment (1500 g palm$^{-1}$ + 0.8 mg L$^{-1}$) by giving it the highest average of 0.523%, while the control treatment was recorded for both factors the lowest average was 0.317%.

**Table (5): Effect of adding a compound chemical fertilizer, spraying with the growth regulator brassinolide and their interaction in phosphorus content of leaves (%)**

| Compound chemical fertilizer (g palm$^{-1}$) | Brassinolide (mg L$^{-1}$) | | | | Average |
|---|---|---|---|---|---|
| | 0.0 | 0.3 | 0.6 | 0.8 | |
| 0 | 0.317 | 0.334 | 0.356 | 0.476 | 0.371 |
| 1000 | 0.367 | 0.372 | 0.377 | 0.491 | 0.402 |
| 1500 | 0.426 | 0.438 | 0.469 | 0.523 | 0.464 |
| Average | 0.370 | 0.381 | 0.401 | 0.497 | |
| $L.S.D_{0.05}$ | Fertilizer | Brassinolide | | Interaction | |
| | 0.007 | 0.008 | | 0.015 | |

**Potassium percentage in leaves (%)**

Table (6) shows that adding compound chemical fertilizer had a significant effect on increasing the percentage of potassium in leaves, as the treatment (1500 g palm$^{-1}$) excelled by giving it the highest average of 1.303%, while the control treatment recorded the lowest average of 1.078%. The reason for the increase in potassium content in leaves may be due to its availability in the soil as a result of adding chemical fertilizer containing it and increasing its absorption by the roots, in addition to its important role in vegetative growth and increasing the efficiency of photosynthesis, as it is considered a carrier of carbohydrates and an activator for many enzymes, which led to its absorption in large quantities. More than the soil to meet the plant's needs [31].

It is clear from the same table that there are significant differences between the Brassinolide spray treatments in potassium concentration, as the treatment (0.8 mg L$^{-1}$) gave the highest average of 1.366%, while the control treatment gave the lowest average of 1.059%. The reason may be attributed to the role of Brassinolide, as it contains a basic group of nutrients that stimulate the enzymes responsible for the process of cell division and elongation. Thus, it contributes directly and indirectly to increasing the activity of the photosynthesis process, which in turn increases the absorption and transfer of nutrients, and this is what reflects positively on the body. Increase the potassium content of leaves [32].

It is also noted from Table (6) that the binary interaction has a significant effect in increasing the percentage of potassium in leaves, as the highest interaction reached in the treatment (1500 g palm$^{-1}$ + 0.8 mg L$^{-1}$) with the highest average reaching 1.433%, while the control treatment was recorded for the study two factors, the lowest average was 0.967%.

**Table (6): Effect of adding a compound chemical fertilizer, spraying with the growth regulator brassinolide and their interaction in potassium content of leaves (%)**

| Compound chemical fertilizer (g palm$^{-1}$) | Brassinolide (mg L$^{-1}$) | | | | Average |
|---|---|---|---|---|---|
| | 0.0 | 0.3 | 0.6 | 0.8 | |
| **0** | 0.967 | 0.997 | 1.067 | 1.280 | 1.078 |
| **1000** | 1.060 | 1.183 | 1.280 | 1.383 | 1.227 |
| **1500** | 1.150 | 1.273 | 1.357 | 1.433 | 1.303 |
| **Average** | 1.059 | 1.151 | 1.234 | 1.366 | |
| **L.S.D$_{0.05}$** | Fertilizer | Brassinolide | | Interaction | |
| | 0.043 | 0.050 | | 0.086 | |

**Iron concentration in leaves (mg kg$^{-1}$)**

The results presented in Table (7) confirm that the chemical compound fertilizer had a significant effect in increasing the concentration of iron in leaves, as the treatment (1500 g palm$^{-1}$) recorded the highest average of 168.720 mg kg$^{-1}$, while the control treatment gave the lowest average of 152.370 mg kg$^{-1}$. The reason for the increase in iron content of leaves may be attributed to it being one of the components of the chemical fertilizer added to the soil, which increases its readiness for absorption by the plant, or perhaps this is due to its role in activating the enzymes that participate in the formation of the chlorophyll molecule, carbohydrates, and cell division, which affects root growth and increased absorption, which was reflected in an increase in its content in leaves [33].

The same table also indicates that there are significant differences in the iron concentration of leaves as a result of spraying with the growth regulator Brassinolide, where the treatment (0.8 mg L$^{-1}$) gave the highest average of 171,880 mg kg$^{-1}$, while the control treatment gave the lowest average of 151,790 mg kg$^{-1}$. The availability of nutrients can contribute to increasing the iron content of leaves, as some nutrients contribute to changing the properties of the soil so that iron becomes more available to plants [34].

The results of Table (7) showed that there was a significant interaction between the study factors in the concentration of iron in leaves. The highest interaction in the treatment (1500 g palm$^{-1}$ + 0.8 mg L$^{-1}$) reached the highest average of 180.870 mg kg$^{-1}$, while the lowest interaction in the control treatment reached an average it reached 144,880 mg kg$^{-1}$ for both factors.

**Table (7): Effect of adding a compound chemical fertilizer, spraying with the growth regulator brassinolide and their interaction in iron content of leaves (%)**

| Compound chemical fertilizer (g palm$^{-1}$) | Brassinolide (mg L$^{-1}$) | | | | Average |
|---|---|---|---|---|---|
| | 0.0 | 0.3 | 0.6 | 0.8 | |
| **0** | 144.880 | 147.950 | 151.740 | 164.920 | 152.370 |
| **1000** | 150.510 | 155.180 | 162.990 | 169.840 | 159.630 |
| **1500** | 159.980 | 162.010 | 172.040 | 180.870 | 168.720 |
| **Average** | 151.790 | 155.050 | 162.250 | 171.880 | |
| **L.S.D$_{0.05}$** | Fertilizer | Brassinolide | | Interaction | |
| | 1.267 | 1.463 | | 2.534 | |

From the above, we can conclude that the chemical fertilizer, has a role in increasing the leaves' content of qualitative characteristics, especially the level (1500 g palm$^{-1}$), which showed good results compared to the other two levels. Spraying with Brassinolide also has a clear role in increasing the plant's ability to exploit the available resources, and it is possible to be one of the factors contributing to increasing the content of qualitative characteristics in palm leaves.

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