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Investigation on the impact of foliar application using varying quantities of chelated iron and dry yeast extract on specific physical and chemical attributes of pomegranate trees.

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Abstract
The investigation took place in the Al-Khamisat region, located in the southeast of Dhi Qar Governorate, during the 2023 growing season. The study focused on pomegranate trees in a private orchard. A total of twenty-seven pomegranate trees, which were uniform in terms of size and growth, were selected as experimental units to investigate the impact of applying chelated iron and dry yeast extract, as well as their interaction, on various physical and chemical attributes of Slimmi variety pomegranate trees. The experiment followed a completely randomized block design, incorporating two factors. The first factor involved spraying with chelated iron at three concentrations (0, 250, 500) mg L-1, while the second factor involved spraying with dried yeast extract at three concentrations (0, 5, 10) g L-1. Each treatment was replicated three times. There are a total of 27 experimental units, with each experimental unit represented by one tree.

The outcomes were as follows: The Y3 treatment exhibited superior characteristics in terms of leaf area (2.494 cm2), stem diameter (24.46 mm), height (197.2 cm), and new growth averaging (29.78 cm).

The Y3 treatment demonstrated superior chemical features in the following areas: dry matter content of 46.53 g, chlorophyll content of 51.82 mg per 100 g of fresh weight, carbohydrate content of 4.20 mg per gram of dry matter, and protein content of 10.85%.

Regarding chelated iron, the F3 treatment demonstrated superior performance in the following characteristics: leaf area (2.601 cm2), stem diameter (26.74 mm), height (209.1 cm), and new growth (29.56 cm).

The F3 treatment exhibited superior chemical features in terms of dry matter content (46.06 g), chlorophyll content (49.73 mg per 100 g), carbohydrate content (4.19 mg per g of dry matter), and protein content.(%10.91)

In regards to the binary interaction between dry yeast extract and chelated iron, the F3 Y3 treatment resulted in a plant height of 235.0 cm and new growths of 34.67 cm at a concentration of 500 mg L-1 mm.

The treatment also performed exceptionally well in terms of dry weight (58.84 g), chlorophyll content (54.32 mg per 100 g), carbohydrate content (4.40 mg per gram of dry matter), and protein content .(%11.74)

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Introduction

The pomegranate tree, scientifically known as *Punica granatum* L., is a member of the pomegranate family, punicaceae. It is a highly significant fruit crop that is widely cultivated in temperate regions. In cold places, this plant loses its leaves throughout the winter and regrows them in the spring. In tropical and subtropical regions, it either keeps its leaves all year round or loses them partially. The pomegranate has been recognized since ancient times and is considered to originate from its natural home. The cultivation of this plant originated in Southwest Asia, specifically in Iran, Iraq, Yemen, and the southern part of the Arabian Peninsula. From there, it spread to countries in the Mediterranean basin. Subsequently, it was introduced to European countries like Spain, Italy, and France, and eventually made its way to America (Mir et al., 2012). In Iraq, there are a total of 6,452,378 fruit trees, each producing an average of 34,000.07 kg (Central Statistical Organization, 2020). Pomegranate fruits have a prolonged shelf life in the market because of their durable and protective leathery skin.

Pomegranates are rich in various essential nutrients. The juice has a caloric content ranging from 23 to 87 calories per 100 grams. It is composed of 18% carbohydrates, 1% protein, and 1% fiber. It has a low fat content and is high in iron and potassium. It includes significant amounts of vitamins, including vitamins C and B. The reference is from Metwally and Al-Wakeel's work published in 2010.

Every plant requires micronutrients in tiny amounts relative to macronutrients, and the absence of these components has a detrimental impact on growth characteristics (Modal and Bose, 2019). Iron is an essential element for plants and plays a vital role in the functioning of numerous enzymes involved in the respiratory process (Al-Tamimi, 1997). Iron has a crucial role in maintaining the green matter within plants, aiding in the production of chlorophyll, and contributing to the formation of cytochromes. These cytochromes are highly significant in the processes of photosynthesis and respiration (Awad, 1986). Chelated compounds consist of an organic compound that binds with a mineral element, causing the element to lose its ionic characteristics but retain the ability to dissolve and move. This allows the element to be easily absorbed by plants (Kabuta, 2005).

Yeast is a type of biofertilizer that has garnered significant interest from researchers due to its non-toxic nature towards humans, animals, and the environment. Additionally, yeast provides essential nutrients to plants, promoting growth and increasing crop yields (Lateif, 2020). Yeast used for making bread. Saccharomyces cerevisiae is a unicellular organism that reproduces asexually by budding and sexually through spores. Baking yeast is environmentally benign and poses no harm to plants (Barnett et al., 2000). Yeast is abundant in essential elements like phosphorus, potassium, and iron, and it also contains a total of 16 amino acids. This study was conducted to address the dearth of research on the impact of foliar spraying with chelated iron and yeast extract on fruit trees, with a specific focus on pomegranate plants. The study aimed to achieve the following objectives:

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1. Assessing the impact of applying chelated iron through spraying on the vegetative development parameters and chemical composition of pomegranate trees.

2. Investigating the impact of foliar application of baking yeast on pomegranate plants, specifically on the parameters of vegetative development and chemical composition.

3. The impact of the interplay between research variables on the morphological and chemical attributes of pomegranate plants

Materials and Methods:

Experiment site:

The research was carried out during the 2023 growing season on Sulaimi variety pomegranate trees (Punica granatum L.) at one of the Al-Ahlia orchards located in the Al-Khamisat region of the southeast Dhi Qar Governorate. The planting dimensions of the area are 4 meters. Each individual tree serves as an experimental unit to investigate the impact of applying various quantities of chelated iron and dry yeast extract to the leaves on thePhenotypic and chemical features of pomegranate plants.

An examination of the soil in the orchard was carried out before to commencing the research. Random samples were collected from various areas within the orchard area, thoroughly mixed, and subsequently dried and sieved.

Table (1) displays the soil properties.

properties	unit	value
Ph	-	8
EC	ds|m	5.8
Sand	%	46.72
Clay	%	21.31
Silt	%	31.96
Soil textuer	-	Loam

Service activities for pomegranate trees involved the pruning and removal of broken, congested, and dead branches. This process was conducted before to commencing the foliar spraying. The soil was also incised shallowly. Subsequently, the chosen trees were labeled with numbered indicators in accordance with the experimental design.

Application technique and timing:

Chelated iron EDTA was made by dissolving 250 mg L-1 and 500 mg L-1 of it separately in one liter of distilled water each. Fertilizer treatments for dry yeast extract were created by dissolving 5 and 10 grams of it in one liter of distilled water for each treatment. A 0.1 ml quantity of a brilliant dispersant was introduced into the blocked solutions in order to decrease the surface tension of water molecules. The control treatment (0%) was made solely using distilled and purified water. A manual pump was utilized

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for the purpose of spraying. The application process was conducted in the morning. The trees were thoroughly drenched with spray. The trees were watered the day prior to the spraying process in order to enhance the ability of the blocked solution's ions to penetrate the leaf cells.

Spraying schedule: The trees were treated with chelated iron and yeast extract, both alone and in combination, during four distinct spraying sessions. The initial application occurred after the leaves had emerged, and there was a 15-day interval between this application and the subsequent one.

Study factors: The experiment used a total of two workers and three different concentrations for each item.

The first factor consists of three levels of chelated iron EDTA concentrations, specifically (0, 250, 500) mg per liter.

The second factor consists of three different quantities of dry yeast extract: 0 g/L, 5 g/L, and 10 g/L.

experiment Design

The experiment used a randomized complete block design (RCBD). There are 27 experimental units, with each unit having one tree. Each treatment is replicated three times. The data were statistically examined using the Genstat program. The differences between the arithmetic averages of the results were compared, and the least significant difference was evaluated at a significance level of 0.05.

Studied characteristics:

First: physical characteristics

1. leaf area:

The dimensions of multiple completely expanded leaves were measured from the central point of the tree branches. The average of these measurements was then multiplied by a constant, as described in the approach by Obiofuna.(1979)

The formula to calculate the paper area is obtained by multiplying the paper length by the paper width and then multiplying the result by 0.8 .

2. stem diameter.

The Vernier caliper was used to measure the stem diameter. At the conclusion of the experiment, the object was positioned 4 cm higher than the level of the earth surface.

3. Average length of recent growth

For all treatments, ten new growths were identified on the four sides of the tree, each at varying heights. The average growth length was determined by dividing the total length of the growths by the number of growths using a measuring tape, after growth had ceased and the leaves had fallen (Khattab et al., 2011).

4. Height of the plant

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This attribute was quantified using a metric tape measure, with the measurement taken from the point where the plant makes contact with the soil to the tip of the plant's uppermost part.

Secondly, the chemical properties.

1. Leaf dry matter percentage:

A specific quantity of pomegranate leaves was collected from each treatment. Subsequently, the moisture content of the leaves for each experimental unit was measured using a precise balance. Subsequently, the leaves were subjected to desiccation in an electric oven set at a temperature of 70 degrees Celsius until a constant weight was achieved. Subsequently, the specimens were re-weighed utilizing a highly sensitive balance, and the proportion of solid material was determined by applying the subsequent equation.

The dry matter percentage is calculated by dividing the dry weight by the wet weight and multiplying the result by 100.

2. The amount of chlorophyll present in leaves(mg 100 g^{-1} of fresh weight):

The estimation of chlorophyll concentration in leaf tissue was conducted using the method proposed by Porra in 2002. A total of 0.5 grams of leaves were measured and combined with 15 cm3 of acetone solution, which was diluted to 80%. The leaves were then crushed using a ceramic mortar. The samples were measured simultaneously, and the absorbance reading was obtained using a spectrophotometer. By utilizing wavelengths of 645 and 663 nm, the chlorophyll concentration can be determined using the subsequent equation .

(663)D(654)+8.02*D)=20-2Mg.L^{-1}(Total Chlorophyll

D = Reading wavelength

The result is converted to mg 100 gm - 1 fresh weight according to the following equation:

100gm mg - 1 fresh weight = yield (mg | l) x final volume of extract (l) / sample weight (g)

100×

3. The percentage of carbohydrates

The carbohydrate content was quantified using the phenol with sulfuric acid technique, as described by Dubios et al. in 1956. A 0.5 gram sample of dried leaves was obtained and placed in a 250 milliliter beaker. To this, 75 milliliters of distilled water were added. The mixture was then subjected to a temperature of 90°C in a water bath for one hour. Finally, the mixture was filtered using filter paper. A volume of 5 milliliters of the filtrate was extracted and mixed with 25 milliliters of distilled water. Subsequently, a volume of 1 milliliter of the filtrate was extracted. For every treatment, a volume of 1 ml of phenol and 5 ml of sulfuric acid (H2SO4) is included. Next, the solution is transferred to a spectrophotometer set at a wavelength of 490 nm.

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The equation provided below was utilized:

Percentage of carbohydrates = (concentration x dilution / 10 x 1 ml x sample weight) x 100

4. Estimation of protein content in leaves

The protein content in leaves was determined by estimating their nitrogen content using the following correlation.

The protein % can be calculated by multiplying the nitrogen percentage in leaves by 6.25, as stated by Abu Dhahi in 1989.

Results and discussion:

Physical characteristics:

1- leaf area (cm2):

The statistical study revealed a notable impact of applying dried yeast extract and chelated iron, as well as their combined effect, on the leaf area.

The results of Table (2) indicate that the application of dry yeast extract through spraying has a substantial impact on the leaf area. Specifically, the Y3 treatment demonstrated superior performance with an average leaf area of 2.494 cm2, whereas the Y0 treatment exhibited the lowest average of 2.172 cm2. The substantial rise can be attributed to The application of dried yeast extract may result in an expansion of leaf surface area, potentially attributed to an augmentation in photosynthetic pigments. The delay in leaf senescence may be attributed to cytokines generated by yeast, which decrease chlorophyll breakdown and promote protein synthesis. This aligns with the findings of Al-Rubaie (2014). When applying yeast extract to orange seedlings using a spray method.

Regarding chelated iron, the table findings demonstrate a clear advantage in leaf area. The Y3 treatment outperformed with an average of 2.601 cm2, whereas the F0 treatment had the lowest average of 2.126 cm2. The increase in leaf area can be related to the action of iron in many processes. The plant undergoes many biological processes, such as the synthesis of amino acids, proteins, and enzymes, which stimulate cell divisions and elongation. This ultimately leads to an increase in the average leaf area (Sharaqi et al., 1985). This finding corroborates the results obtained by Al-Hamdani (2004) in the study of olives.

The binary interaction between dry yeast extract and chelated iron yielded favorable outcomes. Specifically, the F3 Y3 treatment, consisting of 500 mg L-1 of dry yeast extract and 10 g L-1 of chelated iron, outperformed the other treatments and achieved the highest average leaf area of 2.960 cm2 per plant. The comparative treatment (F0Y0) yielded the smallest value of (1.953) cm2 for the same attribute.

Table (2) Effect of spraying with dry yeast extract and chelated iron and their interaction on the leaf area (cm2 plant-1) .

chelated iron	dry yeast extract	Average

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	0	5	10	
0	1.953	2.167	2.257	2.126
250	2.213	2.240	2.267	2.240
500	2.350	2.493	2.960	2.601
Average	2.172	2.300	2.494	
LSD 0.05				
F= 0.1467	Y= 0.1467		F=2541×Y	

2-stem diameter (mm)

The statistical study revealed a notable impact of applying dry yeast extract and chelated iron, as well as their combined effect, on the stem diameter.
The findings from table (3) demonstrated that the application of dry yeast extract through spraying resulted in a notable enhancement in stem diameter. Specifically, the Y3 treatment exhibited the highest average of (24.46) mm, while the Y0 treatment yielded the lowest average of (21.77) mm. This can be linked to the role of yeast. Dried seeds include amino acids, proteins, and mineral components that stimulate the production of growth hormones, specifically cytokines, which effectively promote plant growth (Mohamed & Al-Younis, 1991). Regarding the application of chelated iron spray, the data from the table clearly shows that the F3 treatment outperformed the comparative treatment F0. The F3 treatment had an average stem diameter of 26.74 mm, whereas the F0 treatment had the smallest stem diameter of 20.65 mm. The possible explanation for this phenomenon can be attributed to the function of chelated iron in the synthesis of chlorophyll, cytochromes, and crucial enzymes in plants (Havlin et al., 2005). This finding aligns with the research conducted by Hassoun (2012), who observed that the application of chelated iron to mango seedlings resulted in the highest rate of vegetative growth characteristics, including plant height and stem diameter, with the treatment of 100 mg being the most effective.
The binary interaction between dry yeast extract and chelated iron yielded favorable outcomes. Specifically, the F3Y3 therapy at a concentration of 500 mg L-1 demonstrated positive effects. By comparison, the lowest figure for the same attribute was 19.90 mm in F0Y0.

Table (3) Effect of spraying with yeast extract and chelated iron and their interaction on stem diameter (mm)

chelated iron	dry yeast extract			Average
	0	5	10	
0	19.90	20.92	21.14	20.65
250	21.49	22.12	22.77	22.13

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500	23.93	26.84	29.46	26.74
Average	21.77	23.29	24.46	
LSD 0.05				
F=0.678	Y=0.678		F*Y=1.356	

3-height of the plants (cm)
The statistical study revealed a notable impact of applying dried yeast extract and chelated iron, as well as their combined effect, on the height of the plants.
The findings from Table (4) indicate that the application of yeast extract through spraying significantly enhanced plant height. Specifically, the Y3 treatment demonstrated the highest average of 197.2 cm, while the Y0 treatment had the lowest average of 166.7 cm. The Y3 treatment's superiority stems from the inclusion of yeast extract. demonstrates that nutrients, proteins, carbohydrates, and vitamins are crucial for plant growth. Additionally, these substances contain plant hormones such cytokinins and gibberellins, which promote cell division and elongation. Furthermore, yeast plays a crucial role in the synthesis of the amino acid tryptophan, which triggers the production of auxins, resulting in enhanced growth and higher height. Flora (Hala et al., 2017).
Regarding chelated iron, the data from the table clearly show that the F3 treatment had a significantly higher average height of 209.1 cm compared to the F0 treatment, which had the lowest height of 147.1 cm. Iron has a crucial function in enhancing the chlorophyll content in leaves, which is a fundamental factor in the process of photosynthesis. This, in turn, promotes the production and storage of dry matter, resulting in accelerated growth rates (Broadley et al., 2012). This finding corroborated Hassoun's (2012) results regarding the growth of mango seedlings in terms of plant height. Similarly, in the case of Nour Muhammad (2022), it was found that the application of iron Al-Makhlabi to pomegranate seedlings yielded the most favorable outcomes in terms of their vegetative growth. The interaction between dry yeast extract and chelated iron resulted in positive outcomes. The F3Y3 treatment (500 mg L-1 x 10 g L-1) outperformed the other treatments and achieved the highest average plant height of 235.0 cm. In contrast, the comparison treatment F0Y0 had the lowest value of 126.0 cm.

Table (4) The effect of spraying with yeast extract and chelated iron and their interaction on plant height (cm)

chelated iron	dry yeast extract			Average
	0	5	10	
0	126.0	153.3	162.0	147.1
250	184.0	189.3	194.7	189.3
500	190.0	202.3	235.0	209.1
Average	166.7	181.7	197.2	

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LSD 0.05		
F= 9.76	Y=9.76	F*Y=16.90

4-**Recent growth:**

The statistical analysis revealed a substantial impact of spraying with dry yeast extract and chelated iron, as well as their interaction, on the increase in the length of new growths. The findings from Table (5) indicate a notable impact when using yeast extract for spraying. The Y3 treatment outperformed other treatments with an average height of (29.78) cm, while the comparative treatment Y0 yielded the lowest average of (22.89) cm. Y3's excellence stems from its yeast composition, which is rich in nutrients. This yeast facilitates the process of photosynthesis and utilizes its byproducts to enhance tree growth, including the elongation of new branches. Regarding chelated iron, the data from the table shows a noteworthy increase in the length of new growth. The F3 treatment performed exceptionally well, with an average length of 29.56 cm, surpassing the comparator treatment which had the lowest average of 22.11 cm. This can be explained by the involvement of iron in oxidation and reduction reactions. According to Stanjev et al. (1984), photosynthesis is the process being referred to.

Furthermore, the administration of iron enhances the assimilation of both macro- and micro-nutrients, hence augmenting the rate of vegetative development in trees. Regarding the interaction between yeast extract and chelated iron, the results from the table show a clear advantage. The F3Y3 treatment, with a concentration of 500 mg L-1 x 10 g L-1, performed significantly better with an average of 34.67 cm compared to the lowest average obtained from the comparison treatment F0Y0. He achieved a measurement of 19.0 centimeters.

Table (5) The effect of spraying with dry yeast extract and chelated iron and their interaction in increasing the length of new growths

chelated iron	dry yeast extract			Average
	0	5	10	
0	19.0	20.67	26.67	22.11
250	24.67	27.67	28.0	26.78
500	25.0	29.0	34.67	29.56
Average	22.89	25.78	29.78	
LSD 0.05				
F=1.948	Y=1.948		F*Y=3.896	

Chemical properties

1- Dry matter:

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The statistical analysis reveals that the application of dried yeast extract and chelated iron, as well as their combined effect, have a substantial impact on the dry weight of the shoots. The findings from Table (6) indicate that the application of dry yeast extract resulted in a substantial enhancement in the dry weight of the shoots. Specifically, the Y3 treatment exhibited superiority, yielding an average of 46.53 grams, whereas the Y0 treatment yielded a lower average of 39.37 grams. The rise can be attributed to the material's structure. The yeast cycle stimulates the assimilation of carbohydrates and proteins, as well as the photosynthetic processes, leading to the formation of dry matter in the leaves. This aligns with the findings of Mady (2009) about bean trees. The table results indicate a notable impact of chelated iron spraying on the dry weight of the shoots. Specifically, treatment F3 demonstrated the highest average of 46.06 grams, while the comparison treatment F0 yielded the lowest average of 40.03 grams. The cause for this can be ascribed to the role of iron in enhancing the processes of photosynthesis and respiration. This, in turn, results in an augmentation of vegetative growth and subsequently leads to a rise in dry weight. Abdul Kadhim, (2022). The higher performance can be ascribed to the stability of chelated iron in soils with a reaction degree below 6. The user's text is incomplete.Al-Naimi's work was published in 1999. The plant's absorption of iron enhances the efficacy of auxin in the tissues, resulting in accelerated cell growth and tissue development, ultimately leading to an increase in dry weight. Regarding the interaction between yeast extract and chelated iron, there was a notable impact. The F3Y3 treatment, which consisted of 10 g l-1 of yeast extract and 500 mg l-1 of chelated iron, beat the other treatments. It achieved the greatest average dry weight of 58.84 g. The comparative treatment exhibited the lowest result for the same attribute, measuring 38.32 grams.

Table (6) Effect of spraying with chelated iron and dry yeast extract and their interaction on the dry weight of the shoot (g)

chelated iron	dry yeast extract			Average
	0	5	10	
0	38.32	40.28	41.48	40.03
250	38.94	43.76	39.26	40.65
500	40.84	38.51	58.84	46.06
Average	39.37	40.85	46.53	
LSD 0.05				
F=1.079	Y=1.079		F*Y=1.868	

2-Chlorophyll:

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The statistical analysis reveals that the application of chelated iron and dry yeast extract, as well as their combined effect, has a substantial impact on the overall chlorophyll concentration in the leaves. The findings from Table (7) indicate that dry yeast extract had a notable impact on the chlorophyll content of the leaves. The Y3 treatment performed exceptionally well, with an average of (51.82) mg 100 g -1 fresh weight, whereas the Y0 treatment had the lowest average of (44.19) mg 100 g -1 fresh weight.

The Y3 treatment's superiority can be attributed to the yeast's abundance of nutrients and vitamins, which serve as the primary precursors to auxins and cytokinins. These compounds promote cell division and activate photosynthesis by stimulating the role of auxin. Consequently, this leads to an increase in chlorophyll levels in the leaves. The findings align with the research conducted by Hayat et al. (2007) and Al-Rubaie (2014) about orange seedlings.

The data from the table show a notable impact of chelated iron. The F3 treatment performed exceptionally well with an average of 49.73 mg per 100 g, surpassing the comparator treatment which had the lowest average of 46.03 mg per 100 g. The superiority of the F3 treatment is due to the indirect influence of Iron on the formation of the chlorophyll molecule. Iron is included in a series of compounds that ultimately lead to the formation of chlorophyll. This results in an increase in the chlorophyll content in the leaves and enhances the biosynthesis of the chlorophyll pigment. This finding is consistent with the research conducted by Al-Naimi (2000), Muhammad Al-Younis (1991), and Al-Mousli (2011). Applying a pesticide to young pistachio plants and Somarin (2011). Applying pesticide to peach trees. The interaction between chelated iron and yeast extract had a substantial effect, as shown by the data in the table. The F3Y3 treatment had the highest average of 54.32 mg per 100 g, while the comparison treatment F0Y0 had the lowest average of 43.84 mg per 100 g.

Table (7) The effect of spraying with chelated iron and dry yeast extract and their interaction on the concentration of chlorophyll in leaves (mg 100 gm - 1 fresh weight)

chelated iron	dry yeast extract			Average
	0	5	10	
0	43.84	45.52	48.72	46.03
250	44.05	47.56	52.43	48.01
500	44.67	50.20	54.32	49.73
Average	44.19	47.76	51.82	
LSD 0.05				
F=0.964	0.964Y=		1.669F*Y=	

3-Carbohydrates:

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The statistical analysis reveals a notable impact of foliar spraying with chelated iron and dry yeast extract, as well as their interaction, on the concentration of carbohydrates in the leaves. The findings from Table (8) indicate that the application of chelated iron had a notable impact on the carbohydrate concentration in the leaves. Specifically, the F3 treatment demonstrated superior results with an average of (4.19) mg g-1 dry matter, while the comparison treatment F0 exhibited the lowest average of (3.38) mg g-1 dry matter. Arid. The superiority of the F3 treatment can be linked to the enhanced iron availability in pomegranate trees, which positively impacted the photosynthetic process and consequently raised the carbohydrate content in the leaves. When dry yeast extract was sprayed on the leaves, it was found to have a significant effect on increasing the carbohydrate content. The Y3 treatment had the highest average value of 4.20 mg g-1 dry matter, while the comparison treatment Y0 had the lowest average value of 3.49 mg g-1 dry matter. The increase in carbohydrate content of leaves when sprayed with dry yeast extract may be attributed to yeast's role in enhancing leaf area exposed to photosynthesis, thereby improving leaf efficiency and promoting sugar accumulation, which is a key component of the photosynthesis process. The production of Made in 2009 is attributed to the stimulation of yeast, which releases CO2 during the fermentation process. This CO2 then enters the photosynthetic process, leading to an increase in the production of carbs.

Regarding the interaction between chelated iron and dry yeast extract, it was observed that there was a significant increase in the carbohydrate content in the leaves. The treatment F3Y3 showed the highest rate with an average of 4.40 mg g-1 dry matter, while the control treatment had the lowest average of 2.73 mg g-1 dry matter.

Table (8) Effect of spraying with chelated iron and dry yeast extract and their interaction on the carbohydrate content in the leaves (mg-1 dry matter)

chelated iron	dry yeast extract			Average
	0	5	10	
0	1.36	2.69	3.78	2.61
250	3.10	3.79	4.23	3.71
500	3.78	4.12	4.67	4.19
Average	2.75	3.53	4.23	
LSD 0.05				
F=0.33	Y=0.33		=0.57F*Y	

4-Protein percentage:

The statistical study reveals a notable impact of spraying with chelated iron and dry yeast extract, as well as their combined effect, on the percentage of protein in the leaves. The findings from Table (9) demonstrate a notable impact of chelated iron spraying. The F3 treatment

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outperformed other treatments with an average of (10.91)%, while the comparator treatment F0 had the lowest average of (8.65)%. The rise in the protein percentage in the leaves resulting from the application of chelated iron can be attributed to the enhanced accumulation of amino acids in the leaves. These acids serve as the fundamental building blocks for proteins, which aligns with the findings of Smoien and Wierzbinsk (2010).
Regarding the application of dry yeast extract through spraying, there was a notable impact on the protein percentage. The Y3 treatment resulted in the greatest average of 10.85%, whereas the comparative treatment Y0 had the lowest average of 9.07%. Possible factors contributing to the rise in the protein content in the leaves could be Yeast's function suggests that it contains amino acids, vitamins, and mineral elements that enhance the protein content in leaves. Abd-El-Migeed et al. conducted a study in 2010. Yeast plays a stimulating role in promoting cell division and expansion, as well as enhancing protein synthesis from amino acids. Fathy, (1996).
Regarding the relationship between spraying with chelated iron and dry yeast extract, the F3Y3 treatment (500 mg L-1 x 10 g L-1) resulted in the highest average of (11.74)%, whereas the comparator treatment F0Y0 had the lowest average of (7.01)%.

Table (9) shows the effect of spraying with chelated iron and dry yeast extract and their interaction on the percentage of protein in the leaves(%)

chelated iron	dry yeast extract			Average
	0	5	10	
0	7.01	9.08	9.87	8.65
250	9.95	10.24	10.93	10.37
500	10.24	10.74	11.74	10.91
Average	9.07	10.02	10.85	
LSD 0.05				
F=0.350	Y=0.350		=0.606F*Y	

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