Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 3742 - 3749
Received 25 April 2021; Accepted 08 May 2021.

Effect of Spraying with Nano Iron and Zinc and their Interactions on some Physiological Traits and Yield for Date Palm Fruits (*Phoenix Dactylifera*L) Al-BarhiCultivar

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ABSTRACT

The study was conducted in a palm orchard in the Shatt al-Arab district in Basra province during the 2020 growing season on date palm trees: *Phoenix dactylifera* L, the Barhi cultivar, aged about 15 years, with the aim of studying the effect of spraying nano iron at a concentration of (0, 500, 1000) mg / L and nano zinc at a concentration. (0, 500, 1000) mg / L in some physiological and productive traits of date palm Al-Barhi cultivar. The results showed that the treatment of 1000 mg / L nano iron was significantly excelled and it gave the highest percentage of set and maturity, the highest average of bunch weight and total yield, and the lowest percentage of fruit dropping, which was (83.225%, 63.402%, 6,733 kg, 47,133 kg and 12,813%) respectively, compared to the control treatment. The treatment 1000 mg / L of nano zinc also excelled and giving the highest average of bunch weight and total yield and the lowest percentage of fruit dropping by (6.602 kg, 46,214 kg and 15.674%) respectively, while the treatment 500 mg / L of nano zinc significantly in giving the highest percentage of contract and maturity for fruits, it amounted to 80.741% and 63.916%, respectively compared with the control treatment, That achieved the lowest average for set percentage, bunch weight and total yield (78.429%, 5.532 kg and 38.721 kg), respectively. The results also showed that the bi-interaction between the two study factors gave a significant advantage to the studied traits, where the combined treatment (1000 mg / L nano iron + 500 mg / L nano zinc) excelled with the highest average of maturity and the lowest percentage of fruit dropped (66.750% and 12.521%). respectively. Where, the interaction treatment of 1000 mg / L nano iron + 1000 mg / nano zinc gave the highest average of set percentage, bunch weight and total yield (83.574%, 7,350 kg and 51,450 kg) respectively. The study also showed that all the interaction treatments between the study factors gave a significantly excelled on most of the studied traits, compared to the control treatment, which achieved the lowest average of set, bunch weight and total yield, and the highest percentage of dropping fruits (71.862%, 4,653 kg, 32,571 kg and 25,145%, respectively.

KEYWORD

Date Palm Fruits, Al-Barhi Cultivar,

Introduction

The date palm (*Phoenix dactylifera* L.) is one of the most important evergreen perennial fruit trees known to human, and it represents a fundamental pillar in the agricultural environment of Iraq due to what this blessed tree gives of fruits of great nutritional and economic value, which makes it contribute to the national income (Al Douri and Al-Rawi, 2000). The number of palm trees in Iraq is about 16492121, where the number of fruit trees is 10218000, and their productivity is estimated at 64 kg. Tree- (Central Statistical Organization, 2017). The Barhi cultivar is considered one of the important cultivars in Iraq for the advantages of the fruits of this variety, which are characterized by being fresh fruits with a high percentage of reduced and total sugars. Its fruits are consumed in the various stages of fruit growth (Khalal, Rutab and dates) due to the low percentage of tannins in the fruits, starting from the Khalal stage. At the forefront of the local varieties in Iraq, which are estimated at about 600 agricultural cultivars (Hassan, 2016).Fertilization has an important role in improving tree growth because it provides the necessary nutrients for the completion of fruit formation in a good manner. There is a misconception that date palm trees have the ability to grow and bear fruit without the need for fertilization. It has high productivity and desirable fruit specifications as a result of the agricultural service operations provided to it, primarily fertilization (Ibrahim, 2008). Jampilek and Kraeova, 2015 stated that the application of nanotechnology in the field of agriculture by producing fertilizers reduces the loss of added nutrients as well as the speed of plant utilization of them because fertilizers prepared with nanotechnology are environmentally friendly and of critical importance to promote sustainable to the plant's need, so these fertilizers are called smart fertilizers (Chinnamuthu and Boopathi, 2009, cui et al 2010 and Liu and Lai, 2015).The elements of iron and zinc are necessary for agricultural production in both quantitative and qualitative terms and that fortification by adding supplements or salts is not the best methods to solve the problem and therefore the method of natural biological enrichment was adopted, which includes in one of its methods the addition of these nutrients as foliar fertilizers and it is known that element Iron and zinc are specific

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to plant growth mainly and the quality of the product from a nutritional point of view, and despite the availability of different mineral and chelated fertilizer sources (synthetic and natural - organic) for these nutrients and the availability of different methods of addition (in addition to the soil and adding it as a spray on the leaves or both), the efficiency of use is achieved. Foliar fertilization protects it from fixation in the soil (Al-Hamdani, 2010).Iron is one of the essential nutrients that the plant needs through its effect on the process of RNA formation and the activation of some enzymes such as Catalase, Peroxidase, Oxidases, 6-phosphogluconate dehydrogenase, and it also controls water content and its movement within the plant, preserves the water balance of plant cells and increases potassium absorption by several Times compared to plants suffering from iron deficiency (Mohasedat et al, 2018).The elements of iron and zinc also have a vital effect in the process of photosynthesis, contract and fruit formation of fruit trees, where their deficiency leads to a reduction in the proportion of chlorophyll and carbohydrates in the leaves and this is reflected in the reduction of the proportion of fruits formed (Craig, 2010).The study conducted by Kamiab and Abadi (2016) showed that treating almond trees with Super Plus FZM nan fertilizer significantly increased the amount of total yield and increased the concentration of iron, zinc, manganese, and copper elements in the leaves compared to the control treatment (without fertilization).Al-Rasan (2020) also showed in his study on the effect of nano fertilization on date palm trees that treating date palm trees of the Al-Sayer cultivar with nano-fertilizer Optimus plus at a concentration of (1.5 $ml.L^{-1}$) showed a significant increase in the percentage of Fruit set and the average fresh weight and total yield with a decrease in the percentage of fruit dropping by (78.40%, 9.271 kg, 64.90 kg, and 13.46%), respectively, compared to the control treatment. Al-Tamimi (2020) also explained the positive and significant effect of nano fertilization on increasing the productive traits of date palm in his study to demonstrate the effect of adding IQ Combi nano fertilizer at a concentration of (0, 0.5, 1) gm. L^{-1} with irrigation water for date palm trees, the two types of Zahdi and Khestawi, with a significantly excelled in the dry matter percentage of 69.970% and 70.760% for the fruits, the average fresh weight (11.329 and 9.929) kg and the total yield (67.974 and 59.574) kg. Nakhla-1 compared to the control treatment for the 2018 and 2019 study seasons, respectively.Due to the lack of previous studies on the effect of spraying with nano iron and zinc on date palm trees of the Barhicultivar growing in Basra.This study was conducted with the aim of investigating the effect of nano iron and zinc spraying on the productive and physiological traits of date palm fruits of the Barhi cultivar and determine the optimal concentration of both elements to increase the percentage of fruits set and yield.

Materials and Methods

This study was conducted during the 2020 growing season in one of the palm Orchard in the Shatt al-Arab district - Basra province- Iraq.The 27 date palm trees of the Barhi cultivar were selected on the basis of similarity in vegetative growth strength, free from pathogenicity, and 15 years old cultivated in loam soil with cultivation dimensions of 8 x 8 m. The orchard was prepared and palm trees were identified in the experiment by digitally marking them according to the treatments. All the usual agricultural service operations were conducted, including irrigation, organic fertilization, degradation, and control. The trees were pollinated with green Ghanami pollen on (1/4/2020), with the number of flowering inflorescences standardized by seven inflorescences per palm tree and the leaves were standardized for all palm trees with eight leaves per inflorescences. Soil samples were analyzed for the orchard in the laboratories of the College of Agriculture - University of Basra.

Table 1. Some Chemical and Physical Properties of the Study Orchard Soil

Traits	units	values
The degree of soil pH reaction	1:1	8.23
Electrical conduction (E.C.)	$DS.m^{-1}$	14
CaCO3	%	21.56
Cation exchange capacitance	$Cimol^{+}. Kg^{-1}$	12.4
Organic matter	%	0.248
Soil separators	%	41.24
sand	%	39.43
silt	%	19.33
Soil texture	Loam	

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 3742 - 3749
Received 25 April 2021; Accepted 08 May 2021.

Study Traits

The Study included the experiment of two factors, namely

1. Nano iron at a concentration of (0, 500, 1000) mg / L

Prepare a spraying solution at a concentration of 500 mg / L by dissolving 0.5 g of nano iron in a liter of distilled water.It was prepared by dissolving 1 g of nano iron in a liter of distilled water.As for the zero concentration, it was prepared from mixing distilled water with the diffuser, and Tween 20 was added at a concentration of (0.1%) to all the solutions.

2. Nano zinc at a concentration of (0, 500, 1000) mg / L

Prepare a spraying solution at a concentration of 500 mg / L by dissolving 0.5 g of nano iron in a liter of distilled water and a concentration of 1000 mg / L of nano iron.

It was prepared by dissolving 1 g of nano iron in a liter of distilled water. As for the zero concentration, it was prepared from mixing distilled water with the diffuse Tween 20 was added at a concentration of (0.1%) to all the solutions.

3. Interaction between Iron and Nano-zinc sprayed on the Vegetative Growth

All nutrient solutions were added as a spraying on the vegetative and flowering groups in three batches, the first before pollination (February 15), the second period after a month from the first date (March 15) and the third period (April 15), and the spraying was done until the trees were completely wet by 5 liters / palm / spraying for all treatments.

Physiological Traits

Percentage of Dropping Fruits(%)

The percentage of dropping fruits for all treatments during the rutab stage was calculated by randomly taking 5 inflorescences from each bunch, then the number of fruits present and the number of dropping fruits from each inflorescences is calculated according to the following equation:

$$\text{Percentage of dropping fruits}(\%) = \frac{The\ number\ \ of\ empty\ \ scars}{The\ number\ \ of\ empty\ \ scars + the\ number\ \ of\ fruits\ \ present} \times 100$$

The Percentage of Fruits Set (%)

This percentage was calculated after a month of pollination by randomly taking 10 inflorescences from each bunch, and the number of fruits set and the number of empty scars was calculated according to the following equation (Ream and Furr, 1970):

$$\text{Percentage of fruits set}\ (\%) = \frac{The\ number\ \ of\ fruits\ \ set}{The\ number\ \ of\ fruits\ \ set + the\ number\ \ of\ empty\ \ scars} \times 100$$

The Percentage of Fruit Maturity (%)

It was calculated on the basis of the number of fruits when they entered the rutab stage by taking ten inflorescences for each replicate and calculated in it the number of maturity fruits (rutab) and the number of non-maturity fruits (Khalal). Then the total average of maturity was extracted by the sum of the maturity percentage and dividing it by the number of weeks and the percentage of total maturity was calculated from the following equation:

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$$\text{The percentage of maturity}=\frac{Number\ \ of\ maturity\ \ (Rutab\ )\ fruits}{The\ total\ \ number\ \ of\ fruits\ \ of\ the\ sample}\times 100$$

Productive Traits

1. Average Bunch Weight (kg)

The average weight of bunch for each palm (replicate) was calculated by dividing the total yield for each palm by the number of its bunch.

2. Total Yield (kg)

The yield was measured in the date stage, after harvesting the fruits for each palm tree separately, then weighing with a field balance, and then extracting the total yield for each treatment.

Statistical Design and Used Treatments

The experiment was counteracted according to Randomized Complete Block Design (R.C.B.D.) with three replicates. Where the single palm represented one experimental unit, to demonstrate the effect of the study factors, the first factor nano iron with three concentrations (0, 500, 1000) mg / L and the second factor nano zinc with three concentrations (0, 500, 1000) mg / L.The data used in the study were analyzed statistically using the statistical analysis program Genstate (2007), and the averages were tested using the L.S.D. (Least Significant Difference) test method based on (Alrawiand Khalaf Allah, 1980).

Results and Discussion

The Effect of Nano Iron and Zinc Spraying on the Physiological Traits of the Date Palm Fruits of the BarhiCultivars.

1. Percentage to Fruits Set(%)

The results in Table (2) indicate that there were significant differences in the percentage of fruits set as a result of spraying (with iron and zinc) by nanoparticles.Significant differences were observed when spraying with nano iron, especially the treatment (1000 mg / L) that gave it the highest percentage of set, which amounted to 83.225%, followed by the treatment (500 mg /L for nano iron) with a set percentage 81.172%.The lowest percentage of set was when the control treatment was 75.103%. The reason for this may be due to the role of nano iron in regulating the pollination and fertilization processes, and thus the increase in the percentage of fruit set (Saqr, 2010). While spraying with nano zinc led to increase in the set percentage , where the treatment (500 mg / L nano zinc) gave the highest values, which amounted to 80.741%, compared to the lowest values found in the control treatment, which amounted to 78.429%.This may be due to the role of the nano-zinc in increasing the IAA auxin, which is important in the success of the fertilization process and thus increase the fruit set due to its importance in increasing the vitality of the ovaries of the flowers in attracting the pollen tube, which is an important process for the success of the fertilization process and thus the fruit set (Pilbeam and Barker, 2006).The results of the interaction between iron and nano-zinc, listed in the same table, also showed a significant effect in increasing the percentage of set , where the highest value reached 82.957% when treated (1000 mg / L nano iron + 500 mg / L nano zinc).While the set percentage decreased to 71.862% when compared to the other interaction factors under study.This may be due to the fact that spraying nano iron with nano zinc created a state of integration in the availability of the nutrients necessary for pollination and fertilization processes, which was positively reflected in the increase in the percentage of set in date palms of the Barhi cultivar (Al-Naimi, 2000).

Table 2. The effect of spraying with nano iron and zinc and their interactions on the percentage of fruits set (%) for date palms, cultivar Al Barhi

The Khalal stage				
Nano zinc (mg / L)	**Nano iron (mg / L)**			**The average effect of nano zinc**
	0	500	1000	
0	71.862	80.284	83.142	78.429
1000	77.573	81.691	82.958	80.741

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 3742 - 3749
Received 25 April 2021; Accepted 08 May 2021.

500	75.875	81.541	83.574	80.330
The average effect of nano iron	75.103	81.172	83.225	
L.S.D 0.05 nano iron	**L.S.D 0.05 for interaction**			**L.S.D 0.05 nano zinc**
1.542	2.478			1.542

2.The Percentage of Dropping Fruits(%)

The results in Table (3) show that the difference in spraying concentrations had a significant effect on the percentage of dropping fruits according to the different fertilizer treatments and with the increase in the level used from it.As a clear decrease was observed in the percentage of dropping fruits when spraying trees with nano iron, to reach 12.813% at the fertilization level (1000 mg / L^{-1}), the control treatment gave the highest percentage of dropping fruits, which reached 21.341%. The reason for this may be due to the compatibility of the nano iron concentrations added with the nutritional needs of the date palm trees of the Barhi cultivar, which results in a nutritional balance between the plant and its external surroundings, and thus reflected positively in reducing the percentage of fruit loss (Saqr, 2010). while the effect of spraying with nano zinc, the results showed that the difference in spraying levels had a significant effect on this traits, where the spraying treatment (1000 mg / L nano zinc) was trait by a decrease in the percentage of dropping fruits, where it reached 15.674%, while the percentage of dropping fruits increased when the treatment without spraying reached 18. 107%.This may be due to the role of nano zinc in increasing metabolism in plants, where zinc is a secondary messenger in the cell to regulate cellular vital activities, including reducing the incidence of flower and fruit separation after the set (Meena, 2010).As for the effect of interaction, spraying with iron and nano-zinc reduced the percentage of dropping fruits to 12.521% when treated (1000 mg / L nano iron + 500 mg / L nano zinc), while the treatment (0 iron + 0 zinc) gave the highest percentage of dropping fruits. It reached 25.145%, and the reason for this may be due to the fact that spraying the date palm trees of the Barhi cultivar with nano iron and zinc achieved a state of nutritional balance within the plant, which was reflected in reducing the competition between fruits for nutrients and thus reducing the percentage of fruit loss (Attalla et al, 2007 Sarrwy. et al, 2012 and Al-Mayahi 2019).

Table 3. The Effect of Spraying with nano iron and zinc and their interactions on the percentage of dropping fruits (%) for date palms in the Al Barhi cultivar

Nano zinc (mg / L)	**Nano iron (mg / L)**			**The average effect of nano zinc**
	0	500	1000	
0	25.145	16.504	12.672	18.107
1000	20.232	15.562	12.521	16.105
500	18.645	15.133	13.245	15.674
The average effect of nano iron	21.341	15.733	12.813	
L.S.D 0.05 nano iron	**L.S.D 0.05 for interaction**			**L.S.D 0.05 nano zinc**
1.614	2.472			1.614

Maturity Percentage (%)

The results in Table (4) showed that there were significant differences in the Maturity average as a result of different fertilizer treatments, where spraying with nano iron was distinguished by giving it the highest maturity average of 63.402% upon treatment (1000 mg / L), compared to the control treatment that gave the lowest rate of 55.769%. The reason for this may be due to the role of iron in activating the enzymatic action in cells and thus increasing the activity of cellular metabolism, which contributed to the increase in the percentage of fruit maturity (Ankush, 2017). Also, spraying with nano zinc increased the Maturity average, where the treatment (500 mg / L nano zinc) was excelled by giving it the highest maturity average of 63.916%, which was excelled to the treatment (1000 mg / liter nano zinc), which gave the lowest percentage, which was 58.405%. The reason for this may be that preparing palm trees of the Barhi cultivar with nano-zinc stimulated the plant to produce auxins and form energy compounds that the plant needs in vital processes, especially photosynthesis, carbohydrate formation, and enzymatic accompaniments that contribute to increasing the vital activities, which was reflected in the increase in the percentage of fruit ripening (Al-Zubaidi, 2018) The results of the interaction also showed an increase in the maturity average, where the highest value reached 66.750% when the treatment (1000 mg / L nano iron + 500 mg / L nano zinc), while the lowest maturity average was achieved with the control treatment, which amounted to 53.921%.this may be due to the fact that the interaction between the two study factors makes the controller in determining the trait in two directions, compared to the effect of one factor, which has the least effect because it works in one direction. This was confirmed

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by Fawzia et al, (2014) in their study on the date palm of the Khadrawi cultivars, as they emphasized the importance of the positive significant correlation relationship between the nutrients in plant tissues.

Table 4. The effect of spraying with nano iron and zinc on the maturity percentage (%) of the date palms of the Al-Barhi cultivar

Nano zinc (mg / L)	**Nano iron (mg / L)**			**The average effect of nano zinc**
	0	500	1000	
0	53.921	58.953	62.733	58.536
1000	58.767	66.231	66.750	63.916
500	54.620	59.873	60.723	58.405
The average effect of nano iron	55.769	61.686	63.402	
L.S.D 0.05 nano iron	**L.S.D 0.05 for interaction**			**L.S.D 0.05 nano zinc**
1.195	2.124			1.195

The effect of spraying with nano iron and zinc on yield traits and components of the date palm fruits of the Barhi cultivar.

1. Average Bunch Weight (kg)

The results in Table (5) indicated that there were significant differences between the treatments when spraying palm trees with iron and nano zinc in the weight of the bunch. The effect of spraying with iron differed significantly on the average bunch weight, where the treatment (1000 mg / L) excelled by giving it the highest average, reaching 6,733 kg, excelled on the control treatment, which gave 5,464 kg.The reason for this may be due to the role of iron in the regulation of activities inside the plant, which are related to growth and cell division, in addition to activating enzymes that enter into vital activities inside the plant, including protoplasmic structure, which is positively reflected in the increase in the average bunch weight (Taiz and Zeiger, 2016). Regarding the effect of spraying with nano zinc, the results are in Table (5)shown that the treatment (1000 mg / Lnano zinc) was excelled to giving it the highest weight of the bunch of 6,602 kg compared to the treatment (without spraying) in which the weight of the fresh reached 5,532 kg. The reason for this may be due to the role of nano zinc in increasing the processes of cell division and elongation, which was positively reflected in the increase in the average fruit weight. The results of the interaction in Table (5) showed an increase in the weight of the bunch, where the highest average was 7,350 kg when the treatment (1000 mg / L nano iron + 1000 mg / L nano zinc) was excelled on all other interaction factors, which in turn excelled on the control treatment. Which had the lowest average bunch weight 4,653 kg. This may be due to the consensus of the study factors in creating a state of nutritional balance in the date palm trees of the Barhi cultivar, which helped to increase the percentage of fruit set (Table 3) and increase the Increase fruit cells division and expansion, which led to an increase in the average weight of the fruit and then an increase in the average bunch weight of the Barhi cultivar.

Table 5. The effect of spraying with nano iron and zinc on the average bunch weight (kg) for date palms, Al Barhi cultivar

Nano zinc (mg / L)	**Nano iron (mg / L)**			**The average effect of nano zinc**
	0	500	1000	
0	4.653	5.732	6.210	5.532
1000	5.755	6.279	6.640	6.225
500	5.985	6.471	7.350	6.602
The average effect of nano iron	5.464	6.161	6.733	
L.S.D 0.05 nano iron	**L.S.D 0.05 for interaction**			**L.S.D 0.05 nano zinc**
0.373	0.567			0.373

2.Total Yield (kg)

The results in Table (6) showed that spraying with nano iron led to an increase in the total yield, where the concentration (1000 mg / L) gave the highest total yield average of 47,133 kg, while the control treatment gave the lowest total yield average of 38,250 kg.This may be due to the fact that spraying the date palm trees of the Barhi cultivar with nano iron encouraged most of the vital processes within the plant, such as photosynthesis, respiration,

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 3742 - 3749
Received 25 April 2021; Accepted 08 May 2021.

and the building of carbohydrates, proteins and fats, and then the increase in fruit growth, which was positively reflected in the increase in the amount of yield (Haddad and Bayerley, 2010). The results of the study also showed in the same table the significant effect of spraying with nano zinc in increasing the amount of yield, where the treatment (1000 mg / L of nano zinc) was excelled by giving it the highest yield of 46,214 kg, while the control treatment showed the lowest yield amounted to 38,721 kg.

Table 6. The effect of spraying with nano iron and zinc on the total yield (kg) of date palms, Al Barhi cultivar

Nano zinc (mg / L)	**Nano iron (mg / L)**			**The average effect of nano zinc**
	0	500	1000	
0	32.571	40.124	43.470	38.721
1000	40.285	43.953	46.480	43.573
500	41.895	45.297	51.450	46.214
The average effect of nano iron	38.250	43.125	47.133	
L.S.D 0.05 nano iron	**L.S.D 0.05 for interaction**			**L.S.D 0.05 nano zinc**
1.746	2.565			1.746

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