

## The role of pollen source and calcium in improving the chemical characteristics of date palm Barhi cultivar

Muhammad Thaer Ghadban<sup>1\*</sup> and Ahmed Thamer Homed<sup>1</sup>

<sup>1</sup>Horticulture and Garden Engineering Department, Faculty of Agriculture, Diyala University

\*1E-mail: mohamdh.88@gmail.com

E-mail: ahmedhomed@uodiyala.edu.iq<sup>1</sup>

### Abstract

A field experiment was conducted in Baqubah District, Diyala Governorate in one of the private orchards during the 2023 growing season to determine the effect of the pollinator cultivar and calcium spraying in some chemical characteristics of the Barhi date palm cultivar. The experiment included nine treatments resulting from the interaction of two factors. The first factor was the pollinator cultivar, Ganami yellow (A1), Ganami red (A2), and pollen mixture of both (red + yellow) (A3). The second factor was calcium spraying at concentrations of 1000 mg L<sup>-1</sup> and 2000 mg L<sup>-1</sup>. The experiment was implemented according to a randomized complete block design (RCBD) for a factorial experiment with two factors and three replications. The results showed that the pollinator cultivar had a significant effect on most of the chemical characteristics of date fruits. The mixed pollen cultivars (red Ganami + yellow Ganami) produced the best results for the total sugar content of the fruits, reducing sugars percentage, and non-reducing sugars percentage in the fruits. Spraying with calcium significantly effected most chemical characteristics, with 2000 mg.L<sup>-1</sup> concentration yielding the highest total chlorophyll content in the leaves. The interaction between the pollen type and spraying with calcium had a significant effect in most chemical characteristics. The combination of the mixed pollinator cultivar (red Ganami + yellow Ganami) and 2000 mg.L<sup>-1</sup> calcium spray resulted in the highest total sugar content and the highest percentages of both reduced and non-reducing sugars in the fruits.

**Keywords:** Chlorophyll; Ganami; Pollination; Reducing sugar; Total Sugar

### Introduction

The date palm tree (*Phoenix dactylifera* L.) is one of the oldest essential fruits in the Arabian Peninsula. It belongs to the palm tree family (Arecaceae) and the order Palmae [15]. It is successfully cultivated in the tropical and subtropical regions of South Asia and Africa and has a high nutritional value. Date palms contain various biologically active compounds and have medicinal benefits. It was found that date seeds are effective in resisting *Escherichia coli* and *Staphylococcus aureus* bacteria. Date pollen has also been used to

treat hormonal problems and enhance fertility. Palm leaves have effects on reducing blood sugar by inhibiting alpha-amylase and alpha-glucosidase [11]. Iraq is considered one of the oldest places for date palm cultivation in the world, as nearly 600 varieties are grown there, and date palms are mentioned in 22 verses in the Holy Qur'an [1]. There are more than 30 million palm trees planted in Iraq, but the number of palm trees has become low in the past decades by 50%, as it fell to less than 16 million due to wars, the migration of villages,

and water scarcity. The number of palm trees in Iraq is 17,348,741 palm trees, while the total production amounts to 735,353 tons, with an average production per palm tree of 68.2 kg [4.]

Pollination plays a major role in palm production, and about 75% of global crop species depend partly on pollination, which makes pollination economically important for agriculture and global food security because it affects yields [8]. Pollinator numbers are declining globally due to multiple factors, including exposure to pesticides, diseases, and climate change. Decreased pollination can lead to lower crop yields, lower fruit and seed quality, and potential cascading impacts on ecosystem performance and biodiversity [6]. Since palms are dioecious and unisexual, choosing an effective pollinator that carries a large amount of high-quality pollen is essential. Pollen and pollination are among the most important factors that affect fruit set and yield because they are responsible for obtaining the appropriate yield in quantity and quality. As the use of a pollen cultivar compatible with the female cultivar leads to obtaining a high quantity yield [16.]

Calcium (Ca) is the third most important nutrient for the plant. Its absorption is limited in the plant itself and it is an immobile element, which reduces its effect on the fruits [12]. It is the nutrient responsible for maintaining plant quality and fruit production. Calcium sources such as microcalcium (CaM) and complex calcium (CaC), and their supplementation provide a high-quality yield in palm cultivation and is a nutrient that greatly influences the formation of cell walls, cell membranes and biomass production as the plant grows. Calcium also plays a role in meiotic cell division, and in the structure and stability of chromosomes. Calcium also plays

a activating role in some enzymes. Calcium is also necessary for the absorption of nitrogen in the form of nitrates. Sugars and starches accumulate in plants growing in an environment poor in calcium, and they are unable to absorb nitrate nitrogen. Nitrates appear in a short time when fertilizing with calcium, and most of the calcium in the plant accumulates in the leaves [14]. Foliar spraying of nutrients such as calcium leads to increased fruit set, reduced fruit drop, and high production in addition to quality [3.]

Given that the date palm is dioecious, choosing an effective pollinator that carries a large amount of high-quality pollen is necessary to obtain a high-quality yield. Therefore, the study aimed to determine the effect of the pollinator cultivar and calcium spraying in some chemical characteristics of the Barhi date palm cultivar.

#### Materials and Methods

A field experiment was carried out in Diyala Governorate / Baqubah District in one of the private orchards during the 2023 growing season to determine the effect of the pollinator cultivar and spraying with calcium on some chemical characteristics of the Barhi date palm cultivar. 10-year-old palm trees were used, propagated by vegetative propagation using cuttings and irrigated with an irrigation canal. 27 palm trees that were as homogeneous as possible in their growth and free of insect and disease infestations were selected for treatment. Identification signs were placed on it and it was divided into three sectors, each sector containing 9 palm trees. Soil samples were taken at a depth of 30-60 cm to analyze some chemical characteristics of the agricultural soil before implementing the experiment in the private laboratory Wahaj Al Nakheel. The experiment included nine treatments that resulted from the interaction of

two factors: the first was the pollinated cultivar: yellow Ganami (A1) and red (A2), and the pollen mixture (red + yellow) (A3). The second factor: Spraying with calcium with water only B1 Spraying with 1000 mg L-1

B21, spraying with 0200 mg L-1 3B Calcium was sprayed before the fruit setting process on 4/16/2023, and the second on 4/30/2023, two weeks after the first spray, and the third after Three weeks from the second spray, 5/21/2023

**Table 1: Some physical and chemical characteristics of the orchard soil before implementing the experiment.**

Characteristics		Units	Value
pH		-----	7.01
Available nutrients	Nitrogen	Mg.L <sup>-1</sup>	22.2
	Phosphor	Mg.L <sup>-1</sup>	5.05
	Potassium	Mg.L <sup>-1</sup>	166
Organic matter		%	1.7
Calcium Carbonate			27
Soil Particles	Sand		44.66
	Loam		40.6
	Clay		14.45
Soil texture		Loam	

Soil analysis was conducted in the the private laboratory Wahaj Al Nakheel in Baqubah District / Diyala Governorate

Studied Characteristics:

-1Total chlorophyll content of leaves (mg g-1 fresh weight.(

Chlorophyll was determined according to the method of [6], by mashing 0.5 g of leaves by adding 50 ml of 80% acetone.

The optical absorption of the samples was carried out using a spectrophotometer at the wavelengths of 645 and 663 nanometres, and the content was calculated according to the following equation:

Total chlorophyll content of leaves (mg.l-1) =  

$$\frac{\text{Solution value} \times (A_{663} \times 8.02 + A_{645} \times 20.2)}{\text{Sample Weight} \times 1000}$$

-2Ratio of reduced sugars (glucose + fructose:(

The percentage of reducing sugars was estimated by taking 250 mg of fruits and mashing them well in a ceramic jar by adding 10 ml of distilled water, then taking 1 ml of diluted juice. 1 ml of 5% phenol solution and 5 ml of concentrated sulfuric acid were added to it with continuous shaking and the mixture was left to cool, then the light absorption was

read with a spectrophotometer at a wavelength of 488 nm according to the method of [10.]

-3Percentage of non-reducing sugars (sucrose):

It was estimated by the difference between total sugars and reducing sugars.

-4Percentage of total sugars in fruits:

The percentage of total sugars was estimated by weight of 200 mg of fruits, and 25 ml of dilute perchloric acid (0.01N) was added to it, then 1 ml of juice was taken and placed in a 50

Results

and

discussion

-1 Total chlorophyll content of leaves.

The results presented in Table 2 indicate that there is no significant effect between the pollen cultivar, as the pollen mixture (yellow Ganami + red Ganami) was superior to the total chlorophyll content of the leaves. The results of the same table show that the spraying treatment with calcium at a concentration of 2000 mg L<sup>-1</sup> was significantly superior by a percentage of 24.52 mg. gm<sup>-1</sup> fresh weight for the control treatment and the spray treatment at a concentration of 1000 mg L<sup>-1</sup>, which amounted to 19.72 and 15.43 mg. gm<sup>-1</sup> fresh

ml glass beaker. Add 1 ml of 5% phenol solution and 5 ml of concentrated sulfuric acid with continuous shaking and leave the mixture to cool. A spectrophotometer at a wavelength of 490 nm was used to measure total sugars according to the method of [10.]

Statistical analysis

At a probability level of 0.05, the Duncan's multinomial test was used in the analysis of data [2.]

weight respectively. The results of the same table indicate that the interaction between the pollen cultivar and spraying with calcium significantly affected the total chlorophyll content of the leaves. The spraying treatment at a concentration of 0 mg L<sup>-1</sup> with yellow Ganami pollen was significantly superior to the rest of the treatments of the cultivar and spraying with calcium, reaching 29.52 mg. gm<sup>-1</sup> fresh weight. The spraying treatment was recorded at a concentration of 0 mg l<sup>-1</sup> with the pollen cultivar Gha Yellow. The lowest content of total chlorophyll in the leaves reached 14.98 mg. gm<sup>-1</sup> fresh weight.

**Table 2: The effect of the pollinator cultivar, calcium spray, and their interaction on the total chlorophyll content of leaves of date palm trees, Barhi cultivar.**

Cultivar of pollen grains Calcium (mg L <sup>-1</sup> )	Total chlorophyll content of leaves (mg.g <sup>-1</sup> fresh weight).			
	Yellow *Gha	Red Gha	Yellow Gha + red Gha	Calcium averages
0	14.98 b	21.59 ab	22.59 ab	19.72 AB
1000	19.00 ab	14.98 b	14.15 b	15.43 B
2000	29.52 a	21.52 ab	22.52 ab	24.52 A
Average of pollinated cultivar	21.17 A	18.75 A	19.75 A	

\*Gha = Ganami

\*The means that take the same letter for each factor or for the interaction between them do not differ significantly ( $P \leq 0.05$ ) according to Duncan's multinomial test.

-2 Total sugar content of fruits

The pollen cultivar had a significant effect on the total sugar content of the fruits, Table 3, as the pollen mixture (yellow Ganami + red Ganami) was superior to the pollen cultivar of red ganami by 28.95%, which was superior to the pollen cultivar of yellow ganami by 23.98%. The table results showed that there were no significant effects between calcium concentrations and the total sugar content of fruits. In addition to significant differences between the interactions of the two studied factors, the interaction between the pollen mixture (yellow Ganami + red Ganami) and the spray treatment with a concentration of 2000 mg L<sup>-1</sup> calcium gave the highest content of total sugars, which amounted to 29.07%, while the yellow Ganami treatment with the treatment gave the lowest content of total sugars reached 22.06%

**Table 3: The effect of the inoculated cultivar, calcium spraying, and their interaction on the total sugar content of the fruits of date palm, Barhi cultivar.**

Cultivar of pollen grains Calcium (mg L <sup>-1</sup> )	Total sugar content of fruits (%)			
	Yellow *Gha	Red Gha	Yellow Gha + red Gha	Calcium averages
0	22.36 ab	31.36 a	27.78 a	27.78 A
1000	27.91 ab	27.91 ab	27.03 a	27.03 A
2000	22.06 b	33.58 a	29.07 a	29.07 A
<b>Average of pollinated cultivar</b>	23.98 B	28.95 A	30.95 A	

\*Gha = Ganami

\*Means that take the same letter for each factor or for the interaction between them do not differ significantly ( $P \leq 0.05$ ) according to Duncan's multinomial test.

-3The percentage of reduced sugars in fruits.

The results presented in Table 4 indicate that the pollen mixture (red Ganami, yellow Ganami) and red Ganami were significantly superior, with values of 26.62 and 28.62%, while the percentage of reducing sugars in yellow Ganami was 22.54%. The table results show that there are no significant effects between calcium concentrations and the percentage of reducing sugars in fruits. The results of the same table also show that the interaction between the pollen cultivar and

spraying with calcium significantly affected the percentage of reducing sugars in the fruits. The pollen treatment (yellow Ganami + red Ganami) and concentration 0 and 2000 mg L<sup>-1</sup> and the red Ganami pollen treatment and concentration 2000 mg L<sup>-1</sup> were significantly superior to the rest of the treatments and reached 28.58%, 29.20 and 30.58%. The two spray treatments at concentrations of 0 and 2000 mg L<sup>-1</sup> with the Yellow Ghanami pollen cultivar recorded the lowest percentage of reduced sugars in the fruits, reaching 21.23 and 20.86%.

**Table 4: The effect of the pollinator cultivar and the spraying of calcium and their interaction on the percentage of reduced sugars in the fruits of date palm, Barhi cultivar.**

Cultivar of pollen grains Calcium (mg L <sup>-1</sup> )	Percentage of reduced sugars in fruits (%)			
	Yellow *Gha	Red Gha	Yellow Gha + red Gha	Calcium averages
0	21.23 b	27.20 ab	29.20 a	25.87 a
1000	25.54 ab	24.09 ab	26.09 ab	26.26 a
2000	20.86 b	28.58 a	30.58 a	26.67 a
<b>Average of pollinated cultivar</b>	22.54 B	26.62 A	28.62 A	

\*Gha = Ganami

\*Means that take the same letter for each factor or for the interaction between them do not differ significantly ( $P \leq 0.05$ ) according to Duncan's multinomial test.

The results presented in Table 5 show that there was a significant increase between the pollen cultivar, as the mixture of pollen grains Red Ganami and the mixture (yellow Ganami + red Ganami) exceeded the value of 2.32 and 2.62%, while the percentage of non-reducing sugars in the fruits in the pollen cultivar Yellow Ganami. 1.43%. The table results showed that there were no significant effects between calcium concentrations and the percentage of reducing sugars in fruits. The results of the same table also indicate that the percentage of non-reduced sugars in fruits. bilateral interaction between the pollen cultivar and spraying with calcium significantly affected the percentage of non-reducing sugars in the fruits. The spraying treatment at a concentration of 2000 mg L<sup>-1</sup> with the pollen mixture (yellow Ganami + red Ganami) was significantly superior to the rest of the treatments of the cultivar and spraying with calcium, reaching 3.30%. The spraying treatment at a concentration of 0 mg L<sup>-1</sup> with the Yellow Ghanami pollen cultivar recorded the lowest percentage of non-reducing sugars in the fruits, reaching 1.40%.

**Table 5: The effect of the pollinator cultivar, the spraying of calcium, and their interaction on the percentage of non-reducing sugars in the fruits of date palm, Barhi cultivar.**

grains Calcium (mg L <sup>-1</sup> ) Cultivar of pollen	Percentage of non-reduced sugars in fruits (%)			
	Yellow *Gha	Red Gha	Yellow Gha + red Gha	Calcium averages
0	1.40 c	2.16 abc	2.46 abc	2.00 A
1000	1.71 bc	1.82 bc	2.12 abc	1.88 A
2000	1.19 c	3.00 ab	3.30 a	2.49 A
<b>Average of pollinated cultivar</b>	1.43 B	2.32 A	2.62 A	

\*Gha = Ganami

\*Means that take the same letter for each factor or for the interaction between them do not differ significantly ( $P \leq 0.05$ ) according to Duncan's multinomial test.

## Discussion

The results indicated that pollen grains had a significant effect on most chemicals. The pollen mixture (red Ganami + yellow Ganami) excelled in giving the best results for the total sugar content of fruits, the percentage of reduced sugars in the fruits, the percentage of non-reducing sugars in the fruits, and the total chlorophyll content of the leaves. The reason for this superiority may be that the pollen cultivar (Red Gnami + Yellow Gnami) has a high fertilization rate. The reason may also be due to the high compatibility between the pollen mixture (red Ganami + yellow Ganami) and the cultivar Barhi [9].

The reason for the discrepancy between pollen types may also be due to the difference in the genetic composition of the pollen sources on the chemical characteristics, and the pollen source is an important task in improving the chemical characteristics.

Sugar content is an important indicator of the nutritional value of date fruits, and our results indicate that pollen sources greatly affect it. This difference in sugar content can be

attributed to enzyme systems initiated by metaxane action, which then translocates to extracellular sites and is readily dissolved in water, leading to the inversion of sugars [17]. Degrading enzymes, such as polygalacturonase and cellulase, are thought to play a role in this biochemical process by dissolving pectin and cellulose from the cell wall. Reducing sugars, comprising a mixture of glucose and fructose formed during the hydrolysis of sucrose by invertase, were significantly affected by pollen sources [13]. These results are consistent with the findings of [5], as they found significant differences in total sugars, the percentage of reduced sugars in fruits, and the percentage of non-reducing sugars in fruits of the Barhi palm cultivar.

## Conclusions

The most important conclusions from this study are:

-1 The pollen sources had a significant effect on the chemical characteristics of the date palm, and the pollinated cultivar was superior to the mixture Red Ghanami +

Yellow Ghanami in all chemical characteristics.

-2 Foliar spraying with calcium improved all the chemical characteristics of the date palm, as the treatment with a concentration of 2000 mg L<sup>-1</sup> of calcium excelled in the chemical characteristics of the date palm.

-3 The interaction treatment between the pollen sources and spraying with calcium led to significant differences in all chemical characteristics of the date palm. The interaction treatment of the pollinated cultivar, the mixture of red ghanami + yellow ghanami, and calcium spraying at a concentration of 2000 mg L<sup>-1</sup> excelled in the chemical characteristics of the date palm.

#### Recommendations

Based on the results obtained from this study, we can recommend the following:

-1 Conducting other studies to determine the response of other types of palm to spraying with calcium.

-2 Adopting a concentration of 2000 mg L<sup>-1</sup> of calcium in the production of date palm fruits to give it the best results in the chemical characteristics of the Barhi date palm.

-3 Use the mixture of pollen source (red Ganami + yellow Ganami) to improve the chemical characteristics of the Barhi date palm.

-4 Adopting the interaction treatment of 2000 mg L<sup>-1</sup> of calcium with the pollen source mixture (red Ganami + yellow Ganami) in the production of date palm fruits to give it the best results in the chemical characteristics of the Barhi date palm cultivar.

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