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Effect of potassium, trace elements and cultivar on some physiological traits and sugars at the khalal stage of fruits of date palm (phoenix dactylifera L.) grown in Thi-Qar governorate

[1]Jihan Hasson Muhammad Al-Ibrahimi, [2]Ahmed Dinar Khalaf Al-Asadi

Dhi Qar University College of Agriculture and Marshes Department of Horticulture and Landscape Engineering

[1]*Email: jeehan.h@utq.edu.iq*

[2]*Email: ahmed-d@utq.edu.iq*

SUMMERY

The study was conducted during the growing season 2022 in one of the private orchards in Nasiriya district, the center of Thi-Qar governorate, with the aim of knowing the effect of spraying the fruits with potassium and trace elements on some physiological characteristics and sugars of two cultivars of date palm, Al-Shwathi and Al-Sayer. 4) ml-1 and trace elements with concentrations (0, 1, and 2) ml-1. (10 trees) were selected from date palms (5 trees) from Al-Shwathi cultivar, and (5 trees) from Al-Sayer cultivar. The results of the study showed that there was a significant effect of spraying the fruits with potassium, and the concentration exceeded (4 ml L-1). The rate of sucrose was 16.92%), and the concentration of microelements (2 ml L-1) achieved the highest ripening rate at (87.40%) and the lowest precipitation rate at (18.44%), and the highest rate for sugars. The total and reduced sugars amounted to (52.71 and 35.95)%, respectively, and the lowest rate for sucrose amounted to (16.76%). The effect of the cultivar was significant, and the Al-Shwathi variety excelled significantly, recording the highest rate of ripening and precipitation. Respectively, compared to the Al-Sayer variety, which recorded the lowest rates, and all the two- and three-way interactions between the study factors had a significant effect on precipitation, ripening, total and reduced sugars, sucrose, and the interstitial stage.

I. INTRODUCTION

The date palm dates back to Mesopotamia, and from there it spread widely in the Arabian Peninsula, North Africa and the Middle East about 5000 years ago (Kader and Hussein, 2009). The main area for palm cultivation is the historic city of Ur, which is located in the Dhi Qar Governorate. It contains many Sumerian inscriptions, which indicate how old the date palm was in that region, and the date palm was sacred to the Sumerians, Babylonians, and Assyrians because of its subsistence, economic, and nutritional importance. The date palm is the first tree in Iraq, as it is like the tree of life (Al-Bakr, 1972). There are many commercial cultivars in Iraq, such as (Al-Zuhdi, Al-Sayer, Al-Halawi, Al-Khadhrawi and Al-Shwathi), which alone represent about (85%) of the date palms of Iraq. Al-Sayer constitutes a percentage of (23%), then Al-Halawi was classified

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with a rate of (13%), Al-Khadhrawi with an estimated rate of (6%), and Al-Shwathi with an estimated rate of (15%) from the date palms of Iraq (Matar, 1991). The Al-Shwathi variety is considered one of the rare and late-ripening varieties, and its cultivation is widespread in the southern regions of Iraq, especially in the governorates of Basra and Dhi Qar. Its fruits are distinguished by their good quality, large size, and sweet taste, in addition to their high nutritional value. As for the Al-Sayer variety, it is one of the commercial date palm varieties and ranks second among the date palm varieties in Iraq. Good, its fruits are distinguished by their sweet taste with a slight bitterness in the khalal stage due to the astringent substances, and the fruit has an elongated shape and is consumed in the Rutab and Tamar stages (Al-Rasan, 2020). economic if not compensated by adding fertilizers (Ibrahim, 2013), the date palm needs large quantities of macro and micro nutrients in order to grow and give an economic crop, Fertilization is considered one of the most important service operations that lead to an increase in production and its quality (Al-Rawi, 1998). Potassium is one of the major and important mobile elements needed by trees, due to its important role in physiological processes such as nitrogen transfer in photosynthesis and has a role in osmosis regulation in The cell, the process of opening and closing stomata, activating enzymes, and improving the quality of fruits. Potassium is a measure of quality in many fruits (Ibrahim and Khalif, 2003). The microelements are also important and necessary for the plant, just like the microelements, so that the plant can perform its functions to the fullest. There are many of these elements in the soil, but plants use only small quantities of them. The microelements include boron, chlorine, copper, iron, manganese, zinc, and others (Mortvedt, 2000).

Ezz et al., (2010) found that when fertilizing date palm cultivars Zaghloul and Hayani with potassium fertilizer for two consecutive seasons, there was a significant increase in the fruit content of reducing sugars and total sugars of Hayani variety compared to the control treatment and for the two study seasons, while the results indicated a significant increase for the two study seasons in the proportion of The total and reducing sugars of Zaghloul cultivar, and there was no significant effect on the percentage of non-reducing sugars for both cultivars and for the two study seasons.

Sharif (2011) when studying date palms of the Khadhrawi cultivar indicated that spraying date palm trees with two levels of NPK (2 and 2.5%) led to an increase in the maturity rate, as the concentration (2.5%) significantly increased the maturity rate, which amounted to (80.94%) compared to control treatment.

Mohamed and Saleh (2013) found, in their study on date palm Amhat variety, that spraying date palm fruits with potassium citrate at a concentration of (2%) led to recording the highest rate of total sugars (32.70 and 33.50)% and reduced sugars at a rate of (26.40 and 26.86)%. Compared with the control treatment and for the two study seasons, respectively.

They found Abd Ehaliem et al., (2017) when spraying the elements boron and iron on date palm (Samany variety) with a concentration of (60 g FeSo4 and 15 g H3Bo3) gave the highest percentage of total sugars and non-reducing sugars amounted to (28.05 and 29.32)% and (11.86 and 11.25) % for the two seasons respectively, and the reducing sugars at the same treatment in the first season amounted to (19.13)%, while the treatment with a concentration of (200 g FeSo4 and 15 g H3Bo3) in the second season gave the highest percentage of (19.31)%.

They reached Gupta et al ; (2017) in their study on different varieties of date palms, namely (Al-Halawi, Al-Zahdi, Al-Khadrawi and Shamran), it was noted that the females of the Al-Shamran palm variety were significantly superior in the

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percentage of total and reduced sugars over the females of Al-Khaddawi, Al-Halawi and Al-Zahdi varieties, and recorded the highest rate of (34.93 and 27.10)%, respectively. Compared to the rest of the cultivars, who recorded an average of (34.36, 32.67, and 25.91)% for total sugars and (24.79, 22.26, and 19.16)% for reducing sugars, respectively, while the sweet variety was significantly superior to the rest of the cultivars, and recorded the highest rate of sucrose, amounting to (10.42%) compared to the cultivar. Al-KhaddRawi, Shamran and Al-Zuhdi, who recorded the lowest rate of (9.57, 7.83 and 6.76%), respectively.

Akl et al., (2017) in their study on date palm Zaghloul cultivar, concluded that spraying date palm leaves (with potassium, nitrogen, phosphorus, and magnesium) in a mixed form and at a concentration of (5 g L-1) and in three batches, recorded the highest rate of total sugars amounting to (22.0 and 20.6%, and reduced rates of (15.0 and 15.5%) for the two study seasons, respectively.

Al-Saeedi (2018) showed that spraying date palm trees of the Al-Shwathi variety with Oligo Green fertilizer consisting of microelements at concentrations of (0, 100 and 200) mg L^{-1} gave a significant increase in the percentage of fruit ripening, as the treatment (200 mg L-1) gave the highest rate of The maturity rate was (61.820%) compared to the control treatment, which recorded the lowest rate (50.725%).

Elsayd et al., (2018) found in their study the effect of spraying with potassium and the quality of the fruits of the Barhi cultivar. The treatment with potassium, with a concentration of (3%), gave an increase in the percentage of total sugars amounting to (32.46 and 32.16%) and the reduced percentage was (21.14 and 20.62%) for the two seasons. on the relay.

Between Al-Manea (2018) in her study on date palms of the Al-Shwathi and Al-Khadhrawi cultivars, it was noted that the agricultural variety excelled in the percentage of total and reduced sugars, as the Al-KhaddRawi variety was significantly superior to the Al-Shwathi variety and recorded the highest rate of total and reducing sugars, which reached (64.836 and 42.583)% in the Khalal and (73 and 56.81%) in the Al-Rutab stage, respectively, compared to the fruits of Al-Shwathi cultivar. As for the percentage of sucrose, there were no significant differences between the two cultivars in the effect on the rate of sucrose in the fruits.

Al-Khafaji (2019) explained in her study of three date palm cultivars (Al-Shwathi, Al-Sayer, and Al-Khadhrawi) that there were significant differences between the cultivars in the precipitation and maturity rates, as the Al-Shuwathi variety recorded the lowest precipitation rate of (13.396%) and the highest rate of maturity for the three time periods amounted to (23.34 and 56.70 and 75.15%), and the Al-Shwathi variety was significantly superior to the Al-Sayer and Al-Khadhrawi cultivars, and recorded the highest rate in the percentage of total sugars, which reached (65.55 and 70.97)% for the two stages of Al-Khalal and Al-Rutab, respectively.

Mostafa (2019) mentioned in his study the effect of spraying with zinc on date palms of the Zaghloul cultivar, as zinc was used with two concentrations (500 PPm and 1000 PPm) sprayed on date palm fruits, as it was observed that the concentration exceeded (1000 PPm) and the highest rate of total sugars was recorded. (28.18, 30.24, and 29.85) percent, and reducing sugars, at a rate of (21.18, 21.50, and 20.96) percent, for the three seasons, respectively.

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Al-Falahy and Hasan (2020) explained in their study the effect of potassium sulfate at concentrations of (0, 0.5, 1, and 1.5%) on some physiological and sugar characteristics of date palms of the Barhi variety, that the concentration (1.5%) was significantly superior by recording the lowest rate of fruit drop rate (3.41%), and the highest rate of ripening percentage reached (52.69%), and the concentration exceeded (1%). through.

Al-Tamimi (2020) showed in his study of the two cultivars of date palms, Al-Zuhdi and Al-Khastawi for two seasons, that the agricultural variety had a significant effect in reducing the precipitation rate. %, while Al-Khastawi variety recorded the highest rates for the percentage of fruit ripeness amounted to (39.83 and 41.93)% compared to the Zuhdi variety, which recorded the lowest rates amounting to (39.20 and 41.30)% for the two study seasons, respectively.

Sobeih (2021) showed in her study on date palm, Al-Sayer variety, that spraying boron with a concentration of (300 $mg.L^{-1}$) led to a decrease in the percentage of fruit drop to reach (15.082%) and an increase in the percentage of fruit ripening at a rate of (65.27%), The treatment with boron at a concentration of (300 $mg.L^{-1}$) achieved the highest rate for total sugars (43.342 and 49.650%) and reducing sugars (30.850 and 40.327%) for the interstitial and wet phases respectively, and the lowest rate for sucrose reached (12.491 and 9.323) % compared to the control treatment.

They showed (2022) Radwan et al., in their study on date palm, Sewy variety, that spraying Sewy palm trees with potassium omega at a concentration of (4 cm^3 L) for two seasons gave the best results in terms of total sugars, which amounted to (70.69 and 70.21)%, and reduced (62.00 and 62.03%)% and for two consecutive seasons.

Al-Mousawi and Al-Zubaidi (2022) indicated in their study the effect of the Gorogreen Five Fructus nutrient solution consisting of the major elements NPK on date palm trees of the Barhi variety on the precipitation rate, as the concentration (1.5% ml-1) was superior in reducing the precipitation rate, reaching (13.131%) compared to With the control treatment, which amounted to (16.624%).

In view of the importance of the role of nutrients in improving the quality and quality of date palm fruits, this research was conducted with the aim of knowing the effect of potassium, microelements and cultivar on the percentage of falling and ripening of fruits, total and reducing sugars and sucrose of fruits in the Khalal stage of the two cultivars of date palm Al-Shwathi and Al-Sayer growing in Dhi Qar Governorate.

II. MATERIALS AND METHODS

This study was conducted during the growing season 2022 in one of the private orchards in Nasiriya district, the center of Dhi Qar governorate, where (10) date palm trees were selected, (5) date palms of Al-Sayer cultivar and (5) palm trees of Al-Shwathi cultivar, and the trees were homogeneous in measure Possibility in terms of height, diameter, vegetative growth, service operations, and their absence from disease infections. The study was carried out as a factorial experiment according to the complete randomized design (R.C.B.D) to study three factors:

1_ The first factor: spraying the fruits with potassium in three concentrations (0, 2 and 4) ml. lt^{-1}

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2-The second factor: spraying the fruits with microelements in three concentrations (0, 1, and 2) ml. L^{-1} per taste

3_ The third factor: the female agricultural class, as it adopted two female classes, namely (Al-Sayer and Al-Shuwathi).

Each palm tree was considered a sector containing (9) fruiting bunches, and each bunch was considered an experimental unit with three replicates for each treatment and for each of the two female cultivars under study. Before the start of the study, the results of the analysis were as follows.

Table (1): Physical and chemical analysis of the soil of the orchard in which date palm trees of two varieties, Al-Sayer and Al-Shwathi, are under study, at a depth of (0_30) cm from the soil surface during the 2022 growing season.

Analysis type	The value
PH	7.46
(DC m^{-1}) E.C	10.70
O.M	12%
Na^{+}	3.2 mmol / kg
K^{+}	0.98 mmol / kg
Mg^{++}	1.2 mmol / kg
Ca^{++}	2.1 mmol / kg
$So4^{--}$	2.4 mmol / kg
Cl^{-}	1.0 mmol / kg
Clay	44.2%
Sand	11.0%
Silt	40.8%
N	1.75%
P	0.31%
B	0.69 mg / Kg
Cu	9.8 mg / Kg
Fe	1099 mg / Kg
Mn	310 mg / Kg
Zu	25.9 mg / Kg
Mo	3.2 mg / Kg

Table (2): Physical and chemical analysis of irrigation water in the orchard during the 2022 growing season.

Analysis type	The value
E.C	3.9 Ms / cm
Ca++	168 mg / L
Mg+	140 mg / L
Na^{+}	401 mg / L
K^{+}	9.8 mg / L
Cl^{-}	875 mg / L
$HCO3^{-}$	241 mg / L
$So4^{--}$	1000 mg / L
$Po4^{-}$	0.11
$No3^{-}$	2.9
B	698 mg / L
Cu	17.4 mg / L
Fe	810 mg / L
Mn	18 mg / L

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Analysis type	The value
Zn	160 mg / L
Mo	9.8 mg / L

studied traits

precipitation rate (%):

The percentage of falling for all treatments was measured after (60) days of pollination, by taking (10) saplings randomly from each stem (repeated), then according to the number of existing fruits and the number of fallen fruit sites (empty scars) on each sapling, according to the method of 1970). Ream and furr The percentage of precipitation was calculated according to the following equation:

$$\text{Percentage of fallen fruits} = \frac{\text{The number of empty scars}}{\text{The number of empty scars + the number of fruits present}} \times 100$$

Maturity rate (%):

The ripening percentage was calculated when the fruits entered the wet stage, if ten saplings were randomly taken from each stem, and the ripening percentage was calculated according to the following equation:

$$\text{Fruit maturity percentage} = \frac{\text{The number of ripe fruits}}{\text{The total number of fruits}} \times 100$$

Fruit content of total sugars (%) :

Total sugars were estimated in the flesh of the fruits, according to (Howrtiz, 1995), when (10 g) of the fruits were taken, dried, and (50 ml) of distilled water was added to it, and then mixed using a mixer for (5 minutes), and then the mixture was heated. At a temperature of (70 C 5) for a period of (30 minutes) using a water bath, then it was filtered using filter paper No. (1), and (50 ml) was taken from the filtrate and (5 ml) of concentrated hydrochloric acid was added to it, and (4) drops were added to the solution of phenolphthalein dye concentration (1%) and then the acidity was adjusted using sodium hydroxide concentration (40%) and then the total sugars in the solution were estimated according to the following equation:

$$\text{Total sugars (\%)} = \frac{\text{mg of sugar (equivalent to reading a burette)}}{\text{x dilutions}} \times 100$$

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Sample weight x 1000

Fruit content of reducing sugars (%) :

The (Joslyn, 1970) method was used to calculate the percentage of non-reducing sugars in fruits, as samples were taken from ripe fruits (date stage), cut and dried in an electric oven at a temperature of (65 m 5) until the weight was proven, and after drying, the samples were ground using an electric grinder. And (0.2 g) was taken from the crushed sample and for each experimental unit and placed in test tubes, and (5 ml) of ethyl alcohol (80%) was added to each of them, then the tubes were placed in a water bath at a temperature of (60 m 5) for a period of (30 minutes). with constant stirring, After that, the tubes were placed in a centrifuge at a speed of (3000 revolutions per minute-1) for a period of (15 minutes), and the clear liquid for each sample was separated in glass bottles, which is an ethyl extract from which reducing sugars were estimated, and the color was reduced using charcoal, and then it was taken (1 ml) of the extract was added to it (1 ml Phenol 5% + 5 ml H2SO4 98%), then the samples were cooled for (10 minutes), then they were read with a spectrophotometer at a wavelength (490 nm) and according to the following equation:

$$\text{reducing sugars (\%)} = \frac{\text{mg of sugar (equivalent to reading a burette)}}{\text{Sample weight x 1000}} \times \text{dilutions} \times 100$$

Fruit content of sucrose (%) :

It was estimated by finding the difference between total sugars and reducing sugars, according to the following equation:

sucrose (%) = Total sugars(%) - reducing sugars(%) x 0.95

The results of the experiment were analyzed statistically as a factorial experiment according to the complete randomized design, and the differences between the means were tested using the least significant difference (R.L.S.D) under the significance level of 0.05 (Al-Rawi and Khalafallah, 1980).

III. RESULTS AND DISCUSSION

precipitation rate (%):

The results in Table (3) showed a significant effect of spraying the fruits with potassium element in reducing the percentage of fruit drop, and the concentration treatment (4 ml L^{-1}) achieved the lowest rate of (18.78%), which did not differ significantly with the concentration treatment (2 ml L^{-1}). which recorded a rate of (19.81%) compared to the control treatment, which gave the highest rate of (26.57%).

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As for the effect of spraying with microelements on the fruits, it was significant, in reducing the precipitation rate with an increase in the concentration of microelements. The concentration treatment (2 ml L^{-1}) recorded the lowest rate of (18.44%), followed by the treatment (1 ml L^{-1}) with a rate of (20.30%), compared to the control treatment, which recorded the highest rate of (26.42%).

The results showed in the table that there were significant differences between the two cultivars in the percentage of precipitation, as the Al-Sayer cultivar excelled and recorded the lowest rate of (19.46%) compared to the Al-Shwathi cultivar, which recorded the highest rate of (23.98%).

As for the nature of the interaction between potassium and the cultivar, it was significant in reducing the percentage of fruit dropping, and the interaction treatment between (potassium at a concentration of 4 ml L^{-1} and Al-Sayer variety) achieved the lowest rate of (15.28%) compared to the control treatment of Al-Shwathi variety, which amounted to (29.87%) .

The interaction between the microelements and the cultivar had a significant effect on reducing the precipitation rate, as the interaction treatment between (microelements at a concentration of 2 ml L^{-1} and Al-Sayer variety) achieved the lowest rate of (15.92%) compared to the control treatment of Al-Shwathi variety, which recorded the highest rate of (28.93) %.

As for the effect of interaction treatments between potassium and the mixture of microelements, it was significant in reducing the percentage of fruit drop, as the treatment with a concentration of (4 ml L^{-1} potassium and 2 ml L^{-1} microelements) gave the lowest rate of (17.17%) compared to the control treatment that It gave the highest precipitation rate (37.15%).

As for the effect of the interaction coefficients between potassium, the mixture of microelements and the agricultural variety on the precipitation rate, the results showed a significant superiority in the treatment (4 ml L^{-1} potassium and 2 ml L^{-1} microelements and Al-Sayer variety), which recorded the lowest rate of (12.80%) in comparison with the highest rate when the control treatment of the Al-Shwathi variety, at a rate of (40.93%).

Table (3) Effect of spraying potassium, microelements, cultivar and their interactions on precipitation rate (%)

Cultivar x microelements	Potassium ml L^{-1}			Microelements ml L^{-1}	Cultivar
	4	2	0		
28.93	23.39	22.45	40.93	0	Shuwathi
22.05	21.91	19.80	24.44	1	
20.95	21.54	17.07	24.25	2	
23.92	16.87	21.52	33.37	0	Al-Sayer
18.55	16.16	20.28	19.20	1	
15.92	12.80	17.74	17.22	2	
effect rate Cultivar	1.168			Cultivar L.S.D.≤0.05	
23.98	22.28	19.77	29.87	Shuwathi	×Cultivar Potassium
19.46	15.28	19.85	23.27	Al-Sayer	

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	18.78	**19.81**	**26.57**	Potassium effect rate	
effect rate microelements	**1.431**			Potassium **L.S.D.≤0.05**	
26.42	**20.13**	**21.99**	**37.15**	**0**	Potassium x microelements
20.30	**19.04**	**20.04**	**21.82**	**1**	
18.44	**17.17**	**17.40**	**20.73**	**2**	
Cultivar x Potassium x microelements	Potassium x microelements	Cultivar x microelements	Cultivar × Potassium	Microelements	**L.S.D.≤0.05**
3.505	**2.478**	**2.024**	**2.024**	**1.431**	

Maturity rate (%):

The results showed in Table (4) that there is a significant effect of spraying the fruits with potassium in increasing the ripening rate with an increase in potassium concentration, and the concentration treatment (4 ml L^{-1}) achieved the highest rate of (88.95%), followed by the concentration treatment (2 ml L^{-1}). At a rate of (85.68%), compared to the control treatment, which recorded the lowest rate (80.33%).

The results presented in the table showed that there was a significant effect of spraying with microelements in increasing the ripening rate with an increase in the concentration of microelements. The treatment with a concentration of (2 ml L^{-1}) achieved the highest rate of (87.40%), followed by the treatment with a concentration of (1 ml L^{-1}) with a rate of It reached (85.11%), and compared to the control treatment, which achieved the lowest rate (82.46%).

As for the cultivar, there was a significant difference between the two cultivars in terms of maturity, as the Al-Shwathi cultivar excelled in giving the highest rate of (86.13%) compared to the Al-Sayer cultivar, which recorded the lowest rate of (83.84%).

As for the effect of the interaction treatments between potassium and the cultivar, it was significant in the ripening percentage, and the interaction treatment between potassium at a concentration of (4 ml L^{-1} and Al Shuwathi variety) achieved the highest rate of (90.21%), compared with the control treatment of Al-Sayer variety, which recorded the lowest rate of (80.00 %) which did not differ significantly with the control treatment of Al Shuwathi variety, which recorded an average of (80.67%).

As for the effect of the interaction coefficients between the concentrations of microelements and the cultivar, it was significant in the ripening percentage, and the interaction treatment between (microelements with a concentration of 2 ml L^{-1} and Al-Shwathi cultivar) achieved the highest rate of (87.80%), which did not differ significantly with the treatment of interaction between (microelements). with a concentration of 2 ml L^{-1} and Al-Sayer variety), which recorded a rate of (87.00%), and compared to the control treatment of Al-Sayer variety, which recorded the lowest rate (80.99%).

As for the effect of interaction treatments between potassium and microelements, it was significant in the percentage of fruit ripening, and the interaction treatment between (potassium at a concentration of 4 ml L^{-1} and microelements at a concentration of 2 ml L^{-1}) gave the highest rate of (95.89%) compared to the control treatment that gave The lowest rate was (72.86%).

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As for the triple interaction between potassium, microelements and cultivar, it had a significant effect on increasing the percentage of fruit ripening. The highest rate was recorded (91.05%). Average rate of maturity in the control treatment of Al-Shwathi variety at a rate of (72.65%).

Table (4) Effect of potassium spraying, microelements, cultivar and their interactions on ripening percentage (%)

Cultivar x microelements	Potassium ml L^{-1}			**Microelements ml L^{-1}**	**Cultivar**
	4	**2**	**0**		
83.93	**90.29**	**88.84**	**72.65**	**0**	Shuwathi
86.68	**89.29**	**88.07**	**82.68**	**1**	
87.80	**91.05**	**85.65**	**86.68**	**2**	
80.99	**87.67**	**82.22**	**73.08**	**0**	Al-Sayer
83.54	**86.55**	**83.26**	**80.82**	**1**	
87.00	**88.84**	**86.06**	**86.10**	**2**	
Cultivar effect rate	**1.416**			**Cultivar L.S.D.≤0.05**	
86.13	**90.21**	**87.52**	**80.67**	Shuwathi	×Cultivar Potassium
83.84	**87.69**	**83.85**	**80.00**	Al-Sayer	
	88.95	**85.68**	**80.33**	Potassium effect rate	
micro element effect rate	**1.734**			Potassium **L.S.D.≤0.05**	
82.46	**88.98**	**85.53**	**72.86**	**0**	Potassium x microelements
85.11	**87.92**	**85.66**	**81.75**	**1**	
87.40	**89.95**	**85.86**	**86.39**	**2**	
Cultivar x Potassium x microelements	Potassium x microelements	Cultivar x microelements	Cultivar × Potassium	Microelements	**L.S.D.≤0.05**
4.247	**3.003**	**2.452**	**2.452**	**1.734**	

Percentage of total sugars (%) of fruits in the Khalal stage.

The results of table (5) showed that there was a significant effect of spraying with potassium element in increasing the rate of total sugars of fruits in the khalal stage, as the treatment (4 ml L^{-1}) achieved the highest rate of (53.34%) compared to the control treatment, which recorded the lowest rate of (51.07%), which did not differ significantly with the treatment (2 ml L^{-1}) at a rate of (51.57%).

The results of the statistical analysis showed the significant effect of spraying with microelements on the percentage of total sugars of the fruits in the khalal stage. It reached (52.14%) compared to the control treatment, Which did not differ significantly from the treatment (1 ml liter-1) at a rate of (52.14%). which recorded the lowest rate (51.12%).

The results presented in the table indicated that the Al-Shwathi variety was significantly superior in giving the highest average percentage of total sugars, amounting to (54.13%), compared to the Al-Sayer variety, which recorded the lowest rate, amounting to (49.85%).

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As for the effect of the interaction treatments between potassium and the agricultural variety, it was significant in the rate of total sugars, and the interaction treatment between (potassium at a concentration of 4 ml L-1 and Al-Shwathi variety) achieved the highest rate of (55.92%), while the control treatment of Al-Sayer variety recorded the lowest rate of (49.22%) .

As for the effect of the interaction treatments between the microelements and the agricultural variety, it had a significant effect on increasing the average total sugars, and the interaction treatment between (microelements with a concentration of 2 ml L^{-1} and Al-Shwathi variety) achieved the highest rate of (55.03%), while the control treatment for Al-Sayer variety recorded the lowest rate (49.15%).

As for the effect of the interaction between potassium and microelements, it had a significant effect on increasing the rate of total sugars of date palm fruits, as the interaction treatment between (potassium at a concentration of 4 ml L^{-1} and microelements at a concentration of 2 ml L^{-1}) excelled and recorded the highest rate of (54.08%) compared to The control treatment that recorded the lowest rate was (50.37%).

The nature of the triple interaction between potassium and the microelements and the variety had a significant effect by increasing the rate of total sugars. The control treatment of Al-Sayer variety had the lowest rate (48.61%).

Table (5) Effect of spraying potassium, microelements and cultivar and their interactions on total sugars (%) for the khalal stage

Cultivar x microelements	Potassium ml L^{-1}			Microelements ml L^{-1}	Cultivar
	4	2	0		
53.09	54.96	52.17	52.14	0	Shuwathi
54.29	55.93	53.96	52.98	1	
55.03	56.88	54.58	53.62	2	
49.15	50.12	48.73	48.61	0	Al-Sayer
50.00	50.86	50.17	48.96	1	
50.40	51.29	49.79	50.10	2	
Cultivar effect rate	0.545			Cultivar L.S.D.≤0.05	
54.13	55.92	53.57	52.91	Shuwathi	×Cultivar Potassium
49.85	50.76	49.56	49.22	Al-Sayer	
	53.34	51.57	51.07	Potassium effect rate	
micro element effect rate	0.667			Potassium L.S.D.≤0.05	
51.12	52.54	50.45	50.37	0	Potassium x microelements
52.14	53.39	52.06	50.97	1	
52.71	54.08	52.18	51.86	2	
Cultivar x Potassium x microelements	Potassium x microelements	Cultivar x microelements	Cultivar × Potassium	Microelements ml L^{-1}	L.S.D.≤0.05
1.634	1.155	0.943	0.943	0.667	

Percentage of reducing sugars (%) for fruits in the khalal stage .

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The results of table (6) showed that there was a significant effect of spraying with potassium element in increasing the rate of reducing sugars in the interstitial stage, and the treatment (4 ml L^{-1} potassium) achieved the highest rate of (36.42%), followed by the treatment (2 ml L^{-1}) with a rate of (34.06%), compared to the control treatment, which recorded the lowest rate (31.75%).

The results of the statistical analysis showed the significant effect of spraying with microelements by increasing the percentage of reducing sugars, as the treatment excelled (2 ml L-1) and recorded the highest rate of (35.95%), followed by the treatment (1 ml L-1) with a rate of (33.97%), compared to the treatment The control that recorded the lowest rate was (32.31%).

The results presented in the table indicated that the Al-Shwathi variety was significantly superior in giving the highest rate of reducing sugars, amounting to (36.04%), compared to the Al-Sayer variety, which recorded the lowest rate, amounting to (32.12%) in the Khalal stage.

As for the effect of the interaction treatments between potassium and the agricultural variety, it was significant by increasing the rate of reducing sugars, as the interaction treatment between (potassium at a concentration of 4 ml L^{-1} and Al Shuwathi variety) achieved the highest rate of (38.96%), while the control treatment of Al-Sayer variety recorded the lowest rate of (30.15 %).

As for the effect of the interaction treatments between the microelements and the agricultural variety, it was significant by increasing the rate of reducing sugars. The interaction treatment between (microelements at a concentration of 2 ml L^{-1} and Al Shuwathi variety) recorded the highest rate of (38.31%), while the control treatment of Al-Sayer variety recorded the lowest rate. It reached (30.69%).

As for the effect of interaction treatments between potassium and microelements, it was significant by increasing the rate of reducing sugars, and the interaction treatment between (potassium at a concentration of 4 ml L^{-1} and trace elements at a concentration of 2 ml L^{-1}) achieved the highest rate of (39.07%), compared to the control treatment that The lowest rate was recorded (30.04%).

The nature of the triple interaction between potassium and the microelements and the variety had a significant effect by increasing the rate of reducing sugars. The interaction treatment between (potassium at a concentration of 4 ml L^{-1} and microelements at a concentration of 2 ml L^{-1} and Al-Shwathi variety) excelled and recorded the highest rate of (42.27%). The control treatment for Al-Sayer variety had the lowest rate (28.34%).

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Table (6) Effect of spraying potassium, microelements, cultivar and their interventions on reducing sugars (%) for the khalal stage.

Cultivar x microelements	Potassium ml L^{-1}			Microelements ml L^{-1}	Cultivar
	4	2	0		
33.94	36.58	33.48	31.57	0	Shuwathi
35.87	38.03	35.81	33.76	1	
38.31	42.27	38.12	34.54	2	
30.69	32.64	31.08	28.34	0	Al-Sayer
32.07	33.13	32.64	30.44	1	
33.59	35.88	33.25	31.66	2	
Cultivar effect rate	0.534			L.S.D.≤0.05 Cultivar	
36.04	38.96	35.80	33.35	Shuwathi	×Cultivar Potassium
32.12	33.88	32.32	30.15	Al-Sayer	
	36.42	34.06	31.75	Potassium effect rate	
effect rate micro element	0.654			Potassium L.S.D.≤0.05	
32.31	34.61	32.28	30.04	0	Potassium x microelements
33.97	35.58	34.23	32.10	1	
35.95	39.07	35.68	33.10	2	
Cultivar x Potassium x microelements	Potassium x microelements	Cultivar x microelements	Cultivar × Potassium	Microelements ml L^{-1}	L.S.D.≤0.05
1.601	1.132	0.925	0.925	0.654	

The percentage of sucrose (%) for fruits in the khalal stage

The results showed in Table (7) that there was a significant effect of spraying the fruits with potassium element in reducing the rates of the percentage of sucrose for the fruits in the khalal stage, as the concentration treatment (4 ml L^{-1}) recorded the lowest rate of (16.92%), followed by the concentration treatment (2 ml L^{-1}) at a rate of (17.50%) and compared with the control treatment, which recorded the highest rate of (19.32%).

The results of the statistical analysis showed the significant effect of spraying the fruits with concentrations of microelements in reducing the rates of the percentage of sucrose in the Khalal stage, as the concentration treatment recorded the treatment (2 ml L^{-1}) with the lowest rate of (16.76%), followed by the treatment with the concentration (1 ml L^{-1}) with a rate It reached (18.17%), and compared to the control treatment, which recorded the highest rate (18.81%).

The results in the same table indicated that there was a significant difference between the cultivars in the percentage of sucrose, and the Al-Sayer cultivar recorded the lowest rate of (17.73%) compared to the Al-Shwathi cultivar, which recorded the highest rate of (18.10%).

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As for the effect of the interaction coefficients between potassium concentrations and the agricultural variety, it was significant in decreasing the percentage rates of sucrose, as the interaction treatment between (potassium at a concentration of 4 ml L^{-1} and the al-Sayer variety) recorded the lowest rate (16.87%), which did not differ significantly with the overlap treatment. Between (potassium at a concentration of 4 ml L^{-1} and Al-Shwathi variety), which recorded a rate of (16.96%), while the control treatment of Al-Sayer variety recorded the highest rate of (19.08%), which did not differ significantly with the control treatment of Al-Shwathi variety, which recorded a rate of (19.56%) .

As for the effect of the interaction treatments between the microelements and the variety, it was significant in reducing the rates of the percentage of sucrose, as the interaction treatment between (2 ml L^{-1} and Al Shuwathi variety) recorded the lowest rate of (16.72%), which did not differ significantly with the interaction treatment between (microelements with a concentration of 2 ml L^{-1} and Al-Sayer variety), which recorded a rate of (16.80%), while the control treatment of Al-Shwathi variety recorded the highest rate of (19.16%).

The interaction treatments between potassium and trace elements showed a significant effect in reducing the rates of sucrose percentage, as the interaction treatment was recorded between (potassium at a concentration of 4 ml L^{-1} and trace elements at a concentration of 2 ml L^{-1}), which recorded the lowest rate of (15.01%), while it gave a treatment In comparison, the highest rate was (20.33%).

As for the effect of the interaction coefficients between the concentrations of potassium, microelements and cultivar, it was significant in reducing the percentage rates of sucrose in the fruits of the Khalal stage, as the interaction treatment between (potassium at a concentration of 4 ml L^{-1} and microelements at a concentration of 2 ml L^{-1} and Al Shuwathi cultivar) recorded the lowest rate of (14.61%), while the control treatment of Al-Shwathi class recorded the highest rate of (20.39%).

Table (7) Effect of spraying with potassium, microelements, cultivar and their interactions on the percentage of sucrose (%) for the khalal stage .

Cultivar x microelements	Potassium ml L^{-1}			Microelements ml L^{-1}	Cultivar
	4	2	0		
19.16	18.38	18.69	20.39	0	Shuwathi
18.42	17.89	18.15	19.22	1	
16.72	14.61	16.46	19.08	2	
18.47	17.48	17.65	20.27	0	Al-Sayer
17.92	17.73	17.52	18.52	1	
16.80	15.41	16.55	18.45	2	
effect rate Cultivar	0.327			Cultivar L.S.D.≤0.05	
18.10	16.96	17.77	19.56	Shuwathi	×Cultivar Potassium
17.73	16.87	17.24	1908	Al-Sayer	
	16.92	17.50	19.32	Potassium effect rate	

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effect rate micro element	0.401			Potassium **L.S.D.≤0.05**	
18.81	**17.93**	**18.17**	**20.33**	**0**	Potassium x microelements
18.17	**17.81**	**17.83**	**18.87**	**1**	
16.76	**15.01**	**16.50**	**18.76**	**2**	
Cultivar x Potassium x microelements	Potassium x microelements	**Cultivar x microelements**	Cultivar × Potassium	**Microelements**	**L.S.D.≤0.05**
0.981	**0..694**	**0.567**	**0.567**	**0.401**	

We note from the results of the current study a decrease in the precipitation rate and an increase in the ripening rate. The reason may be due to the fact that potassium and trace elements play a role in building the energy compounds ADP and ATP and the nucleic acids RNA and DNA and the conjugates NADP and NAD+, which have a fundamental role in many vital processes such as construction photosynthesis and respiration, and thus lead to making the treated fruits ripen faster than the untreated fruits (Al-Ashaf, 1989 and Al-Nuaimi, 2000), Or the reason may be due to the role of potassium and microelements in maintaining a nutritional balance within the plant and thus reducing competition between fruits for nutrients, which led to a decrease in the percentage of falling of the fruits treated with them (Matar, 1991), and the results showed a significant increase in the percentage of total and reducing sugars and a decrease Significant effect of sucrose on the effect of concentrations of potassium and trace elements and their interactions with fruits in the interstitial stage. The reason may be attributed to the increase in the percentage of total and reducing sugars being one of the important chemical changes that accompany the ripening process in many fruits (Burton, 1982). Or the reason may be due to their role in increasing the fruit content of the ethylene hormone, which works to activate the genes responsible for the activity of enzymes, including the enzymes responsible for the conversion of sucrose into reducing sugars in the fruit (Al-Mubarak, 2014), or the reason may be due to the concentrations of potassium and trace elements and their interactions It led to a significant increase in the percentage of boron, which plays a role in activating enzymes that raise the efficiency of vital, physiological and enzymatic processes and the transfer of plant hormones and sugars through cell membranes from places of manufacture to places of storage in fruits (Brown et al., 2002) . As for the reason for the significant decrease in the percentage of sucrose in the fruits, it may be due to the significant increase in the percentage of total sugars when the fruit growth is completed in the khalal stage, then the fruit becomes ready to enter the final ripening stage, which is associated with an increase in the speed of respiration, ethylene production, and an increase in the enzyme membrane (Matter , 1991) .

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