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ORIGINAL ARTICLE

INFLUENCE OF POTASSIUM AND GA3 ON YIELD AND SOME FRUIT QUALITY OF DATE PALM *CV.* BARHEE

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Abstract: The experiment was conducted in one of the private orchards at Al-Abayji township –Tarmiyah district, 55 km north of Baghdad, to study the effect of potassium and gibberellic acid on some characteristics of fruit quality and yield of date palm cv. Barhee during the period from March 2020 to September 2020, spraying potassium sulphate included, 0 (spray with distilled water), 1, 1.5 and 2%, on the other hand, spraying GA3 included, 0 (spray distilled water as control), 150 and 200 mg.l-1. The results showed that potassium spray had a significant effect in increasing all fruits characteristics especially 2% compared to the control, while GA3 at 200 mg.l-1 spray had led to increasing fruit weight, bunch weight and yield, while decrease in total sugars, reducing sugars, non-reducing sugars and fruit dry weight but there was no significant effect on content of fruit potassium.

Keywords: Potassium, GA3, Date Palm, Yield, Fruit quality.

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1. Introduction

Date palm (*Phoenix dactylifera* L.) belongs to the family Arecaceae, it is one of the important fruit trees spread in the Arab and Islamic world, opinions differed in determining the native land of date palms, but the Italian scientist "Odardo Beccari", who is considered an argument in the study of the date palm family, believes that the original habitat of date palms is the Arabian Gulf. The date palm includes many important commercial cultivars, including Barhee cultivar, which is considered one of the important cultivars and widespread in the Middle East region. It is usually consumed in the Khalal stage, but soon it enters the Rutab stage, therefore the fruits are eaten in the Khalal, Rutab and Tamar stage [Hussein (2002)].

The number of palm trees in Iraq is 17036560 palm trees and the total production of the covered governorates is 639.3 thousand tons, with an average palm yield of 62.6 kg. Baghdad occupied the first position in terms of production, which was estimated at 135.2 thousand tons, representing (21.1%) of the total production of Iraq, followed by Babil Governorate, whose production was estimated at 93.6 thousand tons (14.6%) of the total production of Iraq, while Karbala governorate ranked third, whose production was estimated at 80.9 thousand tons (12.7%) of the total production of Iraq, while the rest of the governorates constituted a percentage of (51.6%) [Central Statistical Organization (2019)].

Many studies indicate that potassium has important effects in improving the properties of fruits, as it plays an important role in stimulating chemical transformations through its effective role in activating many enzymes that have an important role in the growth and development of fruits by encouraging the process of photosynthesis and assisting in the transfer of processed substances, such as sugars and proteins from places of manufacture to storage sites, including fruits,

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a number of researchers found that there is a positive relationship in stimulating the rate of photosynthesis and the transfer of its products to storage sites in plant organs or fruits in the case of potassium nutrition, which is due to the important role in stimulating the formation of ATP, which is important for the process of carbon dioxide assimilation, in addition to the important role that potassium plays in stimulating the growth and cells division, increases fruits size and improves their quality [Kalavati and Modi (2012), Hasan *et al.* (2020)]

The results of a large number of studies have indicated that spraying the date palm bunches with gibberellic acid often leads to an increase in fruit size and diameter, which lead to an increase in its weight as a direct result of the role of that substance in promoting growth through its role in cell elongation in addition to the role of gibberellic acid in reducing the percentage of fruits drop, increasing the percentage of remaining fruits and thus increasing the yield [Choudhary *et al.* (2018)]. Treatment with gibberellic acid also leads to prolonging the life of the cell through its active role in prolonging the life of chlorophyll as a result of its effect on the hydrolytic enzymes and it also increases the moisture content of the fruits, thus delays ripening [Kassem *et al.* (2011)]. So the study aimed to evaluate the effect of spraying with potassium sulphate, gibberellic acid and the combination between them in some fruit traits to evaluate the best concentrations that affect the yield characteristics of the Barhee cultivar.

2. Materials and Methods

The study was conducted for the period from March 2020 to September 2020 in one of the private orchards of Al-Abayji township -Tarmiyah district, 55 km north of Baghdad, to study the effect of potassium and gibberellic acid foliar spraying on some characteristics of the fruits and the yield of Barhee date palm and the experiment was carried out on 36 palm tree with homogeneous vegetative growth as much as possible at the age of 18 years, planted with dimensions of 10×10 m, same management and cultural practices were conducted for all trees equally and the trees were pollinated in April with the male cultivar (Red Ghanami) by placing 5 male strands in the middle of each female cluster, the bunches were adjusted into 13 bunches for each date palm. The spray was carried out with potassium sulphate (K_2SO_4) at a concentration of K0 (distilled water as control), K1 (1%), K2 (1.5%) and K3 (2%), spraying was done for two time, after fruit set and after 4 weeks from the first spray, the second factor, it included spraying bunches with GA3 at three levels, GA0 (distilled water as control), GA1 (150 $mg.l^{-1}$) and GA2 (200 $mg.l^{-1}$). The bunches were sprayed at the beginning of Kimri stage and the second spray was done after month from the first spray (at the beginning of Khalal stage). Spraying was done early in the morning with 0.1% tween 20 as diffuser and then the following traits were measured:

2.1 Fruit weight (g)

Fruit weight was recorded by using electronic balance and expressed in (g).

2.2 Bunch weight (kg) and yield (kg)

After the fruits reached ripening stage and the fruits reached 30% at Tamar stage, the bunches were harvested at the fourth week of September and weighted using field balance to obtain bunch weight, then the total yield was measured by multiplying the bunch weight by the number of bunches on palm.

2.3 Fruit chemical characteristics (%)

At Rutab stage, 15 fruits was randomly selected from each strands that were marked previously and analyzed to determine the fruits chemical content (Total sugars, Reducing sugars, Non-reducing sugars, Total soluble solids and Fruits dry weight) according to A.O.A.C (1975). To estimate the potassium content of fruits (mg.100-g dry weight), 2 gm of the dry sample was taken and digested using sulfuric acid and perchloric acid at a ratio of 5:3 according to the method suggested by Cresser and Parsons (1979), then potassium was estimated using a flame photometer.

The results were subjected to analysis of variance (ANOVA) and differences between treatments were made by F-test and the least significant differences at P= 5%.

3. Results and Discussion

3.1 Fruit Weight (kg)

It is noticed from the results of Table 1 that spraying with potassium sulphate had a significant effect on increasing fruit weight, which reached its maximum at the concentration K3, as it achieved a value of 19.65 g, compared to the lowest values of K0, which gave a value of 17.65 g. In the same context, spraying with GA3 showed a significant superiority in increasing fruit

weight, the highest value was 19.08 g when treatment G2 compared to the lowest value at treatment G0, which was 18.08 g. The effect of interaction did not differ from the effect of individual factors, K3G2 achieved the highest value of 20.12 g compared to the lowest value at control, which gave 17.32 g.

3.2 Bunch Weight (kg)

Data in Table 1 indicated that spraying with potassium sulphate had a significant effect on the bunch weight, especially treatments K2 (1.5%) and K3, without a significant difference, which amounted to 24.64 and 24.87 kg.bunch-1, respectively. On the other hand, spraying with GA3 also showed a significant effect on this characteristic, G2 achieved the highest value of bunch weight, reaching 24.99 kg. bunch^{-1} while the lowest value at G0, which gave 23.11 kg.bunch-1. As for the interaction between the study factors, K3G2 recorded the highest value of freshness weight, which amounted to 26.00 kg.bunch-1 compared to the lowest value of the control treatment, which amounted to 22.39 kg.

3.3 Yield (kg)

Data in Table 1 indicate that spraying with potassium sulphate had a significant effect on increasing the yield, especially K3, in which the yield weight was 323.41 kg.Palm-1, while the lowest value was recorded at K0, which gave 299.42 kg.palm^{-1}. Similarly, spraying with GA3 showed a significant effect, treatment G2 achieved the highest value of yield 324.87 kg.palm^{-1} compared to the lowest value of yield at treatment G0, which gave 300.50 kg.palm^{-1}. Interaction had a significant effect on the yield, K3G2 achieved the highest value 338.00 kg.palm^{-1} compared to control, which gave 291.11 kg.palm^{-1}.

3.4 Total sugars (%)

It is noticed from the results of Table 2 that an increase in the percentage of total sugars in the fruits as a result of spraying with potassium sulphate, as all spray levels exceeded the spray treatment with distilled water, especially K3, which achieved the highest value of total sugars, which amounted to 41.40%, while the lowest percentage of total sugars was reached when

Table 1: Effect of Potassium Sulphate (K) and GA3 (G) and their Interaction on Fruit Weight (g), Bunch Weight (kg) and Yield (kg) of date palm cv. Barhee.

GA3(G)	Potassum Sulphate (K)				Mean
	K0 = Control	K1 = 1%	K2 = 1.5%	K3 = 2%	
	Fruit Weight(kg)				
G0 = Control	17.32	17.97	18.28	18.76	18.08
G1 = 150mg.l^{-1}	17.74	18.44	18.53	20.07	18.69
G2 = 200mg.l^{-1}	17.88	18.69	19.63	20.12	19.08
Mean	17.65	18.36	18.81	19.65	
L.S.D 0.05	K	G	K × G		
	0.07	0.06	0.12		
Bunch Weight(kg)					
G0 = Control	22.39	22.93	23.66	23.46	23.11
G1 = 150mg.l^{-1}	22.91	23.80	24.76	25.16	24.16
G2 = 200mg.l^{-1}	23.79	24.66	25.50	26.00	24.99
Mean	23.03	23.80	24.64	24.87	
L.S.D 0.05	K	G	K × G		
	0.30	0.26	0.52		
Yield(kg)					
G0 = Control	291.11	298.13	307.67	305.07	300.50
G1 = 150mg.l^{-1}	297.83	309.40	321.97	327.17	314.09
G2 = 200mg.l^{-1}	309.31	320.67	331.50	338.00	324.87
Mean	299.42	309.40	320.38	323.41	
L.S.D 0.05	K	G	K × G		
	3.96	3.43	6.86		

LSD = Least significant difference at 5% probability.

treatment K0, amounted to 36.92%, on the other hand, spraying with GA3 showed a decrease in the total sugars in the fruits, the highest value was reached at G0, which reached 42.04%, while the lowest value have been recorded at G2, which gave 37.30%, while the total sugars were not significantly affected by the interaction between the study factors, however, there was a slight natural increase as a result of these interactions.

3.5 Reducing sugars (%)

The study coefficients resulted in significant differences in this trait, the results of a Table 2 shows that spraying with potassium sulphate had led to an increase in the reducing sugars, which was recorded high value as when spraying K3, reaching 28.43%, while the lowest value was recorded at K0, which gave 24.05%, whereas, the percentage of reducing sugars in the fruits decreased when spraying with GA3 and the highest value was 27.24% with the treatment G0, while the lowest value was recorded with the two treatments G1 and G2, without a significant difference between them, which gave 25.81 and 25.73%, respectively. The results also showed that the reducing sugars was affected By the interaction between the two study factors, this was demonstrated by the superiority of the K3G2, giving it the highest value of 28.96%, while the lowest value was recorded with the treatment K0G2, which amounted to 22.70%.

3.6 Non-reducing sugars (%)

Data in the Table 2 revealed that the spraying with potassium sulphate did not significantly affect the percentage of non-reducing sugars in the fruits, while spraying with GA3 showed a significant effect in this characteristic, spraying with GA3 had led to a decrease in the percentage of non-reducing sugars and the lowest value reached 11.56% at G2 compared to the highest value at G0, which gave 14.80%, The interaction between the study factors also showed a significant effect on this trait, K3G0 was distinguished by achieving the highest percentage of non-reducing sugars, which amounted to 16.50%, while the lowest value was recorded at K3G2, which gave 10.43%.

Table 2: Effect of Potassium Sulphate (K) and GA3 (G) and their Interaction on Total Sugars (%), Reducing Sugars (%) and Non-reducing Sugars (%) of date palm cv. Barhee.

GA3(G)	Potassum Sulphate (K)				Mean
	K0 = Control	K1 = 1%	K2 = 1.5%	K3 = 2%	
	Total Sugars (%)				
G0 = Control	39.77	41.18	42.77	44.43	42.04
G1 = 150mg.l^{-1}	36.21	38.07	39.20	40.37	38.46
G2 = 200mg.l^{-1}	34.77	36.97	38.07	39.39	37.30
Mean	36.92	38.74	40.01	41.40	
L.S.D 0.05	K	G	K × G		
	0.92	0.80	N.S		
Reducing Sugars (%)					
G0 = Control	26.40	27.03	27.60	27.93	27.24
G1 = 150mg.l^{-1}	23.06	25.47	26.30	28.40	25.81
G2 = 200mg.l^{-1}	22.70	25.57	25.69	28.96	25.73
Mean	24.05	26.02	26.53	28.43	
L.S.D 0.05	K	G	K × G		
	0.46	0.39	0.79		
Non-Reducing Sugars (%)					
G0 = Control	13.37	14.15	15.17	16.50	14.80
G1 = 150mg.l^{-1}	13.14	12.59	12.90	11.97	12.65
G2 = 200mg.l^{-1}	12.06	11.39	12.37	10.43	11.56
Mean	12.86	12.71	13.48	12.97	
L.S.D 0.05	K	G	K × G		
	N.S	0.85	1.71		

LSD = Least significant difference at 5% probability.

3.7 Total soluble solids (%)

It is evident from the results of the Table 3 that there was a significant increase in the percentage of total soluble solids, as a result of spraying with potassium sulphate, the highest value for treatment K3 was 49.64%, while the lowest value for treatment K0 was 43.49%, whereas, the total soluble solids in the fruits decreased as a result of spraying with GA3, G0 achieved the highest value of 48.24% compared to the lowest value of treatment G1 and G2 without significant difference between them, which amounted to 45.18% and 45.56%, respectively. The interaction had a significant effect on this characteristic, K3G0 achieved the highest value of 51.77% compared to the lowest value of treatment K0G2, which amounted to 42.15%.

3.8 Fruit Dry Weight (g)

The results shown in Table 3 showed that spraying the fruits with potassium sulphate increased the dry matter percentage, the highest value was 69.07% when treatment K3, while the lowest value was for the dry matter percentage at K0, which gave a value of 61.72%, on the other hand, spraying with GA3 showed a decrease in the dry matter percentage, the highest value was recorded at G0, which amounted to 68.66%, while the treatment with GA3 with a concentration of G1 and G2 gave the lowest values without a significant difference between them, which amounted to 63.25 and 64.07 %, respectively. The interaction between the study factors showed that K3G0 achieved the highest values of the dry matter percentage, which reached 72.80%, while the lowest values were reached 59.94% at K0G2.

3.9 Fruit Potassium Content (mg.100g-1 dry weight)

Results shown in Table 3 revealed that spraying of potassium sulphate had a significant effect on the potassium content, the highest value was 734.34 mg.100g.-1 dry weight when treating with K3, compared to the lowest value of 643.07 mg.100g^{-1} dry weight when treatment K0, while there were no significant differences between the levels of spraying with GA3 in their effect on the potassium content of fruits, the interaction treatment K3G0 showed the highest value of 774.73 mg.100g^{-1} dry weight, while the lowest value reached 639.00 mg.100g^{-1} dry weight

Table 3: Effect of Potassium Sulphate (K) and GA3 (G) and their Interaction on TSS (%), Fruit Dry Weight (g) and Fruit Potassium Content (mg.100g^{-1} dry weight) of date palm cv. Barhee.

GA3(G)	Potassum Sulphate (K)				Mean
	K0 = Control	K1 = 1%	K2 = 1.5%	K3 = 2%	
	TSS (%)				
G0 = Control	45.88	47.93	47.37	51.77	48.24
G1 = 150mg.l^{-1}	42.43	44.53	47.20	46.53	45.18
G2 = 200mg.l^{-1}	42.15	43.60	45.87	50.63	45.56
Mean	43.49	45.36	46.81	49.64	
	K	G	K × G		
	1.04	0.90	1.80		
Fruit Dry Weight (g)					
G0 = Control	64.56	65.82	71.48	72.80	68.66
G1 = 150mg.l^{-1}	60.66	61.82	62.93	67.60	63.25
G2 = 200mg.l^{-1}	59.94	63.02	66.54	66.80	64.07
Mean	61.72	63.55	66.98	69.07	
	K	G	K × G		
	1.41	1.22	2.45		
Fruit Potassium Content (mg.100g^{-1} dry weight)					
G0 = Control	639.00	660.13	669.53	774.73	685.85
G1 = 150mg.l^{-1}	648.43	687.23	677.50	735.20	687.09
G2 = 200mg.l^{-1}	641.77	677.80	736.67	693.10	687.33
Mean	643.07	675.06	694.57	734.34	
L.S.D 0.05	K	G	K × G		
	2.01	N.S	3.48		

when the interaction treatment K0G0.

It is noticed from the results of the Tables 1 and 2, that physical, chemical characteristics of fruits and yield, have increased as a result of spraying with potassium sulphate, especially the spray level 2%. The reason may be attributed to the fact that potassium influences many physiological processes such as photosynthesis and chlorophyll formation and its role is through activation of many enzymes that leading to the encouragement of cell division and tissue growth, as reported by Taiz and Zeiger (2010), who indicated that elongation depends on the concentration of solutes such as potassium in the cells which is considered one of the main solutes in the cell and thus the osmotic pressure increases and according to that, cell elongation increases, in addition, potassium plays an important role in transporting the substances that have been represented and facilitating their transfer from the places of manufacture to storage sites, including fruits [Kalavati and Modi (2012), Kumar *et al.* (2019)]. These results are in harmony with Al-Falahy and Hasan (2020) on the Barhee date palm fruits. As for the reason for the superiority of spraying treatments with GA3, especially the concentration (200 $mg.l^{-1}$), it may be due to the role of gibberellin in cell division and elongation as well as its role in increasing the elasticity of cell walls, causing an increase in the permeability, thus allowing the entry of large quantities of water and materials, nutrients enter the cells and swell, as a result increase the dimensions of the fruit, or gibberellin may increase the number of cells when the spraying time coincides with the stage of differentiation that the fruit cells go through, which starts from kimri stage until the final stages of maturity, which leads to an increase in the number of cells and their sizes, then leads to an increasing in fruit weight which leads to increasing bunch weight. These results are in agreement with Ashour *et al.* (2018) on the Barhee date palm fruits [Al-Samaraie and Al-Falahy (2020)] on Braim date palm fruits.

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