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EFFECT OF SPRAYING DATE OF GIBBERELLIC ACID AND BORON ON SOME PHYSICAL CHARACTERISTICS OF PALM TREES CV. KHADHRAWI

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Abstract

A filed experiment was carried out in Palm orchard-Palm research station in Alza'afaraniah-Ministry of Agriculture during two seasonal growth 2018-2019 to evaluate the effect of spraying dates of Gibberellic acid and Boron on growth and yield quality of Palm trees *cv*. Khadhrawi, 54 of uniformed trees were selected and each tree were considered as an experimental unit. The experiment involved three factors, the first factor is the spraying at the beginning of the flowering stage and the beginning of the Kemiri stage in the first season 2018 and the beginning of Hababouk stage and Kemiri stage in the second season 2019, on the other hand, the second factor was the spraying of Gibberellic acid in three concentrations (0, 100, 200) mlg.L^{-1} and the third factor included spraying of Boron in three concentrations (0, 50, 100) mlg.L^{-1}. A factorial randomized complete block design (RCBD) in Split-plot system with three replicates was conducted in this experiment, the spraying was considered as the Main plots and the application of Gibberellic acid and Boron was the Sub-plots. Results revealed that the foliar application during flowering stage (S_1) in the first season and Hababouk stage (S_1) in the second season has decreased the fruits drop and the foliar spraying during Hababouk stage in the second season gave the highest value in fruit set, while there were no significant differences among the two stages in the rest of parameters. furthermore, the treatment G_2 has reduced the fruit drop percent and increased the fruit diameter and volume in comparison with G_0 for both seasons, the treatment B_2 has given the most significant value in reducing the fruit drop percentage and increasing the fruit setting percentage and the treatment B_1 gave the highest fruit length, diameter and volume compared to B_0 for two consecutive seasons.

Key words: Palm *cv*. Khadhrawi, Gibberellic acid, Boron, Hababouk, Kemiri.

Introduction

Date palm (*Phoenix dactylifera* L.) is one of the most important monocotyledoneae fruit trees that belong to Arecaceae family, It's one of the oldest trees known to humans, dating back more than 5000 years BC and was concerned by the Babylonians, Assyrians and was sacred to the Sumerians, Palm has a great economic importance in the world, especially in the Middle East and the Islamic community, which due to the fruit's nutrient and economic importance of this blessed tree, making it one of the main tributaries of the economy that contribute to national income (Al-khafaf *et al*., 1998 and Letouze *et al*., 1998). The plant growth, development and productivity increment are controlled by several factors, including fertilization which is playing the key role in regulating growth and plant development as well as improving the specifications of fruits, which is reflected positively on increasing yield and farms income. Palm trees need nutrients to be used in various biological processes, these nutritional requirements vary greatly at every stage of tree growth. It is noted that spraying palm trees with boron has an important role in increasing fruit set and quality through its effect on many functions within Plants such as plant hormones transition and increase the flowering set which is directly affect the growth of pollen tube in flowers, as well as its role in regulating cells membranes work, As well as its role in regulating the cell membranes work and the production of

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carbohydrates, proteins and phenols in addition to the transfer of sugars from places of producing to the areas of growth and storage (Cupta, 1979 and Atalla *et al*., 2007). EL-Mahdy *et al*., (2017) mentioned that the spraying of seaweed extract, boron and silicon in three phases (beginning of flowering, at setting and after 45 days of setting) on some of the growth, yield and qualitative characteristics of 15 years palm trees treated by the following concentrations seaweed extract 0.3% + boron 05% + silicon 0.1% had an increase in the setting ratio, fruit's length, diameter, size and weight. Omar *et al*., (2014) obtained the highest percentage of fruit setting and the highest increase in fruit length and diameter by spraying 10-year-old palm trees *cv*. Mnifi with boron at 1500 ppm before pollination and 4 weeks after pollination. Zean EL-Dean *et al*., (2017) mentioned in a study during the 2016-2017 seasons on palm trees 10-year *cv.* Barhi, that spraying the trees with borax at the concentration 4 gm.$^{-1}$ with pollen caused a significant increase in the setting percentage And fruit's length, diameter and weight. Gibberellin is one of the most important plant hormones (Phytohormones) naturally produced within plant tissues, there are more than 120 species of GAs, it has an important role in increasing the cells division and enlargement, It also plays a role in the physiological changes in the plant, as it contributes in reducing the chlorophyll destruction and increase the fruits size, weight and delay the ripening of the fruits and stimulate the production of enzymes (Dorcey *et al*., 2009) (Peter and stephen, 2012). Al-Janabi, (2006) showed that there was a significant decrease in fruit dropping for the khalal, rutab and tamar phases by the application of gibberellic acid at a concentration of 20 mg.L^{-1} on palm trees Baghdad strain *cv*. Prem. Ali and soliman, (2009) recorded the application of gibberellic acid (0, 50, 100, 150 ppm) on 30 years palm trees *cv*. Sakkoty after 50 years of flowering has positively increased the yield and fruit characters, especially the concentration of 100 ppm, which gave the highest fruit size for both seasons, the highest fruit length and diameter for the first season, while the concentration 150 ppm gave the highest fruit weight for both seasons respectively and the highest fruit length and fruit diameter in the second season. Kassem *et al*., (2011) recorded that the application of gibberellic acid 50 ppm on palm trees *cv*. Barhi during 2008-2009 season growth has increased the fruit weight and length in the 2008 season. Al-Qurash *et al*., (2012) found that the application of gibberellic acid on palm trees cv. Rotana and *cv*. ghur in the concentration 150 ppm has significantly decreased the fruit dropping in both seasons, while the concentration 100 ppm has increased the fruit weight, length and diameter for both seasons. Choudhary *et al*., (2018) mentioned that the foliar application of gibberellic acid (50, 100, 150, 200 ppm) on four cultivars of palm trees Barhi, Halawy, Khadhrawi and Zahdi that the concentration 200 ppm gave the highest values in fruit weight, length, diameter and volume. The research aimed to Study the effect of spraying with Gibberellic acid and boron and their interaction in improving the qualitative qualities of fruits and productivity, Determine the ideal date for the treatments and its effect on the physical and chemical characteristics of the fruits and Reduce the rate of fruit dropping by using Gibberellic acid.

Materials and Methods

The study was carried out during the growing season 2018-2019 in the palm orchard that belongs to palm research station in Zafaraniya-Ministry of Agriculture to study the effect of spraying date of gibberellic acid and boron on the growth and quality of palm fruits *cv.* Khadhrawi, in this study 54 uniformed trees were chosen over three replicates with nine experimental units, each experimental unit contained one palm tree. The irrigation, lowering, bunch removal and control of insects processes was conducted during the growth seasons. The experiment included three factors, the first was the foliar application in the beginning of flowering and Kemiri phases in 2018 season and the beginning of Hababuk and kemiri phases in 2019 season. The second factor was the foliar application of gibberellic acid in three concentrations (0, 100, 200) mlg.L^{-1} and the third factor was the foliar application of Boron in three concentrations (0, 50, 100) mlg.L^{-1} as it followed:

1. G_0B_0 0 mlg.L^{-1} GA_3 + 0 mlg.L^{-1} B.
2. G_0B_1 0 mlg.L^{-1} GA_3 + 50 mlg.L^{-1} B.
3. G_0B_2 0 mlg.L^{-1} GA_3 + 100 mlg.L^{-1} B.
4. G_1B_0 100 mlg.L^{-1} GA_3 + 0 mlg.L^{-1} B.
5. G_1B_1 100 mlg.L^{-1} GA_3 + 50 mlg.L^{-1} B
6. G_1B_2 100 mlg.L^{-1} GA_3 + 100 mlg.L^{-1} B.
7. G_2B_0 200 mlg.L^{-1} GA_3 + 0 mlg.L^{-1} B.
8. G_2B_1 200 mlg.L^{-1} GA_3 + 50 mlg.L^{-1} B
9. G_2B_2 200 mlg.L^{-1} GA_3 + 100 mlg.L^{-1} B.

The experiment was carried out according to split-plot design with three replicates and the treatments was randomly distributed using RCBD design. The foliar application was considered as the main plot, on the other hand, the Gibberellic acid and boron was considered as the sub plot. (AL-Sahuki and Wahib, 1990) the physical parameters for palm fruits was measured during the Khalal phase which were, the fruit dropping percent (%): measured by collecting 10 strands randomly from each

Table 1: Effect of Spraying Date of Gibberellic Acid and Boron on fruit dropping percent (%) for 2018 season.

Dates S	GA3	Boron			Interaction S × G	average S
		B_0	B_1	B_2		
Flowering S_1	G_0	31.18	18.84	17.43	22.48	20.43
	G_1	25.05	17.61	16.69	19.78	
	G_2	24.32	16.95	15.76	19.01	
Kemiri S_2	G_0	33.22	33.68	29.11	32.00	31.46
	G_1	33.85	30.69	33.58	32.71	
	G_2	31.39	29.53	28.09	29.67	
L.S.D 0.05			3.002		1.520	0.618
Interaction S × B	Flowering	26.85	17.80	16.63	**L.S.D 0.05**	
	Kemiri	32.82	31.30	30.26	1.520	
Interaction G × B	G_0	32.20	26.26	23.27	27.24	
	G_1	29.45	24.15	25.13	26.24	
	G_2	27.86	23.24	21.93	24.34	
	average B	29.84	24.55	23.44		
L.S.D 0.05						
G × B		B			G	
2.242		1.295			1.295	

Table 2: Effect of Spraying Date of Gibberellic Acid and Boron on fruit dropping percent (%) for 2019 season.

Dates S	GA3	Boron			Interaction S × G	average S
		B_0	B_1	B_2		
Hababouk S_1	G_0	47.22	32.05	25.63	34.97	24.32
	G_1	25.66	19.92	17.35	20.98	
	G_2	22.99	15.27	12.80	17.02	
Kemiri S_2	G_0	51.39	36.01	32.63	40.01	33.35
	G_1	33.85	29.69	28.56	30.70	
	G_2	31.56	29.40	27.09	29.35	
L.S.D 0.05			2.078		1.081	0.725
Interaction S × B	Hababouk	31.96	22.41	18.59	**L.S.D 0.05**	
	Kemiri	38.93	31.70	29.43	1.081	
Interaction G × B	G_0	49.31	34.03	29.13	37.49	
	G_1	29.79	24.80	22.96	25.84	
	G_2	27.28	22.34	19.95	23.19	
	average B	35.45	27.06	24.01		
L.S.D 0.05						
G × B		B			G	
1.540		0.889			0.889	

bunch and calculated according to the following equation:

$$\textit{Fruit dropping percent}\ (\%) = \frac{\text{empty scars number}}{\text{empty scars number} + \textit{fruits number}} * 100$$

Fruit setting percent: measured after a month of pollination by collecting 10 strands randomly from each bunch and calculated according to the following equation:

$$\textit{fruit setting percent}(\%) = \frac{\text{fruit setting number}}{\text{fruit setting number} + \textit{fruits number}} * 100$$

Fruit length and diameter (cm): measured by using Vernier, 20 fruits were taken randomly from each replicate. Fruit volume (cm^3) measured by calculating the amount of water displaced by immersion 20 fruits into a listed cylinder, the fruit volume founded by dividing the total volume of fruits by the number of fruits.

Results and Discussions

Fruit dropping percent (%)

Results in table 1 & 2, shows that the foliar spraying dates has a significant effect on the fruit dropping percent among the fertilization treatments, in the first season during the S_1 flowering stage, a significant reduction in fruit dropping was observed reached 20.43%, while the fruit dropping percent has increased during the S_2 stage foliar application and reached 20.34%. Also results shows a significant effect among the GA_3 concentrations for both seasons, in the first season the treatment G_2 gave the most significant value reached 24.34% followed by the treatment G_1 which gave 26.24%, while the treatment G_0 gave the lowest decrease value reached 27.24%. In the second season the fruit dropping percent has decreased by the treatment G_2 which recorded 23.19% in comparison to G_0 which gave 37.49%. The foliar application of boron at B_2 gave the most significant value in the first season reached 23.44% while the treatment B_0 gave the lowest decrease reached 29.84%, in the second season the treatment B_2 gave 24.01% while the treatment B_0 gave the highest value reached 35.45%. Also results revealed that the foliar application of GA_3 during the flowering and Kemiri phases of the first season has a significant effect in the studied parameter, the interaction S_1G_2 gave the highest decrease reached 19.01%, while the interaction S_2G_1 has increased the fruit dropping 32.71%, in the second season the treatment S_1G_2 gave the highest decrease reached 17.02% while the interaction S_2G_0 has raised the fruit dropping to 40.01%. Also the foliar application of Boron in the flowering and kemiri phases has decreased the fruit dropping at the interaction S_1B_2 to 16.63% in comparison with S_2B_0 which gave 32.82%, the second season shows a similar results in the studied parameter, the application of the treatment S_1B_2 gave

Table 3: Effect of Spraying Date of Gibberellic Acid and Boron on fruit setting percent (%) for 2018 season.

Dates S	GA3	Boron			Interaction S × G	average S
		B_0	B_1	B_2		
Flowering S_1	G_0	68.82	83.05	84.24	78.70	64.28
	G_1	51.47	61.42	64.31	59.07	
	G_2	47.15	58.30	59.80	55.08	
Kemiri S_2	G_0	66.78	68.61	68.70	68.03	68.67
	G_1	66.32	70.47	67.18	67.99	
	G_2	69.31	70.89	69.74	69.98	
L.S.D 0.05			3.002		1.520	0.618
Interaction S × B	Flowering	55.81	67.59	69.45	**L.S.D 0.05**	
	Kemiri	67.47	69.99	68.54	1.520	
Interaction G × B	G_0	67.80	75.83	76.47	73.37	
	G_1	58.90	65.95	65.75	63.53	
	G_2	58.23	64.60	64.77	62.53	
	average B	361.64	68.79	69.00		
L.S.D 0.05						
G × B			B		G	
2.242			1.295		1.295	

Table 4: Effect of Spraying Date of Gibberellic Acid and Boron on fruit setting percent (%) for 2019 season.

Dates S	GA3	Boron			Interaction S × G	average S
		B_0	B_1	B_2		
Hababouk S_1	G_0	72.82	72.83	76.65	74.18	75.64
	G_1	73.28	74.99	76.65	74.97	
	G_2	74.34	79.05	79.90	77.76	
Kemiri S_2	G_0	72.12	68.66	74.23	71.67	70.58
	G_1	66.15	69.31	70.76	68.74	
	G_2	68.61	71.47	73.91	71.33	
L.S.D 0.05			4.097		2.605	3.182
Interaction S × B	Hababouk	73.48	75.62	77.82	**L.S.D 0.05**	
	Kemiri	68.96	69.81	72.96	2.605	
Interaction G × B	G_0	72.47	70.74	75.56	72.93	
	G_1	69.72	72.15	73.70	71.86	
	G_2	71.48	75.26	76.91	74.55	
	average B	71.22	72.72	75.39		
L.S.D 0.05						
G × B			B		G	
2.852			1.647		1.647	

the most significant value reached 18.59% in comparison with S_2B_0 which recorded 38.93%. The interaction between GA_3 and Boron gave a significant values in both seasons, the treatment G_2B_2 gave the highest decrease values reached (21.93, 19.95)% respectively, while the treatment G_0B_0 gave the highest fruit dropping reached (32.20, 49.31)% in both seasons respectively. The interaction between spraying dates and fertilization at the treatment $S_1G_2B_2$ gave the lowest fruit dropping value reached (15.76, 12.80)% for both seasons respectively, while the interaction $S_2G_1B_0$ has increased the fruit dropping to 33.85% for the first season and the treatment $S_2G_0B_0$ gave 51.39% in the second season.

Fruit setting percent (%)

Results in table 3 & 4, revealed a significant differences among the spraying dates, the treatment S_2 gave the highest value reached 68.67% in comparison with S_1 which gave the lowest value reached 64.28% in the first season. In the second season, the treatment S_1 gave the highest value reached 75.64% while the treatment S_2 recorded the lowest value reached 70.58%. Also the foliar application of GA_3 at G_0 gave the most significant value 73.37%, followed by G_1 63.53% and the lowest was G_2 62.53%, In the second season the treatment G_2 gave the highest value in fruit setting reached 74.55% in comparison to G_1 which gave 71.86%. The foliar spraying of Boron the treatment B_2 gave the highest value in the studied parameter reached (69.00, 75.39)% for both seasons respectively, while the treatment B_0 gave the lowest value reached (62.64, 71.22)% for both seasons respectively. Also results revealed a significant effect by the foliar application of GA_3 during the flowering and kemiri phases in the first season at the treatment S_1G_0 which gave the highest value reached 78.80% while the treatment S_1G_2 has the lowest value reached 55.08%, in the second season it was noticed that the treatment S_1G_2 recorded the highest value reached 77.76% in comparison with S_2G_1 which gave the lowest value reached 68.74%. The interaction between spraying dates and Boron at S_2B_1 gave the highest value reached 69.99% while the treatment S_1B_0 gave the lowest value reached 55.81% in the first season, while in the second season the treatment S_1B_2 gave the highest value reached 77.82% in comparison with S_2B_0 which recorded the lowest value reached 68.96%. The interaction between GA_3 and Boron gave the most significant values at the treatment G_0B_2 reached 76.47% in comparison with G_2B_0 which gave 76.91% followed by G_0B_2 which gave 75.56%. The

Table 5: Effect of Spraying Date of Gibberellic Acid and Boron on fruit length (cm) for 2018 season.

Dates S	GA3	Boron			Interaction S × G	average S
		B_0	B_1	B_2		
Flowering S_1	G_0	3.33	3.60	3.08	3.34	3.33
	G_1	3.01	3.45	3.41	3.29	
	G_2	3.47	3.45	3.17	3.36	
Kemiri S_2	G_0	3.23	3.49	3.05	3.26	3.65
	G_1	3.59	4.04	4.02	3.88	
	G_2	3.51	4.18	3.69	3.79	
L.S.D 0.05		0.321			0.161	0.049
Interaction S × B	Flowering	3.27	3.50	3.22	**L.S.D 0.05**	
	Kemiri	3.44	3.90	3.59	0.161	
Interaction G × B	G_0	3.28	3.55	3.07	3.30	
	G_1	3.30	3.75	3.71	3.59	
	G_2	3.49	3.82	3.43	3.58	
	average B	3.36	3.70	3.40		
L.S.D 0.05						
G × B		B			G	
0.240		0.139			0.139	

Table 6: Effect of Spraying Date of Gibberellic Acid and Boron on fruit length (cm) for 2019 season.

Dates S	GA3	Boron			Interaction S × G	average S
		B_0	B_1	B_2		
Hababouk S_1	G_0	3.13	3.37	3.22	3.24	3.42
	G_1	3.11	3.65	3.69	3.48	
	G_2	3.17	3.67	3.78	3.54	
Kemiri S_2	G_0	3.06	3.24	3.29	3.19	3.55
	G_1	3.17	4.04	3.68	3.63	
	G_2	3.36	4.17	3.94	3.82	
L.S.D 0.05		0.211			0.122	NS
Interaction S × B	Hababouk	3.14	3.56	3.57	**L.S.D 0.05**	
	Kemiri	3.20	3.82	3.64	0.122	
Interaction G × B	G_0	3.09	3.31	3.26	3.22	
	G_1	3.14	3.85	3.69	3.56	
	G_2	3.27	3.92	3.86	3.68	
	average B	3.17	3.69	3.60		
L.S.D 0.05						
G × B		B			G	
0.151		0.087			0.087	

triple interaction in the first season gave a significant differences in fruit setting at the treatment $S_2G_0B_2$ reached 84.24% while the treatment $S_1G_2B_0$ gave the lowest value reached 47.15%, in the second season the treatment $S_1G_2B_2$ gave the highest value reached 79.90% while the treatment $S_2G_1B_0$ gave the lowest value reached 66.15%.

Fruit length (cm)

Results in table 5 & 6, revealed a significant effect among the spraying dates, it was noticed that the foliar application of during kemiri stage S_2 reached 3.65 cm while the fruit length was decreased during flowering stage to 3.33 cm, in the second season the foliar spraying dates hasn't given a significant difference. The foliar application of GA_3 at G_1 gave highest value reached 3.59 cm which is not significantly differs from G_2 which gave 3.58 cm, in the second season the treatment G_2 gave the highest value in fruit length reached 3.68 cm in comparison with G_0 which gave the lowest values (3.30, 3.22) cm in both seasons respectively. The foliar application of Boron at the treatment B1 gave the most significant value reached (3.70, 3.69) cm for both seasons respectively, while the treatment B0 gave the lowest value in both seasons reached (3.36, 3.17) cm respectively. Also the interaction treatments between GA_3 and spraying dates at S_2G_1 gave the most significant value reached 3.88 cm in the first season while the treatment S_2G_2 gave the highest value in the second season reached 3.82 cm in comparison with S_0G_0 which gave the lowest values in both seasons reached (3.26, 3.19) cm respectively. The interaction between boron and spraying dates gave a significant value at S_2B_1 reached (30.90, 3.82) cm in both seasons respectively, while the lowest values given by the treatments S_1B_2 in the first season and S_1B_0 in the second season reached (3.22, 3.14) cm respectively. Also the interaction between GA_3 and boron has a significantly increased the fruit length at the treatment G_2B_1 which gave the highest values in both seasons reached (3.82, 3.92) cm respectively, while the lowest values given by G_0B_2 in the first season and G_0B_0 in the second season reached (3.07, 3.09) cm respectively. The triple interaction at the treatment $S_2G_2B_1$ gave the most significant values in both seasons reached (4.17, 4.18) cm respectively, while the treatments $S_1G_1B_0$ gave the lowest value in the first season reached 3.01 cm and the treatment $S_2G_0B_0$ at the second season reached 3.06 cm.

Table 7: Effect of Spraying Date of Gibberellic Acid and Boron on fruit diameter (cm) for 2018 season.

Dates S	GA3	Boron			Interaction S × G	average S
		B_0	B_1	B_2		
Flowering S_1	G_0	1.60	1.73	1.79	1.71	1.71
	G_1	1.63	1.74	1.69	1.69	
	G_2	1.68	1.79	1.71	1.73	
Kemiri S_2	G_0	1.65	1.77	1.69	1.70	1.82
	G_1	1.77	1.85	1.76	1.79	
	G_2	1.85	2.12	1.91	1.96	
L.S.D 0.05		0.209			0.145	NS
Interaction S × B	Flowering	1.64	1.75	1.73	**L.S.D 0.05**	
	Kemiri	1.76	1.91	1.79	0.145	
Interaction G × B	G_0	1.63	1.75	1.74	1.71	
	G_1	1.70	1.80	1.73	1.74	
	G_2	1.77	1.96	1.81	1.77	
	average B	1.70	1.84	1.76		
L.S.D 0.05						
G × B		B			G	
0.141		0.082			NS	

Table 8: Effect of Spraying Date of Gibberellic Acid and Boron on fruit diameter (cm) for 2019 season.

Dates S	GA3	Boron			Interaction S × G	average S
		B_0	B_1	B_2		
Hababouk S_1	G_0	1.56	1.78	1.70	1.68	1.68
	G_1	1.47	1.81	1.73	1.67	
	G_2	1.58	1.75	1.76	1.70	
Kemiri S_2	G_0	1.64	1.70	1.79	1.71	1.76
	G_1	1.60	1.82	1.74	1.72	
	G_2	1.73	1.97	1.83	1.85	
L.S.D 0.05		0.197			0.156	NS
Interaction S × B	Hababouk	1.54	1.78	1.73	**L.S.D 0.05**	
	Kemiri	1.66	1.83	1.79	0.156	
Interaction G × B	G_0	1.60	1.74	1.75	1.70	
	G_1	1.53	1.81	1.73	1.69	
	G_2	1.66	1.86	1.80	1.77	
	average B	1.60	1.81	1.76		
L.S.D 0.05						
G × B		B			G	
0.124		0.072			0.072	

Fruit diameter (cm)

Results in table 7 & 8, revealed that the spraying date hasn't a significant effect on fruit diameter in both seasons, Also the foliar application of GA_3 has no significant effect on the studied parameter in the first season, while the concentration G_2 gave the most significant value in the second season reached 1.77 cm in comparison with G_1 and G_0 which gave (1.69, 1.70) cm respectively. The foliar application of boron at the treatment B_1 gave the highest value reached (1.84, 1.181) cm in both seasons respectively, in comparison with B_0 which gave the lowest values reached (1.70, 1.60) cm respectively. Also results revealed a significant effect of the interaction between spraying dates and GA_3 at S_2G_2 reached (1.96, 1.85) cm in both seasons respectively, in comparison with S_1G_1 which gave the lowest values reached (1.69, 1.67) cm respectively. Also the interaction between spraying dates and boron at S_2B_1 gave the highest values reached (1.91, 1.83) cm in both seasons respectively, while the treatment S_1B_0 gave the lowest values reached (1.64, 1.54) cm respectively. The interaction between GA_3 and boron at G_2B_1 gave the highest values in both seasons reached (1.86, 1.96) cm respectively, while the interaction G_0B_0 gave the lowest value in the first season reached 1.93 cm and G_1B_0 1.53 cm in the second season. The interaction between spraying dates, GA_3 and boron at $S_2G_2B_1$ gave the most significant values in both seasons reached (2.12, 1.97) cm respectively, while the interaction $S_1G_0B_0$ gave the lowest value in the first season reached 1.60 cm and $S_1G_1B_0$ in the second season reached 1.47 cm.

Fruit volume (cm^3)

Results revealed that the spraying dates has a significant effect in the first season at S_2 reached 7.90 cm^3 in comparison with S_1 which gave the lowest value reached 6.77 cm^3, while in the second season it noticed that there is no significant effect among the spraying dates. Also the foliar application of GA_3 at G_2 has significantly increased the fruit volume reached (7.56, 7.41) cm^3 in both seasons respectively, in comparison with G_0 which gave the lowest values in both seasons reached (6.71, 6.17) cm^3 respectively. The foliar application of boron at B_1 gave the most significant values in both seasons reached (7.98, 7.84) cm^3 respectively, while the treatment B_0 gave the lowest values in both seasons reached (60.06, 60.63) cm^3 respectively. Also result shows that the interaction between spraying dates and GA_3 at S_2G_1 gave the highest value in the first season

Table 9: Effect of Spraying Date of Gibberellic Acid and Boron on fruit volume (cm^3) for 2018 season.

Dates S	GA3	Boron			Interaction S × G	average S
		B_0	B_1	B_2		
Flowering S_1	G_0	5.67	6.03	7.53	6.41	6.77
	G_1	6.10	7.50	6.47	6.69	
	G_2	7.10	7.87	6.70	7.22	
Kemiri S_2	G_0	6.07	7.23	7.70	7.00	7.90
	G_1	7.53	8.77	9.00	8.43	
	G_2	7.30	9.63	7.90	8.28	
L.S.D 0.05		0.914			0.633	0.816
Interaction S × B	Flowering	6.29	7.13	6.90	**L.S.D 0.05**	
	Kemiri	6.97	8.84	8.20	0.633	
Interaction G × B	G_0	5.87	6.63	7.62	6.71	
	G_1	6.82	8.13	7.73	7.56	
	G_2	7.20	8.75	7.30	7.75	
	average B	6.63	7.84	7.55		
L.S.D 0.05						
G × B		B			G	
0.615		0.355			0.355	

Table 10: Effect of Spraying Date of Gibberellic Acid and Boron on fruit volume (cm^3) for 2019 season.

Dates S	GA3	Boron			Interaction S × G	average S
		B_0	B_1	B_2		
Hababouk S_1	G_0	5.93	6.77	6.33	6.34	6.99
	G_1	5.80	7.40	7.87	7.02	
	G_2	6.13	8.07	8.57	7.59	
Kemiri S_2	G_0	5.57	6.00	6.43	6.00	7.45
	G_1	6.23	9.40	7.77	7.80	
	G_2	6.67	10.23	8.73	8.54	
L.S.D 0.05		1.028			0.703	NS
Interaction S × B	Hababouk	5.96	7.41	7.59	**L.S.D 0.05**	
	Kemiri	6.16	8.54	7.64	0.703	
Interaction G × B	G_0	5.75	6.38	6.38	6.17	
	G_1	6.02	8.40	7.82	7.41	
	G_2	6.40	9.15	8.65	8.07	
	average B	6.06	7.98	7.62		
L.S.D 0.05						
G × B		B			G	
0.696		0.402			0.402	

reached 8.43 cm^3 while the treatment S_1G_0 gave the lowest value reached 6.41 cm^3, in the second season the treatment S_2G_2 gave the highest value reached 8.54 cm^3 in comparison with S_2G_0 which gave 6.00 cm^3. The interaction between boron and spraying dates at the treatment S_2B_1 gave the highest values in the first season reached (8.84, 8.54) cm^3 respectively, while the treatment S_1B_0 gave the lowest value in the second season reached (6.29, 5.96) cm^3 respectively. Also the interaction between GA_3 and boron at the treatment G_2B_1 gave the highest values reached (8.75, 9.15) cm^3 respectively in the first season, while the treatment G_0B_0 gave the lowest value in the second season reached (5.87, 5.75) cm^3 respectively. The interaction between spraying dates. GA_3 and boron at $S_2G_2B_1$ gave the highest values in the first season reached (9.63, 10.23) cm^3 respectively, while lowest values given by the treatment $S_1G_0B_0$ in the first season and the treatment $S_2G_0B_0$ in the second season reached (5.67, 5.57) cm^3 respectively.

The decrease in fruit dropping percent and the increase in fruit setting as a result of the foliar spraying of boron maybe due to the role of boron in pollination process through its effect on growth and elongation of pollen tube, as well as its role in the transfer of sugars to the active sites such as flowers during the setting process (Barker and pilbeam, 2007; Meena, 2010). A study showed that boron had a positive effect on increasing fruit length, diameter and volume, that maybe due to its role in regulating the pollination and fertilization processes, as well as the fruit setting, then increase cells number and enlargement by doing a certain role in transferring the sugars and regulating the water relations (Meena, 2010). These results are in agreement with Dawood *et al.,* (2010) and Khrbeet and Alisawi, (2011) and Omar *et al.,* (2014) and Zean El-Dean *et al.,* (2017) who obtained a significant effect in fruit setting by the foliar application of boron on palm trees. Also the foliar application of GA_3 has a significant effect on fruit length, diameter and volume, This may be attributed to the role of gibberellic acid in increasing cell elongation and the cell walls elasticity and permeability, which contributes to increase the amount of water and nutrients entering the cells and make it swell and enlarge (Mohammed and Reis, 1990 and Abu Zaid, 2000). These results are in agreement with AL-Ani *et al.,* (2008) and Ali and Soliman, (2009) and Al-Qurash *et al.,* (2012).

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