



Applications of Calcium Boron or Potassium Phosphite Combined with Different Fruit Thinning Styles to Enhance Fruit Quality of Barhee date palm

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Abstract

This study was carried out on a 6-year-old Barhee date palm during 2019-2020 seasons under Bahriya oasis conditions. It was aimed to study the effect of different treatments on fruit characteristics. Different thinning styles were removing 1/3 strand length of bunch (SLB), removing 1/3 central strands of bunch (CSB), removing 1/3 of total bunches number (TB) and control (without thinning). Thinning styles were divided to three groups. The first group was sprayed with 0.25% calcium boron (CaB), the second group was sprayed with 0.2% potassium phosphite (KP) and the third group was sprayed with tap water. Spraying treatments were applied once after fruit set or at kimri stage, or at khalal stage. The results indicated that, spraying CaB and KP with thinning style CSB improved fruit physical and chemical properties. Moreover, spraying after fruit set stage improved fruit weight, length, diameter and fruit size, while spraying at Kimri stage improved fruit chemical properties. The interaction between treatments of thinning style and spraying substances and spraying stages cleared that CSB thinning style with spraying CaB at fruit set stage increased fruit weight, size, as well as total and reducing sugar in both seasons.

Keywords: *Phoenix dactylifera*; Fruit quality; Nutrients; Thinning

1. Introduction

Date palm (*Phoenix dactylifera* L.) belonging to family Arecaceae is the most important subsistence crop in arid and semi-arid regions [1]. It is considered the most suitable fruit tree under global warming and climate changes conditions. The total production of dates in Egypt is 1.68 million tons, which represents 15.1% of the global production of date fruit [2]. The low fruit quality is one of the most important obstacles facing many palm-producing countries, especially that obtained by tissue culture methods. It is mostly absorbed by the local market at low prices [3]. Date palm cultivars had a wide range differences in their bunch and strand characteristics. So, the thinning methods should be carried out according to cultivar, nutrition statuses and growing region.

Fruit thinning practice is an important cultural and management approach in date palm production to improve fruit quality (size, weight, length of fruits) and reduce the chances of alternate bearing and bunches breaking. Several techniques have been used to thin date palm fruits including bunch, strand and fruit thinning [4]. It was stated that date palm cultivars had a wide differences in their bunch and strand characteristics [5]. Also, they concluded that, thinning methods should be carried out according to cultivar and site. Ahmed et al.[6] reported that thinning the 1/3 terminal tips of central strands of 'Zaghloul' CV. in early Kimri stage increased total soluble solid (TSS%). However, reducing 5 to 10 cm of 'Barhee' CV. Bunch length four weeks after pollination did not affect fruit

quality [7].

Several studies revealed the importance of micro and macro nutrients application for improving the quality and yield of date palm fruits [8,9] Potassium is a quality element involved in quality-related properties of fruit [6] It regulates transport of photosynthetic products and enzyme activation [10]. Application of 1, 2% potassium sulfate at Khalal stae for 'Shahany' date palm increased fruit length, diameter, TSS% and yield [11]. Also, application of phosphorous at 125, 250 mg in March and 45 days later to 'Shukar' dates increased fruit weight, length, diameters, TSS% and yield [12]. Calcium inhibits fruit abscission and delays fruit senescence development [13]. It increases fruit firmness [14]. Boron enhancing fruit quality in Barhee [15], altering the translocation and concentration of nutrients [16].

Therefore, the aim of this study is to explain the effects of calcium born and potassium phosphate at different fruit growth stages under different thinning style on Barhee fruit quality.

2. Material and methods

This experiment was conducted during 2019 and 2020 seasons on 6-years-old Barhee palm, which were propagated from tissue culture. Barhee palms were in the fourth year of production and grown under Bahariya Oasis Giza, Egypt. (Bahariya Oasis is located between latitudes 31° and 31.5°, and longitudes 28.3 and 29.1°). One hundred and eight Barhee palms were selected. The number of bunches has been standardized to 12 bunches for each

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palm. The orchard soil was sandy and irrigated using a drip irrigation system. Annually agricultural practices were carried out on the all tested date palms [17]. Pollination was done manually using Ghanami pollens source [18] during the first week of April in both seasons.

Calcium boron (trade name Set- calcium at a concentration of 11.4% and boron at a concentration of 0.7%) and potassium phosphite (trade name Phitason-at a concentration of 0-20-30) were purchased from the two companies, Misr Holland for Investment and Agricultural Development and Agro Gibson Company, respectively.

Experimental procedure

All palm trees under study were exposed to the following treatments.

- Control: palms were left without thinning which bearing 12 bunches per palm.
- Removing 1/3 strands length of bunch (SLB)
- Removing 1/3 central strands of bunches (CSB)
- Removing 1/3 of total bunches number (TB), 8 bunches per palm.

The fruit thinning treatments were carried out after fruit set immediately at the third week of April. Removing 1/3 central strands of bunches (CSB) carried out by counting total strands per bunch, then a third of the total number was removed from the bunch center.

The integrated spraying substance either 0.25% calcium boron (CaB) or 0.2% potassium phosphite (KP) as well as control (tap water) ones were applied with each group of thinning styles on palms after fruit thinning as follows:-

- Spraying after fruit set during second week of April.
- Spraying at kimri stage during mid of June.
- Spraying at beginning of khalal stage during first week of August. Each as aforementioned (36 treatments) contained three replicates as on palm for each replicate.

Measurements

Barhee fruit were harvested at maturity stage [19] Fruit samples of each replicate for each treatment were randomly taken in the second half of august to assess the fruit characteristics as follows :

a. Fruit Physical Quality Parameters

Ten fruits sample were taken at harvest to measure fruit weight (g) with a digital balance. Fruit diameter and length (mm) were measured using a digital caliper. Fruit size (cm³) was measured with standard graduated cylinder.

b. Fruit chemical Quality Parameters

Fruit total soluble solids (TSS %) were estimated by a digital refractometers (DBR95,Taiwan) according to A.O.A.C. [20] moisture content % was determined by drying fruit samples in a vacuum oven at 70°C until it reach consistent weight [20]. Total sugars, reducing and non-reducing sugars % were determined using the Smogy method [20].

c. Statistical analysis

The experimental work was arranged as a Randomize Complete Block Design (RCBD). It was consisted of three factors which were thinning style as factor (1), spraying time as factor (2) and spraying substances as factor (3). Significance of differences among treatments means were judged using Duncan multiple range test [21] at the 5% level of probability according to Snedecor and Cochran [22].

3. Results and Discussion

Fruit weight

Data in table1.referred that with regard to effect of thinning style, removing 1/3 of the central strands of

bunches (CSB) increased fruit weight with significant values in the first season.

Regard to the effect of spraying stage it can be observed that, either spraying after fruit set or at kimri stage increased fruit weight significantly compared to spraying at khalal stage in both seasons. Concerning the effect of spraying substances it can be noticed that, both CB and KP significantly increased fruit weight compared to the control spraying in both season.

With respect to the interaction effect (thinning style X spraying stages X spraying substances) it can be observed that spraying after fruit set either with KP combined removing of the 1/3 central strands of bunches (CSB) with KP or combined with removing 1/3 strand length of bunch (SLB).

Harhash et al.[23] Found that 2%K-citrate+0.2% boric acid increased “Khalas” fruit weight by 53.64 and 56.66%. Also, thinning 1/3 of terminal tips of central strands and thinning 1/3 of total strands from terminal tips increased “Ruzeiz” fruit weight [24].

Fruit length

With regard to effect of thinning style, it can be found that removing either 1/3 central strands of bunches (CSB) or 1/3 strand length of bunch (SLB) increased fruit length significantly compared to removing 1/3 total bunches / number – (TB) in both seasons.

Regard to the effect of spraying time, it can be observed that, spraying after fruit set increased fruit length in both seasons compared to the other two spraying stages (kimri and khalal).

Concerning the effect of spraying substances it can be noticed that, both CaB and KP significantly increased fruit length compared to the control treatment in both season.

With respect to the interaction effect (thinning style X spraying time X spraying substances) it can observed that removing 1/3 strand length of bunch (SLB) combined with CaB spraying at the fruit set stage increased fruit length followed by removing 1/3 central strands of bunches (CSB) combined with KP spraying at kimri stage.

These results were in line with Mohamed [25] who found that spraying “Samany” and “Zaghloul” date palm cv. with 5% calcium carbonate significantly increased fruit length. Also, spraying “Khalas” date palm cv. with 2% K-Citrate + 0.2 %Boric acid recorded the highest fruit length [23].Also, Radwan [26] noticed that 30% thinning of the number of bunches of “Bint Aisha” and “Al-Siwi” cv. increased fruit length.

Fruit Diameter

With regard to effect of thinning style in table 3, it can be found that removing 1/3 strand length of bunch (SLB) increased fruit diameter compared to another thinning styles (CSB or TB) in both seasons. Regard to the effect of spraying time , it can be observed that, spraying after fruit set increased fruit diameter in both seasons compared to the other two spraying stages (kimri and khalal) . Concerning the effect of spraying substances it can be noticed that, both CaB and KP significantly increased fruit length compared to the control spraying in both season. With respect to the interaction effect (thinning style X spraying time X spraying substances) it can observed that removing 1/3 strand length of bunch (SLB) combined with CaB spraying at the fruit set stage increased fruit diameter in both seasons.

These results go in line with [26] who noticed that 30% thinning of bunches number increased fruit diameter of “Bint Aisha” and “Al-Siwi” CV. Also, spraying

“Khalas” date palm cv. with potassium citrate and boric acid increased fruit diameter [23].

Fruit size

With regard to effect of thinning style, according to the data in table 4, removing of the 1/3 central strands of bunches (CSB) increased fruit size in both season with a significant values in the first season.

Regard to the effect of spraying time, it can be observed that, spraying after fruit set increased fruit size in both seasons compared to the other two stages.

Concerning the effect of spraying substances it can be noticed that, both CaB and KP significantly increased fruit size compared to the control spraying in both season (Kimiri and Khalal). With respect to the interaction effect (thinning style X spraying time X spraying substances) it can be observed that removing either 1/3 central strands of bunches (CSB) and removing or 1/3 strand length of bunch (SLB) which sprayed by CaB at the fruit set stage increased fruit length comparing with other interaction in both seasons.

The previous findings were observed by Harhash and Abdel-Nasser [23], as they found that, Spraying “Khalas” date palm cv. with potassium or boron improved fruit volume significantly. Also, Elsabagh[27] found that, spraying H_3BO_3 at 1500 and 1000 ppm and $ZnSO_4$ at 250 and 500 ppm during Kimiri stage significantly increased “Deglet Nour” fruit size. Moreover, thinning 30% of the number of bunches of “Khadrawi” cv. increased fruit size [28].

TSS content of Barhee date fruit

Table 5 showed that, effect of thinning style, it can be found that removing 1/3 central strands of bunches (CSB) increased fruit TSS content significantly in both seasons followed by removing 1/3 total bunches / number –(TB).

Regard to the effect of spraying stage it can be observed that, spraying at kimiri stage increased fruit TSS content with a significant value in the second season.

Concerning the effect of spraying substances it can be noticed that, KP significantly increased fruit

Table 1. Effect of different thinning style and spraying substances at different fruit growth stages on fruit weight (g) of Barhee.

Spraying stages	Spraying calcium born(CaB) or Potassium phosphate(KP)	Thinning				Mean
		Removing 1/3 strands length of bunch(SLB)	Removing 1/3 central strands of bunches(CSB)	Removing 1/3 total bunches number(TB)	Control without thinning	
1 st season						
Fruit Set	Control	14.28 h-j	14.95 f-j	12.83 k	13.70 jk	13.94 d
	0.25%CaB	15.73 d-g	15.37 e-i	15.63 d-h	14.80 f-j	15.38bc
	0.2%KP	14.77 f-j	16.87 a-d	16.10 b-f	16.50 a-e	16.06bc
Mean		14.93 b-d	15.73 ab	14.86 cd	15.00 b-d	15.13 a
Kimiri	Control	14.28 h-j	14.95 f-j	12.83 k	13.70 jk	13.94 d
	0.25%CaB	15.57 d-i	17.23 a-c	17.50 a	14.37 g-j	16.17 a
	0.2%KP	14.73 f-j	14.93 f-j	15.23 ei	15.93 b-f	15.21 c
Mean		14.86 cd	15.71 ab	15.19 bc	14.67 cd	15.11 a
Khalal	Control	14.28 h-j	14.95 f-j	12.83 k	13.70 jk	13.94 d
	0.25%CaB	14.97 f-j	17.30 ab	10.77 l	15.87 c-f	14.73 c
	0.2%KP	13.60 jk	16.80 a-d	14.23 i-j	15.67 d-h	15.08 c
Mean		14.28 d	16.35 a	12.61 e	15.08 b-d	14.58 b
Control	Control	14.28 de	14.95 cd	12.83 f	13.70 e	13.94 b
	0.25%CaB	15.42 bc	16.63 a	14.63 cd	15.01 cd	15.42 a
	0.2%KP	14.37 de	16.20 ab	15.19 c	16.03 ab	15.45 a
Mean		14.69 b	15.93 a	14.22 c	14.91 b	
2 nd Season						
Fruit Set	Control	14.82 fg	14.82 fg	14.82 fg	15.24 ef	14.93 c
	0.25%CaB	19.54 a	18.64 ab	17.64 bc	17.43 bc	18.31 a
	0.2%KP	17.54 bc	17.33 bc	14.89 fg	17.27 bc	16.76 b
Mean		17.30 a	16.93 a	15.79 c	16.65 ab	16.67 a
Kimiri	Control	15.24 ef	15.24 ef	14.43 fg	14.43 fg	14.84 c
	0.25%CaB	16.92 c	14.79 fg	16.49 c-e	17.44 bc	16.41 b
	0.2%KP	13.83 g	17.69 bc	16.47 c-e	16.40 c-e	16.10bc
Mean		15.33 cd	15.91 bc	15.80 c	16.09 bc	15.78 a
Khalal	Control	14.43 fg	14.46 fg	14.46 fg	14.46 fg	14.45 c
	0.25%CaB	14.82 fg	15.26 ef	15.43 d-f	16.50 c-e	15.50 c
	0.2%KP	14.81 fg	17.07 c	16.75 cd	16.76 cd	16.35bc
Mean		14.69 d	15.60 c	15.55 c	15.91 bc	15.43 b
Control	Control	14.82 fg	15.24 ef	14.43 g	14.46 fg	14.74 b
	0.25%CaB	18.61 a	16.38 b-d	16.25 b-d	15.73 de	16.74 a
	0.2%KP	16.59 bc	16.26 b-d	15.90 ce	16.86 b	16.40 a
Mean		16.67 a	15.96 b	15.52 b	15.68 b	

Table 2. Effect of different thinning style and spraying substances at different fruit growth stages on fruit length (mm) of Barhee.

Spraying stages	Spraying calcium born(CaB) or Potassium phosphate(KP)	Thinning				Mean
		Removing of 1/3 of strands length of bunch(SLB)	Removing of 1/3 of central strands of bunches(CSB)	Removing of 1/3 of total bunches number(TB)	Control without thinning	
1st season						
Fruit Set	Control	31.50 il	34.03 dh	31.98 gl	33.32 ej	32.71 c
	0.25%CaB	35.27 ae	32.87 fk	33.74 ci	33.21 ek	33.77 ac
	0.2%KP	33.24 ek	34.22 bh	34.86 af	35.85 ac	34.54 ab
Mean		33.34 bc	33.71 bc	33.53 bc	34.13 ab	33.67 a
Kimir	Control	31.50 il	34.03 dh	31.98 gl	33.32 ej	32.71 c
	0.25%CaB	30.99 kl	36.61 a	34.11 dh	31.96 hl	33.42 bc
	0.2%KP	35.65 ad	34.83 af	34.26 bg	34.71 af	34.86 a
Mean		32.71 c	35.16 a	33.45 bc	33.33 bc	33.66 a
Khalal	Control	31.50 il	34.03 dh	31.98 gl	33.32 ej	32.71 c
	0.25%CaB	35.30 ae	36.19 ab	30.52 l	34.25 bg	34.07 ab
	0.2%KP	33.46 dj	35.19 ae	31.37 jl	33.60 cj	33.41 bc
Mean		33.42 bc	35.14 a	31.29 d	33.72 bc	33.39 a
Control		31.50 e	34.03 ac	31.98 ef	33.32 cd	32.71 b
0.25%CaB		33.85 bd	35.22 a	32.79 df	33.14 ce	33.75 a
0.2%KP		34.12 ac	34.75ab	33.50 bd	34.72 ab	34.27 a
Mean		33.16 bc	34.67 a	32.76 c	33.73 b	
2nd Season						
Fruit Set	Control	33.20 cf	33.20 cf	33.20 cf	32.81 ef	33.10 d
	0.25%CaB	36.11 a	34.83 ad	35.02 ac	34.55 ae	35.13 a
	0.2%KP	35.25 ab	34.83 ad	32.99 df	34.69 ae	34.44 ab
Mean		34.85 a	34.29 ab	33.74 ad	34.02 ac	34.22 a
Kimir	Control	32.81 ef	32.81 ef	32.11 f	32.11 f	32.46 d
	0.25%CaB	33.05 df	32.88 ef	34.48 ae	34.44 ae	33.71 cd
	0.2%KP	33.05 df	34.46 ae	35.38 ac	34.44 ae	34.33ac
Mean		32.97 cd	33.38 bd	33.99 ac	33.67 bd	33.50 b
Khalal	Control	32.11 f	34.13 be	34.13 be	34.13 be	33.63 cd
	0.25%CaB	32.95 df	33.76 bf	34.32 ae	34.39 ae	33.86 cd
	0.2%KP	33.04 df	34.13 be	34.32 ae	34.32 ae	33.95 bd
Mean		32.70 d	34.01 ac	34.26 ab	34.28 ab	33.81 ab
Control		33.20 ce	32.81 de	32.11 e	34.13 bc	33.06 b
0.25%CaB		35.32 a	33.49 bd	33.96 bc	34.16 bc	34.23 a
0.2%KP		34.36 ab	34.06 bc	34.29 ac	34.25 ac	34.24 a
Mean		34.29 a	33.46 b	33.45 b	34.18 a	

Table 3. Effect of different thinning style and spraying substances at different fruit growth stages on fruit diameter (mm) of Barhee .

Spraying stages	Spraying calcium born(CaB) or Potassium phosphate(KP)	Thinning				Mean
		Removing of 1/3 of strands length of bunch(SLB)	Removing of 1/3 of central strands of bunches(CSB)	Removing of 1/3 of total bunches number(TB)	Control without thinning	
1st Season						
Fruit Set	Control	25.37 fi	26.97 cg	25.32 gi	26.68 dh	26.09 d
	0.25%CaB	31.57 a	26.61	27.18 bg	26.41	27.94 ab
	0.2%KP	27.50 bf	27.35 bg	27.99 be	29.27 b	28.03 a
Mean		28.15 a	26.98 ae	26.83 be	27.45 ad	27.35 a
Kimir	Control	25.37 fi	26.97 cg	25.32 gi	26.68 dh	26.09 d
	0.25%CaB	24.72 hi	29.09 bc	27.68 be	25.36 fi	26.71 cd
	0.2%KP	27.61 be	27.25 bg	26.79	27.21 bg	27.22 ac
Mean		25.90 ef	27.77 ac	26.60 ce	26.42 de	26.67 b
Khalal	Control	25.37 fi	26.97 cg	25.32 gi	26.68 dh	26.09 d
	0.25%CaB	28.56 be	28.34 be	23.59 i	27.32 bg	26.95 bd
	0.2%KP	28.51 be	28.81 bd	25.40 fi	27.61 be	27.58 ac

- Mean		27.48 ad	28.04 ab	24.77 f	27.20 ad	26.87 ab
Control		25.37 e	26.97 bd	25.32 e	26.68 cd	26.09 b
0.25%CaB		28.28 a	28.01 ab	26.15 de	26.36 de	27.20 a
0.2%KP		27.87 ac	27.81 ac	26.73 cd	28.03 ab	27.61 a
Mean		27.17 a	27.60 a	26.07 b	27.02 a	
2nd season						
Fruit Set	Control	25.44 hi	25.44 hi	25.44 hi	26.31 c-i	25.66 b
	0.25%CaB	29.08 a	28.37 ab	27.72 a-e	27.58 a-f	28.19 a
	0.2%KP	27.87 a-e	28.35 ab	25.62 hi	25.10 i	26.73 b
Mean		27.46 a	27.38 ab	26.26 bc	26.33 a-c	26.86 a
Kimir	Control	26.31 c-i	26.31 c-i	26.20 c-i	26.20 c-i	26.26b
	0.25%CaB	25.90 fi	25.91 di	27.16 a-h	27.88a-d	26.71 b
	0.2%KP	25.06 i	28.05 a-c	27.46 ag	26.21 c-i	26.70 b
Mean		25.76 c	26.76 a-c	26.94 ab	26.76 a-c	26.55 a
Khalal	Control	26.20 c-i	26.81 b-i	26.81 b-i	26.81 b-i	26.66 b
	0.25%CaB	25.10 i	27.49 a-g	26.28 c-i	27.60 a-e	26.62 b
	0.2%KP	25.60 g-i	28.07 ac	26.98 b-i	27.53a-g	27.04 ab
Mean		25.63 c	27.46 a	26.69 a-c	27.31 ab	26.77 a
Control		25.44e	26.31 ce	26.20 ce	26.81 bd	26.19 b
0.25%CaB		28.39 a	26.46 be	26.71 bd	27.13 bd	27.17 a
0.2%KP		27.28 ac	26.07 de	26.42 be	27.53 ab	26.83 a
Mean		27.04 ab	26.28 c	26.45 bc	27.15 a	

Table4. Effect of different thinning style and spraying substances at different fruit growth stages on fruit size (cm³) of Barhee.

Spraying stages	Spraying calcium born(CaB) or Potassium phosphate(KP)	Thinning				Mean
		Removing 1/3 strands length of bunch(SLB)	Removing 1/3 central strands of bunches (CSB)	Removing 1/3 total bunches number(TB)	Control Without thinning	
1st season						
Fruit Set	Control	12.67 g-i	13.83 d-h	12.33 hi	13.17 f-i	13.00 c
	0.25%CaB	15.33 b-e	15.33 b-e	15.67 b-d	15.67 b-d	15.50 a
	0.2%KP	14.33 c-g	15.33 b-e	14.33 c-g	15.33 b-e	14.83 ab
Mean		14.11 c-f	14.83 a-c	14.11 c-f	14.72 a-d	14.44 a
Kimir	Control	12.67 g-i	13.83 d-h	12.33 hi	13.17 f-i	13.00 c
	0.25%CaB	11.67 i	16.33 ab	15.67 b-d	14.33 c-g	14.50 b
	0.2%KP	16.33 ab	15.67 b-d	13.00 g-i	15.00 b-f	15.00 ab
Mean		13.56 ef	15.28 ab	13.67 d-f	14.17 b-f	14.17 a
Khalal	Control	12.67 g-i	13.83 d-h	12.33 hi	13.17 f-i	13.00 c
	0.25%CaB	16.00 bc	18.00 a	11.67 i	15.33 b-e	15.25 ab
	0.2%KP	13.67 e-h	15.00 b-f	15.33 b-e	15.33 b-e	14.83 ab
Mean		14.11 c-f	15.61 a	13.11 f	14.61 a-e	14.36 a
Control		12.67 e	13.83 cd	12.33 e	13.17 de	13.00 b
0.25CaB		14.33 bc	16.56 a	14.33 bc	15.11 b	15.08 a
0.25%CaB		14.78 bc	15.33 b	14.22 b- d	15.22 b	14.89 a
0.2%KP		13.93 BC	15.24 A	13.63 C	14.50 B	
2nd season						
Fruit Set	Control	13.67 f	13.67 f	13.67 f	14.33 ef	13.83 d
	0.25%CaB	17.67 a	17.67 a	16.00 b-d	15.00 c-f	16.58 a
	0.2%KP	16.00 b-d	15.67 b-e	13.67 f	16.00 b-d	15.33 bc

Mean		15.78 a	15.67 a	14.44 c	15.11 a-c	15.25 a
	Control	14.33 ef	14.33 ef	13.67 f	13.67 f	14.00 d
Kimiri	0.25%CaB	16.33 a-c	14.00 f	16.33 ac	16.00 b-d	15.67 ab
	0.2%KP	14.33 ef	17.00 ab	16.00 b-d	14.67 d-f	15.50 bc
Mean		15.00 a-c	15.11 a-c	15.33 ab	14.78 bc	15.06 ab
	Control	13.67 f	14.17 f	14.17 f	14.17 f	14.04 d
Khalal	0.25%CaB	14.33 ef	15.00 c-f	14.67 d-f	15.67 b-e	14.92 c
	0.2%KP	15.67 b-e	14.67 d-f	14.67 d-f	14.67 d-f	14.92 c
Mean		14.56 bc	14.61 bc	14.50 c	14.83 bc	14.63 b
Control		13.67 f	14.33 df	13.67 f	14.17 ef	13.96 c
0.25%CaB		17.11 a	15.11 b-d	15.56 b	15.11 b-d	15.72 a
0.2%KP		15.11 b-d	15.78 b	15.44 bc	14.67 c-e	15.25 b
Mean		15.30 a	15.07 ab	14.89 ab	14.65 b	

Table5.Effect of different thinning style and spraying substances at different fruit growth stages on TSS content % of Barhee .

Spraying stages	Spraying calcium born(CaB) or Potassium phosphate(KP)	Thinning				Mean
		Removing 1/3 strands length of bunch(SLB)	Removing 1/3 central strands of bunches(CSB)	Removing 1/3 total bunches number(TB)	Control without thinning	
1st season						
Fruit Set	Control	31.00 L	35.95 D-H	33.80 IJ	31.48 KL	33.06 D
	0.25%CaB	37.00 C-E	36.45 D-G	35.05 F-I	32.95 JK	35.36 C
	0.2%KP	36.70 C-F	41.55 B	38.35 C	34.75 HI	37.84 B
Mean		34.90 C-E	37.98 B	35.73 C	33.06 G	35.42 B
Kimiri	Control	31.00 L	35.95 D-H	33.80 IJ	31.48 KL	33.06 D
	0.25%CaB	34.70 hi	36.80 c-e	42.20 b	37.20 c-e	37.73 b
	0.2%KP	37.40 cd	41.60 b	40.70 b	35.60 e-h	38.83 a
Mean		34.37 ef	38.12 b	38.90 b	34.76 de	36.54 a
Khalal	Control	31.00 l	35.95 d-h	33.80 ij	31.48 kl	33.06 d
	0.25%CaB	40.70 b	41.00 b	35.90 d-h	36.20 d-h	38.45 ab
	0.2%KP	35.00 g-i	47.30 a	37.00 c-e	33.50 ij	38.20 ab
Mean		35.57 cd	41.42 a	35.57 cd	33.73 fg	36.57 a
Control		31.00 g	35.95 d	33.80 f	31.48 g	33.06 c
0.25%CaB		37.47 c	38.08 bc	37.72 bc	35.45de	37.18 b
0.2%KP		36.37 d	43.48 a	38.68 b	34.62 ef	38.29 a
Mean		34.94 c	39.17 a	36.73 b	33.85 d	
2nd season						
Fruit set	Control	33.35 l	33.35 l	33.35 l	35.90 h-j	33.99 e
	0.25%CaB	36.60 hi	37.20 f-h	33.80 kl	38.85 d-f	36.61 c
	0.2%KP	36.50 hi	35.70 h-j	33.60 l	49.75 a	38.89 b
Mean		35.48 fg	35.42 g	33.58 h	41.50 a	36.50 b
Kimiri	Control	35.90 h-j	35.90 h-j	36.75 g-i	36.75 g-i	36.33 c
	0.25%CaB	41.85 c	38.80 d-f	40.05 de	35.40 i-k	39.03 b
	0.2%KP	46.30 b	43.50 c	38.35 e-g	40.10 d	42.06 a
Mean		41.35 a	39.40 b	38.38 c	37.42 cd	39.14 a
Khalal	Control	36.75 g-i	34.25 j-l	34.25 j-l	34.25 j-l	34.88 d
	0.25%CaB	37.20 f-h	32.70 l	36.90 g-i	36.30 hi	35.78 d
	0.2%KP	33.90 kl	38.80 d-f	39.70 de	38.70 d-f	37.78 bc
Mean		35.95 fg	35.25 g	36.95 de	36.42 ef	36.14 b
Control		33.35 f	35.90 de	36.75 cd	34.25 f	35.06 c

0.25%CaB	35.87 de	39.83b	37.55 c	35.30 e	37.14 b
0.2%KP	35.27 e	46.52 a	37.45 c	39.07 b	39.58 a
Mean	34.83 d	40.75 a	37.25 b	36.21 c	

TSS content followed by CaB compared to the control treatment in both season.

With respect to the interaction effect (spraying substances X spraying stage X thinning style) it can be observed that KP spraying either combined with removing 1/3 central strands of bunches (CSB) or removing 1/3 strand length of bunch (SLB) at kimri stage increased fruit TSS content.

In this regard, Harhash and Abdel-Nasser [23] found that spraying "Khalas" date palm with potassium increased fruit TSS content, while spraying with potassium and boric acid gave the highest values. Also, thinning 1/3 of terminal tips of central strands of "Khadrawi" date palm cultivar it led to an increase in the fruit content of TSS [28]. Moreover, thinning via removing 1/3 of terminal tips of central strands of "Succary" date palm cv. at 15% and 30% during Al-Baiser and Tamer stages increased fruits TSS content [29].

Moisture content %

The result showed that removing 1/3 central strands of bunches (CSB) increased fruit moisture content significantly in both seasons compared with another thinning style (Tb or SLB).

Regard to the effect of spraying stage it can be observed that, spraying after fruit set stage increased fruit moisture content.

Concerning the effect of spraying substances it can be noticed that, CaB gave the highest increase in fruit moisture content with a significant value in the first season compared sprayed with KP.

With respect to the interaction effect (spraying substances X spraying stage X thinning style) it can be observed that KP spraying combined with removing 1/3 central strands of bunches (CSB) at Khalal stage increased fruit moisture content.

These results were in line with Mohamed [25] who found that calcium carbonate spraying increased "Zaghloul" date palm fruit moisture content.

Total sugar

With regard to effect of thinning style data in table7, removing 1/3 central strands of bunches (CSB) increased fruit total sugar content significantly in both seasons.

Regard to the effect of spraying stage it can be observed that, spraying at kimri stage gave the highest fruit total sugar content.

Concerning the effect of spraying substances it can be noticed that, CaB gave the highest increase in fruit total sugars content with a significant value in the first season.

With respect to the interaction effect (spraying substances X spraying stage X thinning style) it can be observed that CaB spraying either combined with removing 1/3 central strands of bunches (CSB) after fruit set or combined with removing 1/3 strand length of bunch (SLB) at kimri stage increased fruit total sugars content.

These results were in line with Mohamed [25] who found that spraying "Sammany" and "Zaghloul" date palm cultivars with calcium carbonate (0.5-5%) increased fruit total sugar content. Also, Harhash and Abdel-Nasser [23] proved that spraying "Khalas" date palm cultivar with

potassium citrate and boric acid increased fruit total sugars content. Moreover, Mostafa et al. [28] as well as Soliman and Harhash [29] showed that thinning the centre with a percentage of 30% increased fruits total sugars content of "Khadrawi" and "Succary" cultivars.

Reducing sugar

Regarding the effect of the thinning style, it can be found that removing 1/3 central strands of bunches. (CSB) increased fruit reducing sugar content compared another thinning styles significantly in both seasons (table8). Regard to the effect of spraying stage it can be observed that, spraying at khalal stage gave the highest fruit reducing sugar content. Concerning the effect of spraying substances it can be noticed that, CaB gave the highest increase in fruit total sugars content with a significant value in both seasons.

With respect to the interaction effect (spraying substances X spraying stage X thinning style) it can be observed that CaB spraying either combined with removing 1/3 central strands of bunches (CSB) after fruit set stage increased fruit reducing sugars content in both seasons.

Abdi and Hedayat [31] Found that potassium fertilization with three treatments (in soil with f 3 kg/palm as potassium sulfate 48% K₂O - Foliar spray of potassium sulfate (%2) (Kf)- potassium sulfate injection into the trunk of tree (%2) (Kt).increased) on fruit reducing sugar contents of "kabkab" date palm cultivar. Also, Radwan [26] found that thinning "Siwi" cultivar whether by thinning the fruits or by removing the stalks or by thinning the center increased fruit reducing sugar contents.

Non reducing sugar

Data in Table 9 showed removing 1/3 total bunches (TB) increased fruit non reducing sugar content significantly in both seasons.

Regard to the effect of spraying stage it can be observed that, spraying at kimri stage gave the highest fruit non reducing sugar content significantly in both seasons.

Concerning the effect of spraying substances it can be noticed that, KP increased in fruit non reducing sugar content with a significant value in both seasons compared spraying CaB.

With respect to the interaction effect (spraying substances X spraying stage X thinning style) it can be observed that KP spraying either combined with removing 1/3 total bunches (TB) after fruit set increased fruit non reducing sugar content significantly in the second season.

These results go in line with Harhash and Abdel-Nasser [23] they found that, spraying with potassium increased fruit non-reducing sugars content compared to spraying with boron. Also, thinning "Succary" cultivar during Bisr and Tamar stages increased fruit non-reducing sugars [29].

Table6. Effect of different thinning style and spraying substances at different fruit growth stages on moisture content % of Barhee.

Spraying stages	Spraying calcium born(CaB) or Potassium phosphate(KP)	Thinning				Mean
		Removing 1/3 strands length of bunch(SLB)	Removing 1/3 central strands of bunches(CSB)	Removing 1/3 total bunches number(TB)	Control without thinning	
1st season						
Fruit Set	Control	65.95 f-h	69.00 c	65.30 e	66.95 ef	66.80 cd
	0.25%CaB	67.00 ef	66.60 e-g	71.80 b	73.10 a	69.63 a
	0.2%KP	64.70 i-l	67.50 de	64.80 i-k	72.20 ab	67.30 c
Mean		65.88 de	67.70 c	67.30 c	70.75 a	67.91 a
Kimir	Control	65.95 f-h	69.00 c	65.30 e	66.95 ef	66.80 cd
	0.25%CaB	67.00 ef	65.00 h-j	65.00 h-j	65.80 g-i	65.70 e
	0.2%KP	63.70 k-m	71.60 b	65.40 h-j	64.30 j-m	66.25 de
Mean		65.55 e	68.53 b	65.23 e	65.68 e	66.25 c
Khalal	Control	65.95 f-h	69.00 c	65.30 h-j	66.95 ef	66.80 cd
	0.25%CaB	68.50 cd	67.60 e-g	67.40 de	69.30 c	68.20 b
	0.2%KP	73.00 a	65.50 g-i	63.60 lm	63.30 m	66.35 d
Mean		69.15 b	67.37 c	65.43 e	66.52 d	67.12 b
Control		65.95 gh	69.00 a	65.30 h	66.95 d-f	66.80 b
0.25%CaB		67.50 cd	66.40 fg	68.07 bc	69.40 a	67.84 a
0.2%KP		67.13 de	68.20 b	64.60 i	66.60 e-g	66.63 b
Mean		66.86 b	67.87 a	65.99 c	67.65 a	
2nd Season						
Fruit Set	Control	64.30 e-i	64.30 e-i	64.30 e-i	66.85 cd	64.94 b
	0.25%CaB	61.70 k-m	65.40 d-f	63.60 g-j	68.75 ab	64.86 b
	0.2%KP	65.50 d-f	62.50 jl	64.70 e-i	64.85 e-h	64.39 b
Mean		63.83 b	64.07 b	64.20 b	66.82 a	64.73 a
Kimir	Control	66.85 cd	66.85 cd	67.60 bc	67.60 bc	67.23 a
	0.25%CaB	63.95 f-g	63.25 cd	61.30 lm	63.30 h-k	62.95 b
	0.2%KP	62.55 j-l	69.75 a	63.10 ik	61.70 k-m	64.28 b
Mean		64.45 b	66.62 a	64.00 b	64.20 b	64.82 a
Khalal	Control	67.60 bc	64.38 e-i	64.38 e-i	64.38 e-i	65.18 a
	0.25%CaB	65.20 d-g	68.45 a-c	65.80 de	66.80 cd	66.56 a
	0.2%KP	59.40 n	68.55 ab	61.80 k-m	60.80 mn	62.64 b
Mean		64.07 b	67.13 a	63.99 b	63.99 b	64.79 a
Control		64.30 d	66.85 a	67.60 a	64.38 cd	65.78 a
0.25%CaB		63.57de	65.32 bc	63.27 e	67.02 a	64.79 b
0.2%KP		64.23 de	65.72 b	61.40 f	63.72 de	63.77 c
Mean		64.03 c	65.96 a	64.09 c	65.04 b	

Table7. Effect of different thinning style spraying substances at different fruit growth stages on total sugar % of Barhee .

Spraying stages	Spraying calcium born(CaB) or Potassium phosphate(KP)	Thinning				Mean
		Removing 1/3 strands length of bunch(SLB)	Removing 1/3 central strands of bunches(CSB)	Removing 1/3 total bunches number(TB)	Control without thinning	
1st season						
Fruit Set	Control	27.05 l	33.68 de	32.65 fg	32.39 gh	31.44 d
	0.25%CaB	30.62 i	34.21 d	30.20 ij	30.50 ij	31.38 de
	0.2%KP	26.52 l	36.85 b	28.90 k	31.68 h	30.99 f
Mean		28.06 g	34.91 a	30.58 e	31.52 d	31.27 c

	Control	27.05 l	33.68 de	32.65 fg	32.39 gh	31.44 d
Kimir	0.25%CaB	38.90 a	33.46 d-f	32.30 gh	35.80 c	35.12 a
	0.2%KP	29.70 jk	32.61 fg	30.45 ij	34.14 d	31.73 cd
Mean		31.88 <u>d</u>	33.25 <u>c</u>	31.80 <u>d</u>	34.11 <u>b</u>	32.76 a
	Control	27.05 l	33.68 de	32.65 fg	32.39 gh	31.44 d
Khalal	0.25%CaB	27.35 l	35.87 c	32.85 e-g	32.15 gh	32.06 c
	0.2%KP	33.35 d-f	32.33 gh	33.62 de	33.68 de	33.25 b
Mean		29.25 <u>f</u>	33.96 <u>b</u>	33.04 <u>c</u>	32.74 <u>c</u>	32.25 b
Control		27.05 j	33.68 bc	32.65 d-f	32.39 ef	31.44 c
0.25%CaB		32.29 fg	34.51 a	31.78 g	32.82 de	32.85 a
0.2%KP		29.86 i	33.93 b	30.99 h	33.17 cd	31.99 b
Mean		29.73 d	34.04 a	31.81 c	32.79 b	
2 nd Season						
	Control	25.85 op	25.85 op	25.85 op	31.33 g	27.22 d
Fruit Set	0.25%CaB	27.65 l	37.15 a	25.25 p	33.21 cd	30.82 b
	0.2%KP	25.58 p	28.95 jk	32.25 ef	36.35 a	30.78 b
Mean		26.36 <u>g</u>	30.65 <u>cd</u>	27.78 <u>f</u>	33.63 <u>a</u>	29.61 b
	Control	31.33 g	31.33 g	30.22 hi	30.22 hi	30.78 b
Kimir	0.25%CaB	33.76 c	34.72 b	26.60 no	31.60 fg	31.67 a
	0.2%KP	32.81 de	31.05 g	26.50 no	29.60 ij	29.99 c
Mean		32.63 <u>b</u>	32.37 <u>b</u>	27.77 <u>f</u>	30.47 <u>d</u>	30.81 a
	Control	30.22 hi	28.74 k	28.74 k	28.74 k	29.11 cd
Khalal	0.25%CaB	31.60 fg	26.75 mn	31.05 g	27.55 km	29.24 cd
	0.2%KP	31.09 dg	27.85 l	31.45 fg	30.85 gh	30.31 bc
Mean		30.97 <u>c</u>	27.78 <u>f</u>	30.41 <u>d</u>	29.05 <u>e</u>	29.55 c
Control		25.85 g	31.33 c	30.22 d	28.74 ef	29.04 b
0.25%CaB		30.02 d	33.90 a	29.93 d	28.45 f	30.57 a
0.2%KP		28.93 e	33.40 b	29.06 e	30.05 d	30.36 a
Mean		28.26 d	32.88 a	29.74 b	29.08 c	

Table8.Effect of different thinning style and spraying substances at different fruit growth stages on reducing sugar % of Barhee.

Spraying stages	Spraying calcium born(CaB) or Potassium phosphate(KP)	Thinning				Mean
		Removing 1/3 strands length of bunch(SLB)	Removing 1/3 central strands of bunches(CSB)	Removing 1/3 total bunches number(TB)	Control without thinning	
1 st season						
	Control	14.55 n	16.75 i	14.32 n	21.55 e	16.79 f
Fruit Set	0.25%CaB	15.40 lm	24.45 b	15.90 k-m	20.05 f	18.95 c
	0.2%KP	12.68 o	23.07 d	14.31 n	21.85 e	17.98 e
Mean		14.21 <u>j</u>	21.42 <u>c</u>	14.84 <u>h</u>	21.15 <u>cd</u>	17.91 b
	Control	14.55 n	16.75 i	14.32 n	21.55 e	16.79 f
Kimir	0.25%CaB	23.65 cd	18.30 g	16.05 j-l	24.25 bc	20.56 a
	0.2%KP	17.59 h	16.18 i-k	15.28 m	25.15 a	18.55 d
Mean		18.60 <u>e</u>	17.08 <u>f</u>	15.22 <u>h</u>	23.65 <u>a</u>	18.64 a
	Control	14.55 n	16.75 i	14.32 n	21.55 e	16.79 f
Khalal	0.25%CaB	16.63 ij	21.76 e	16.55 i-k	22.15 e	19.27 c
	0.2%KP	16.63 ij	24.61 ab	14.02 n	25.25 a	20.13 b
Mean		15.94 <u>g</u>	21.04 <u>d</u>	14.96 <u>h</u>	22.98 <u>b</u>	18.73 a
Control		14.55 h	16.75 e	14.32 h	21.55 c	16.79 c
0.25%CaB		18.56 d	21.50 c	16.17 f	22.15 b	19.60 a

0.2%KP		15.63 g	21.29 c	14.54 h	24.08 a	18.89 b
Mean		16.25 c	19.85 b	15.01 d	22.59 a	
2 nd Season						
Fruit Set	Control	14.15 mn	14.15 mn	14.15 mn	17.55 i	15.00 d
	0.25%CaB	14.25 mn	23.10 b	15.58 l	24.22 a	19.29 ab
	0.2%KP	12.63 p	17.04 j	14.58 m	20.32 f	16.14 d
Mean		13.68 j	18.10 g	14.77 h	20.70 g	16.81 c
Kimir	Control	17.55 i	17.55 i	15.35 l	15.35 l	16.45 d
	0.25%CaB	18.75 h	21.51 d	15.60 l	20.40 f	19.07 b
	0.2%KP	16.23 k	24.30 a	13.10 o	16.50 k	17.53 c
Mean		17.51 f	21.12 b	14.68 h	17.42 f	17.68 b
Khalal	Control	15.35 l	20.25 f	20.25 f	20.25 f	19.03 b
	0.25%CaB	16.20 k	19.80 g	21.80 d	21.00 e	19.70 a
	0.2%KP	13.81 n	21.00 e	22.30 c	21.60 d	19.68 a
Mean		15.12 g	20.35 d	21.45 a	20.95 bc	19.47 a
Control		14.15 g	17.55 d	15.35 e	20.25 c	16.83 c
0.25%CaB		17.64 d	21.49 a	17.40 d	20.87 b	19.35 a
0.2%KP		14.75 f	20.28 c	14.47 g	21.63 a	17.78 b
Mean		15.51 c	19.78 b	15.74 d	20.92 a	

Table 9. Effect of different thinning style and spraying substances at different fruit growth stages on non-reducing sugar % of Barhee .

Spraying stages	Spraying calcium born(CaB) or Potassium phosphate(KP)	Thinning				Mean
		Removing 1/3 strands length of bunch(SLB)	Removing 1/3 central strands of bunches(CSB)	Removing 1/3 total bunches number(TB)	Control without thinning	
1 st Season						
Fruit Set	Control	12.50 g	16.94 c	18.33 b	10.84 ij	14.65 a
	0.25%CaB	15.22 d	9.76 k	14.30 ef	10.45 jk	12.43 d
	0.2%KP	13.84 f	13.78 f	14.59 de	9.83 k	13.01 bc
Mean		13.85 d	13.49 de	15.74 c	10.37 g	13.37 b
Kimir	Control	12.50 g	16.94 c	18.33 b	10.84 ij	14.65 a
	0.25%CaB	15.25 d	15.16 d	16.25 c	11.55 hi	14.55 a
	0.2%KP	12.11 gh	16.43 c	15.17 d	8.99 l	13.18 b
Mean		13.29 ef	16.18 b	16.58 b	10.46 g	14.13 a
Khalal	Control	12.50 g	16.94 c	18.33 b	10.84 ij	14.65 a
	0.25%CaB	10.72 j	14.11 ef	16.30 c	10.00 k	12.78 cd
	0.2%KP	16.72 c	7.72 m	19.60 a	8.43 lm	13.12 bc
Mean		13.31 ef	12.92 f	18.08 a	9.76 h	13.52 b
Control		12.50 h	16.94 b	18.33 a	10.84 i	14.65 a
0.25%CaB		13.73 f	13.01 g	15.62 d	10.67 i	13.26 b
0.2%KP		14.22 e	12.64 gh	16.45 c	9.08 j	13.10 b
Mean		13.48 c	14.20 b	16.80 a	10.20 d	
2 nd Season						
Fruit Set	Control	11.70 j	11.70 j	11.70 j	13.78 fg	12.22 c
	0.25%CaB	13.40 gh	14.05 f	9.67 l	8.99 m	11.53 d
	0.2%KP	12.95 i	11.91 j	17.67 a	16.03 c	14.64 a
Mean		12.68 d	12.55 d	13.01 c	12.9 c	12.80 b
Kimir	Control	13.78 fg	13.78 fg	14.87 e	14.87 e	14.33 b
	0.25%CaB	15.01 de	13.21 hi	11.00 k	11.20 k	12.61 c
	0.2%KP	16.58 b	6.75 o	13.40 gh	13.10 hi	12.46 c

Mean		15.12 b	11.25 e	13.09 c	13.06 c	13.13 a
	Control	14.87 e	8.49 n	8.49 n	8.49 n	10.09 e
Khalal	0.25%CaB	15.40 d	6.95 o	9.25 m	6.55 o	9.54 e
	0.2%KP	17.28 a	6.85 o	9.15 m	9.25 m	10.63d
Mean		15.85 a	7.43 h	8.96 g	8.10 f	10.09 c
Control		11.70 g	13.78 d	14.87 a	8.49 h	12.21 b
0.25%CaB		12.37 f	12.40 f	12.53 f	7.58 i	11.22 c
0.2%KP		14.18 c	13.12 e	14.59 b	8.42 h	12.58 a
Mean		12.75 c	13.10 b	14.00 a	8.16 d	

Conclusions

Individual spraying of CaB and KP as well as CSB thinning style improved physical and chemical properties of Barhee fruit. Also, spraying of CaB and KP after fruit set stage and at Kimri stage improved fruit physical and chemical properties. Moreover, CSB thinning style combined with spraying CaB during fruit set stage increased fruit weight, size, as well as total and reducing sugar in both seasons.

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