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EFFECT OF BORON, ZINC AND SEAWEED SPRAYS ON YIELD AND FRUIT QUALITY OF BARHEE DATE PALMS

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Abstract

This investigation was carried out through two successive seasons to study the effect of boric acid (BA) at 500 and 1000 ppm, zinc sulfate (ZS) at 500 and 1000 ppm and seaweed extract (SE) at 0.5 and 1.0% as single treatments or in combinations for two times (just after pollination and one month latter) on fruit set, fruit retention, yield and fruit quality of Barhee date palms. The obtained results showed that all treatments either as single or combined applications were very effective in increasing fruit set, fruit retention, yield, physical and chemical fruit properties comparing with the untreated palms (control). Generally, seaweed application was preferable than using zinc sulfate or boric acid solely concerning fruit set, bunch weight, yield per palm, fruit weight, fruit dimension, TSS%, TSS/acid ratio, reducing and nun-reducing also total sugars. The combined applications were preferable than single or control treatments. In this respect, spraying 1000 ppm of zinc sulfate + 1000 ppm of boric acid + 1% seaweed extract for two times was the promising treatment under this study conditions.

Key words: Barhee date palms, seaweed extract, zinc, boron, yield, fruit quality

Introduction

Date palm (*Phoenix dactylifera* L.) is considered as one of the important fruit crops in arid and semi-arid regions. Dates are considered the ancient domestic fruits in the Middle East countries and as major food source for many people. Moreover, date palms have an important role in the economic and social life of the people of these regions. The total production of date fruits in Egypt is about 1.3 million tons (FAO estimation, 2012). Foliar fertilization has the advantage of low application rates, uniform distribution of fertilizer materials and quick responses to applied nutrients (Umer *et al*., 1999).

Spraying micro-nutrients improves fruit set, fruit retention and development as well as yield and fruit quality (Sarrwy *et al*., 2012; Omer *et al*., 2014 and Mostafa, 2015). In this concern, boron is involved in many processes such as protein synthesis, transport of sugars and carbohydrate metabolism (Hansch and Mendel, 2009). The impact of some micro-elements, such as boron on dates yield and fruit quality seems to play an important role in achieving satisfactory fruit set and fruit quality (Etmon *et al*., 2007 and Khayyat *et al*., 2007).

Spaying date palm inflorescences with boric acid and/or calcium nitrate had a significant effect on fruit set, yield and fruit quality (Harhash & Abdel-Nasser, 2010; Sarrwy *et al*., 2012; Omar *et al*., 2014 and Mostafa, 2015).

Zinc is an essential micro-element for plant; it is involved in many enzyme reactions and is necessary for growth and development, as well as protein and carbohydrate metabolism. Foliar application of zinc sulfate is more effective on yield and fruit quality of date palms (Omar *et al*., 2014 and Mostafa, 2015).

Moreover, use of bio-fertilizers is recommended as a safe fertilization method to increase productivity and fruit quality of many fruit species, also, using bio-fertilizers are considered a promising alternative for chemical fertilizers and they are safe for human, animals and environment (Verna, 1990). Previous studies revealed that using seaweed extract was very important in improving growth and production of fruit crops (El-Sawy, 2005; Merwad, 2011; Mahmoud, 2012; Oraby, 2013 and Roshdy, 2014). The stimulating effect of seaweed extract on growth might be attributed to its essential action on enhancing cell division because it contains higher amounts of natural hormones like cytokinins, IAA and GA_3, also amino acids, vitamins and antioxidants (James, 1994 and Soliman *et al*., 2000).

The objective of this investigation is to study the effect of spraying bunches of Barhee date palms with zinc, boron and seaweed extract on fruit set, fruit retention, yield and fruit quality.

Materials and Methods

This investigation was carried out during 2016 and 2017 seasons on 10 years old Barhee date palms grown in private orchard situated at point of 63 kilometer from Cairo-Alexandria desert road.

Barhee date palms have been grown on sandy soil with 6X6 meters distance under drip irrigation system. The selected palms were healthy, nearly uniform in growth vigor also fruiting and received regular horticultural practices. The leaf/bunch ratio was adjusted at the end of the blooming seasons to meet their value (8 leaves/bunch ratio). Bunches were thinned to 8 per each palm and the artificial pollination was carried out using the same pollen grain source. Twenty seven palms were selected and divided into 9 treatments in three replicates (each was one palm) and arranged in a randomized compete block design. Palms were subjected for the following spraying treatments.

1. Control (spraying water only).
2. 500 ppm zinc sulfate (ZS).
3. 1000 ppm zinc sulfate (ZS).
4. 500 ppm boric acid (BA).
5. 1000 ppm boric acid (BA).
6. 0.5 % seaweed extract (SE).
7. 1 % seaweed extract (SE).
8. 500 ppm ZS + 500 ppm BA + 0.5 % seaweed extract.
9. 1000 ppm ZS + 1000 ppm BA + 1 % seaweed extract.

Table 1: Analysis of seaweed extract according to James (1994).

Component	Values
Proteins	6 – 8
Aliginic acid %	10 – 23
Mannitol %	3 – 6
Total N %	1 – 1.8
P %	0.03 – 0.08
K %	1 – 1.4
Ca %	0.2 – 1.6
S %	3 – 9
Mg %	0.4 - 0.8
Micronutrients	ppm
Fe	50 – 200
Mn	6 – 14
Zn	10 – 100
B	20 – 100
Natural hormones	%
Cytokinins	0.03
IAA	0.02
ABA	0.02

Triton B as a welling agent at 0.05 % was added to all solutions of zinc, boron and seaweed extract. All treatments were sprayed two times (just after pollination and one month later). Bunches were harvested at the second week of September in both studied seasons.

Yield was estimated as average weight (Kg) for each treatment crossing the number of bunches/palm.

For determination the physical properties, 30 fruits were picked at random from each bunch to determine such as fruit weight (gm), fruit dimensions (cm), flesh percentage (%) and seed percentage (%).

Also the chemical fruit properties i.e. total soluble solids %, acidity %, reducing and non-reducing also total sugars % were measured as outlined in the methods of AOAC (2000).

Statistical Analysis:

Data were subjected to analysis of variance and Duncan's multiple test was used to differentiate means (Duncan, 1955).

Results

Results presented in Table (2) show the effect of boron, zinc and seaweed sprays on fruit set and fruit retention percentages, bunch weight and palm yield as kg of Barhee date palms during 2016 and 2017 seasons. In general, most treatments especially the combined ones significantly increased the fruit set and fruit retention percentages, bunch weight and yield/palm compared with the untreated palms (control).

Foliar spray treatments with the combination of 1000 ppm ZS + 1000 ppm BA plus 1% SE showed the highest percentage of fruit set (65.6 and 64.6%), fruit retention (50.1 and 50.9%), and the heaviest bunch weight (15.96 and 16.56 kg) and yield /palm (127.7 and 132.5 kg) in the first and second seasons, respectively, followed by foliar application with the combination of 500 ppm ZS + 500 ppm BA + 0.5% SE.

The lowest percentage of fruit set (53.2 and 58.3%), fruit retention (39.0 and 39.6%), bunch weight (10.4 and 10.8 kg) and yield per palm (83.7 and 86.6 kg) were obtained from control in the first and second seasons, respectively.

Results in Table (3) show that fruit weight (gm), fruit dimension (cm), flesh and seed percentages were significantly affected by foliar applications of ZS, BA and SE either solely or in combinations during both seasons.

All combination treatments were preferable in enhancing fruit weight, fruit dimension, flesh and seed percentages than using each of them alone.

The heaviest fruit weight (12.4 and 12.8 gm), fruit length (3.50 and 3.56 cm), fruit diameter (2.36 and 2.46 cm), flesh percentage (91.36 and 91.43 %) and seed percentage (8.63 and 8.56 %) were obtained from the combination treatments of 1000 ppm ZS + 1000 ppm BA + 1% SE followed by foliar sprays with the combination of 500 ppm ZS + 500 ppm BA + 0.5 % SE in the first and second seasons, respectively. the lowest fruit weight (10.1 and 10.36 gm), fruit length (2.96 and 3.06 cm), fruit diameter (1.90 and 1.90 cm), flesh percentage (88.6 and 88.0 %) and seed percentage (11.3 and 12.0 %) were recorded due to the control in both studied seasons.

Concerning fruit chemical properties, results in table (4) clearly show that single and combined applications of the using materials significantly improved fruit chemical properties in terms of total soluble solids, TSS/acid ratio and acidity percentage rather than control treatment. The highest value of total soluble solids (34.76 and 34.93 %), and TSS/acid ratio (193.1 and 197.8) were obtained from the palms sprayed with 1000 ppm ZS + 1000 BA + 1% SE in both seasons, followed by foliar sprays with 500 ppm ZS + 500 ppm BA + 0.5% SE in the two seasons of the study.

The lowest value of TSS (29.7 and 29.6 %) and TSS/acid ratio (178.7 and 181.7) were recorded from the untreated palms in both studied seasons, respectively.

As for acidity % in the fruits, the control treatment recorded the lowest value in both studied seasons, while all spraying treatments significantly increased the acidity value than the control except that of ZS at 500 ppm.

Results in Table (5) indicate that foliar spraying any of ZS or BA or SE either as individual or combined treatments significantly increased non-reducing, reducing and total sugars of Barhee fruits compared with the control in both seasons.

All combination treatments of ZnOS4, BA and SE were preferable in enhancing the reducing, non-reducing or total sugars than using each of them solely.

The highest values of non-reducing sugars in fruits (13.6 and 14.06 %), reducing sugars (39.8 and 40.6 %) and total sugars (53.4 and 54.6) were obtained due to spraying palms with 1000 ppm ZS + 1000 ppm BA + 1% seaweed extract, followed by foliar spray with 500 ppm ZS + 500 ppm BA + 0.5% SE which recorded 13.2 and 13.9% for non-reducing sugars, 39.7 and 40.2% for reducing sugars, 52.9 and 54.1% for total sugars in the fruits. Those were true in the first and second seasons, respectively. The lowest non-reducing sugars (11.8 and 11.9%), reducing sugars (35.3 and 36.0%) and total sugars (47.2 and 47.9%) were recorded from the control in the first and second seasons, respectively.

Discussion

The obtained results are confirmed with those obtained by Omer *et al*. (2014) who reported that fruit set, fruit retention % and bunch weight as well as yield of date palm cultivars had been improved with boron and zinc applications. In this concern, a tentative explanation is that boron and zinc increase removal force due to their involvement in many enzymatic reactions which regulate protein and carbohydrate metabolism that necessary for growth and development (Swietlik, 1999 and Sarrway *et al*., 2012). On the other hand, using SE on fruit trees has received apparent interest. The positive effects of applying SE were attributed to its content of essential nutrients, amino acids, antioxidants, organic acids, vitamins, natural hormones and phenolic compounds (Soliman *et al*., 2000).

The obtained results are nearly in the same line with those obtained by Khayyat *et al*. (2007), El-Sawy (2005), Harhash & Abdel-Nasser (2010), Soliman & Obeed (2011), Osman *et al*. (2011), Mohamoud (2012), Elkhyat & Elniam (2013), Omar *et al*. (2014), Mostafa (2015) and Roshdy (2014).

Fruit quality of date palm cultivars had been improved with boron, zinc and bio-fertilization application. Boron and zinc had a main role in many processes, especially transport of sugars and carbohydrate and proteins metabolism that increased cell division and cell enlargement leading to increase the fruit weight and dimensions, as well as hasten the maturation of fruits. In addition, SE have amounts of essential nutrients, amino acids, vitamins, natural hormones which enhance cell division and enlargement induce an increase the fruit weight and size as well as hastened the fruit maturation. Such results are in harmony with those obtained by Ahsour *et al*. (2004), El-Sawy (2005), Khayyat *et al*. (2007), Harhas & Abdel-Nasser (2010), Sarrwy *et al*. (2012), Mahmoud (2012), Oraby (2013), Roshdy (2014), Ome *et al*. (2014) and Mostafa (2015).

Conclusion

In general, it could be concluded that all treatments had a positive effect on yield and fruit quality comparing with the control. In this concern, SE spray was more effective than both boric acid and zinc sulfate sprays. However, spraying bunches of Barhee date palms with mixture of 1000 ppm of zinc sulfate + 1000 ppm boric acid and 1 % seaweed extract just at pollination and one month later was the most effective treatment on yield and fruit quality.

Table 2: Effect of zinc, boron and seaweed on fruit set, fruit retention and yield of Barhee date palms

Characters / Treatments	Fruit set (%)		Fruit retention (%)		Bunch weight (kg)		Yield /palm (kg)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	53.20 e	58.26 e	39.00 c	39.66 h	10.46 h	10.83 h	83.7 h	86.6 h
ZS 500ppm	54.13 de	59.16 de	40.23 c	41.03 g	11.60 g	11.86 g	92.1 g	94.9 g
ZS 1000ppm	55.00 d	59.96 d	41.80 c	42.00 f	12.53 f	12.96 f	100.2 f	103.7 f
BA 500ppm	55.16 d	61.26 c	48.50 ab	45.66 e	12.76 f	13.23 f	102.1 f	105.8 f
BA 1000ppm	55.66 cd	59.86 d	45.50 b	46.40 d	13.40 e	13.93 e	107.2 e	111.4 e
SE 0.5%	57.26 c	60.00 d	47.70 ab	48.16 c	14.60 d	15.06 d	116.8 d	120.5 d
SE 1.0%	63.33 b	61.63 c	48.50 ab	49.33 b	15.06 c	15.43 c	120.5 c	123.4 c
ZS 500ppm+ BA 500ppm+ SE 0.5%	65.00 a	63.43 b	49.46 a	50.33 a	15.50 b	16.06 b	124.0 b	128.5 b
ZS 1000ppm+ BA 1000ppm+ SE 1.0%	65.66 a	64.66 a	50.13 a	50.93 a	15.96 a	16.56 a	127.7 a	132.5 a
LSD at 0.05 level	S	S	S	S	S	S	S	S

Table 3: Effect of zinc, boron and seaweed on physical fruit quality of Barhee date palms

Characters / Treatments	Fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)		Flesh (%)		Seed (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	10.10 ab	10.36 h	2.96 d	3.06 f	1.90 e	1.90 f	88.66 e	88.00 h	11.33 a	12.00 a
ZS 500ppm	10.33 ab	10.53 g	3.06 d	3.23 e	2.00 de	2.00 e	89.67 d	90.06 g	10.33 b	9.93 b
ZS 1000ppm	10.60 ab	10.90 f	3.20 c	3.30 de	2.10 cd	2.13 d	90.20 cd	90.23 fg	9.80 bc	9.76 bc
BA 500ppm	10.90 ab	11.40 e	3.23 c	3.30 de	2.20 bc	2.26 c	90.46 bc	90.40 ef	9.53 cd	9.60 cd
BA 1000ppm	11.13 ab	11.56 d	3.30 bc	3.36 cd	2.20 bc	2.26 c	90.73 bc	90.53 de	9.26 cd	9.46 de
SE 0.5%	11.90 b	11.63 d	3.40 ab	3.43 bc	2.20 bc	2.30 c	90.90 ab	90.83 bc	9.10 de	9.16 fg
SE 1.0%	11.70 a	11.93 c	3.40 ab	3.46 abc	2.30 ab	2.30 c	90.00 ab	91.06 b	9.00 de	8.93 g
ZS 500ppm+ BA 500ppm+ SE 0.5%	12.06 a	12.40 b	3.50 a	3.50 ab	2.36 a	2.40 b	90.60 bc	90.73 cd	9.40 cd	9.26 ef
ZS 1000ppm+ BA 1000ppm+ SE 1.0%	12.46 a	12.80 a	3.50 a	3.56 a	2.36 a	2.46 a	91.36 a	91.43 a	8.63 e	8.56 h
LSD at 0.05 level	S	S	S	S	S	S	S	S	S	S

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test

Table 4 : Effect of zinc, boron and seaweed on TSS, acidity and TSS/acid ratio of Barhee date palms

Characters / Treatments	TSS (%)		Acidity (%)		TSS/acid ratio	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	29.76 i	29.66 g	0.167 d	0.163 d	178.7 d	181.7 bcd
ZS 500ppm	30.63 h	30.53 f	0.170 d	0.163 d	180.2 cd	187.1 b
ZS 1000ppm	31.53 g	31.56 e	0.180 c	0.176 c	175.1 d	178.8 bcd
BA 500ppm	32.26 f	32.43 d	0.180 c	0.186 ab	179.2 d	173.8 d
BA 1000ppm	32.63 e	32.93 c	0.186 ab	0.180 bc	174.9 d	182.9 bc
SE 0.5%	33.40 d	33.20 c	0.180 c	0.190 a	185.5 bc	174.7 cd
SE 1.0%	33.90 c	33.93 b	0.190 a	0.186 ab	178.4 d	181.9 bcd
ZS 500ppm+ BA 500ppm+ SE 0.5%	34.26 b	34.16 b	0.183 bc	0.183 abc	187.0 b	186.4 b
ZS 1000ppm+ BA 1000ppm+ SE 1.0%	34.76 a	34.93 a	0.180 c	0.176 c	193.1 a	197.8 a
LSD at 0.05 level	S	S	S	S	S	S

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test

Table 5 : Effect of zinc, boron and seaweed on non-reducing, reducing and total sugars (%) of Barhee date palms

Characters / Treatments	Non-reducing sugars (%)		Reducing sugars (%)		Total sugars (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	11.86 e	11.93 e	35.33 d	36.00 e	47.20 f	47.93 f
ZS 500ppm	12.16 e	12.40 d	36.00 d	36.00 e	48.16 e	48.40 ef
ZS 1000ppm	12.60 d	12.60 d	36.00 d	36.16 e	48.60 e	48.40 e
BA 500ppm	12.86 cd	13.06 c	37.00 c	37.33 d	49.86 d	50.40 d
BA 1000ppm	12.93 bcd	13.36 b	37.66 c	38.66 c	50.60 d	52.03 c
SE 0.5%	13.30 ab	13.50 b	38.66 b	39.00 c	51.96 c	52.50 c
SE 1.0%	13.30 ab	13.60 b	39.00 ab	39.53 b	52.30 bc	53.13 b
ZS 500ppm+ BA 500ppm+ SE 0.5%	13.20 bc	13.93 a	39.73 a	40.23 a	52.93 ab	54.16 a
ZS 1000ppm+ BA 1000ppm+ SE 1.0%	13.60 a	14.06 a	39.80 a	40.60 a	53.40 a	54.66 a
LSD at 0.05 level	S	S	S	S	S	S

Means within a column followed by the same letter (s) are not statistically different at 5 % level by Duncan's multiple range test

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