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Effect of different levels of irrigation and micronutrient fertilization on productivity of Seewy date palms

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Abstract

During 2017, 2018 and 2019 seasons, fruit bunches of Seewy date palm grown in sandy soil under drip irrigation system were exposed to micronutrient fertilization i.e., boron as boric acid solution at rates of 2000 ppm, zinc as zinc sulfate solution at rates of 1000 ppm and silicon as potassium silicate solution at rates of 1% each alone or in combination between the three materials as well as three levels of irrigation water: 25, 50 and 100% of field capacity from pollination stage to harvest stage. Bunches were sprayed twice with above micronutrients after pollination and at Kimri stage. The aim was improving yield and quality of Seewy cv. Using all micronutrient treatments and irrigation levels was very effective in improving the yield and quality over the control treatment. The highest values of fruit set, fruit retention, bunch weight (Kg), Yield/palm (Kg/ Palm), TSS, total sugars and reducing sugars were achieved by aplication of 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment plus all irrigation levels. While the highest values of fruit weight, pulp weight and pulp/fruit weight were achieved by aplication of 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment plus 25or 100% irrigation levels. This study suggested that application of 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment twice after pollination and at Kimri stage plus all irrigation levels (25, 50 and 100% of field capacity) consider auseful technology for producing high fruit quality of Seewy date palm cultivar under Sohag climatic conditions.

Keywords
Seewy cv., fruit bunches, boric acid, zinc sulfate, potassium silicate, Kimri stage, fruit retention, irrigation levels.

INTRODUCTION

Date palm (*Phoenix dactylifera* L.), a monocotyledonous and dioecious species belonging to the Palmaceae family, is widely cultivated in arid regions of the Middle East and North Africa (Chao and Krueger 2007 and Marzouk, 2011). The total world number of date palms is about 120 million trees, distributed in 30 countries and producing nearly 7.5 million tons of fruit per year (FAO 2013). Arab countries account for 70% of the world's date palms number and are responsible for 67% of the global production of date palm (El-Juhany, 2010). In Egypt, date palm fruits are one of the most important export fruit crops where they are harvested and marketed at three stages of their development. It ranked the third fruit crop after orange and grape (Agric. Econ. Bull., 2005). Because of date palm can grow and produce under a wide range of soil and climatic conditions. The total number of date palm trees reached 14,379,648 producing about 1,644,417 tons yearly. While the number of Seewy dates reached 3,526,974 palm producing 381,003tons yearly (Statistics of Ministry of Agriculture, 2019 Egypt). Seewy date palm cultivar is the best semi-dry type cultivars in most Egyptian regions. Low yield of Seewy date palms grown under sandy soil is considered a major problem that faces growers. Sandy soils are poor in low macro and micro – nutrients. Many efforts have been established for finding out the best horticultural practices that are responsible for enhancing yield and fruit quality of Seewy date palm cv. Using boron (B), zinc (Zn) and silicon (Si) under different levels of irrigation water are considered the best treatment for solving the problem of poor fruit set and high fruit drop percentage at different fruit growth stages especially in the new reclaimed lands. The micro-nutrient boron (H3 BO3) plays as important role in growth behavior and productivity of trees. It increases pollen grains germination and pollen tube elongation, consequently fruit set percentage and finally the yield (Khayyat *et al.*, 2007 and Ahmad *et al.*, 2009). The main function of boron relate to cell wall strength and development, cell division, sugar transport and hormones development, RNA metabolism, respiration, indole acetic acid (IAA) metabolism and as part of the cell membranes (Camacho-Cristóbal, *et al.* 2008). The role of zinc in plant that it affects the synthesis of tryptophan which is a precursor of Indole acetic acid and the formation of the growth substance is directly influenced by Zn. It has also an important role in starch metabolism in plant. It is well known that zinc acts a co–factor of many enzymes and affects many biological processes such as photosynthesis reactions, nucleic acids metabolism, protein and carbohydrate biosynthesis (Mengel *et al.* 2001 and Alloway, 2008). Silicon is considered as an important beneficial element as it helps in growth and development of plant. Most of the plants absorb silicon in the form of monosilicic acid (Si $(OH)_4$). Silicic acid is not much mobile element in plants. Therefore a continued supply of this element would be required particularly for healthy and productive development of plant during all growth stages. Silicon is known to effectively mitigate various abiotic stresses such as manganese, aluminum and heavy metal toxicities, salinity, drought, chilling and freezing stresses (Liang *et al.*, 2007). The nutrient spray applications can also cause yield and fruit size improving, without thinning agent's requirements (Khayyat *et al.*, 2007). It is known that water regime, has a direct effect on flowering, fruit setting and total yield. Correct and adequate irrigation is very important for date palm trees to ensure good palm growth, high yields and good fruit quality (Bazza, 2008). Therefore, the main objective of the present study was to investigate the effect of spraying fruit bunches twice with micronutrient fertilization (boron at rates of 2000 ppm, zinc at rates of 1000 ppm and silicon at rates of 1% alone or in combination between the three materials) after pollination and at Kimri stage under three levels of irrigation water (25, 50 and 100% of available water) on growth and productivity of Seewy date palm cultivar under Upper Egypt conditions.

MATERIALS AND METHODS

Plant material

This study was carried out during three successive seasons of 2017, 2018 and 2019 on fifteen years old Seewy date palm orchard which is one of the most important cultivar of semi dry dates in Egypt, grown in sandy soil under drip

irrigation system, planted at 10m apart at El-Kwamel farm, college of Agriculture, Sohag University, Egypt, is subject to mild winters and warm and dry summer. All the chosen trees were uniform in growth, free from insects damage and diseases, and were subjected to the same management and cultural practices. The leaf/bunch ratio was adjusted at the value of 6:1 for all experimental palms. Pollination of the experimental palms was uniformly performed in respect of the same source, date and method to avoid residues of metaxinia.

Physical and chemical properties of soil

Table (1): Some physical and chemical properties of soil according to the methods described by Page *et al.* (1982) and Klute (1986).

Physical properties		Chemical composition				
Sand%	89.6	pH	8.7	Na	Meq/L	0.54
Silt%	5.85	EC dSm-1	1.2	K		0.37
Clay%	4.55	N%	0.05	Ca		8.62
CaCO3%	3.1	P ppm	0.8	Mg		3.28
O.M%	0.07	K ppm	185	Cl		6
Texture	Sandy	SO4 meq/L	3.9	HCO_3		3

Chemical analyses of irrigation water:

Table (2): Chemical analyses of irrigation water were performed according to the methods described by Ayers and Westcot (1994).

property	unit	value
pH	-	7.64
EC	Mg/-1	971.2
Na	Mg/-1	82.90
K	Mg/-1	134.92
Ca	Mg/-1	80.42
Mg	Mg/-1	40.62
HCO3	Mg/-1	191.06
Cl	Mg/-1	80.26
SO4	Mg/-1	354.72

Climatic data

Mean monthly temperature and relative humidity (maximum and minimum) for El-Kwamel region (farm location) during 2017, 2018 and 2019 seasons (according to Metrology Organization in Cairo) are shown in Figure (1).

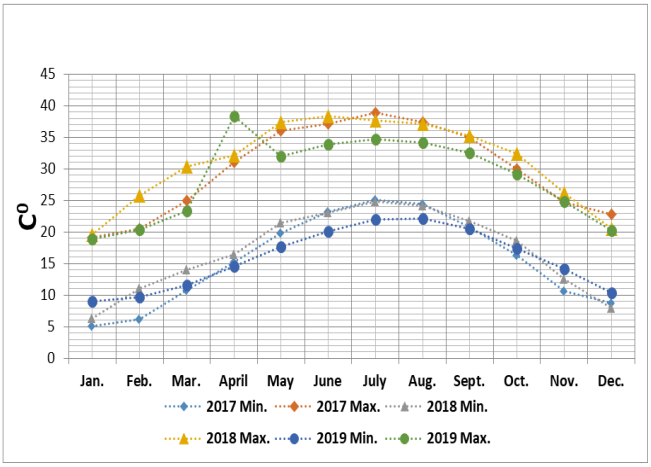

Figure (1): Meteorological data (mean monthly maximum and minimum temperature and relative humidity) for 2017, 2018 and 2019 under Sohag climatic conditions.

Experimental work

Eighteen female uniform date palm tree of Seewy cultivar were randomly selected to study the effect of micronutrient fertilization i.e., boron (B) as boric acid solution at rates of 2000 ppm, zinc (Zn) as zinc sulfate solution at rates of 1000 ppm and silicon (SL) as potassium silicate solution at rates of 1% each alone or in combination between the three materials and three levels of irrigation water: 25, 50 and 100% of field capacity from pollination stage to harvest stage (calculated using Tenshometer) on growth and productivity of date palm under south Egypt conditions. Bunches were simultaneously pollinated with same pollen by placing six fresh male strands on female spadix center to avoid residues of metaxinia and were sprayed twice with above micronutrients after pollination with three days for the first time and at Kimri stage for the second time by using compression sprayers (5L solution/tree) until run-off excepting control treatment (three tree) received distilled water during the three seasons of study. Wetting agent Tween 20 (1%) was applied with spraying solution to reduce the surface tension and increase the contact angle of sprayed droplets.

Treatments

The details of the treatment composition were as follow:

(T1) Control (distilled water spray).

(T2) Spraying 2000 ppm (B) twice with above micronutrients after pollination with three days for the first time and at Kimri stage for the second time.
(T3) Spraying 1000 ppm (Zn) twice with above micronutrients after pollination with three days for the first time and at Kimri stage for the second time.
(T4) Spraying 1% (SL) twice with above micronutrients after pollination with three days for the first time and at Kimri stage for the second time.
(T5) Spraying 2000 ppm (B) and 1000 ppm (Zn) twice with above micronutrients after pollination with three days for the first time and at Kimri stage for the second time.
(T6) Spraying 2000 ppm (B) and 1% (SL) twice with above micronutrients after pollination with three days for the first time and at Kimri stage for the second time.
(T7) Spraying 1000 ppm (Zn) and 1% (SL) twice with above micronutrients after pollination with three days for the first time and at Kimri stage for the second time.
(T8) Spraying2000 ppm (B), 1000 ppm (Zn) and 1% (SL) twice with above micronutrients after pollination with three days for the first time and at Kimri stage for the second time.

Experimental design

This experiment was arranged in Randomized Complete Block Design (RCBD) with three replications (one palm pear each replicate), in split plot method with three irrigation levels in main plots, and three micronutrient elements in sub plots during 2017-2019.

Experimental measurements

Productivity

Fruit set (%)

The number of initial fruit set was counted by using 10 marked strands per spathe after thirty five days from pollination then the percentage of initial fruit set (I.F.S.) was calculated using the following equation.

Initial fruit set (%) =Av. number of set fruit per strand/ Av. number of set fruit+ Av. number of flower scars X 100.

Fruit retention (%)

At harvest time the number of retained fruits on the same ten marked strands was counted then the fruit retention percentages (horticultural fruit set %) were determined using the following equation.

Horticultural fruit set %=Av. number of retained fruit/Av. number of retained fruit + Av. number of flower scars X 100.

Palm yield (Kg)

All bunches of the selected palms were harvested through the first week of August during the fruit Rutab stage, bunch weight was recorded then yield per palm was calculated according to an equation described below.

Yield/palm (kg) = number of bunches x average bunch weight.

Fruit properties

Samples of twenty (20) ripe dates from the yield of each palm (replicate) were taken randomly and the following physical and chemical characteristics were measured.

Physical characteristics

Average of fruit weight (g), pulp weight (g) and pulp/fruit weight ratio were determined. Fruit volume (cm^3) was determined using water displacement.

Chemical characteristics

Total soluble solids % (T.S.S %): was determined by hand refract meter. Total acidity was determined as malic acid per 100 g pulp according to A.O.A.C., (1995). TSS/acid ratio was calculated for each sample. Sugar contents including reducing and total sugars were determined according to Lane and Eynon described in A.O.A.C. (1995), while non-reducing sugars were calculated as the difference between total sugars and reducing sugars.

Statistical analysis

The obtained data were subjected to statistical analysis of variance (ANOVA) according to the methods described by Snedecor and Cochran (1989). Mean separation was done using Duncan multiple range test (Duncan, 1958) at 5 % level to determine the significance of differences between the conducted treatments.

RESULTS AND DISCUSSION

Effect of some micronutrients treatments on productivity under different levels of irrigation

Fruit set (%)

Table (3): Mean values of the interaction of irrigation levels and micronutrient treatments on fruit set percentage of date palm cv. Seewy during 2017, 2018 and 2019 seasons.

Levels (A) / Treatments (B)	Season 2017			Season 2018			Season 2019		
	25%	50%	100%	25%	50%	100%	25%	50%	100%
Control	79.67	81.00	79.67	77.85	67.85	77.85	52.00	65.93	46.93
2000 ppm (B)	90.75	86.33	91.25	91.00	87.76	91.54	85.22	82.10	86.33
250 ppm (Zn)	87.07	88.67	88.67	88.33	79.48	88.50	84.90	82.99	87.36
1% Silicon (SL)	87.50	86.50	87.57	84.23	87.67	86.36	86.57	81.10	85.97
2000 ppm (B) + 250 ppm (Zn)	87.65	85.67	89.57	86.93	88.64	86.33	87.83	82.55	82.96
2000 ppm (B) + 1% (SL)	91.33	87.00	88.58	86.31	87.47	85.83	85.10	85.83	82.17
250 ppm (Zn) + 1% (SL)	89.83	86.93	86.08	88.65	87.76	85.43	87.74	83.51	87.36
2000 ppm (B) + 250 ppm (Zn) + 1% (SL)	89.18	88.33	86.93	88.88	89.00	89.26	85.25	85.13	88.74
LSD at 5% level (A x B)	7.58			4.85			7.50		

With respect to fruit set percentage data in Table (3) revealed that, statistical analysis indicated significant differences for the interaction of irrigation levels and micronutrient treatments. The highest values achieved by 2000 ppm (B) x 100% irrigation level (91.25, 91.54%), respectively in the first and second seasons, and by 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) x 100% irrigation level (88.74%) in the third season compared with the control and other treatments.

Fruit retention (%)

Table (4): Mean values of the interaction of irrigation levels and micronutrient treatments on fruit retention percentage of date palm cv. Seewy during 2017, 2018 and 2019 seasons.

Levels (A) / Treatments (B)	Season 2017			Season 2018			Season 2019		
	25%	50%	100%	25%	50%	100%	25%	50%	100%
Control	66.67	58.33	65.00	65.28	88.61	75.28	60.48	70.07	53.40
2000 ppm (B)	95.87	79.00	84.73	91.25	86.83	89.33	72.81	79.52	78.58
250 ppm (Zn)	88.87	79.83	91.83	91.00	74.62	86.59	90.17	72.62	79.50
1% Silicon (SL)	76.00	82.67	72.27	66.87	77.52	86.09	70.22	77.67	86.79
2000 ppm (B) + 250 ppm (Zn)	89.90	90.67	66.60	69.53	86.00	87.33	79.67	91.61	73.97
2000 ppm (B) + 1% (SL)	67.67	79.07	87.22	78.20	93.33	86.99	72.92	85.12	89.17
250 ppm (Zn) + 1% (SL)	69.67	94.47	79.22	91.22	87.79	86.48	75.49	78.67	87.05
2000 ppm (B) + 250 ppm (Zn) + 1% (SL)	83.33	91.00	78.05	83.20	93.57	93.43	82.56	82.00	75.33
LSD at 5% level (A x B)	7.74			7.48			12.73		

As for the fruit retention percentage data in Table (4) preformed that, statistical analysis indicated insignificant differences for the interaction of irrigation levels and micronutrient treatments. The highest value achieved by the 2000 ppm (B) x 25% irrigation level (95.87%) in the first season, 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) x 50% irrigation level (93.57%) in the second season and by 2000 ppm (B) + 250 ppm (Zn) x 50% irrigation level (91.61%) in the third season compared to the control and other treatments.

Bunch weight (Kg)

Table (5): Mean values of the interaction of irrigation levels and micronutrient treatments on bunch weight (Kg) of date palm cv. Seewy during 2017, 2018 and 2019 seasons.

Levels (A) / Treatments (B)	Season 2017			Season 2018			Season 2019		
	25%	50%	100%	25%	50%	100%	25%	50%	100%
Control	6.31	4.63	6.31	4.55	5.88	5.55	5.04	4.70	5.37
2000 ppm (B)	6.61	5.68	5.06	6.44	6.29	6.69	5.74	5.52	6.03
250 ppm (Zn)	5.66	5.93	5.76	5.98	7.23	6.74	6.62	5.91	6.16
1% Silicon (SL)	5.94	5.03	4.73	7.20	7.11	6.43	5.10	5.50	6.77
2000 ppm (B) + 250 ppm (Zn)	5.86	5.24	5.72	5.68	6.45	5.40	4.97	5.69	6.33
2000 ppm (B) + 1% (SL)	5.60	6.72	5.58	7.82	6.97	6.43	5.43	5.95	7.21
250 ppm (Zn) + 1% (SL)	6.19	5.49	4.48	5.86	6.03	5.57	4.89	6.13	7.48
2000 ppm (B) + 250 ppm (Zn) + 1% (SL)	6.84	5.36	6.04	6.95	7.60	6.93	6.75	6.12	8.36
LSD at 5% level (A x B)	**0.92**			**1.15**			**1.24**		

As related to the bunch weight (Kg) data in Table (5) showed that, statistical analysis indicated significant differences for the interaction of irrigation levels and micronutrient treatments. The highest values were achieved by 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) x 25% irrigation level (6.84 Kg) in the first season, 2000 ppm (B) + 1% (SL) x 25% irrigation level (7.82 Kg) in the second season and by 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) x 100% irrigation level (7.08 Kg) in the third season compared to the control and other treatments.

Yield/palm (Kg/ Palm)

Table (6): Mean values of the interaction of irrigation levels and micronutrient treatments on Yield/palm (Kg/ Palm) of date palm cv. Seewy during 2017, 2018 and 2019 seasons.

Levels (A) / Treatments (B)	season 2017			Season 2018			Season 2019		
	25%	50%	100%	25%	50%	100%	25%	50%	100%
Control	42.78	41.60	41.94	37.80	51.10	48.50	30.83	33.72	42.05
2000 ppm (B)	62.83	62.33	48.33	44.2l	57.30	57.80	47.05	49.00	60.33
250 ppm (Zn)	49.50	61.00	58.83	47.00	52.70	52.70	43.33	41.00	57.50
1% Silicon (SL)	47.67	55.33	39.33	42.80	51.80	58.20	38.50	43.17	59.67
2000 ppm (B) + 250 ppm (Zn)	49.00	48.67	44.00	62.50	58.80	54.00	49.67	53.83	57.00
2000 ppm (B) + 1% (SL)	61.67	48.33	57.17	49.50	52.80	53.50	43.83	49.17	58.00
250 ppm (Zn) + 1% (SL)	47.17	45.00	46.50	64.50	60.30	56.20	47.00	44.83	52.83
2000 ppm (B) + 250 ppm (Zn) + 1% (SL)	63.50	64.50	54.00	65.80	57.20	62.50	52.67	54.83	58.17
LSD at 5% level (A x B)	**4.94**			**5.77**			**8.74**		

Concerning the Yield/palm (Kg/ Palm) data in Table (6) preformed that, statistical analysis indicated significant differences for the interaction of irrigation levels and micronutrient treatments. The highest values achieved by 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment x 50% irrigation level (64.50 Kg/ Palm) in the first season, 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) x 25% irrigation level (65.80 Kg/ Palm) in the second season and by2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment x 100% irrigation level (58.17 Kg/ Palm) in the third season compared to the control and other treatments.

These data are in harmony with those reported by El Sabagh (2012) and Omar *et al.* (2015) found that spraying date palm bunches with boron significantly increased fruit set and fruit yield of some date palm cultivars.

Also, El-assar and El-sehrawy (2011) indicated that spraying B and Zn treatments significantly improved the yield of Zaghloul date palms. Besides, Sarrwy *et al.* (2012) found that Boric acid significantly rising fruit retention and bunch weight of date palm cv. Amhat. On the other hand, similar results were reported by Rahnama *et al.* (2012) showed that there was not significant effect of irrigation treatments on fruit set and yield of Barhee date palms, but fertilization treatments had significant effects. The interaction effects were significant on all characteristics. In addition, AL-Qurashi *et al.* (2016) revealed that increasing the water regime increased yield per Barhee date palms.

fruit quality characteristics

Fruit weight (g)

Table (7): Mean values of the interaction of irrigation levels and micronutrient treatments on fruit weight (g) of date palm cv. Seewy during 2017, 2018 and 2019 seasons.

Levels (A) / Treatments (B)	Season 2017			Season 2018			Season 2019		
	25%	50%	100%	25%	50%	100%	25%	50%	100%
Control	191.33	190.33	182.33	168.98	163.31	233.40	173.86	108.86	130.53
2000 ppm (B)	233.61	235.78	275.08	229.50	226.47	282.03	240.34	229.37	281.33
250 ppm (Zn)	245.95	199.67	239.63	237.34	231.81	251.91	238.47	250.33	275.70
1% Silicon (SL)	259.18	217.65	247.99	233.86	213.70	303.63	239.43	233.63	264.33
2000 ppm (B) + 250 ppm (Zn)	255.80	237.10	258.92	219.46	228.91	252.15	209.67	246.87	290.57
2000 ppm (B) + 1% (SL)	242.27	247.50	264.60	214.55	234.79	265.00	227.00	224.87	287.50
250 ppm (Zn) + 1% (SL)	260.17	234.03	273.63	242.99	236.79	273.39	240.57	245.53	290.30
2000 ppm (B) + 250 ppm (Zn) + 1% (SL)	266.28	238.39	369.77	260.59	234.03	304.98	260.10	253.70	295.73
LSD at 5% level (A x B)	**13.21**			**23.33**			**15.80**		

In regard to the fruit weight (g) data in Table (7) showed that, statistical analysis indicated significant differences for the interaction of irrigation levels and micronutrient treatments. The highest values achieved by 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment x 25% irrigation level (369.77, 304.98 and 295.73 g) in the three seasons, respectively compared to the control and other treatments.

Pulp weight (g)

Table (8): Mean values of the interaction of irrigation levels and micronutrient treatments on pulp weight (g) of date palm cv. Seewy during 2017, 2018 and 2019 seasons.

Levels (A) / Treatments (B)	Season 2017			Season 2018			Season 2019		
	25%	50%	100%	25%	50%	100%	25%	50%	100%
Control	138.63	149.33	231.46	130.23	128.09	130.23	132.16	88.00	100.50
2000 ppm (B)	173.14	203.09	196.70	168.03	165.94	203.11	200.57	197.03	209.97
250 ppm (Zn)	182.59	200.12	199.28	170.66	158.53	172.01	200.90	213.33	191.03
1% Silicon (SL)	191.67	203.75	196.33	176.88	172.94	175.98	206.70	198.33	251.07
2000 ppm (B) + 250 ppm (Zn)	196.97	199.04	231.83	159.44	172.32	183.47	171.77	206.67	201.33
2000 ppm (B) + 1% (SL)	186.94	174.27	203.33	170.14	174.49	203.82	189.60	184.87	242.33
250 ppm (Zn) + 1% (SL)	196.89	203.76	305.09	184.95	177.19	205.36	205.20	209.63	204.40
2000 ppm (B) + 250 ppm (Zn) + 1% (SL)	194.93	219.20	231.46	195.07	184.02	226.58	230.50	204.03	248.93
LSD at 5% level (A x B)	**8.01**			**14.32**			**18.62**		

In terms of the pulp weight (g) data in Table (8) revealed that, the interaction (irrigation levels × micronutrient treatments) was significant in the three seasons. The irrigation level at 100% × 2000 ppm

(B) + 250 ppm (Zn) + 1% (SL) treatment was generally superior to all treatments and gave the highest significant values (231.46 and 226.58 g.) in the first and second seasons, except in the third season the irrigation level at 100% × 1% Silicon (SL) treatment gave the highest significant values (251.07 g.) compared to the control and other treatments.

Pulp/fruit weight ratio

Table (9): Mean values of the interaction of irrigation levels and micronutrient treatments on pulp/fruit weight ratio of date palm cv. Seewy during 2017, 2018 and 2019 seasons.

Levels (A) / Treatments (B)	Season 2017			Season 2018			Season 2019		
	25%	50%	100%	25%	50%	100%	25%	50%	100%
Control	0.72	0.78	0.85	0.77	0.78	0.42	0.76	0.80	0.77
2000 ppm (B)	0.74	0.86	0.84	0.73	0.73	0.72	0.83	0.85	0.74
250 ppm (Zn)	0.74	0.91	0.82	0.71	0.79	0.73	0.84	0.85	0.69
1% Silicon (SL)	0.73	0.85	0.82	0.74	0.73	0.74	0.86	0.84	0.95
2000 ppm (B) + 250 ppm (Zn)	0.77	0.83	0.75	0.72	0.75	0.72	0.81	0.83	0.69
2000 ppm (B) + 1% (SL)	0.77	0.88	0.87	0.79	0.74	0.76	0.83	0.82	0.84
250 ppm (Zn) + 1% (SL)	0.75	0.87	0.74	0.76	0.74	0.76	0.85	0.85	0.70
2000 ppm(B) + 250 ppm(Zn)+1% (SL)	0.76	0.87	0.80	0.75	0.74	0.69	0.88	0.80	0.84
LSD at 5% level (A x B)	**2.95**			**5.52**			**7.12**		

As related to the pulp/fruit weight percentage data in Table (9) illustrated that, the interaction (irrigation levels × micronutrient treatments) was significant in the three seasons. The best treatments belonged to 250 ppm (Zn) × 25% irrigation levels (0.91and 0.79%) in the first and second seasons, respectively and 1% Silicon (SL) × 100% irrigation levels in the third season (0.95%) compared to the control and other treatments.

This finding is in line with that reported by Merwad *et al.* (2014) found that the higher physical fruit parameters were obtained by spraying Hayany date palm with Zn chelate.

Total soluble solids percentage (TSS %)

Table (10): Mean values of the interaction of irrigation levels and micronutrient treatments on total soluble solids percentage (TSS %) of date palm cv. Seewy during 2017, 2018 and 2019 seasons.

Levels (A) / Treatments (B)	Season 2017			Season 2018			Season 2019		
	25%	50%	100%	25%	50%	100%	25%	50%	100%
Control	12.33	13.00	13.00	15.01	16.34	16.01	16.90	13.57	13.57
2000 ppm (B)	19.53	20.20	20.00	18.70	17.80	19.53	19.40	20.07	18.43
250 ppm (Zn)	18.60	20.13	19.77	18.03	18.50	16.10	20.00	20.80	18.07
1% Silicon (SL)	18.40	19.63	14.33	18.50	17.00	16.50	19.35	19.67	19.00
2000 ppm (B)+250 ppm (Zn)	18.37	19.93	15.33	15.67	19.83	19.07	20.25	20.30	18.90
2000 ppm (B) + 1% (SL)	20.23	18.87	19.53	20.37	18.63	15.87	17.63	17.27	18.33
250 ppm (Zn) + 1% (SL)	15.20	20.07	13.60	16.83	18.77	17.67	17.00	17.93	18.83
2000 ppm (B) + 250 ppm (Zn) + 1% (SL)	19.83	19.70	18.47	18.27	17.83	18.33	20.70	19.93	20.17
LSD at 5% level (A) (B) (A x B)	**0.84**			**1.46**			**0.71**		

As for the total soluble solids percentage data in table (10) preformed that, statistical analysis indicated significant differences for the interaction of micronutrient treatments × irrigation levels. The highest values in the three seasons were always recorded for 2000 ppm (B) + 1% (SL) treatment ×

25% irrigation level (20.23 and 20.37%) in the first and second season, respectively and 250 ppm (Zn) treatment × 50% irrigation level (20.80%) in the third season compared to the control and most treatments.

Total sugars (%)

Table (11): Mean values of the interaction of irrigation levels and micronutrient treatments on total sugars percentage of date palm cv. Seewy during 2017, 2018 and 2019 seasons.

Levels (A) / Treatments (B)	season 2017			Season 2018			Season 2019		
	25%	50%	100%	25%	50%	100%	25%	50%	100%
Control	9.99	9.92	9.92	8.00	11.04	8.70	8.49	10.7	6.41
2000 ppm (B)	10.47	13.10	9.17	11.33	14.67	10.50	11.27	15.03	10.47
250 ppm (Zn)	13.03	7.07	8.37	17.33	14.33	11.10	11.80	10.57	9.53
1% Silicon (SL)	11.40	10.57	9.80	11.83	9.67	10.32	14.55	12.47	11.37
2000 ppm (B) + 250 ppm (Zn)	13.00	12.00	11.07	13.33	12.40	12.57	12.65	13.33	12.43
2000 ppm (B) + 1% (SL)	9.47	9.27	11.73	10.71	13.00	10.33	11.23	11.80	15.62
250 ppm (Zn) + 1% (SL)	12.10	9.27	10.13	10.20	9.87	10.03	12.27	12.50	11.30
2000 ppm (B) + 250 ppm (Zn) + 1% (SL)	11.70	11.13	10.57	11.40	11.87	11.53	13.10	13.80	15.65
LSD at 5% level (A x B)	**1.82**			**3.02**			**2.58**		

With respect to the total sugars percentage data in table (10) revealed that, statistical analysis indicated significant differences for the interaction of micronutrient treatments × irrigation levels. The highest values in the three seasons were always recorded for 2000 ppm (B) treatment × 50%irrigation level (13.10 and 14.67%) in the first and second season, respectively and 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment × 100% irrigation level (15.65%) in the third season with insignificant differences between 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment × 100% irrigation level and 2000 ppm (B) + 1% (SL) treatment × 100% irrigation level compared to the control and most treatments.

Reducing sugars (%)

Table (12): Mean values of the interaction of irrigation levels and micronutrient treatments on reducing sugars percentage of date palm cv. Seewy during 2017, 2018 and 2019 seasons.

Levels (A) / Treatments (B)	Season 2017			Season 2018			Season 2019		
	25%	50%	100%	25%	50%	100%	25%	50%	100%
Control	5.52	2.52	2.45	4.34	4.61	4.34	5.52	5.52	3.19
2000 ppm (B)	6.40	6.87	3.63	8.80	7.50	5.63	5.60	5.47	4.97
250 ppm (Zn)	6.70	3.50	3.73	9.27	3.60	4.97	6.00	5.80	6.33
1% Silicon (SL)	6.80	3.97	5.80	5.90	5.77	8.90	5.80	5.93	5.17
2000 ppm (B) + 250 ppm (Zn)	6.40	7.07	5.57	6.80	6.67	7.47	6.75	6.13	6.37
2000 ppm (B) + 1% (SL)	5.57	4.10	3.93	7.47	5.60	8.43	5.23	6.93	4.45
250 ppm (Zn) + 1% (SL)	6.30	4.57	5.20	6.63	7.23	7.30	6.23	5.43	5.93
2000 ppm(B) + 250 ppm(Zn)+1% (SL)	6.73	5.33	7.17	6.37	8.03	8.63	6.17	8.13	6.45
LSD at 5% level (A x B)	**0.89**			**1.64**			**1.46**		

In regard to the reducing sugars percentage data in table (12) showed that, statistical analysis indicated significant differences for the interaction of micronutrient treatments × irrigation levels. The highest values in the three seasons were always recorded for 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment × 25% irrigation level (6.73%) with in significant differences between 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment × 25% irrigation level and 100% irrigation level in the first season, 2000 ppm (B) + 250 ppm (Zn) + 1% (SL) treatment × 50% irrigation level (8.13%) in the third season and 1% Silicon (SL) treatment × 100% irrigation level in the second season compared to the control and other treatments. These results are in consistent with those reported by Harhash and Abdel-Nasser (2010) indicated that fruit quality characteristics were significantly improved with spraying date palm bunches with boron solution. Also, El Sabagh (2012) and Omar *et al.* (2015) found that Inflorescence boron spraying significantly increased fruit quality of some date palm cultivars. In addition, Akl *et al.* (2017) revealed that the best result with regard to fruit quality of Zaghloul date palms was obtained by spraying a mixture of silicon and nutrients. On the other hand, similar results were proved by Sadik *et al.* (2018) concluded that the quality parameters except the total soluble solid content of the date palm fruits were highest under the applied irrigation water levels 100% treatment (control). Finally, spraying date palm by micro nutrients had important role in fruit set, fruit retention and development and cause efficient yield and quality improvement (Moghimi, 2007 and Westover and Kamas, 2009). Many trails to supply boron to fruits have been confirmed that boron plays an important role for increasing pollen grains germination, pollen tube elongation, consequently, fruit set % and total yield, cell division, biosynthesis and translocation of sugars water and nutrient uptake (Khayyat *et al.*, 2007 and Ahmad *et al.*, 2009). Generally, date fruit production is negatively affected by lack of an adequate level of irrigation water. Applied irrigation methods have a large effect on date palm water requirements (Al-Almoud, 2010). Use of different mixed and single micronutrients like, zinc sulphate, ferrous sulphate, copper sulphate, magnesium sulphate, manganese sulphate, boric acid are known to play crucial role in growth, yield and quality of fruits (Alloway, 2008, Kumawat *et al.*, 2012 and Rakshit *et al.*, 2013). Therefore, nourish effect of macro and micro elements and adequate level of irrigation water had important role in fruit set, retention development and lead to increasing yield and improving fruit quality.

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تأثير مستويات مختلفة من الري والتسميد بالعناصر الصغرى على إنتاجية نخيل البلح السيوي

الملخص العربي

خلال مواسم 2017 و 2018 و 2019 ، تمت معاملة سوباطات نخيل البلح صنف السيوي المزروع في تربة رملية تحت نظام الري بالتنقيط للتسميد بالعناصر الصغرى مثل البورون في صورة حمض البوريك بمعدلات 2000 جزء في المليون ، الزنك في صورة كبريتات الزنك بمعدل 1000 جزء في المليون والسيليكون في صورة سيليكات البوتاسيوم بمعدل 1٪ لكل منهما بمفرده أو بالخلط بين المواد الثلاثة، تحت ثلاثة مستويات من مياه الري: 25 و 50 و 100٪ من السعة الحقلية، بداية من مرحلة التلقيح إلى مرحلة الحصاد. تم رش السوباطات مرتين، بعد التلقيح وفي مرحلة الكمرى. تهدف هذه الدراسة إلى تحسين إنتاجية وجودة ثمار صنف نخيل البلح السيوي. كان تطبيق معاملات المغذيات الصغرى ومستويات الري فعالاً للغاية في تحسين المحصول والجودة مقارنة بمعاملة الكنترول، تم تحقيق أعلى قيم لعقد الثمار، الثمار المتبقية بعد العقد، وزن السوباطة (كجم)، محصول النخلة(كجم)، المواد الصلبة الذائبة، السكريات الكلية والسكريات المختزلة عند المعاملة 2000 جزء في المليون (بورون) + 250 جزء في المليون (زنك) + 1 ٪ (سليكون)تحت جميع مستويات الري. بينما تم تحقيق أعلى قيم لوزن الثمار، وزن اللب ، وزن اللب / وزن الثمرة الكلي، عن طريق المعاملة 2000 جزء في المليون (بورون) + 250 جزء في المليون (زنك) + 1٪ (سليكون)تحت كلا من مستوى ري 25 أو 100٪ من السعة الحقلية. اقترحت هذه الدراسة أن تطبيق معاملة 2000 جزء في المليون (بورون) + 250 جزء في المليون (زنك)+ + 1 ٪ (سليكون) مرتين بعد التلقيح وفي مرحلة الكمري تحت جميع مستويات الري (25 و 50 و 100 ٪ من السعة الحقلية) يعتبر تقنية مفيدة في إنتاج ثمار عالية الجودة من صنف نخيل البلح السيوي تحت الظروف المناخية بسوهاج.
الكلمات المفتاحية: صنف السيوي ،حمض البوريك ، كبريتات الزنك ، سيليكات البوتاسيوم ، مرحلة الكمري ، ومستويات الري.