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Foliar Spray of Some Growth Regulators and Nutrient Elements for Improving Yield and Fruit Quality of Hayany Date Palm

[1]Merwad, M.A., [2]Eisa R.A., [1]Ashour, N. E. and Saleh, M.M.S.[1]

[1]Pomology Dept., National Research Center, (NRC), Cairo, Egypt
[2]Hort. Tech. Crop Dept. National Research Center, (NRC), Cairo, Egypt

ABSTRACT

The present investigation was carried out during the seasons of 2012 and 2013 seasons to study the effect of Naphthalen Acetic Acid (NAA), zinc chleate , boric acid and calcium chleate on fruit set, yield and fruit quality of Hayany date palm.

Generally , the higher fruit set and fruit retention percentage, and fruit weight, volume, length and diameter were obtained by spraying Hayany date palm with Zn chleate at 0.2% in both experimental seasons. While the highest bunch weight and palm yield were recorded by spraying calcium chleate at 0.4 % (20.67 and 23.67 kg/bunch) and (219.10 and 250.90 kg/palm) in the 1st and 2nd seasons, respectively , moreover, the highest total soluble solids and total acidity were cleared in fruits by spraying boric acid at 200 ppm (18.0 and 20.0 kg) in the 1st and 2nd seasons, respectively and gave the highest reducing sugars and total sugar percent in both seasons.

The lowest values of tannins content in fruit were obtained by spraying date palm with boric acid at 200 ppm (0.43 %) in 1st season and calcium chleate at 0.4 % (0.47 %) in the 2nd season.

***Kew words*:** Naphthalen acetic acid (NAA), zinc, boric acid , calcium , fruit set, yield , fruit quality , date palm .

Introduction

Date palms (*Phoenix dactylifera* L.) is one of the ancient domestic fruit crops in the Middle East countries and its fruits play an important role in the nutritious pattern of many people. It has always played an important role in the economic and social life of the people of these regions. In Egypt many cultivars were located at different districts, according to the diversity of their climatic requirement, especially average temperature and relative humidity which affect fruit maturation processes (Ibrahim and Hagag,1993). The total production of date fruits in Egypt is about 1.3 million tons (FAO, 2010).

Spraying NAA affected fruit retained percentage, bunch weight and fruit quality as well as fruit contents of TSS, total sugars and reducing sugars of date palm (Tavakkoli *et al*., 2007).

Spraying date palm by micro nutrients such as zinc, boron and calcium had important role in fruit set, fruit retention and development and cause efficient yield and quality improvement (Singh, and Sant Ram, 1983). Linkage impact of some micro elements on date yields and fruit quality were reported by many investigators (Etman, *et al*., 2007 , Atalla, *et al*., 2007, Westover and Kamas, 2009). In addition, many investigators mentioned that, the effect of micro-nutrient in pollen grain germination and pollen tube growth in many plant species (Talaie , *et al*., 2001 and Wojcik, & Wojcik, 2003). Boron plays an important roles in many functions of the plant such as hormone movement, activate salt absorption, flowering and fruiting process , and pollen germination specially its influences on the directionality of pollen tube growth (Robbertse *et al*.,1990]. Also, boron seems to play an important role in achieving satisfactory fruit set (Khayyat , *et al.* 2007) synthesis, transport of sugars and carbohydrate. Calcium is consider as one of the most important minerals determining the quality of fruit since it is required for cell elongation and cell division (Rizzi, & Abruzzese, 1990). Till now, a little attention have been paid towards nutrient elements, particularly Ca for palm nutrition. Despite minor elements affect greatly the physiological processes and play an important role in fruit retention of many fruit trees, as well as, improving the yield and fruit quality (Batru, *et al.,* 1984 and Khan, *et al.,* 1993).

The aim of this study is to evaluate the effect of NAA, zinc, boron and calcium spray on yield and fruit quality of Hayany date palm.

Materials and Methods

This investigation was carried out during the seasons of 2012 and 2013 on ten years old Hayany date palm, grown in sandy soil under drip irrigation system, planted at 7×7m apart at a private orchard at Blbies, El- Sharkia Governorate, Egypt. The selected palms were uniform in vigor and size , height and pollen

Corresponding Author: Merwad, M.A., Pomology Department, National Research Center, Giza, Egypt
E-mail: abdo.soil@yahoo.com

source. Twenty palms were selected and arranged in a completely randomized design with four replicates (1 replicate = 1 palm) per treatment (i.e. 5×4×1 = 20 palm). Five spraying treatments were arranged as follows:

T1: Naphthalen acetic acid (NAA)at 25 ppm
T2: Zinc chleate at 0.2%
T3: Boric acid at 200 ppm
T4. Calcium chleate at 0.4%
T5: Control (treated with water only)

Zn , B and Ca in the form of zinc chleate containing 14 % Zn and boric acid (H_3BO_3) having 18 % boron and Ca chleate (16%) , also NAA were sprayed to study their defection .

Bunches were sprayed after one week from pollination (in the first week of April by small hand gun sprayer until run-off. Wetting agent Tween 20 (1%) was applied with spraying solution.

Measurements:

Fruit set :

During the last week of June in each season fruit set percentage was determined by the following formula:

$$\text{Fruit set \%} = \frac{\text{The total number of fruits /spike}}{\text{The total number of flowers position in the same spike}} \times 100$$

Fruit retained percentage: it was calculated using the following formula

$$\text{Total number of retained Fruits (\%)} = \frac{\text{Total number of retained fruits per bunch}}{\text{Total scares number per bunch}} \times 100$$

Palm yield

At harvesting, bunches of dates were weighted and recorded, then multiplied by the number of bunches/palm to obtain the total yield/palm during the mid of September in both seasons**.**

Fruit samples were collected at the ripening stage. Hundred fruits were taken randomly from all bunches of each palm to determine physical characteristics as follows: fruits of each sample were weighed (g) and measured as length (cm) and diameter (cm), fruit shape index and then the flesh and seeds of the same samples were separately weighed (g). Also fruits of each sample were measured as volume (cm^3).

Fruit chemical characteristics at the rutab stage:

Total Soluble Solids (TSS) was determined by hand refractometer. Total acidity was determined according to (A.O.A.C.,1995). TSS/acid ratio was calculated for each sample.
Fruit sugars and tannins content: Total sugars were determined in the methanol extract using the phenol sulphoric acid and the percentage was calculated on dry weight basis according to Dubois *et al*. (1956).
Reducing sugars were determined in methanol extract according to the methods described in (A.O.A.C., 1995), while Non-reducing sugars were calculated as the difference between total sugars and reducing sugars.
Tannins: It was determined according to the Folin-Denis method described by Schanderl (1970).

Statistical analysis

Data were analyzed using analysis of variance (ANOVA) and means were compared using Duncan (1955) test at $p< 0.05$ to determine the significance of differences between the conducted treatments.

Results and Discussion

1. Fruit set, retention percentages and bunch weight

Regarding the percentages of fruit set and fruit retention in response to NAA, Zn, B and Ca spraying treatments , it is evident from the data presented in Table (1) that all treatments resulted in significant increase in fruit set percentage comparing with the control in both experimental seasons. Spraying Zn chleate at 0.2%

ppm gave the highest value of fruit set % (64.36 and 62.70 %) in both seasons, followed by spraying boric acid at 200 ppm (60.64 and 54.90 % in the first and the second seasons, respectively, meanwhile, the lowest fruit set was recorded by the control (15.7 and 20.27 %) in the 1st and 2nd seasons, respectively. Regarding fruit retention %, data indicated that spraying Zn chleate at 0.2% increased fruit retention percentage as compared with the control in the two seasons. The highest fruit retention percentage (25.3 and 25.0 %) was obtained by spraying zinc chleate at 0.2% in both seasons, followed by spraying boric acid at 200 ppm (22.0 and 21.6 %) in both experimental seasons. In the contrary, control treatment recorded the lowest fruit retention percent (6.0 and 8.3 %) in the 1st and 2nd seasons , respectively.

Table 1. Effect of some foliar spray with some growth regulators and nutrient elements on fruit retention , fruit set and yield of Hayany date palm during the seasons of 2012 and 2013

Treatments	Fruit retention (%)		Fruit set (%)		Bunch weight (kg)		Palm yield (kg)	
	1st season	2nd season	1st season	2nd season	1st season	2nd eason	1st eason	2nd season
NAA (25ppm)	8.67b	11.50c	19.52c	29.49d	15.00c	14.67d	159.0c	155.50d
Zn 0.2%	25.33a	25.00a	64.36a	62.70a	18.00b	20.00b	190.8b	212.00b
Boric acid (200 ppm)	22.00a	21.67a	60.64a	54.95b	17.00b	17.25c	180.2b	182.85c
Ca 0.4%	19.67a	17.00b	42.25b	36.73c	20.67a	23.67a	219.1a	250.90a
Control	6.00b	8.33c	15.73c	20.27e	9.00d	10.00e	95.40d	106.00e

A tentative explanation for increasing fruit drop percentage and yield per palm due to calcium and zinc sprays, may be due to explain as improving the formation of cellulose and lignin. These materials are required for building plant structure or preventing the abscission layer formation and consequently, reduction in pre-harvest fruit drop (Nijjar, 1985).

The increase in growth criteria of date palm fruit due to calcium and zinc sprays in addition to the reduction in the pre-harvest fruit drop surely reflected on improving the yield (Yogeratnam and Greenham 1982).

Concerning the average bunch weight and yield /palm as indication of yield of Hayany date palm due to zinc, boric acid, calcium and NAA sprays is illustrated in Table (1). All treatments increased bunch weight as compared with control. Spraying Hayany date palm with Ca at 0.4% gave the highest bunch weight (20.67 and 23.67 kg) and palm yield (219.1 and 250.90 kg) followed by zinc chleate at 0.2% (18.00 and 20.00kg) for bunch weight and (190.8 and 212.0 kg) for yield per palm, while NAA at 25 ppm recorded 15.00 and 14.67 kg/ bunch and 159.0 and 155.5 kg/palm in the 1st and 2nd seasons, respectively. On the other hand, the lowest bunch weight and palm yield recorded with the control treatment (9.00 and 10.00 kg / bunch for bunch weight and 95.40 and 106.0 kg for yield per palm) in the 1st and 2nd seasons, respectively. In this connection, calcium is consider as one of the most important minerals determining the quality of fruit since it is required for cell elongation and cell division (Rizzi, and Abruzzese, 1990). Zinc is applied to increase fruit number, size and quality. Also, application of Zn is effective in improving the yield, fruit quality parameters and reducing fruit drop of citrus fruit (Yasin *et al*., 2012).

Fruit physical characteristics

Fruit volume , length , diameter and fruit shape index

Data presented in Table (2) showed that, all foliar spray treatments had significant effect on fruit physical characteristics, i.e. fruit volume , length and diameter comparing with control treatment in both seasons, but no significant effect on fruit shape index was observed .

Generally, spraying palms with zinc chleate at 0.2% recorded the highest values of fruit volume, length and diameter in both seasons. On the contrary, the lowest values of physical characteristics were obtained with the control treatment (spraying with water only) in both seasons.

Increasing fruit physical characteristics may be attributed to the improvement of fruit growth and uptake of both Zn and/or Ca nutrients that accelerate metabolic processes.

Similar finding were reported by Khayat *et al.* (2007) and Desouky *et al. (*2007*)* on date palm.

Table 2. Effect of some foliar spray with some growth regulators and nutrient elements on fruit physical properties of Hayany date palm during the seasons of 2012 and 2013 seasons

Treatments	Fruit volume (cm^3)		Fruit length (cm)		Fruit diameter (cm)		Fruit shape index	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
NAA (25ppm)	13.67c	14.83b	4.93bc	5.08b	2.32b	2.43a	2.12a	2.09a
Zn 0.2%	20.17a	18.33a	5.54a	5.49a	2.60a	2.53a	2.13a	2.16a
Boric acid (200 ppm)	13.33c	12.67c	5.28ab	5.32ab	2.37b	2.40a	2.22a	2.21a
Ca 0.4%	16.50b	15.33b	5.48a	5.48a	2.51a	2.54a	2.18a	2.15a
Control	9.83d	11.33c	4.68c	4.67c	2.18c	2.22b	2.14a	2.10a

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Fruit weight, flesh, seed and flesh fruit ratio

Data presented in Table (3) indicated that all different spraying treatments had reflected a significant effect on fruit weight, flesh and seed as well as flesh fruit ratio of Hayany date palm than control treatment in both seasons.

As for fruit weight, spraying palm with Zn at 0.2% gave the highest fruit weight (20.67 and 19.83 g) without significant differences than Ca at the rate of 0.4% (18.83 and 19.00 g) in the 1st and 2nd seasons, respectively. While boric acid at 200 ppm gave intermediate value (17.17 and 17.00 g) in both seasons. On the other hand control treatment gave the lowest values (12.50 and 12.83g) in both seasons.

Table 3. Effect of some foliar spray with some growth regulators and nutrient elements on fruit weight , flesh and seed weight as well as flesh/fruit ratio of Hayany date palm during the seasons of 2012 and 2013.

Treatments	Fruit weight (g)		Flesh weight (g)		Seed weight (g)		Flesh / fruit ratio	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
NAA (25ppm)	16.83b	17.67bc	13.83b	15.17b	3.00a	2.50a	0.82b	0.86a
Zn 0.2%	20.67a	19.83a	18.00a	17.83a	2.67ab	2.00a	0.87ab	0.90a
Boric acid (200 ppm)	17.17b	17.00c	15.00b	14.67b	2.17ab	2.33a	0.87ab	0.86a
Ca 0.4%	18.83ab	19.00ab	16.83a	17.00a	2.00b	2.00a	0.89a	0.89a
Control	12.50c	12.83d	10.67c	11.00c	1.83b	1.83a	0.85ab	0.86a

Concerning flesh weight (g), data depicted in Table (3) clearly indicated that all spaying treatments significantly affected fruit flesh weight in both seasons. In this concern spraying date palm with Zn at 0.2% gave the highest flesh weight (18.00 and 17.83 g) without significance than Ca at 0.4% (16.83 and 17.00 g) in the 1st and 2nd seasons, respectively , followed by boric acid at 200 ppm (15.00 and 14.67 g) and NAA at 25 ppm (13.83 and 15.17g) while control treatment gave the lowest flesh weight (10.67 and 11.00 g) in both experimental seasons.

Respecting seed weight, results tabulated in Table (3) indicted that, seed weight significantly affected by different spraying treatments in the first season only. Control treatment gave the lowest seed weight (1.83 g) without significant differences than other spraying treatments, except NAA treatment in the 1st season.

As for flesh/fruit fruit ratio, the same data in Table (3) showed that , spraying date plam with Ca at 0.4% significantly increased flesh fruit ratio (0.89) without significant differences with all spraying treatments, except NAA at the first season only.

The increment in fruit weight and diameter with zinc sprays might be due to important component for fruit growth and development which have been influenced via tryptophan by zinc sprays (Sahota and Arora, 1981). The improvement occurred in fruit quality and quantity due to spraying palm with zinc could be attributed to its effects on enhancing formation and translocation of carbohydrates and carbohydrate enzymes (Sadrollah and Akhtar 2009).

The above results are in agreement with those reported by (Batru, *et al.,* 1984). Since they found that application of Zn at 0.6% as foliar spray gave the best results with regard to fruit weight and diameter in Kagzi lime.

Fruit chemical characteristics

TSS, acidity and TSS/ acid ratio

The results in Table (4) indicate that foliar spray treatments included NAA, Zn, Bo and Ca had a significant effect on TSS, acidity and TSS/ acid ratio in both seasons.

As for TSS and acidity, data showed that , the highest TSS and acidity were obtained when the palm sprayed with Ca at 0.4% (33.73 and 34.27) regarding TSS and (0.28 and 0.27) as for total acidity in fruits in the 1st and 2nd seasons, respectively without significant than control treatment in both studied seasons and with boric acid at 200 ppm in the 2nd season with respect total acidity.

Concerning TSS/ acid ratio, all treatments had a significant effect on TSS / acid ratio than spraying date palm with NAA at 25 ppm in both seasons.

Table 4. Effect of some foliar spray with some growth regulators and nutrient elements on TSS, acidity and TSS/ acid ratio of Hayany fruits during the seasons of 2012 and 2013.

Treatments	TSS		Total acidity (%)		TSS/acid ratio	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
NAA (25ppm)	30.30b	29.87c	0.12c	0.14c	264.93a	228.43a
Zn 0.2%	30.30b	31.13b	0.17bc	0.21b	185.17b	150.74b
Boric acid (200 ppm)	30.93b	31.07b	0.21b	0.23ab	147.61bc	135.22b
Ca 0.4%	33.73a	34.27a	0.28a	0.27a	120.60c	127.31b
Control	30.60b	30.13c	0.22ab	0.26ab	137.49bc	117.64b

Sugars and total Tannins

Reducing sugars percentage, it was significantly affected by different foliar spray treatments in both seasons (Table 5). Foliar spray of bunches with the boric acid at 200 ppm recorded higher reducing sugars (64.87 and 64.70 %), in the 1st and 2nd seasons, respectively, followed by spraying palms with Ca at 0.4 % .

Concerning non-reducing sugars percentage, data in Table (5) indicated that fruit content of non-reducing sugars was affected significantly by different treatments than NAA at 25 ppm in the two season and control fruits in the 2nd season . The highest value of non-reducing sugars percentage was obtained with spraying palms with 0.2 % Zn chleate in the 1st season (7.39 %) and with 200 ppm boric acid in the 2nd season (8.60%) .

As for total sugars percentage, results in Table (5) showed that, spraying palm with boric acid at 200 ppm had significantly increased total sugars % comparing with other treatments (71.91 and 73.30%) in the 1st and 2nd seasons, respectively .

Respecting Tannin content in the fruits, data in Table (5) illustrate that , foliar spray treatments had significant effect on total tannens in both seasons. Spraying bunches of date palm with NAA at 25 ppm significantly increased tannin values in fruit and recorded the highest values (0.62 and 0.64) in the 1st and 2nd seasons, respectively. On the other hand, spraying palms with boric acid at 200 ppm or Ca at 0.4 % recorded the lowest value of tannin in the fruit (0.43 and 0.47 %) in the 1st and 2nd seasons, respectively. The improvement occurred in the fruit quality due to supplying trees via leaves with calcium and zinc could be attributed to their effects on enhancing formation and translocation of carbohydrates and carbohydrate enzymes, Yogeratnam and Greenham (1982). Also, Hansch and Mendel (2009) found that boron has a main role in many processes specially transport of sugars and carbohydrate metabolism.

It can be concluded that , spraying date palms with zinc at 0.2 % was the best treatment for enhancing fruit retention , fruit set percentages and bunch weight of Hayany date palm.

Table 5. Effect of some foliar spray with some growth regulators and nutrients elements on sugars and tannins of Hayany fruits during the seasons of 2012 and 2013

Treatments	Reducing sugar (%)		Non reducing sugars (%)		Total sugars (%)		Total tannins (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
NAA (25ppm)	61.23 c	61.80c	6.21 b	6.03c	67.45 d	67.83e	0.62 a	0.64a
Zn 0.2%	61.63 c	62.03c	7.39 a	7.80ab	69.03 c	69.83c	0.52 b	0.49bc
Boric acid (200 ppm)	64.87 a	64.70a	7.04 a	8.60a	71.91 a	73.30a	0.43 c	0.54b
Ca 0.4%	63.03 b	62.93b	7.08 a	8.03ab	70.12 b	70.97b	0.50 b	0.47c
Control	61.47 c	61.87c	7.11 a	6.90bc	68.59 c	68.77d	0.50 b	0.48c

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