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Effect of Potassium and Boron Fertilization on Vegetative Growth and Mineral Contents in leaves of Hayany Date Palm

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ABSTRACT

The present study was carried out during 2014/15 seasons on hayany date palm cultivar (*Phoenix dactylifera* L.) grown in sandy loam soil in a private date palm orchard at El-Qurin district, Sharkia Governorate, Egypt to evaluate the effect of potassium sulfate and boron on vegetative growth and mineral contents of leaves of Hayany date palm cultivar. Potassium sulfate broadcasted in two rates: 0 and 2 kg/palm (48% K_2O); while boron was sprayed on inflorescence as boric acid at three rates: 0.0, 40 and 60 mg /l. during 2 – 3 days of natural inflorescence cracking before pollination. Results showed that soil application of potassium sulfate at 2 kg /palm /year and /or inflorescence boron spraying at (60 mg /l) showed positive effect to enhancing vegetative growth of date palm Hayany cultivar and increased palm yield and fruit weight. In addition, results demonstated that the treatments were increased insignificantly on N, P and K percentage contents in the leaves of Hayany date palm compared to control. Due to the obtained results it could be recommended to fertilize hayany date palms using 2 kg K_2 SO_4/palm /year as soil application and of inflorescence boron spraying at 60 mg /l to get the desirable vegetative growth concerning fruit weight and yield / palm and a good level of mineral percentages in the leaves.

Key words: Hayany date palm cultivar, sandy loam soil, potassium sulfate,boron.

Introduction

The date palm (*Phoenix dactylifera* L.) has been an important crop in arid and semi-arid regions of the world. Date palm is one of the ancient domestic fruit trees in the Middle East countries and their fruits play an important role in the nutrition pattern of many people. It has always played an important turn in the economic and social life of the people of these regions.

In Egypt, date palm ranked the third crop after orange and grape (Agric. Econ. Bull., 2005). Owing to date palm can grow and produce under a wide range of soil and climatic conditions, growers have mistakenly believed that it does not require much attention. The successful orchard management practices are directed toward obtaining a suitable yield with good fruit quality.

Date fruits are very popular in the Arab and Islamic regions. In Egypt, the total number of date palm trees reached 12,296,593 producing 1,328,468 tons yearly. While the number of Hayany dates reached 2,401,193 palm producing 317,257 tons yearly (Statistics of Ministry of Agriculture, 2013 Egypt). Hayany is one of the very important local date cvs. in most Egyptian regions.

It has been well known that the nutrient requirements of the date palms could be fulfilled through the fertilizers application for the inter planted crops. However, this pattern of application depends on soil texture and the interplant crops. In addition, the nutrient requirements of the date palms differ greatly within each stage of tree life. Montasser *et al.* (1991) recommended 2 or 3 Kg of potassium sulphate to increase the vegetative growth of Seewy date palm. In addition, Shawky *et al.* (1999), Harhash (2000) and Bamiftah (2000) supported this result.

Potassium fertilizer rate increased both N and K concentration in leaves of 'Zaghloul' date palm cultivar Kassem *et al.,* (1997) and in 'Seewy' date palm cultivar Montasser *et al.* (1991), while Ca and Mg contents tended to decrease. Increasing potassium fertilization increased the pinnae contents of N, P, K, Fe, Mn, Cu and Zn, while the Ca and Mg contents were decreased significantly on date palm cultivar "Zaghloul" Harhash, and Abdel-Nasser 2007. Potassium fertilization gave a significant

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increase in the content of N, P, K and Ca, but the increase of Mg content was not significant on date palm cultivar "Khalas" Shahin (2007). Osman (2010) showed that, potassium sulphate fertilization gave the highest leaf mineral content of "Bartamoda" cultivar date palm.

Pinnae length was increased because of flower boron spray Bent Eisha date palm cultivar Ahmed while Ahmed (1997) and on Zaghloul date palm, N, P and K were significantly higher than those of the control (Etman 2007).

Improving plant uptake reflects on increasing vegetative growth and consequently improves efficiency for absorption and utilization of nutrients (Mangel and Kirkby, 1987). Increasing elemental contents on leave olive due to K-fertilization may be attributed to the fact that increasing K-fertilization can improve plant ability to uptake soil nutrients (Abdel-Nasser and El-Shazly, 2001 and Saadati *et al.,* 2016).

The present thrasher was conducted out to study the effect of potassium and boron on vegetative growth and mineral contents of leaves of Hayany date palm cultivar under El-quren, Sharkeia Governorate conditions

Materials and Methods

The present investigation was carried out during two successive seasons; 2014 and 2015 on hayany date palm cultivar (*Phoenix dactylifera* L.) grown in a private date palm orchard at El-Quren district, El-Sharkeia Governorate, Egypt, to study the effect of soil application using potassium sulfate and inflorescence boron spraying on vegetative growth and mineral contents of leaves.

Fifteen -year-old hayany palms were selected for the study, planted at 10 x 10 meters apart and grown on sandy loam soil. Some physical and chemical properties of the soil are presented (Table 1) in El-quren private orchard located at Sharkeia Governorate, Egypt.

Table 1: Some physical and chemical properties of orchard soil at start of the experiment:

Particle size distribution, %			Textural Class	$CaCo_3$ %	pH**	EC dS/m	Ions me, $100g^{-1}$ Soil							
Sand	Silt	Clay					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$Co_3^{=}$	HCO_3^{-}	Cl	$SO_4^{=}$
73.3	2.0	24.7	SCL *	2.2	8.5	0.27	0.50	0.55	0.73	0.07	-	0.80	0.60	0.48

*SCL * sand clay loam ** in 1: 2.5 soils: water suspension*

Eighteen palms, as uniform as possible, were randomly selected. The experimental design was factorial experiment between soil application of potassium sulfate at (0 & 2 kg /palm) and three inflorescence boron spraying (as boric acid at 0.0, 40 and 60 mg /l) in completely randomized design, including 6 treatments each with three replicates and one palm per each replicate. All selected palms were fertilized with the recommended dose of 2 kg N and 1 kg P / palm required for Hayany date palm in equal three doses at (Feb., Apr., and May) as soil broadcast around the trunk of each palm received the same cultural practices and soil application with (200 g Fe + 100 g Mn + 100 g Zn) /palm /year for all treatments.

All spathes on each palm were sprayed once with boric acid, 2-3 days after spathe cracking (before pollination) during April in the two experimental seasons. The quantities of potassium sulfate were broadcasted around each palm trunk in one dose in the first week of April. The experimental palms were immediately irrigated after treatments. The same pollen source was used to pollinate the experimental palms during the two seasons of study.

In order to determine vegetative growth and its mineral content, twenty pinnae per each replicate were collected in November, from the middle pinnae of the full-developed leaves around the axis above fruiting zone as recommended by Abdalla *et al.,* (1998). For each pinnae sample, length and maximum width were determined. Pinnae (leaflet) area was calculated according to the equation of Shabana and Antoun (1980) as follows:

Leaflet area = length × maximum width × 0.84. Length of new growing leaves were determined at the end of each growth season, average number of pinnae/leaf was determined for mature leaves, and leaf area was calculated by multiplying the average pinnae area by average number of pinnae/leaf.

The Pinnae samples were washed, dried ground and digested using sulphoric acid and hydrogen peroxide according to Chapman and Pratt (1961). N, P, K and Ca were determined in the digested solution as follows:

a) Total nitrogen was determined using the micro-Kjeldahl method as described by Pregl (1945).

b) Phosphorus was estimated colorimetrically by the stannous chloride method according to Truog and Meyer (1929).

c) Potassium content was determined by Flame photometer according to method of Jackson (1958).

d) Calcium was determined by titration against versenate solution (Na-EDTA) according to Chapman and Pratt (1961).

Collected data were subjected to statistical analysis according to the methods described by Snedecor and Chochran (1989). Mean separation was done using Duncan multiple range test at 5 % level (Duncan, 1958). Analysis of variances and mean comparison were performed using SPSS software version14. The combined data of yield components and vegetative growth were subjected to simple correlation according to Svab (1973).

Results

Pinne characteristic:

Data in Fig. 1, clearly showed that potassium sulphate through soil application at 2 kg /palm /year increased pinne characteristics of Hayany date palm, while it was only significant with average pinne area in both seasons.

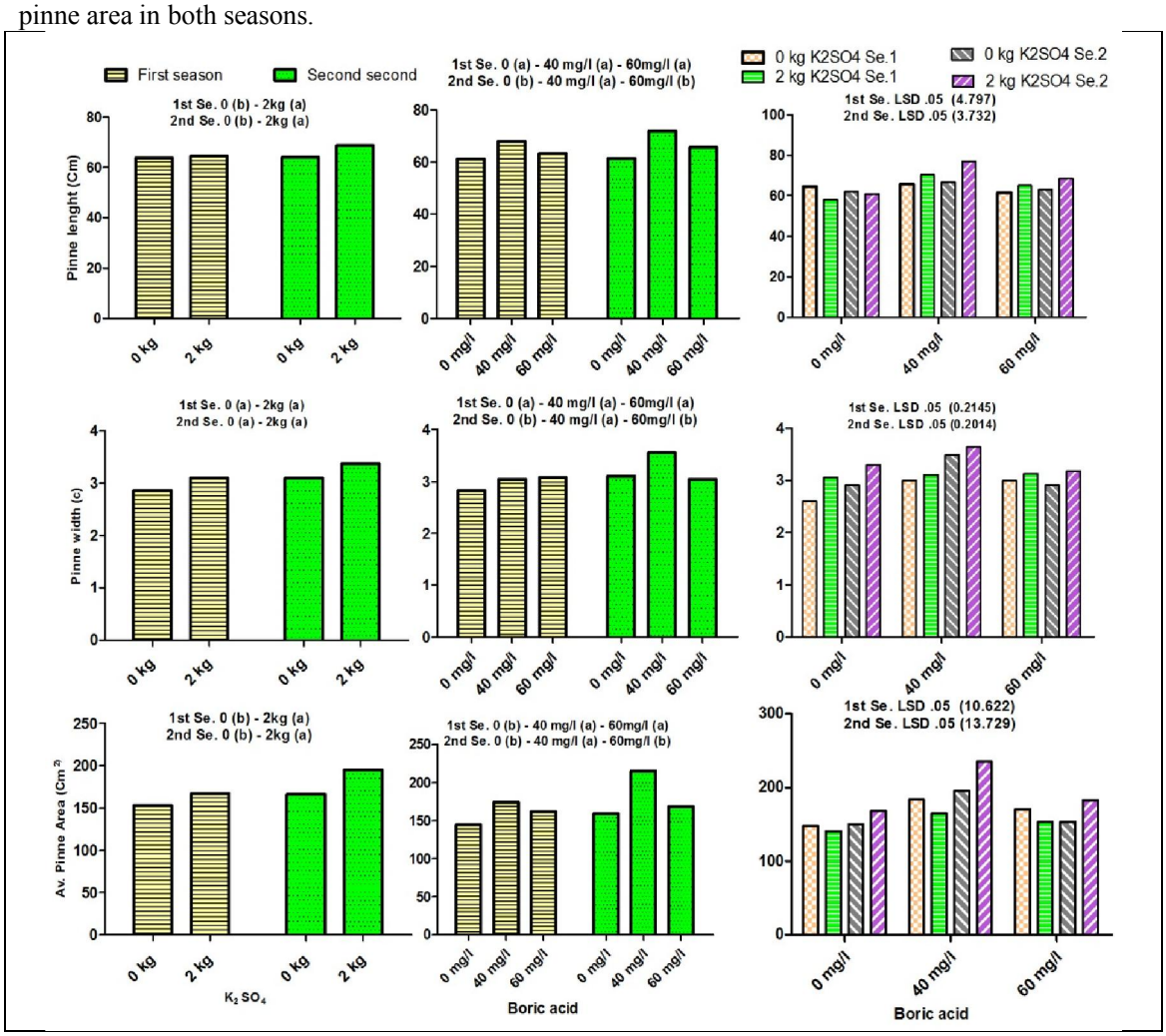

Fig. 1: Effect of soil application of potassium and flower boron spray on pinne characteristic of Hayany date palm in 2014 and 2015 seasons.

Inflorescence B spray 40 ppm significantly increased pinne characteristic of Hayany date palm in alike seasons.

The interaction between potassium sulfate soil application and inflorescence boron spray on pinne characteristics of Hayany date palm was significant in both seasons. The interacted 2 kg K_2SO_4 /palm /year increased these parameters with of boron spray 40 mg /l.

Leave characteristics:

Results presented in fig. 2 revealed significant increments in leave characteristics of Hayany date palm resulting due to increasing K fertilization in both seasons.

Results indicated that no. pinne / leave and av. leaf area were significantly increased by increasing boron levels in both seasons. While, the effect of boron treatments on leaf length has not given a clear trend.

As for the interaction effects, Fig. 2, illustrates that cluster boron spraying in most cases at 60 mg /l treatment increased leaf characteristics of Hayany date palm with soil application of 2 kg K_2SO_4 /palm /year in both seasons.

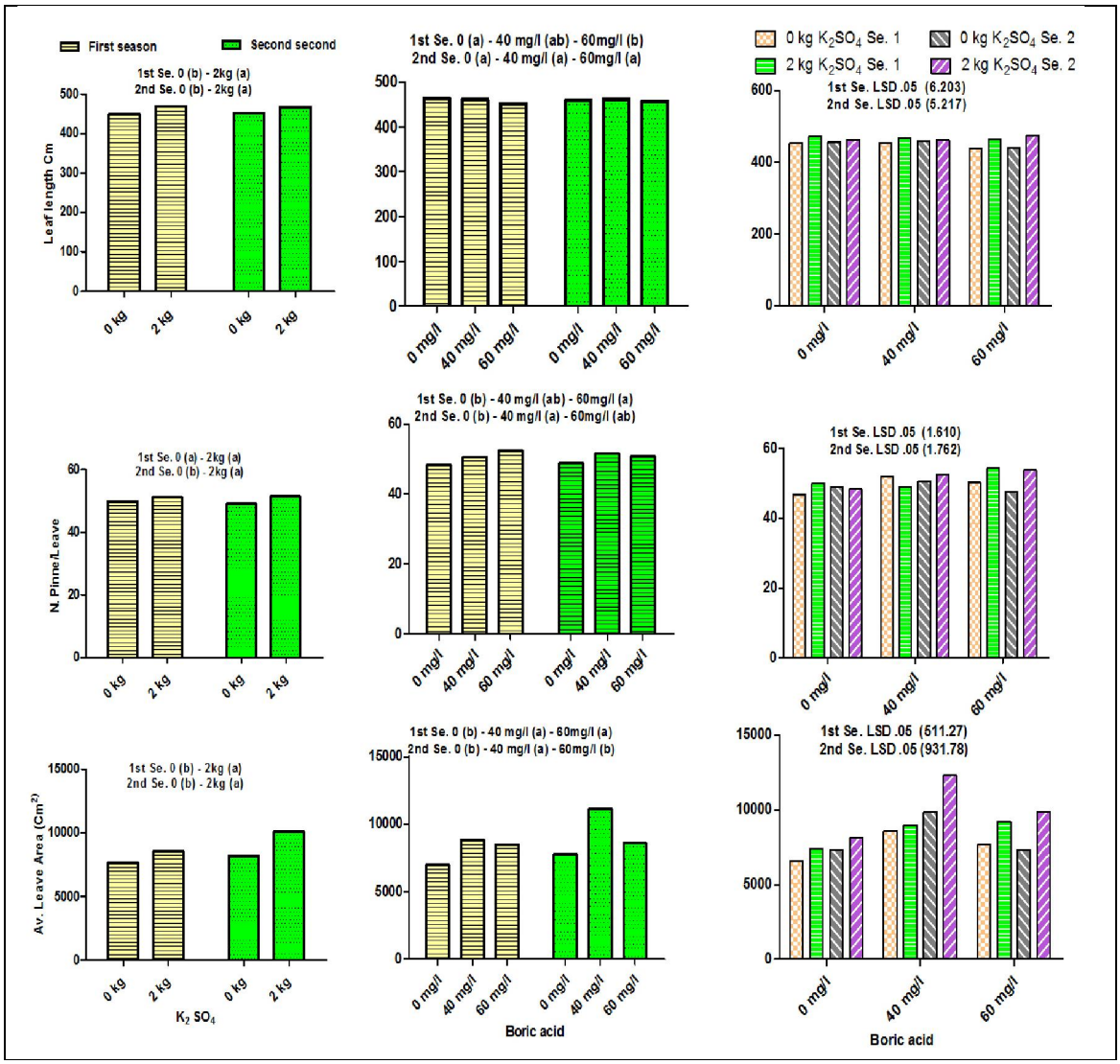

Fig. 2: Effect of soil application of potassium and flower boron spray on leaf characteristic of Hayany date palm in 2014 and 2015 seasons.

Leaf mineral content:

The data in Fig. 3 indicate the effects of potassium sulfate soil application on N, P and K percentage contents in the leaves of Hayany date palm. It was insignificantly but soil application at 2 kg /palm /year was significantly increase of Ca percentage contents in the leaves. This was confirmed during the two tested seasons.

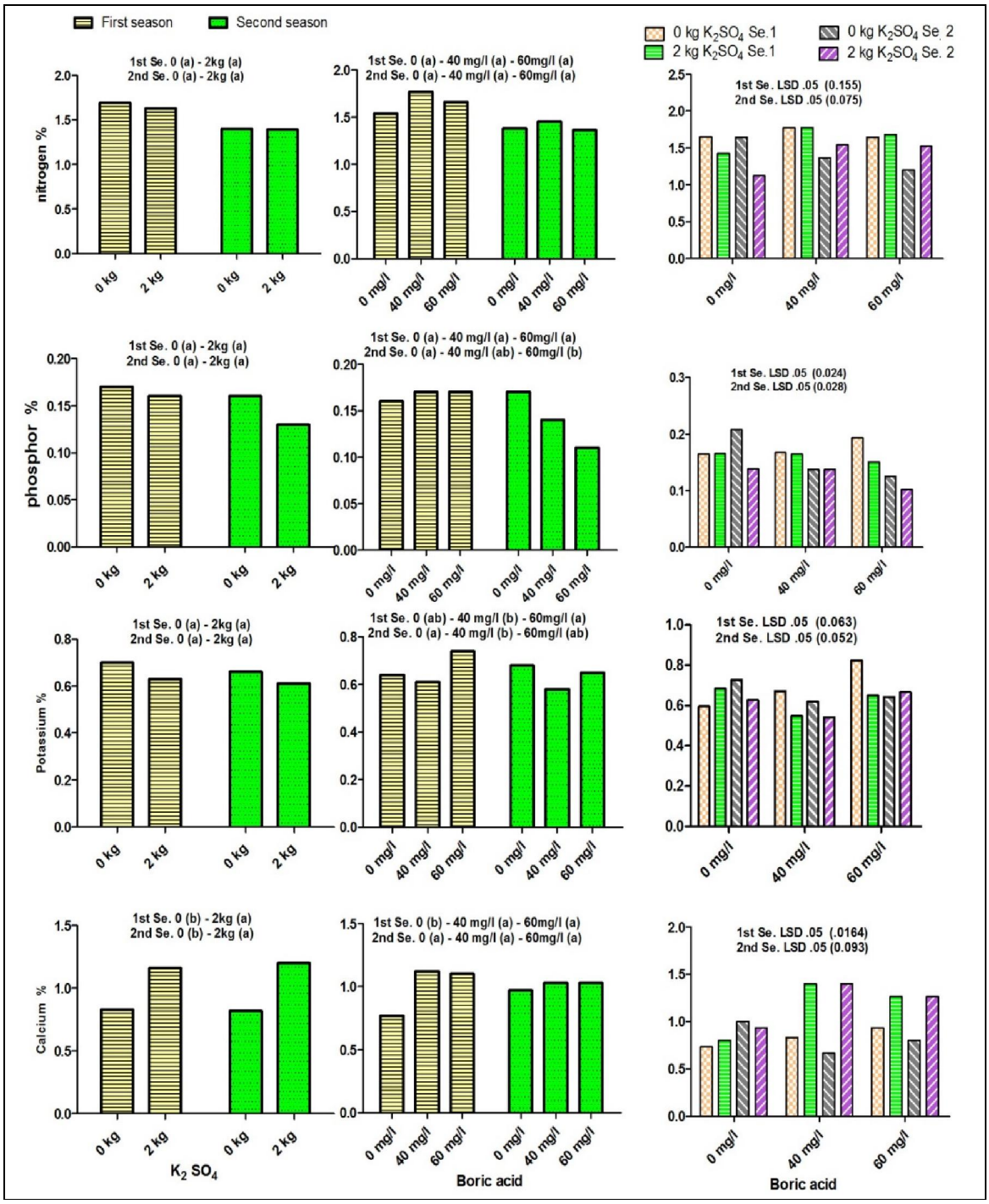

Fig. 3: Effect of soil application of potassium and flower boron spray on leaf mineral content of Hayany date palm in 2014 and 2015 seasons

Results indicated that no significant difference between boron treatments in effect of nitrogen concentrations in Hayany date palm leaf, while 40 mg /l treatment increased showed the highest nitrogen concentration. The effect of boron treatments on P and K percentages contents in the leaves of Hayany date palm did not gave a clear trend. While, Ca percentage contents in the leaves was increased with 40 and 60 mg /l treatments in the two seasons.

The interaction between (K_2SO_4 x boron) was significant on effect of nitrogen and phosphor concentrations in Hayany date palm leaf in the two seasons, but did not showing a clear trend. The highermost percentage of potassium was acquisitive from the interaction between boron spraying at 60 mg /l treatment and zero & 2 kg K_2SO_4 /palm /year in the first and second seasons, respectively. The highest Ca percentage contents in the leaves obtained from the interaction between soil application at 2 kg /palm /year with 40 and 60 mg /l treatments in the two seasons.

Fruit weight and yield / palm:

In addition, from Fig. 4 data show the fruit weight and yield / palm resulted from potassium sulphate through soil application at 2 kg /palm /year and spraying inflorescence with boron at 60 mg /l. These results were discussed by Zagzog and Salem (2016).

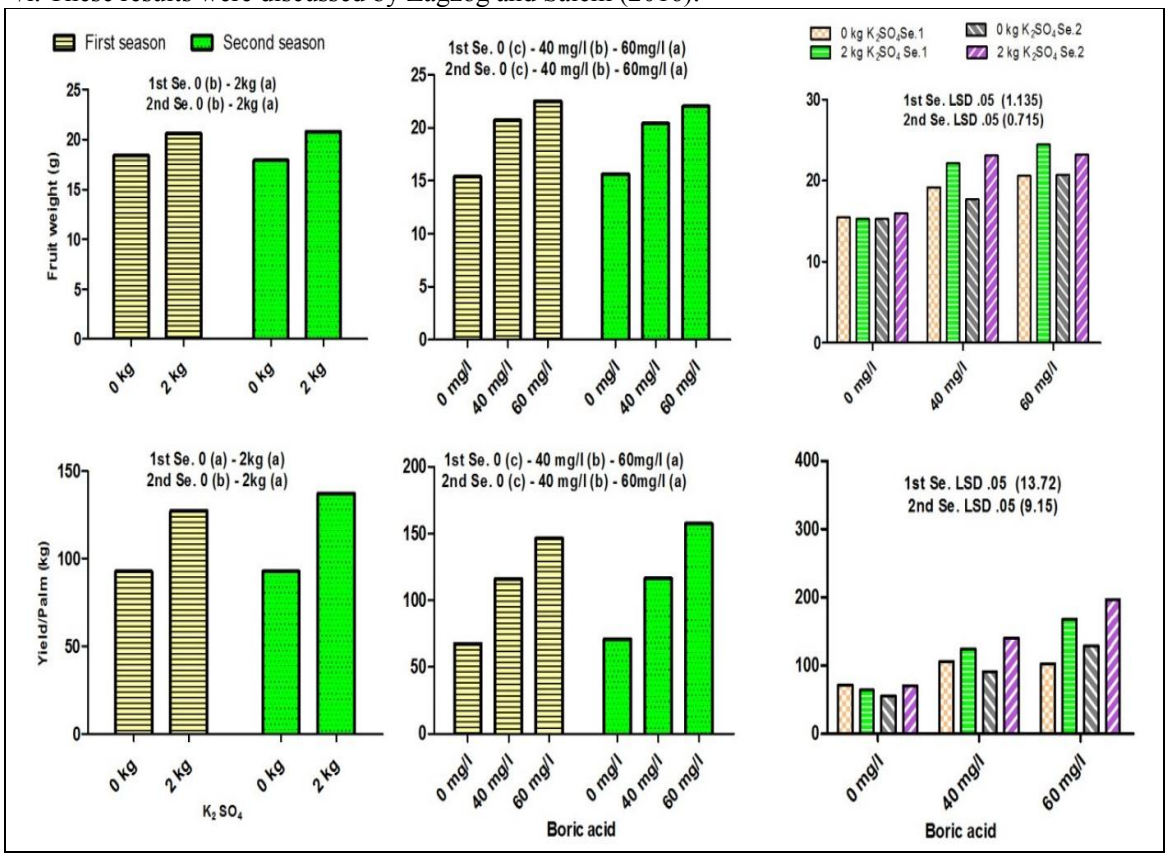

Fig. 4: Effect soil application of potassium and flower boron spray on fruit weight and yield / palm of Hayany date palm in 2014 and 2015 seasons.

Correlation coefficients:

Combined analysis data described in Table 2 show the simple correlation coefficients between palm yield and the studied characters.

It is clear that, palm yield was positive and highly significant correlated with each of Ca percentage, pinne length, number of pinnes / leaf as well as fruit weight. Both av. pinne area and fruit weight showed the same relations with the other listed characters. In addition, palm yield was positive

and significant correlated with av. pinne area. However, the correlation coefficient between palm yield and P percentage was negatively.

Average pinne area was positive and highly significant correlated with each of Ca percentage, pinne length and pinne width as well as that trait was positive and significant correlated with no. of pinne / leaf. K percentage showed the same relations with leaf length.

In addition, the correlation coefficients between N percentage and P percentage as well as between Ca percentage and pinne length were positively and highly significant.

Phosphor percentage was negative and significant correlated with each of pinne width, av. pinne area and av. leaf area. Potassium percentage showed the same relations with each of pinne length and av. pinne area.

Table 2: Simple correlation coefficients between palm yield and some elements content of leaf, pinne and leaf determinations as well as fruit weight

Classification	1	2	3	4	5	6	7	8	9	10	11
Y= Palm yield	0.024	- 0.359*	-0.162	0.598**	0.447**	0.183	0.467**	0.150	0.413*	0.488**	0.811**
1- N %		0.501**	0.037	0.304	0.172	- 0.169	0.115	- 0.039	- 0.011	0.022	0.235
2- P %			0.319	- 0.096	- 0.092	- 0.425*	- 0.304	- 0.159	- 0.363*	- 0.402*	- 0.298
3- K %				- 0.175	- 0.391*	- 0.141	- 0.049	0.335*	- 0.358*	- 0.326	- 0.198
4- Ca %					0.456**	0.288	0.305	0.271	0.490**	0.502**	0.625**
5- Pinne length						0.119	0.276	0.174	0.719**	0.704**	0.443**
6- Pinne width							0.273	0.189	0.774**	0.735**	0.254
7- No pinne / leaf								0.309	0.367*	0.599**	0.527**
8- Leaf length									0.241	0.292	0.068
9- Av. Pinne area										0.964**	0.458**
10- Av. leaf area											0.540**
11- Fruit weight											

Discussion

According to our results, the soil application of potassium sulfate and/or inflorescence boron spraying improved vegetative growth of Hayany date palm. These results are in parallel with the findings of Montasser *et al.* (1991), Ahmed and Ahmed (1997), Shawky *et al.,* (1999), Harhash (2000), Bamiftah (2000) and Etman *et al.* (2007) with different cultivars of date palm. Improving plant uptake reflects on increasing vegetative growth and consequently improves efficiency for absorption and utilization of nutrients (Mangel and Kirkby, 1987 and Abdel-Nasser and El-Shazly, 2001).

The beneficial effect of K-fertilization may be attributed to the physiological role of potassium in carbohydrate formation, translocation and accumulation within plant organs (Evans and Sorger, 1966 and Mayer and Anderson, 1970). In addition, K is involved in plant meristematic growth (Mangel and Kirkby, 1987). Also, synergistic effect between K and indole acetic acid and the enhancement of K on gibberelic acid and cytokinins effects on plant growth (Coccuci and Dalla Rosa, 1980 and Green, 1983).

According to obtained data, the soil application of potassium sulfate and/or inflorescence boron spraying on N, P and K percentages contents in the leaves of Hayany date palm was insignificant. The effect of boron treatments on P and K percentages contents in leaves of Hayany date palm has not given a clear trend. While, Ca percentage contents in that leaves was increased with 40 and 60 mg /l treatments in the two seasons. Also, results showed that the soil application of potassium sulfate and/or inflorescence boron spraying increased yield of palm, the average of fruit weight and improved vegetative growth of Hayany date palm. However, these did not influence to increase nutrients percentages in leaves of Hayany date palm may be due to increased average leaf area and therefore less relative concentration nutrients. These results are in agreement with Harhash and Abdel-Nasser (2010), Dialami & Mohebi (2010) and Ibrahim *et al.,* (2013). While, results contradict with Montasser *et al.,* (1993), Kassem *et al.,* (1997), Harhash, and Abdel-Nasser (2007), Shahin (2007) and Osman (2010) with different cultivars of date palm.

Conclusions

Boron and potassium plays an important role in the development of date palm and cause efficient yield and improved vegetative growth. Results revealed that mixture of boric acid and potassium sulphate had a positive effect to enhancing vegetative growth of date palm Hayany cultivar and increase palm yield and fruit weight. However, it could be concluded that the promising treatments are 2 kg K_2SO_4 /palm /year and / or boric acid 60 mg /l gave the good vegetative growth concerning fruit weight and yield / palm.

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