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INFLUENCE OF CHEMICAL FERTILIZER, EM BIOSTIMULANT AND THEIR COMBINATIONS ON GROWTH AND QUALITY OF *PHOENIX DACTYLIFERA* L. CV. SIWI OFFSHOOTS

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ABSTRACT: A trial was carried out at the Experimental Farm of Hort. Res. Inst., ARC, Giza, Egypt during 2013 and 2014 seasons to study the effect of individual application of EM biostimulant solution at 25 ml/l, NPK complete chemical fertilizer (20:20:20 + microelements) at the rates of 0, 2.5, 5.0, 7.5 and 10.0 g/bag and their combinations on growth and chemical composition of 2-years – old offshoots of date palm (*Phoenix dactylifera* L.) cv. Siwi planted in 50-cm-diameter plastic bags filled with about 35 kg of a mixture of sand and clay (2 : 1, v/v) under the full sun.

The results showed that all fertilization treatments used in this study markedly improved all vegetative growth characters with various significant levels when compared to control in both seasons. The results indicated also that EM solution alone gave means closely near to those gained by NPK complete fertilizer at 5 g/bag with few exceptions in the two seasons. Moreover, increasing application rate of NPK fertilizer to 7.5 g/bag or more did not cause a pronounced increment in growth, but combining between EM treatment and NPK fertilizer at any rate did so, with the superiority of combining between 25 ml/l EM and 5 g NPK/bag, as this combination gave the highest means over all sole and other combined treatments in both seasons. Similar observations were also attained concerning the leaf let content of N, P, K, total indoles, chlorophylls a and b and carotenoids.

Hence, it can be recommended to treat the 2-years-old offshoots of date palm cv. Siwi cultivated in 50-cm-diameter plastic bags with EM solution at 25 ml/l and NPK complete fertilizer at 5 g/bag to improve growth and quality of such offshoots before transferring to the permanent field.

Key words: Date palm, *Phoenix dactylifera* L. cv. Siwi, EM biostimulant, NPK fertilization, Vegetative growth, Chemical composition.

INTRODUCTION

Phoenix dactylifera L., date palm (Fam. Palmaceae) is one of the common and popular fruit grown in tropical and subtropical areas. There are many cultivars of date palm, some of them gave semi-dry fruits, among which cv. Siwi. It is one of the most famous and distributed cultivar in Egypt, especially at the governorates of New Valley, Wahat, Giza and Fayoum. Each cv. Siwi date palm tree yields about 90 up to more than 150 kg fruits per year. The fruits are somewhat big-sized, reaching 3.5-4.0 cm

in length and 2.0-2.5 cm in diameter. They are yellow at mature stage as they can be consumable at this phase. After drying, these fruits turn to deep brown. It is among the highly qualified cultivars for processing and packing as pressed dates. The fruits can be stored for long time after harvest.

It is will known that all palm plants grow slowly, and fertilizing them with either chemical or bio-preparations usually enhance growth, especially at the first stages. In this concern, Abdel-Galeil *et al*. (2010) found that survival and rooting percentages, root length and No. roots/offshoot of date palm cv. Zaghloul were linearly increased with increasing the level of commercial liquid fertilizer (10 N:10 P:10 K + micro-elements) from 5 to 10 ml/l. A similar trend was also attained regarding leaf length, No. new formed leaves/offshoot, fresh and dry weights of the new formed leaves, as well as the percentages of N, P and K in the new leaves. However, Abdel-Galeil (2010a) on date palm cv. Malacabe mentioned that combining between NPK liquid fertilizer (10:10:10 + microelements) at 2 ml/l as a foliar spray and at 20 ml/l as a soil drench greatly improved trunk length, No. leaves/plant and leaf width. Meantime, connecting between potassien-N (K-N) at 2 ml/l as a foliar spray and NPK liquid fertilizer (10:10:10 + microelements) at 20 ml/l as a soil drench significantly increased trunk length, No. leaves/ plant, leaf width, as well as content of chlorophyll a, b, carotenoids, N, P and K in the leaves of cv. Sakkoty plant (Abdel-Galeil, 2010b).

On ornamental plants, Agina *et al*. (2005) on *Ficus macrocarpa* cv. Hawaii, reported that foliar application of kristalon (19:19:19 + micronutrients) markedly improved vegetatie growtn, fresh and dry weights of leaves, stem and roots, as well as pigments and minerals content in the leaves. Similarly, were those results of Kandeel *et al*. (2002) on *Melia azedarach*, Sarhan *et al*. (2002) on *Taxodium disticum*, Gad (2003) on *Ficus benjamina*, El-Sayed *et al*. (2008) on *Ficus macrocarpa* cv. Hawaii, Abdel-Fattah *et al*. (2009) on Dracaena and Ruscus, Shahin *et al*. (2012) on Schefflera and Euonymus, El-Fouly *et al*. (2014) on *Ficus deltoidea* and Shahin *et al*. (2014) on *Merremia dissecta*.

A commercial Japanese product, EM is a biostimulant that contains more than 60 selected strains of "Effective Microorganisms", viz., Photosynthetic bacteria, lactic acid bacteria, yeast, actinomycetes and various fungi that improve growth and health of plants (Primavesi, 1999). Janas (2009) revealed that effective microorganisms (EM) is characterized by a wide spectrum of activity and complex effect on plant living environment. Thus, it may be used as foliar treatments, on the seeds or in soil application. Its effects on inducing plant disease resistance, yield creating and protective were observed in many industrial, medicinal and ornamental plant species. It is also creates humus substances and regulates basic relations in the soils. Therefore, the EM bistimulant is used in many countries, on a large scale, in organic production of agricultural crops. In this regard, Thach *et al*. (1999) indicated that treatment orchids with EM led to larger stems, darker green leaves and accelerating flowering in Dendrobium plants. On jojoba, Sarhan *et al*. (2007) noticed that Biomagic (a commercial biopromotor) at 10 g/l and inoculation with a mixture of *Azotobacter* and *Bacillus* significantly increased vegetative growth parameters, pigments content, total carbohydrates, N, P, K, Fe, Zn and Cu in the leaves. On the same line, were those results recorded by El-Seginy (2006) on pear and apricot and El-Sayed (2012) on paspalum turf.

This work was set out to discover the beneficial effects of both chemical fertilizer and biostimulant, alone or in combinations on growth and quality of date palm cv. Siwi.

MATERIALS AND METHODS

A study was conducted at the Experimental Farm of Hort Res. Inst., ARC,

Giza, Egypt during the two consecutive seasons of 2013 and 2014 to reveal the effect of complete chemical fertilizer and Effective microorganism (EM biostimulant) only or in combined treatments on growth and chemical composition of Siwi cultivar date palm.

Therefore, two-years-old unifor offshoots of date palm (*Phoenix dactylifera* L.) cv. Siwi were selected carrying about 4-5 leaves. The base of the selected offshoots were first dipped in a 0.5% solution of Topsin-M, 70% WP (Sumitomo Chemical Co., Ltd., Osaka, Japan) for 30 minutes, and then planted on April, 1st for the two studied seasons in 50-cm-diameter plastic bags (one offshoot/bag) filled with about 35 kg of sand and clay soil mixture (2:1, by volume). Some physical and chemical properties of the sand and clay used in both seasons were determined according to the standard methods described by Richards (1954) and illustrated in Table (1).

After one week from planting, the planted offshoots were irrigated with 10 liters of fresh water/bag. On 15th of April, the offshoots received the following treatments:

1- No fertilization, referred to as control.

2- EM biostimulant solution consisting of 0.5 l EM+ 1 l molasses +20 l well water (25 ml EM/l) was fermented for one week under an aerobic conditions before application as a soil drench and 500 ml of EM suspension solution were added to a bag.

3- A commercial complete chemical fertilizer 20 N:20 P:20 K + microelements) known as Ectaful was added also as a soil application at the rates of 2.5, 5.0, 7.5 and 10.0 g/bag. The chemical composition of such fertilizer is shown in Table (2).

4- EM solution at 25 ml/l was combined with each level of NPK commercial fertilizer to form 4 combinations as follows:

   a. EM at 25 ml/l + NPK fertilizer at 2.5 g/bag.
   b. EM at 25 ml/l + NPK fertilizer at 5.0 g/bag.
   c. EM at 25 ml/l + NPK fertilizer at 7.5 g/bag.
   d. EM at 25 ml/l + NPK fertilizer at 10.0 g/bag.

Table 1. Some physical and chemical properties of the used sand and clay in both seasons.

Soil type	Particle size distribution (%)				S.P	E.C. (ds/m)	pH	Cations (meq/l)				Anions (meq/l)		
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{-}
Sand	18.72	71.28	4.76	5.34	21.83	1.58	8.20	2.65	2.48	21.87	0.78	3.85	13.00	10.93
Clay	7.46	16.75	34.53	40.89	41.76	2.18	8.33	16.93	9.33	20.44	0.37	3.82	1.46	41.79

Table 2. The chemical composition of the commercial NPK fertilizer used in the two seasons.

Component	Value	Component	Value	Component	Value
Nitrogen (N)	20%	**Chelated Fe**	700 ppm	**Chelated Zn**	140 ppm
Phosphorus (P)	20%	**Chelated Mn**	420 ppm	**Chelated Mo**	140 ppm
Potassium (K)	20%	**Chelated Cu**	160 ppm	**Boron (B)**	220 ppm

The previous treatments were applied 4 times commencing from mid of April till mid of October (one every two months). The experimental treatments in both seasons were arranged in a complete randomized design (Mead *et al*., 1993) and the treatments were replicated 3 times with 3 offshoots for each replicate, i.e. 10 treatments × 3 replicates × 3 offshoots = 90 offshoots for each season. All the offshoots received the usual agricultural practices recommended for such plantation whenever needed.

At the end of each season (end of October), the following data were recorded: length of the first new formed leaf (cm), number of the new formed leaves/offshoot, trunk length and circumference (cm) and fresh and dry weights of the first new leaf (g). In fresh leaf samples taken from the leaflets of first new leaf, photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g f.w.) and total indoles were determined according to the methods of Moran (1982) and A.O.A.C. (1980), respectively, while in dry leaf samples, the percentages of nitrogen (using micro-Kieldahle method described by Pregl *et al*., 1945) and potassium (using flame photometer set as explained by Jackson, 1973) were evaluated.

Data were then tabulated, and the morphological ones were subjected to analysis of variance according to SAS Institute Program (1994) and Duncan's Multiple Range Test (Duncan, 1955) was used to compare between the means of the different treatments.

RESULTS AND DISCUSSION

Effect of fertilization treatments on:

1- Vegetative growth parameters:

It is evident from data presented in Table (3) that all fertilization treatments employed in this study in general improved, all vegetative growth parameters with various significant differences when compared to the untreated control in both seasons. It was also noticed that Effective microorganism (EM biostimulant) alone gave means closely near to those of NPK fertilizer at 5 g/bag, with few exceptions in the two seasons, while combining between these two treatments gave the utmost high means over control and all other individual or combined treatments in both season. Increasing the rate of NPK fertilizer to 7.5 g/bag or more did not induce valuable additional increment in growth, whereas combining between EM treatment and NPK fertilizer at any level did so, especially between 25 ml/l EM and 5 g NPK/bag combination, which was superior over all other sole and combined treatments in both seasons, as mentioned before.

Thus, using NPK complete fertilizer with EM biostimulant seemed to be valuable for enhancing growth through providing the plants with macro-and micro-nutrients necessary for good and healthy growth, inducing plant disease resistance by EM, which also creates humus substances and regulates basic relations in the soil (Janas, 2009). Moreover, EM may play a role in enhancing the enzymatic systems in the plant tissues, and consequently activating growth (Thach *et al*., 1999).

The present results are in good harmony with those postulated by Abdel-Galeil (2010a and b) on date palm cvs. Malacabe and Sakkoty, Kandeel *et al*. (2002) on *Melia azedarach*, Agina *et al*. (2005) on *Ficus macrocarpa* cv. Hawaii, Abdel-Fattah *et al*. (2009) on Dracaena and Ruscus and El-Sayed (2012) who elicited that complete fertilizer (19:19:19 + micronutrients) at 2 g/pot plus EM at 1ml/l as a soil drench gave the best growth, density and color in seashore paspalum turf.

Table 3. Effect of fertilization treatments on vegetative growth traits of *Phoenix dactylifera* L. cv. Siwi during 2013 and 2014 seasons.

Treatments	Length of the first new leaf (cm)	No. the new leaves/ offshoot	Trunk length (cm)	Trunk circumference at the base (cm)	F.W. the first new leaf (g)	D.W. the first new leaf (g)
			First seasons 2013			
Control	63.00 e	2.00 c	28.67 f	25.37 f	64.31 d	30.50 c
EM at 25ml/l (A)	75.40 cd	3.00 b	36.00 d	31.33 e	68.40 c	33.16 bc
NPK at 2.5g/bag (B)	72.33 d	3.00 b	31.50 e	30.50 e	66.35 cd	32.18 cb
NPK at 5.0g/bag (C)	75.65 cd	3.33 b	38.46 cd	31.60 e	68.50 c	33.44 bc
NPK at 7.5g/bag (D)	78.00 c	3.33 b	45.00 bc	39.73 c	73.33 b	35.20 b
NPK at 10.0g/bag (E)	78.33 c	3.00 b	46.10 b	37.00 d	72.38 b	35.00 b
A + B	76.10 cd	3.33 b	45.33 b	44.00 b	70.45 bc	34.56 bc
A + C	113.33 a	4.00 a	53.67 a	51.00 a	80.34 a	41.78 a
A + D	92.48 b	3.33 b	38.70 cd	42.71 bc	77.50 ab	36.85 b
A + E	93.21 b	3.33 b	41.33 c	39.80 c	73.44 b	35.22 b
			Second seasons 2014			
Control	56.33 g	2.33 c	31.30 e	26.33 e	60.33 e	30.00 d
EM at 25ml/l (A)	68.10 e	3.00 bc	40.00 c	33.50 d	68.14 de	31.34 cd
NPK at 2.5g/bag (B)	61.79 f	3.00 bc	35.67 d	31.67 d	67.13 ed	33.18 c
NPK at 5.0g/bag (C)	71.50 ed	3.33 b	43.33 b	42.33 b	70.45 d	35.23 bc
NPK at 7.5g/bag (D)	74.00 d	3.00 bc	37.90 dc	41.00 b	73.40 c	36.20 b
NPK at 10.0g/bag (E)	72.43 de	3.00 bc	36.50 d	37.38 c	72.12 cd	35.03 bc
A + B	76.00 cd	3.33 b	41.86 bc	36.51 c	75.33 cb	35.11 bc
A + C	95.97 a	4.33 a	50.98 a	53.00 a	85.48 a	42.16 a
A + D	88.33 b	3.00 bc	40.36 c	41.83 b	78.43 b	37.10 b
A + E	79.00 c	3.00 bc	38.39 cd	40.33 b	73.12 c	35.14 bc

Means within column having the same letters are not significantly different according to Duncan's multiple range test at 5% level.

2- Leaf chemical composition:

The data averaged in Table (4) show that the percentages of N, P and K were markedly increased in the leaves of plants treated with either NPK complete fertilizer or EM biostimulant, alone or in combination over the percentages gained by the untreated plants in the two seasons. The least records of these nutrients in both seasons was found due to EM solution (25 ml/l) and the low rates of NPK fertilizer when each of them was applied alone. However, combining between EM and the complete fertilizer gave higher records, especially at the combining between EM at 25 ml/l and NPK fertilizer at 5 g/bag, as this combination registered the highest content at all in both seasons. A similar response occurred as well in respect of total indoles content (ppm) and pigments content (mg/g f.w.) in the two seasons, except for EM solution and NPK fertilizer at 10.0 g/ bag treatments which gave less content of chlorophyll b in the first season than control (0.055 and 0.058 mg/g f.w., respectively against 0.064 mg/g f.w. for control), and EM solution alone that recorded less content of carotenoids than control in the two seasons (0.058 mg/g f.w. against 0.070 mg/g f.w. for control in the 1st season, and 0.061 mg/g f.w. against 0.072 mg/g f.w. for control in the 2nd one).

In general, the prevalence in all previous constituents' content was for the combined treatment of 25 ml/l EM+ 5 g/bag NPK complete fertilizer which scored the utmost high records in both seasons.

These findings are reasonable because the presence of EM, as a biostimulant reinforce the beneficial effects of NPK fertilizer which supply the plants with the different nutrients necessary for good growth, besides the role of EM in increasing the surface unit area of root length and hence enhancing the root hair branching with an

Table 4. Effect of fertilization treatments on chemical composition of *Phoenix dactylifera* L. cv. Siwi leaves during 2013 and 2014 seasons.

Treatments	N %	P %	K %	Total indoles (ppm)	Pigments content (mg/g f.w.)		
					Chlo. a	Chlo. b	Carotenoids
First seasons: 2013							
Control	1.78	0.11	1.07	0.139	0.099	0.064	0.070
EM at 25ml/l (A)	2.47	0.15	1.19	0.226	0.182	0.055	0.058
NPK at 2.5g/bag (B)	2.33	0.16	1.26	0.198	0.120	0.068	0.073
NPK at 5.0g/bag (C)	2.56	0.28	1.50	0.377	0.156	0.068	0.097
NPK at 7.5g/bag (D)	2.90	0.30	1.50	0.240	0.133	0.079	0.099
NPK at 10.0g/bag (E)	2.71	0.26	1.63	0.293	0.137	0.058	0.096
A + B	2.50	0.31	1.44	0.232	0.376	0.087	0.100
A + C	3.31	0.43	1.72	0.521	1.182	0.183	0.127
A + D	2.95	0.30	1.58	0.395	0.490	0.076	0.093
A + E	2.95	0.24	1.50	0.253	0.286	0.065	0.089
Second seasons: 2014							
Control	1.81	0.10	1.13	0.143	0.095	0.062	0.072
EM at 25ml/l (A)	2.50	0.13	1.20	0.231	0.174	0.074	0.061
NPK at 2.5g/bag (B)	2.37	0.15	1.27	0.198	0.124	0.064	0.077
NPK at 5.0g/bag (C)	2.61	0.21	1.45	0.373	0.231	0.071	0.090
NPK at 7.5g/bag (D)	2.95	0.27	1.51	0.393	0.190	0.076	0.091
NPK at 10.0g/bag (E)	2.70	0.30	1.60	0.370	0.135	0.084	0.086
A + B	2.63	0.30	1.50	0.391	0.277	0.090	0.091
A + C	3.18	0.36	1.76	0.458	1.310	0.181	0.115
A + D	2.87	0.28	1.63	0.239	0.383	0.103	0.101
A + E	2.90	0.25	1.51	0.352	0.381	0.092	0.094

eventual increase in acquisition of nutrients from the soil solution (Primavesi, 1999). These positive responses were also acknowledged by numerous investigators such as Abdel-Galeil *et al*. (2010) on date palm cv. Zaghloul, Gad (2003) on *Ficus benjamina*, El-Sayed *et al*. (2008) on *Ficus macrocarpa* cv. Hawaii and Shahin *et al*. (2014) on *Merremia dissecta*. In this regard, El-Seginy (2006) declared that the use of organic fertilizer (10:10:10 + micro-nutrients and humates) and EM biostimulant on young Le Conte pear and Canino apricot trees grown in calcareous soil gave vigorous growth and increased leaf nutrients content. It also decreased the cost production and boosted the income.

From the aforementioned results, it can be advised to treat the 2-years-old offshoots of date palm cv. Siwi with EM solution (25 ml/l) plus NPK complete fertilizer (5 g/bag) 4 times commencing form mid of April till October (once every two months) to improve their vegetative growth and quality.

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تأثير التسميد الكيماوي والمنشط الحيوي EM والتوليفات بينهما على نمو وجودة فسائل نخيل البلح (صنف سيوي)

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أجريت هذه الدراسة بالمزرعة التجريبية لمعهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر خلال موسمي ٢٠١٣، ٢٠١٤ لدراسة تأثير الإضافة الفردية الأرضية لمحلول المنشط الحيوي (EM) بمعدل ٢٥ مللى /لتر، السماد الكيماوي المتكامل NPK (٢٠ : ٢٠ : ٢٠+ عناصر صغرى) بمعدل: صفر، ٢.٥، ٥، ٧.٥، ١٠جم/ كيس (أي لكل فسيلة) والتوليفات بينهما على النمو والتركيب الكيميائي لفسائل عمر سنتين من نخيل البلح صنف سيوي (نصف جاف) المنزرعة في أكياس بلاستيك قطرها ٥٠ سم ملأت بحوالي ٣٥ كجم من مخلوط الرمل والطين (بنسبة ٢ : ١ حجمًا) تحت ظروف الحقل المفتوح

أوضحت النتائج المتحصل عليها أن جميع المعاملات المطبقة بهذه الدراسة أحدثت تحسنًا ملحوظًا في جميع صفات النمو الخضري للفسائل المنزرعة وبمستويات معنوية مختلفة عن مقارنتها بالكنترول في كلا الموسمين. أوضحت النتائج أيضًا أن محلول المنشط الحيوي (EM) بمفرده أعطى متوسطات نمو قريبة من تلك التي حققتها معاملة التسميد بالسماد الكيماوي الكامل بمعدل ٥ جم/ كيس مع بعض الاستثناءات القليلة بكلا الموسمين. كذلك، فإن زيادة معدل إضافة السماد الكيماوي الكامل إلى ٧.٥ جم/ كيس أو أكثر لم تحدث أية زيادة إضافية ملحوظة في معدل النمو الخضري، بينما أدى الجمع بين المعاملة بالـEM والسماد الكيماوي المتكامل بأي معدل إلى إحداث ذلك زيادة واضحة بمعدلات النمو الخضري)، خاصة عند الجمع بين المعاملة بالمنشط الحيوي (EM) بمعدل ٢٥ مل/ لتر والتسميد بالسماد الكيماوي المتكامل بمعدل ٥ جم/ كيس، حيث أعطت هذه التوليفة أعلى المتوسطات على الإطلاق مقارنة بالمعاملات الفردية والتوليفات الأخرى بمعظم الحالات بكلا الموسمين. ولقد أمكن الحصول على نتائج مشابهة فيما يتعلق بمحتوى الوريقات من عناصر النيتروجين، الفوسفور، البوتاسيوم، وكذلك من الإندولات الكلية والتمثل الضوئى (كلوروفيللي أ، ب الكاروتينويدات).

وعليه، يمكن التوصية بمعاملة فسائل نخيل البلح (صنف سيوي)، عمر سنتين والمنزرعة في أكياس بلاستيك قطرها ٥٠سم تحت ظروف الحقل المفتوح بمحلول المنشط الحيوي EM بمعدل ٢٥مل/ لتر + السماد الكيماوي الكامل (٢٠ن: ٢٠ فو: ٢٠ بو + عناصر صغرى) بمعدل ٥جم/ فسيلة كإضافة أرضية مرة كل شهرين بداية من شهر فبراير الى شهر اكتوبر للحصول على أفضل نمو وأعلى جودة لهذه الفسائل قبل نقلها للزراعة في الحقل.