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Effect of Natural Potassium Resource (K_2O 10 %) with Bio-fertilizer on Performance of Date Palms *Cv.* Zaghloul

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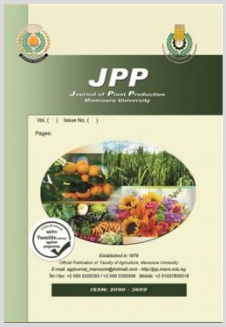

ABSTRACT

Performance of the palm trees and fruit quality of cv. Zaghloul under different levels of natural potassium (NP) resource (K_2O 10 %) individually or in combination with potassium soluble bacteria (KSB) were studied in the 2016 and 2017 seasons. Treatments included 3, 6 or 9 kg/palm per year of NP either individually or in combination with KSB on 'Zaghloul' date palms grown on sandy soil with 7 meters apart under surface irrigation system; whereas, palms received 2 kg/palm per year potassium sulfate (50% K) served as the control. The results revealed that 9 kg of NP in combination with KSB enhanced vegetative growth, pinnae mineral content, chlorophyll, bunch weight, palm yield and fruit quality than other applications or control palms. Therefore it is recommended to use 9 kg of NP in combination with KSB/palm/year for increasing yield of Zaghlol date palms and improving fruit quality.

Keywords: Date palm – Potassium – Biofertilizer - yield – fertilizers –Zaghlol.

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is one of the oldest and economically most substantial trees in the Middle East and North Africa (Chao and Krueger, 2007); hence, Zaghloul date is the preferable soft date varieties appropriate for marketing in Egypt at the Bisir stage. Total harvested area of dates during 2017 in Egypt attained about 49522 ha with total production of 1590414 tonnes; while, the total harvested area was 38503 ha with total production 1400072 tonnes during 2012 (FAO, 2017). The present situation reflects that Egyptian farmers have a problem how to reach the balanced fertilizer needs for date palm trees to produce high yield and good qualities, especially under the high price for chemical fertilizers; where, date palm trees need a large amount of potassium than other elements.

Potassium is an essential element for date palm growth since dates accumulate high sugar percentage about 44-88% upon cultivar, ripening stage and environmental conditions (Al-Shahib and Marshall, 2003 and Awad *et al.*, 2011). Indeed, K is implicated in controlling water status of trees, photosynthetic activity and in the translocation of predigests to fruit and other active sinks (Archer, 1988 and Khayyat *et al*., 2007).

One of the mining companies in Egypt produce a cheap natural potassium in the form of potassium oxide by 10%; therefore, it was urgent to study the response of date palms to this type of fertilizer at different concentrations individually or in the presence of potassium solubilizing bacteria in the soil. Hence; Sindhu *et al.* (2010) reported that potassium solubilizing bacteria (KSB), when used as bio-fertilizer for agriculture, can reduce the use of chemical fertilizer and backup ecofriendly fruit production. Potassium solubilizing bacteria (KSB) dissolve K from insoluble K-bearing minerals such as micas, illite, and orthoclase, by excreting organic acids which either directly dissolved rock potassium or chelated silicon ions to bring potassium into the solution.

However, there is less obtainable information about the impact of natural potassium fertilizers on date palms performance in a newly reclaimed orchard. So, this study aimed to estimate the impact of fertilization by natural potassium (K_2o 10%) at different concentrations either individually or in combination with potassium solubilizing bacteria on vegetative growth, yield and fruit quality of 'Zaghloul' date palms.

MATERIALS AND METHODS

Plant materials and experimental procedure

During the 2016 and 2017 growing seasons, 21 uniform palms of 20 years old of 'Zaghloul' date palms cultivar with 7 meters apart under surface irrigation system were chosen in a newly reclaimed orchard at the experimental station of the Faculty of Agriculture at Kalabsho city, Mansoura Governorate, Egypt. The trial was designed as a randomized complete block design with three replicates (one palm/replicate). All the palms were hand-pollinated from one male palm in both seasons. After fruit set (about 4 weeks from pollination), the palm load was regulated during both seasons (illustrating leaf/bunch ratio of about 8:1). A liquid culture of *Bacillus circulans* bacteria was used as potassium solubilizing bacteria (KSB) in this study which provided by the Unit of Bio-fertilizers, Faculty of Agriculture, Ain Shams University; hence, it was grown in batch culture to the late exponential phase of *Bacillus circulans* bacteria to give cell suspension of

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4×107 cell/ml (Gomaa, 1995). Depended on the literature review, the endorse requirements for full mature date palm was about 1000 g N, 775 g P and 2 kg potassium sulfate (50% K) (1000 g K) /palm per year (Shawky *et al.*, 1999; Bamiftah, 2000 and Harhash, 2000) and that was applied for control palms (T1) in three equal doses (March, May, and July) but the residual experimental trees received the similar doses except potassium was added as natural potassium (NP) (K_2o 10%) as follows:

(T2) 3 kg NP (300 g K) /palm / year.	(T5) 3 kg NP (300 g K) /palm / year + KSB.
(T3) 6 kg NP (600 g K) /palm / year.	(T6) 6 kg NP (600 g K) /palm / year + KSB.
(T4) 9 kg NP (900 g K) /palm / year.	(T7) 9 kg NP (900 g K) /palm / year + KSB.

The above quantities of potassium were divided into three equal doses; the first added in the soil after pollination in March, the second after fruit set in May and the last one were added at the beginning of coloring in July during both seasons. All treatments were applied as soil broadcast in a circle around the palm trunk (100 cm away from the palm trunk) and were integrated into the top 30 cm layer of soil by mixing with 10 L irrigation water. Referring to potassium solubilizing bacteria (KSB), one liter of liquid culture of *Bacillus circulans* bacteria was dissolving in 8 L water to form 9 L and each palm irrigated with one liter after irrigation at the three additional dates of this study.

Soil analysis

Before implementing this trail, the soil's physical and chemical features were determined as follow:

The electrical conductivities of the 1:5 soil paste extracts were measured by EC meter according to the method of SALINITY LAB US (1954). Soil reaction (pH) was estimated according to Jackson (1973). The mechanical analysis was estimated as described by Kilmer and Alexander (1949). Organic matter content was determined according to Jackson (1973). Available NPK was estimated as described by the methods of Chapman and Pratt (1982). And the results of this analysis are presented in Table (1).

Table 1. Physical and chemical analysis of the experimental soil.

Soil depth (cm)	Mechanical Analyses (%)					Chemical Analyses									
						Water soluble ions (meq/100g soil)							Available (ppm)		
	Texture	pH 1:2.5	E.C dS/m^{-1} (1:5)	Total $CaCO_3$ (%)	O.M (%)	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCo_3^{-}	Cl^{-}	SO_4^{--}	N	P	K
0-30	Sandy	7.93	1.18	6.08	0.89	1.18	0.79	3.79	0.28	1.32	2.98	1.74	43.2	4.61	109.2
30-60	Sandy	8.07	1.10	5.81	0.72	1.07	0.64	3.75	0.17	1.19	3.42	1.02	39.6	4.09	66.3
60-90	Sandy	8.18	1.03	5.16	0,64	0.98	0.61	3.54	0.14	1.12	3.38	0.77	35.4	3.87	54.6

Vegetative growth, chlorophyll and pinnae (leaflets) mineral content

A leaf sample of three fully widened leaves which afford the fruit bunches in their axis around the head of each palm (about two years old) was taken at random from each replicate after two weeks of the last addition during both seasons to determine vegetative growth (leaf and leaflet length cm), pinnae mineral content (K, Ca, Mg, Zn, Mn, Cu) and chlorophyll. Pinnae (leaflets) samples (20 leaflets/replicate) were haphazardly gathered from the middle part of the leaves to determine chlorophyll by using CCM-200 plus Chlorophyll Content Meter which uses transmittance to determine the chlorophyll content; hence, two wavelengths are used for absorbance estimations. One wavelength falls within the chlorophyll absorbance range while the other serves to compensate for mechanical differences such as tissue thickness. The meter measures the transmittance of both wavelengths and calculates a CCI (chlorophyll content index) value that is proportional to the amount of chlorophyll in the sample (CCI = %Transmittance at 931nm / %Transmittance at 653nm). Then pinnae samples were washed with tap water, rinsed twice in distilled water, oven-dried at 70 oC till a steady weight and then ground to determine potassium by the flame-photometer and Ca, Mg, Zn, Mn, and Cu contents by using an atomic absorption spectrophotometer (Model 305B). The concentrations of K, Ca and Mg were expressed as percentages, while Zn, Mn, and Cu as parts per million (ppm) on a dry weight basis as outlined in Jones (2001).

Yield Determination

In the two seasons, bunches were collected during the second seven day prolong of October when fruits came to the bisir phase (fully develop, crunchy and red) and bunch weight was recorded in kilograms. The number of bunches/palm was recorded and all-out yield (kg/palm) was determined by multiplying the mean bunch weight by the total number of bunches per palm. Moreover, fruit samples were haphazardly collected from four unique bunches to determine fruit physical and chemical characteristics.

Fruit Physical Characters, soluble solids content (SCC), acidity and SCC/acid ratio

Average fruit length and diameter were estimated by utilizing a Vernier caliper as cm; while, fruit diameter was estimated from the center of the fruit. Fruit firmness was estimated by utilizing a hand Effegi-Penetrometers attached to plunger 3 mm diameter and the average was determined as Ib.in-2. Besides, average fruit weight (g) was determined. All previous estimates were recorded autonomously in each of 40 fruit per replicate at the bisir stage. A homogeneous sample was set up from 25 fruits per replicate for determining soluble solids content (SCC), acidity. Soluble solids content (SCC) was estimated as

Brix % in fruit juice with a digital refractometer (DR 6000, A. Kruss Optronic GmbH, Hamburg, Germany). Titratable acidity was estimated in fruit juice as a percentage of malic acid (AOAC, 1980). SSC/acid ratio was expressed by the ratio between SSC and total titratable acidity.

Total sugar percentage

It was estimated by utilizing phenol 18% and sulphuric acid 96% and the absorbance was measured by spectrophotometer at 490 nm (Sadasivam and Manickam, 1996).

Fruit content of calcium (mg/100g)

Titrimetric estimation of calcium is done by sedimenting it as calcium oxalate. The sediment is then dissolved in sulphuric acid and the amount of calcium dissolved in the acid is estimated by titrating against a standard potassium permanganate solution (Mazumdar and Majumder, 2003).

Soluble tannin percentage

Dissolvable tannins were estimated by Taira (1996). Hence, it extracts from 5 g of fruit tissue (involving skin and flesh) by 80% methanol and 0.5 ml Folin-ciocalteu reagent (previously diluted 10- fold with distilled water) was used. And the samples were measured at 750 nm using a UV-Vis spectrophotometer. The blank contained only water and the reagents. Dissolvable tannins were evaluated from a calibration curve obtained by measuring the absorbance of known concentrations of gallic acid.

Total anthocyanin content

Total anthocyanin content in fruit skin was estimated as outlined by Mazumdar and Majumder (2003). A half gram of fruit skin was extracted in ten ml of the ethanolic-hydrochloride acid mixture and The samples were then measured through 535 nm wavelength against blank by a spectrophotometer.

Statistical analysis

The acquired values were statistically analyzed as a randomized complete design by analysis of variance (ANOVA) as outlined by Snedecor and Cochran (1994), using the statistical package software SAS (SAS Institute Inc. Cary, NC, USA). Comparisons between means were made by using the least significant differences test (LSD) at 5% level of probability as referenced by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Vegetative growth

An increase in vegetative growth (leaf and leaflet length) and chlorophyll has occurred at the highest concentration of natural potassium (9 kg NP) in combination with KSB (T7) following by control (T1). Moreover, all- natural potassium concentrations with KSB were better than used individually in this respect; hence, the NP at 3 Kg (T2) displayed the lowest impact in these parameters during the two seasons (Table 2). The illustrated data are in concurrence with Harhash (2000) and Awad *et al.* (2014) and that might be because of the job of potassium on plant development, for example, advancement of enzymes activity and upgrading the translocation of acclimatizes and protein composition (Salim *et al*., 2014). Likewise, synergistic impact among K and indole acetic acid and the enhancement of potassium on gibberellic acid and cytokinins effects on plant development (Coccuci and Dalla Rosa, 1980 and Green,1983); moreover, the capability of KSB (*Bacillus circulars)* to produce hormone, especially IAA (Sheng and Huang, 2002). In addition, potassium alleviate the adverse effect of salinity stress on date palm and improved leaf total chlorophyll content by its role inactivation of enzymes, regulation of osmotic pressure and stomata movement (Gollback *et al.,* 2003), likewise; it diminishes the creation of reactive oxygen species (Cakmak, 2005), by improving activities of antioxidant enzymes (Zheng *et al.*, 2008).

Table 2. Effect of treatments on Vegetative growth (leaf and leaflet length (cm)) and chlorophyll (%) of Zaghlol date palm during 2016 and 2017 seasons.

Treatments (T)	leaf length (cm)		leaflet length (cm)		chlorophyll (%)	
	2016	2017	2016	2017	2016	2017
T1	436.66	438.00	62.67	63.00	52.40	53.00
T2	416.66	423.33	58.00	58.33	27.53	33.10
T3	418.33	430.00	58.66	59.00	29.53	34.67
T4	418.68	433.33	59.00	59.66	36.03	39.00
T5	430.00	435.00	60.00	60.66	43.50	44.73
T6	435.66	440.00	61.00	61.66	47.76	49.50
T7	448.33	450.00	64.67	65.66	59.53	60.80
LSD at 5%	20.84	13.24	2.39	2.16	2.38	5.16

Leaflet mineral content

A positive relationship was found obviously between all estimated leaflet mineral and natural potassium treatments either individually or in combination with KSB, except Ca % which decreased by increasing NP concentration in all treatments; hence, 9 kg of NP with KSB and control (T1) enhanced leaf mineral content except Ca % significantly compared with other treatments but 9 kg of NP with KSB (T7) was the superior treatment in this regard during the two seasons (Table 3).

Increasing pinnae (leaflet) mineral contents due to utilizing NP as soil broadcast might be referring to that potassium increment as soil broadcast can enhance plant capability to absorb soil nutrients which improve growth and nutrients utilization (Mengle and Kirkby, 2001 and Abdel-Nasser and El-Shazly, 2001). Decreasing pinnae Ca content at the high dose of NP application might be because more absorption of K ion may lead to the antagonistic effect of such an element with Ca (Epestein, 1972). Furthermore, Zakaria (2012) declared that the soil pH decreased with increasing the rate of potassium fertilization combined with bio-fertilizer due to high supplies of Ca++, K+, and production of organic acid. These results were confirmed by Sajid and Asghari (2016) who found decrease soil pH results from the production of organic acids due to soil micro-organisms activity. These results were confirmed by Harhash and Abdel-Nasser 2007 on "Zaghloul" cultivar date palm and Osman (2010) who showed that potassium fertilization gave the highest leaf mineral content of "Bartamoda" cultivar date palm.

Table 3. Effect of treatments on leaf mineral content of Zaghlol date palm during 2016 and 2017 seasons.

Treatments	K (%)		Ca (%)		Mg (%)		Zn (ppm)		Mn (ppm)		Cu (ppm)	
(T)	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
T1	2.03	2.11	0.41	0.39	0.76	0.78	2.57	2.58	5.73	5.74	3.58	3.57
T2	1.35	1.39	0.92	0.89	0.38	0.39	1.66	1.42	5.09	5.11	2.87	2.88
T3	1.42	1.48	0.76	0.73	0.43	0.44	2.07	2.08	5.17	5.18	2.93	2.95
T4	1.71	1.79	0.69	0.68	0.59	0.61	2.33	2.34	5.45	5.47	3.16	3.18
T5	1.78	1.86	0.62	0.60	0.64	0.65	2.39	2.39	5.52	5.54	3.21	3.27
T6	1.93	1.96	0.58	0.56	0.71	0.73	2.51	2.52	5.66	5.68	3.32	3.34
T7	2.41	2.49	0.36	0.34	0.94	0.95	2.84	2.85	6.03	6.04	3.61	3.62
L SD at 5%	0.03	0.08	0.04	0.02	0.02	0.02	0.38	0.33	0.02	0.02	0.22	0.21

Bunch weight and yield/palm

The highest bunch weight and yield detected at the level of 9 kg of NP with KSB. The values of bunch weight and yield/palm due to this treatment were 18.33 & 19.44 kg for bunch weight and 265 & 266 kg for yield per palm during both seasons, respectively. While, the level of 3 kg of NP individually decreased significantly the bunch weight and yield/palm compared to the other applications; hence, the values of bunch weight and yield/palm due to this treatment were 11.33 & 12.33 kg for bunch weight and 159.33 & 172.33 cm for yield/palm during both seasons, respectively (Table 4).

The increment in bunch weight and yield may be attributed to the high percentage of minerals in pinnae, chlorophyll and length of growing leaves under this study (Tables 2 and 3). Thus, an increase will be prospective in the photosynthesis rate. Hence, potassium has an active role in photosynthesis and osmoregulatory, (Amro *et al.*, 2014); in addition, it is desired for physiological operations such as activation of enzymes, regulation of osmotic pressure and stomata movement (Gollback *et al.,* 2003). The obtained data go in line with those found by Harhash and Abdel-Nasser (2007) on "Zaghloul" date palm; Osman (2010) on "Bartamoda" date palm and Al-Obeed *et al.* (2013) on "Khalas" date palm.

Table 4. Effect of treatments on bunch weight (Kg) and yield/palm (Kg) of Zaghlol date palm during 2016 and 2017 seasons.

Treatments	bunch weight (Kg)		yield/palm (Kg)	
(T)	2016	2017	2016	2017
T1	18.00	19.00	261.33	261.67
T2	11.33	12.33	159.33	172.33
T3	14.67	15.67	207.67	219.33
T4	16.00	17.00	224.67	238.00
T5	17.33	18.67	249.00	256.67
T6	17.67	18.88	251.00	258.33
T7	18.33	19.44	265.00	266.00
L SD at 5%	2.70	1.48	32.95	20.54

Fruit length, diameter and weight

Fruit length, diameter, and weight are important parameters for dates quality and these parameters were affected significantly under different levels of NP either individually or in combination with KSB in the two seasons of this experiment; especially, 9 kg of NP with KSB recorded higher fruit length, diameter, and weight than the other doses of NP; hence, it displayed 5.97& 6.17cm for fruit length, 2.67 & 2.83 cm for fruit diameter and 33.24 & 35.21g for fruit weight in both seasons, respectively followed by control and T6 in this enhancement. As for level of 3 kg of NP individually, it displayed the lowest fruit length, diameter and weight than the other doses; it recorded 5.30 & 5.50 cm for fruit length, 2.37& 2.45 cm for fruit diameter and 22.25 & 23.95 g for fruit weight in the two seasons, respectively (Table 5).

Table 5. Effect of treatments on length, diameter (cm) and weight (g) of Zaghlol fruit date palm during 2016 and 2017 seasons.

Treatments (T)	Fruit length (cm)		Fruit diameter (cm)		Fruit weight (g)	
	2016	2017	2016	2017	2016	2017
T1	5.96	6.13	2.60	2.63	32.93	32.41
T2	5.30	5.50	2.37	2.45	22.25	23.95
T3	5.33	5.87	2.40	2.50	23.06	27.49
T4	5.83	5.93	2.48	2.53	25.87	28.97
T5	5.73	6.00	2.50	2.56	30.10	30.24
T6	5.87	6.10	2.53	2.60	31.49	31.65
T7	5.97	6.07	2.67	2.83	33.24	35.21
L SD at 5%	0.39	0.56	0.21	0.31	1.50	1.64

The increments in fruit length, diameter, and weight by increasing NP levels either individually or in combination with KSB may be due to NP support cell extension, division, size, number and turgidity, in addition it has an important role in stomatal movement, photosynthesis, protein synthesis, pH stabilization, enzyme activation, and osmoregulation. Moreover, the increment in fruit weight might be referring to the physiological role of potassium in increasing the osmotic potential of fruit cells which could stimulate the circulation of water in the fruit and accordingly enhance its volume and weight (Mengel and Kirkby, 2001). These results are confirmed Dialami and Mohebi (2010), Al-Obeed *et al.* (2013) and Rasmia *et al.* (2015).

Soluble solids content (SSC %), titratable acidity, SSC/acid ratio and total sugar

The illustrated results on SSC% obvious that palms treated with level of 9 kg NP with KSB (T7) enhanced the value of SSC significantly than the other applications pursued by a slight decline in control palms followed by palms fertilized with the level of 6 kg of NP with KSB (T6) in the two seasons of this study. Also, palms fertilized with a level of 6 kg of NP individually (T3) reduced SSC % significantly pursued by the palms fertilized with 3 kg of NP individually (T2) which showed the lowest SSC% value. Referring to the impact of treatments on titratable acidity, it is obvious that titratable acidity gave a contrary trend to that observed with SSC %. Therefore, palms fertilized with a level of 9 kg of NP with KSB (T7) demonstrated the lowest titratable acidity in date fruit juice compared to the other applications; in contrast, palms fertilized with the level of 3 kg of NP individually (T2) obtained the highest titratable acidity in date fruit juice compared to the other treatments in the two seasons.

Finally, SSC/acid ratio and total sugar showed a similar trend to that observed with SSC %; consequently, palms fertilized with a level of 9 kg of NP with KSB (T7) gave the highest SSC/acid ratio than other treatments under this study. Whereas, palms fertilized with the level of 3 kg of NP individually (T2) showed the lowest value of SSC/acid ratio and total sugar than the other levels of NP individually or in combination with KSB in the two seasons of this study (Table 6).

The increments in SSC, SSC/acid ratio and total sugar versus the reductions in titratable acidity as the levels of NP increase either individually or in combination with KSB may be attributed to the physiological role of NP in carbohydrate formation, translocation and accumulation within plant organs (Evans and Sorger, 1966 and Mayer and Anderson, 1970). As well as, it stimulates the enzymes involved in sugar biosynthesis and helps in translocation of sugars (Archer, 1988). These results were in agreement with Dialami and Pezhman (2005) on 'Toory' date palm and Ouamane *et al.* (2017) on Deglet Nour date palm.

Table 6. Effect of treatments on SSC (Brix %), titratable acidity %, SSC / acid ratio and total sugar (%) of Zaghlol fruit date palm during 2016 and 2017 seasons.

Treatments (T)	SSC (Brix %)		Acidity (%)		SSC / acid ratio		Total sugar (%)	
	2016	2017	2016	2017	2016	2017	2016	2017
T1	29.0	30.0	0.151	0.140	192.05	214.29	22.18	25.85
T2	23.2	24.6	0.248	0.245	93.55	100.41	19.24	24.11
T3	23.5	28.0	0.223	0.218	105.38	128.44	19.80	24.46
T4	24.5	28.3	0.190	0.173	128.95	163.58	20.88	24.92
T5	27.0	29.3	0.169	0.165	159.76	177.58	21.60	25.11
T6	27.5	29.7	0.164	0.158	167.68	187.97	21.75	25.40
T7	29.2	30.3	0.138	0.132	211.59	229.55	23.84	26.38
L SD at 5%	1.22	2.15	0.05	0.05	37.24	48.92	1.24	0.64

Firmness, calcium, tannins and anthocyanin of Zaghlol fruit date palm

The values of fruit firmness, calcium content and tannins were significantly decreased by increasing the level of NP either individually or in combination with KSB. Therefore, palms fertilized with the level of 3 kg of NP individually (T2) recorded the highest significant effect than the other doses or control; conversely, palms fertilized with the level of 9 kg of NP with KSB (T7) showed the lowest values of fruit firmness, calcium content, and tannins in the two seasons of this study (Table 7).

Referring to anthocyanin content, different fertilizer levels by NP in combination with KSB enhanced anthocyanin content in fruit skin; hence, palms fertilized by 9 kg of NP with KSB (T7) gave the highest values in this parameter pursued by control and the doses of 6 and 3 kg NP with KSB; on the contrary, the level of 3 kg of NP individually introduced a forcefully diminish about this parameter in the two seasons of this study (Table 7).

These mentioned results for the above parameters may be due to the potassium enhance physiological processes like stomata movement, regulation of osmotic pressure and activation of enzymes (Gollback *et al.*, 2003); hence, potassium is involved in the activation of more than 60 enzymes, which help plant in several processes like respiration, N metabolism, starch synthesis and energy utilization (Wallingford, 1980). All these together reflected on enhancing ripening process which leads to the above-mentioned results for these parameters like tannins percentage which decreases by developing ripening (Myhara *et al.*, 2000); hence, the solubility of tannins are related with specific proteins that help in the precipitation of tannins during fruit ripening (Barreveld, 1993). These data are in the same line with the results obtained by Shahein *et al.* (2003) on Samany date and Marzouka and Kassem (2011) on Zaghloul date

Table 7. Effect of treatments on firmness (Ib.in^{-2}), calcium (mg/100g), tannins (%) and anthocyanin (%) of Zaghlol fruit date palm during 2016 and 2017 seasons.

Treatments (T)	firmness (Ib.in^{-2})		calcium (mg/100g)		tannins (%)		anthocyanin (%)	
	2016	2017	2016	2017	2016	2017	2016	2017
T1	11.00	10.60	124.63	102.43	0.24	0.23	24.23	24.43
T2	16.36	16.10	197.00	171.57	0.35	0.33	18.23	19.70
T3	15.26	13.80	172.43	147.50	0.32	0.31	22.03	22.23
T4	13.60	13.10	148.47	141.37	0.28	0.27	22.27	22.93
T5	12.57	12.40	142.17	129.20	0.27	0.26	22.53	22.97
T6	12.16	11.40	130.20	123.47	0.25	0.24	23.10	23.27
T7	10.73	10.70	103.50	96.17	0.22	0.21	24.67	25.00
L SD at 5%	0.85	1.79	3.05	3.09	0.01	0.02	2.69	2.82

CONCLUSION

It is obvious from the obtained data that utilizing natural potassium with potassium soluble bacteria as a soil broadcast enhanced Zaghloul date palm performance and fruit quality especially at 9 kg of NP with KSB. Therefore, date palm farmers are advised to use natural potassium as a cheap alternative to mineral potassium in the production of organic palm dates, considering the addition of solvent bacteria and orchard soil conditions. Further studies are necessary in order to determine the adequate levels of nitrogen and phosphorous as natural resource with natural potassium at 9 kg with KSB for completely organic yield of Zaghlol date palms.

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تأثير مورد البوتاسيوم الطبيعي (بو$_2$أ 10%) مع الأسمدة الحيوية على أداء نخيل البلح صنف الزغلول

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تمت دراسة أداء أشجار نخيل البلح الزغلول و جودة ثماره تحت مستويات مختلفة من مصدر البوتاسيوم الطبيعى (بو$_2$أ 10%) سواء منفرداً أو مختلطاً بالبكتريا المذيبة للبوتاسيوم فى موسمى 2016 و 2017. حيث أجريت المعاملات بتركيزات 3، 6، 9 كجم للنخلة سنوياً من البوتاسيوم الطبيعى سواء منفرداً أو مختلطاً بالبكتريا المذيبة للبوتاسيوم على نخيل البلح الزغلول النامى فى أرض رملية على مسافة 7 م تحت نظام الرى السطحى، فى حين أن النخيل الذى يأخذ 2 كجم سلفات بوتاسيوم (50% بو) كان ممثلاً للكنترول. و لقد أظهرت النتائج أن إضافة 9 كجم من البوتاسيوم الطبيعى مختلطاً بالبكتريا المذيبة للبوتاسيوم أعطى أفضل نمو خضرى، محتوى الرويشات من العناصر، الكلوروفيل، وزن السوباطة و محصول النخلة و جودة الثمار عن باقى المعاملات أو الكنترول. لذلك ينصح باستخدام 9 كجم من البوتاسيوم الطبيعى مختلطاً بالبكتريا المذيبة للبوتاسيوم للنخلة سنوياً لزيادة محصول نخيل البلح الزغلول و تحسين جودة الثمار تحت ظروف الأراضى الرملية.