

Response of date palm (*Phoenix dactylifera* L.) to foliar application of potassium silicate

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Abstract

The Effect of potassium silicate sprays on yield and fruit quality of Saidu date palm was studied during 2013, 2014 and 2015 seasons. This study aimed to examine potassium silicate spraying effects (from 2.5, 5, 10 to 20 ml/L) on the date palm fruiting. Spraying was done at mid of May till the first of July with spraying four times, each one after fifteen days. Results declared that carrying out sprays of potassium silicate at 2.5 to 20 ml/l water caused a remarkable promotion on bunch weight and yield as well as physical and chemical characteristics of the fruits compared to untreated ones (control). The promotion was associated with increasing concentrations of potassium silicate. It could be concluded that spraying bunches of Saidu date palms with 10 ml/L potassium silicate four times was suggested to improve all physical and Chemical properties of fruits. Such fruit improvement is very important target than total yield since improvement in physical fruit traits induces an increase in packable yield.

Keywords: Saidu date palm, potassium silicate, yield, fruit quality

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Introduction

Date palm (*Phoenix dactylifera* L.) is considered an old fruit tree in many countries all over the world. Iraq, Iran, Saudi Arabia, Algeria, Libya and Egypt are the leading countries in date palm cultivation and production. Dates are a high energy food and its fruits contain carbohydrate (60-70% sugar, mainly glucose and fructose) serve as an important food (Wrigley, 1995 and FAO, 2014).

Owing to the fact that the world population increases demand for agricultural products especially food is great. New insights and techniques are required in order to achieve sufficient and sustainable yields to meet global food demand and prevent world hunger. Plant growth, nutritional status and cropping in different date palm cultivars are obviously affected by various biotic and abiotic stresses as well as nutritional factors and physiological changes.

Low yield of Saidu date palms grown under New Valley region is considered a major problem that faces growers. Finding out recent methods for promoting yield of date palms under such region is an important task for pomologists.

One of the important factors affecting yield and fruit quality of date palm is fertilization. Macro and micro-elements cause an efficient yield and fruit quality improvement while soil application can supply enough nutrients to improve date palm production. It also causes worldwide anxiety about environmental pollution by nutrients leaching into ground water (Dinnes *et al.*, 2002). Foliar fertilization has an advantage of low application rates, uniform distribution of fertilizer materials and quick responses to applied nutrients (Umer *et al.*, 1999). One of the best

tools for date palm reproductive potential studies is the direct application of nutrient elements on inflorescences and fruit (Al-Khateeb *et al.*, 2006).

The beneficial effects of silicon forms double layers on plant tissues which could explain its effect on protecting the trees from higher transpiration rate and the incidence of different disorders (Melo *et al.*, 2003). The important roles of silicon as an antioxidant on protecting the plant cells from aging and senescence through chelating free radicals namely OH, O₃ as well as, preventing the free radically ROS (reactive oxygen species) from destroying stopped (Boukachabine *et al.*, 2011).

Silicon plays an important role in increasing and enhancing with standing of fruit crops to biotic and abiotic stresses, photosynthesis, nutrient and water uptake, plant pigments and all cell division (Epstein, 1999 and Ma, 2004).

This study aims to study the effect of potassium silicate sprays (2.5, 5, 10 and 20 ml/l) on date palm bunch weight and yields during three successive seasons. Also physical and chemicals analysis of fruits were investigated.

Materials and methods

This study was carried out during three successive seasons of 2013, 2014 and 2015 on Saïdy date palms grown at Research Farm in Agricultural Research Station located at El-Kharga Oasis, New Valley, Egypt.

Fifteen palms in the same age and uniform in growth and bearing of approximately the same number of spathes were selected

The following treatments were done:

- 1- Spraying water without potassium silicate (control).
- 2- 2.5 cm potassium silicate/1 water.
- 3- 5 cm potassium silicate/1 water.
- 4- 10 cm potassium silicate/1 water.
- 5- 20 cm potassium silicate/1 water

Each treatment contains three replicates; one palm per each, spraying times was mid. of May and until the first of July with fifteen days intervals.

Generally, the following measurements were determined during the three studied seasons.

All bunches were harvested at tamr stage. Samples of 30 fruits were randomly picked from each bunch to determine the physical and chemical fruit properties

A. Physical characteristics

The bunch weight (kg) was determined then the average yield/palm (kg) for each treatment was recorded, fruit weight/bunch and yield/palm (kg) according by A.O.A.C (2005).

B. Chemical characteristics

Total soluble solids (TSS), total acidity as malic acid, moisture, ash, protein, total lipids, crude fiber, total soluble sugars, reducing and non-reducing sugars contents were determined following the methods of A.O.A.C (2005).

Statistical analysis

The experiment was arranged in a complete randomized block design. Data were subjected to statistical analysis according to the procedure reported by Gomez and Gomez (1984) and Snedecor and Cochran (1990). Treatments means were compared by the least significant difference test (L.S.D.) at the 5% level of probability in the three experimental seasons

Results and discussion

A. Physical characteristics

1. Yield index

Data presented in Table (1) shows the effect of potassium silicate on bunch weight of Saidu date palms during 2013, 2014 and 2015 seasons. It is obvious from the obtained data that the results took the similar trend during the three studied seasons.

In general view, bunch weight significantly increased due to spray potassium silicate compared to untreated one. The promotion of bunch weight was associated with increasing the concentrations of spraying solution. In addition, there was insignificant difference due to increase the potassium silicate from 10 to 20 ml/L. The heaviest bunch weight (12.23 & 12.37 kg as an. av. of three studied seasons) was recorded by spraying potassium silicate at (10 or 20 ml/L), respectively.

The recorded fruit weight/bunch was (10.42, 11.10, 10.65, 12.23 & 12.37) kg due to control (T₁), spraying potassium silicate at 2.5 ml/L (T₂), 5 ml/L (T₃), 10 ml/L (T₄) and 20 ml/L (T₅), respectively.

Hence, the increment percentage of fruit weight/bunch over to unsprayed ones were attain (6.53, 11.80, 17.37 & 19.05% as an average. of three studied seasons) spray potassium silicate at 2.5% (T₂), 5.0 (T₃), 10.0 (T₄) and 20 ml/L (T₅), respectively.

No significant differences could be noticed due to potassium silicate spraying at 10 ml/L and 20 ml/L.

Moreover, all treatments significantly increased the yields/ palm compared to untreated one (control). The increment was associated with increasing the potassium silicate concentration spraying. The maximum yield/palm (123.10 & 124.13 kg as an average. of three studied seasons) were recorded on the palms that sprayed with 10 or 20 ml/l potassium silicate, respectively.

On the other hand, the lightest yield /palm (104.23) kg as an average of three studied seasons) was recorded in the unsprayed Saidu date palms.

Then the increment percentage of yield/palm attained (6.97, 12.47, 18.10 & 19.09% as an average. of three studied seasons) due to spray with T₂, T₃, T₄ and T₅ over untreated ones, respectively.

No significant differences were observed on fruit yield/palm affecting by potassium silicate spraying at 10 to 20 ml/L.

In general, these findings indicated that it is suggested to spray potassium silicate at 10 ml/L four times to obtain the high yield of Saily date palms.

Table (1) Effect of potassium silicate spraying on fruit weight/bunch and yield/palm (kg) of Saily date palms during 2013, 2014 and 2015 seasons.

potassium silicate (ml/l)	Fruit weight/bunch (kg)				Yield/palm (kg)			
	2013	2014	2015	Mean	2013	2014	2015	Mean
control	9.65	11.10	10.50	10.42	96.50	110.80	105.40	104.23
2.5	10.35	11.75	11.20	11.10	103.80	118.10	112.60	111.50
5	10.80	12.40	11.75	11.65	109.10	124.50	118.10	117.23
10	11.40	12.95	12.35	12.23	114.30	130.80	124.20	123.10
20	11.50	13.10	12.50	12.37	114.80	131.60	126.00	124.13
LSD 5%	0.41	0.55	0.31	0.46	3.38	5.18	4.68	3.82

2. fruit weight, fruit flesh percentage, dimensions and fruit moisture percentage

Data presented in Tables (2 and 3) show the effect of spraying potassium silicate on some physical properties i.e. fruit weight, fruit flesh percentage, dimensions and fruit moisture percentage of Saily date cultivar during 2013, 2014 and 2015 seasons. The results took similar trend during the three studied seasons.

Spraying Saily date bunches with potassium silicate significantly increased the fruit weight, flesh percentage, fruit length and fruit moisture percentage compared (control). The promotion of these traits was improved associated with increased of the potassium silicate concentration spraying. Spraying 20 ml/L potassium silicate gave the highest parameters values during the three studied seasons.

Hence, the heaviest fruit weight (10.33 & 10.38 g), flesh percentage (88.01 & 88.10%), fruit length (3.62 & 3.63 cm) and fruit moisture percentage (15.57 & 15.61% as an average. of three studied seasons), respectively. Whereas, the lowest values of fruit weight was (8.45g), flesh percentage (85.75%), fruit length (3.50 cm) and fruit moisture percentage (14.13% as an average. three studied seasons) unsprayed ones, was recorded with

Table (2) Effect of potassium silicate spraying on fruit weight (g) and flesh percentage% of Saily date palms during 2013, 2014 and 2015 seasons.

potassium silicate(ml/l)	Fruit weight (g)				Flesh percentage			
	2013	2014	2015	Mean	2013	2014	2015	Mean
Control	8.30	8.67	8.38	8.45	86.12	85.47	85.67	85.75
2.5	9.10	9.48	9.15	9.24	86.96	86.26	87.31	86.91
5	9.33	9.75	9.42	9.50	87.18	86.70	87.60	87.16
10	10.12	10.62	10.25	10.33	88.18	87.69	88.14	88.01
20	10.18	10.65	10.30	10.38	88.10	88.01	88.17	88.10
LSD 5%	0.35	0.47	0.43	0.41	0.73	0.79	1.12	0.93

Table (3) Effect of potassium silicate spraying on fruit length (cm) , fruit diameter (cm) and fruit moisture % of Saidu date palms during 2013, 2014 and 2015 seasons.

potassium silicate(ml/l)	Fruit length (cm)				Fruit diameter (cm)				Fruit moisture %			
	2013	2014	2015	Mean	2013	2014	2015	Mean	2013	2014	2015	Mean
Control	3.43	3.59	3.48	3.50	2.13	2.23	2.15	2.17	14.31	14.10	13.98	14.13
2.5	3.50	3.66	3.55	3.58	2.19	2.30	2.20	2.23	14.84	14.57	14.60	14.67
5	3.53	3.68	3.56	3.59	2.20	2.31	2.22	2.24	14.93	14.65	14.83	14.80
10	3.54	3.71	3.61	3.62	2.20	2.29	2.21	2.23	15.68	15.45	15.50	15.57
20	3.55	3.69	3.65	3.63	2.19	2.29	2.12	2.23	15.72	15.50	15.61	15.61
LSD 5%	0.09	0.88	0.08	0.07	N.S.	N.S.	N.S.	N.S.	0.52	0.46	0.59	0.47

B. Chemical characteristics:

1. Total soluble solids, sugar contents

Data presented in Tables (4, 5) show the effect of potassium silicate spraying on some chemical properties i.e. total soluble solids, sugar contents of Saidu date fruits during 2013, 2014 and 2015 seasons. It is obvious from data that the results took similar trend during the three studied seasons.

Spraying Saidu date bunches with potassium silicate significantly improved the dates chemical constituents in terms of increasing the total soluble solids, and sugar contents compared to untreated one (control).

It could be simply to see from data that total soluble solid were equivalent to sugar content and reversed current.

Spraying potassium silicate at 10 ml or 20 ml/L four times gave the highest total soluble solids and sugar contents of fruits during the three studied seasons. without significant difference in between.

The highest values of total soluble solids as well as total and reducing sugars were obtained due to spray 20 ml/L potassium silicate and in descending order with decreasing potassium silicate concentration from 20 ml/L to 2.5 ml/L. Hence, these TSS values were (80.06, 79.58, 78.21 & 77.78%), total sugars (73.24, 73.19, 71.54 & 70.98%) and reducing sugars (64.96, 64.93, 63.79 & 63.34%) and non-reducing sugars (8.23, 8.26, 7.75 & 7.64% as an average. of three studied season), respectively.

Whereas, the least values of TSS, total sugars, reducing sugars and non-reducing sugars contents were recorded due to unsprayed one (control). These values were (76.43, 70.00, 62.60 and 7.40 as an average of three studied seasons), respectively. Hence,

Generally, the above results disclosed that spraying of 20 ml/L potassium silicate revealed highest improvement of tested chemicals properties of Saidu date.

No significant differences were obtained in such studied traits due to spray bunches of Saidu date palm with either potassium silicate at 10.0 or 20.0 ml/L.

Thus, from the economic point of view should be used 10 ml/Lm, hence, it could be concluded that spraying the bunches of Saidu date palm with 10 ml/L potassium silicate four times was done to get high yield with good dates quality.

Table (4): Effect of potassium silicate spraying on TSS% and Total sugars of Saidu date palms during 2013, 2014 and 2015 seasons.

potassium silicate(ml/l)	TSS %				Total sugars%			
	2013	2014	2015	Mean	2013	2014	2015	Mean
control	76.31	76.10	76.89	76.43	69.89	69.67	70.44	70.00
2.5	77.72	77.40	78.22	77.78	70.82	70.64	71.48	70.98
5	78.14	78.06	78.42	78.21	71.37	71.18	72.07	71.54
10	78.31	78.47	79.97	79.58	72.98	72.84	73.75	73.19
20	78.83	78.99	80.37	80.06	73.04	72.88	73.80	73.24
LSD 5%	0.97	0.94	1.05	0.98	0.83	0.92	0.99	0.88

Table (5): Effect of potassium silicate spraying on reducing and non-reducing sugars contents of Saidu date palms during 2013, 2014 and 2015 seasons.

potassium silicate(ml/l)	Reducing sugars %				Non reducing sugars (%)			
	2013	2014	2015	Mean	2013	2014	2015	Mean
control	62.50	62.31	63.00	62.60	7.39	7.36	7.45	7.40
2.5	63.16	63.04	63.82	63.34	7.66	7.60	7.66	7.64
5	63.58	63.15	63.92	63.79	7.79	8.03	8.15	7.75
10	64.39	64.32	65.32	64.93	8.59	8.52	8.43	8.26
20	64.43	64.50	65.20	64.96	8.61	8.38	8.60	8.23
LSD 5%	0.59	0.65	0.69	0.64	0.16	0.17	0.21	0.18

No significant differences were observed in these traits due to spray bunches with potassium silicate at 10 or 20 ml/L.

Thus, from the economic point of view should be used 10 ml/L, hence the promised treatment is 10 ml/L potassium silicate four times bunch spraying.

Hence, it could be concluded that spraying bunches of Saidu date palms with 10 ml/L potassium silicate four times was suggested to improve all physical properties of fruits. Such fruit improvement is very important target than total yield since the improve in physical fruit traits induce an increase in packable yield.

Total acidity

Data presented in Tables (5, 6 & 7) show the effect of potassium silicate spraying on some chemical properties i.e. total soluble solids, sugar contents, as well as total acidity and total soluble tannins percentage of Saidu date fruits during 2013, 2014 and 2015 seasons. It is obvious from the data that the results took similar trend during the three studied seasons.

Spraying Saidu date bunches with potassium silicate significantly improved the dates chemical constituents in terms of increasing the total soluble solids, sugar contents and decreasing the total acidity and total soluble tannins percentages compared to untreated ones (control).

It could be simply to see from data that total soluble solid were equivalent to sugar content and reversed current with total acidity and tannins content.

Spraying potassium silicate at 10 ml or 20 ml/L four times gave the highest total soluble solids and sugar contents of fruits during the three studied seasons without significant difference in between .

The highly values of total soluble solids as well as total and reducing sugars were obtained due to spray 20 ml/L potassium silicate and in descending order with decreasing potassium silicate concentration from 20 ml/L to 2.5 ml/L. Hence, these TSS values were (80.06, 79.58, 78.21 & 77.78%), total sugars (73.24, 73.19, 71.54 & 70.98%) reducing sugars (64.96, 64.93, 63.79 & 63.34%) and non-reducing sugars (8.23, 8.26, 7.75 & 7.64% as an average. of three studied season), respectively.

Whereas, the least values of TSS, total sugars, reducing sugars and non-reducing sugars contents were recorded due to unsprayed ones (control). These values were (76.43, 70.00, 62.60 and 7.40 as an av. of three studied seasons), respectively. Hence, On other hand, the values of titratable acidity percentage were (0.233, 0.225, 0.197 & 0.186%) and soluble tannins (0.477, 0.442, 0.380 & 0.365% as an av. of three studied seasons), due to sprayed with 2.5, 5.0, 10.0 or 20.0 ml/L of potassium silicate compared the highest ones (0.268 & 0.578%) as an av. of three studied seasons), on untreated ones (control), respectively.

Hence, the corresponding decrement percentages of titratable acidity were (13.06, 16.05, 26.49 & 30.59%) and soluble tannins were (17.47, 23.53, 34.26 & 36.85% as an av. three studied seasons) due to spray potassium silicate compared to control, respectively.

Generally, the above results disclosed that spraying of 20 ml/L potassium silicate revealed the highest improvement of tested chemicals properties of Saily date

No significant differences were obtained in such studied traits due to spray bunches of Saily date palm with either potassium silicate at 10.0 or 2.0 ml/L.

Thus, from the economic point of view should be used 10 ml/Lm, hence, it could be concluded that spraying the bunches of Saily date palm with 10 ml/L potassium silicate four times was done to get high yield with good dates quality.

Such finding was in harmony with many investigators on certain date cultivars and other fruit trees. On date cultivars, Ahmed *et al.*, (2013a), Al-Wasfy (2013), Gad El-Kareem *et al.*, (2014), Badran *et al.*, (2015) and Badran (2016). They concluded that treatment palms three or four times with potassium silicate improved fruit quality in terms of increasing fruit weight, dimension, TSS, sugar content and decreasing total acidity and soluble tannins. The same finding were obtained by El-Khawaga and Mansour (2014), Ibrahim and Al-Wasfy (2014), Abdel-Wahab (2015) and Mohamed (2016) on some orange, mango or olive cultivars.

Conclusion

On account of the obtained results one can conclude that spraying bunches of Saidy date palm after two months of pollination with 10 m/L potassium silicate four times every two weeks had an increased in the total yield. Also, It increased the most of fruit quality properties.

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استجابة نخيل البلح (*Phoenix dactylifera* L.) للرش بسليكات البوتاسيوم

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الملخص العربي

أجريت هذه الدراسة خلال ثلاثة مواسم متتالية هي 2013, 2014, 2015 على نخيل البلح الصعيدي النامية بالمزرعة البحثية بمحطة البحوث الزراعية بواحة الخارجة - الوادي الجديد - مصر. لدراسة تأثير رش سيليكات البوتاسيوم علي المحصول وخصائص جودة الثمار .

واشتملت هذه الدراسة علي الرش بالماء فقط (معاملة المقارنة) والرش 4 مرات بتركيزات 2.5 , 5 , 10 , 20 , مل سلكات بوتاسيوم / لتر ماء وذلك بعد التلقيح بشهرين ثم مرة كل أسبوعين أدي الرش بسلكات البوتاسيوم الي زيادة معنوية في متوسط وزن السباطة وكذلك الخواص الطبيعية (وزن الثمرة - ابعاد الثمرة - % اللحم) وأيضاً زيادة معنوية في المواد الصلبة الذائبة الكلية والسكريات الكلية مقارنة بثمار السوباتات المرشوشة بالماء فقط وارتبط التحسن في المحصول وخصائص الثمار بزيادة تركيز سلكات البوتاسيوم في محلول الرش من 2.5 حتي 10 مل /لتر ولم تسجل زيادة بزيادة محلول الرش من 10 الي 20 مل /لتر

من الناحية الاقتصادية ينصح برش العزوق بمعدل 10مل سليكات بوتاسيوم / لتر أربع مرات وذلك بعد العقد بشهرين ثم الرش دورياً كل أسبوعين وذلك لانتاج محصول عالي ذو خصائص جودة ممتازة

الكلمات الدالة: نخيل البلح الصعيدي، سليكات البوتاسيوم، كمية المحصول، جودة الثمار