Available online free at www.futurejournals.org

The Future Journal of Agriculture

Print ISSN: 2687-8151 Online ISSN: 2687-8216

Future Science Association

Future J. Agric., 2 (2022) **1-9** **OPEN ACCES**

DOI: 10.37229/fsa.fja.2022.04.16

EFFECT OF SPRAYING MICRONIZED SULFUR ON GROWTH AND FRUITING OF SEWY DATE PALM GROWN IN SANDY SOIL

Ali H. Ali.; Farouk, H. Abd Elaziz; Moawad A. Mohamed and Atteya K. Abd-El Wahab

Hort. Dept. (Pomology), Fac. of Agric., Minia Univ., El-Minia, **Egypt**.

*Corresponding author: hamdy_france@yahoo.com **Received:** 14 Feb. 2022 **; Accepted:** 16 April 2022

ABSTRACT: In order to study the effect of spraying different concentration (200, 300 and 400 ppm) of micronized sulfur on vegetative growth, yield and fruit physic-chemical characteristics of Sewy date palm trees, un field experiment was conducted during 2018 and 2019 in sandy soil located at El-Karaga oasis New Valley Governorate, Egypt. The obtained results confirmed that all vegetative growth leaves main pigments (chlorophyll a, b and total carotenoids), yield in kg/palm as well as physic-chemical characteristics were significantly improved as a result of spraying micronized sulfur at 200 to 400 ppm, rather than control treatment. This increment was parallel and correlated with increasing the concentration used from 200 to 400 ppm. However, non-significant differences were observed between the two highest concentrations (300 and 400 ppm), neither during the first nor during the second season. Generally, in order to improving the growth and fruiting of Sewy date palm trees grown under sandy soil, this study strongly recommended by spraying the palms with 300 ppm micronized sulfur three times yearly.

Key words: *Phoenix dectylifera*, Sewy date palm, growth, fruiting, micronized sulfur.

INTRODUCTION

Date palm tree (*Phoenix dectylifera* L.) is one of the old fruits trees in Arab regions as old as agriculture. The date palm is one of the tropical and subtropical region fruits (**Hodel and Johnson 2007**). Egypt considered as the first one of the major production countries of date palm (**FAO, 2016**). Sewy cultivar (also known as Saedy date palm in New valley Governorate) considered as one of the most pupillary cultivar in Egypt **(Hussein, 2005** and **Abd-Allah, 2016**). This cultivar well adapted and cultivated in middle Egypt and New valley (**Hussein 2005 and Abd-Allah, 2016)**. Among all the Egyptian Governorates, New valley Governorate ranked the third position after Behaira and Sharkia according to the numbers of female date palm trees (**Annual Reports of Statistical and Agricultural Economics in Arab Republic of Egypt, 2018**).

Sulfur considered as one of the macro essential element for plant nutrition. This element plays many important physiological roles in growth and plant healthy (**Turrell, 1950; Neilsen *et al.*, 1993** and **Leustek & Saito 1999**). Sulfur has become more important as a limiting nutrient in crop production in recent years for several reasons (**Turrell, 1950 and Marschner, 1995**). However, sulfur serves many functions in plants, such as: 1- it is use in amino acids formation, 2- it is necessary for chlorophyll formation and it is essential building block, 3- it help develop and it is required by the nitrogen fixing bacteria, it play an important role in activation of certain enzymes, 4- it participate the structure of two very important amino acids (**Marschner, 1995 and Leustek & Saito 1999**). Sulfur is soluble and easily lost from soil by leaching spatially in sandy soil, such as New Valley land, Elemental sulfur is a good acidifying agent, So, applied 500 pounds of sulfur per acre on sandy soil can reduces the pH from 7.5 to 6.5 (**Maathuis, 2009**). Sulfur ion (SO_4) is the form primarily absorbed by plants (**Maathuis, 2009**).

The target of this investigation was examining the effect of spraying three gradual concentrations (200m 300 and 400 ppm) three times yearly on leaf vegetative growth, fruiting and fruit quality of Sewy date palms cultivar grown in sandy soil under New Valley conditions.

MARTIALS AND METHODS

The current investigation was carried out during two successive seasons 2018 and 2019 on sixteen uniform in vigor 15-years old Sewy date palm cultivated in private orchard located at El-Kharga Oasis - New Valley Governorate (600 km south western Cairo city) - Egypt, where the soil texture was sandy soil. The chosen palms are planted at 8 X 8 meters apart. The chosen palms are subjected to regular horticulture practices that were commonly applied in date palm orchards including fertilization, irrigation, hoeing and pest management. Pruning was performed to maintain leaf / bunch ratio at 8:1. The number of female spathes per palm was adjusted to 10 spathes by removing excess earliest, latest and small bunches.

Soil and water used in irrigation analysis

Composite samples of soil well water used in irrigation were collected and subjected to physical and chemical analysis according to **Wilde *et al.*, 1985 and Walsh & Beaton (1986)**. The obtained data are illustrated in the following Table.

Table 1. Physical and chemical analysis of experiment orchard soil and the water used in irrigation

Soil analysis		Water analysis	
Constituents	**Values**	**Constituents**	**Values**
Sand %	81.5	E.C (m.mhos/cm/25C)	0.8
Silt %	11.0	Hardness	19.7
Clay %	7.5	pH	7.35
Texture	Sandy	Ca (mg/L)	40.4
EC (1:2.5Extract) mmhos/cm/ 25 C	0.75	Mg (mg/L)	24.3
Organic matter %	0.4	K (mg/L)	6.07
pH (1 : 2.5 extract)	8.6	Na (mg/L)	21.8
Active lime %	8.3	Sum of Cations (mg/L)	8.16
N (mg/kg)	0.2	Alkalinity (mg/L)	165
Phosphorus (ppm)	2.1	Chlorides (mg/L)	108
Available Ca (meq/100g)	0.51	Nitrate (mg/L)	10.2
C/N Ratio	16.7	SAR	1.97

Experimental work

In order to study the effect of spraying miconized sulfur on Sewy date palm, three gradual concentrations (200, 300 and 400 ppm) were examined during this experiment. All treatments were applied three times yearly (just at fruit setting, one month after fruit setting and one month later). Then, this study arranged in complete randomized block designee (RCBD) and included the following four treatments.

1- Control (0.0% sulfur, untreated palms, sprayed with water).

2- Spraying micronized sulfur at 200 ppm.

3- Spraying micronized sulfur at 300 ppm.

4- Spraying micronized sulfur at 400 ppm.

All treatments were replicated four times times, and each replicate was represented by one palm. The following parameters were measured during this study:

Vegetative growth parameters and leaves pigments contents

- Number of green leaves: The numbers of green leaves/palm were counted at harvest time, during the two experimental seasons.

- Eight leaves per palm have a six months has been labeled, two leaves in each major geographic direction. Then, the total number of leaflets per each leaf were counted and noted.

- The average leaflet numbers/leaf was calculated for each leaf, so the main was calculated. Leaflet area (cm^2) was determined using, **Ahmed and Morsy (1999)** equation: leaflet area (W X L) x 0.67 + 10.29, in which W and L are the maximum width and length of leaflet. Then leaf area (m^2) was calculated by multiplying the number of leaflets/leaf X the leaflet area.

- Leaves main pigments: Sample of six mature and fresh leaflets/leaf taken from the six month old leaves (at harvest time 2^{ed} week of August). The leaflets were cut into small pieces, 0.5 g from each sample was taken, homogenized and extracted by

85% acetone in the presence of little amounts of Na_2CO_3 and filtered. The residue washed several times using acetone 85% until the filtrate became colourless. Then the extract completed to a known volume (20 ml) with acetone 85%. A portion of this extract was taken for the determination of chlorophylls A and B calorimetrically and acetone (85 % V/V) used as a blank. The optical density of the filtrate determined at wave length of 662 for chlorophyll a and 664 nm for chlorophyll b. The concentration of each pigment was calculated by using the following equations (according to **Ward and Johnston, 1962, illustrated in Martin-Prevel *et al.*, 1984).**

Chl. a = (9.784 x E 662) – (0.99 x E 662) = mg / 100 g F.W.

Chl. b = (21.426 x E 644) – (4.65 x E 644) = mg / 100 g F.W.

Total Carotenoids = (4.695 × E 440) – 0.268 (E 662 + E 644) = mg / 100 g F.W.

However, E = optical density at a given wavelength. Total chlorophyll was estimated by summation of chlorophyll a plus chlorophyll b (mg/ 100 g. F.W.)

Yield and its component

Bunches were picked at the optimum commercial harvesting time in New Valley region conditions (the second week of Augusts) during the two seasons. Then, each punch was weighted (kg) and recorded, and the main punch weight was calculated. Then, the yield in kg per palm was calculated, by multiplying the average bunch weight (kg) by total number of bunches per palm.

Fruit physical characteristics

Samples of one hundred dates from the yield of each palm were taken randomly and the following physical and chemical characteristics were studied:

- Average fruit weight (g) was recorded, as a result of tack 20 fruit weight individually, using balance of 0.01g sensitivity.

- Fruit dimensions (length and diameter in cm) were recorded as a result of 2o fruit length and diameter (cm) individually, by using vernier caliper.

Fruit Chemical characteristics

Sample (100 g) of fruit pulp was added to 100 ml distilled water and stand 4 hours, and then the samples minced will with electric blender for determination of the following chemical constituents: Percentage of total soluble solids (T.S.S %) were determined by hand refractometer (**according to A.O.A.C., 1995**); Percentage of total and reducing sugar and total sugars (%), according to Lane and Eynone volumetric method (illustrated in **Ranganna, 1977**). Percentage of total acidity (expressed as grams of malic acid per 100 grams of fruit pulp) by titration against with 0.1 NaOH in presence of phenolphthalein as an indicator (according to **A.O.A.C, 1995**).

Statistical analysis

The obtained data were tabulated and subjected to the statistical analysis; using analysis of variance (ANOVA) by MSTATC Program. Comparisons between means were made using least significant differences (L.S.D) at p= 0.05 (**Snedecor and Cochran, 1977**).

RESULTS AND DISCUSSION

Effect different sources of sulfur on date palm growth

Number of green leaves/palm and number of leaflet/leaf

The obtained data presented in Table (2) showed that the both characters (number of green leaf/palm and number of leaflet/leaf) of Sewy date palm trees were remarkable enhanced as a result of spraying micronized sulfur at 200 ppm to 400 ppm, rather than untreated palms, during the two experimental seasons (2018 and 2019). This increment reached a maximum when Sewy date palm received micronized sulfur at 400 ppm sulfur (25.0 & 25.6 green leaves / palm 186.7 & 188.2), followed by those received micronized sulfur at 300 ppm (24.3 & 24.7 green leaves/palm and 184.1 & 185.8 leaflet/leaf), however, non-significant differences were observed between the two highest concentrations. On the other hand, untreated palms present the lowest number of green leaves / palm (20 and 20.2 leaves) and lowest number of leaflet/leaf (170 and 171.4 leaflet), these data were true during both two experimental seasons.

Leaflet area (cm^2) and leaf area (m^2)

Leaflet area (cm^2) and leaf area (m^2) differed significantly among different concentrations of sulfur micronized (Table 2). Gradual and parallel increment in leaflet area cm^2 and leaf area m^2 were obtained whine the concentration used increased from 200 to 400 ppm. However, the palms received micronized sulfur at 400 ppm present the highest leaflet area (167.9 & 164.8 cm^2) and leaf area (3.06 & 4.05 m^2), during the two experimental seasons respectively. However, non-significant differences were observed between the two highest concentrations. Contrary, untreated palms present the lowest leaflet area (146.0 & 147.1 cm^2) and leaf area (2.50 & 2.56 m^2), during the two experimental seasons respectively.

These results concerning the stimulation of Sewy date palm vegetative growth as a result of treated the palms with sulfur which obtained during the present study are in harmony with those obtained by **Vargas *et al.*, (2014)** on avocado trees growing

organically under Michoacan – Mexico. **Shivay *et al.*,** (**2016**) on the effect of sulfur-coated urea as a source of sulfur on vegetative growth of different fruit trees growing under New Delhi conditions – India and **Belikova *et al.*, (2019)** on apple trees cultivar Glosterto.

It is worth to mention that increasing the vegetative growth of Sewy date palm obtained in this investigation may be explained by the essential role sulfur as a constituent of the amino acids cysteine and methionine and part of proteins that plays an important role in the synthesis of vitamins and chlorophyll **(Marschner, 1995; Kacar and Katkat, 2007)**. Some authors demonstrated that sulfur fertilization can be significantly changes the chemical composition of crops. The availability of sulfur can determine the efficient use of nitrogen by plants, and then consequently affects plant mineral composition (**Wielebski and Muśnicki, 1998; Krauze and Bowszys, 2000; Podlesna 2003 and Kulczycki G. 2003).** Nitrogen content in tested plants is significantly modified by the sulfur available (**Marschner, 1995**). Furthermore, application of sulfur element significantly increased Zn solubility in soil, these lead to increasing their uptake by trees roots, then increasing the synthesis of tryptophan amino acid which participant the structure of indol acetic acid (**Marschner 1995 and Kayser *et al.*, 2001**).

Table 2. Effect of micronized sulfur at different concentrations on number of green leaves/palm, number of leaflet/leaf, leaflet area and leaf area (m^2) of Sewy date palm, during 2018 and 2019 seasons

Treatments	No. of green leaves /palm		No. of leaflets/leaf		Leaflet area (cm^2)		Leaf area (m^2)	
	2018	2019	2018	2018	2018	2019	2018	2019
Control	20.0	20.2	170.0	171.4	146.0	147.1	2.50	2.56
Micronized sulfur at 200g/palm	23.1	23.6	180.0	182.6	162.0	158.0	2.86	2.95
Micronized sulfur at 300g/palm	24.3	24.7	184.1	185.8	165.5	162.0	2.97	3.07
Micronized sulfur at 400g/palm	25.0	25.6	186.7	188.2	167.9	164.8	3.06	4.05
New LSD at 5%	**0.9**	**1.0**	**3.0**	**3.1**	**2.9**	**3.0**	**0.09**	**0.10**

Leaves main pigments contents

Data in Table (3) showed that, the content of Sewy date palm leaves from chlorophyll a, chlorophyll b and total carotenoids significantly increased as a result of spraying micronized sulfur, during the two experimental seasons. However, non-significant differences were observed between the two highest concentrations (300 and 400 ppm). Furthermore, increasing the concentration used was very effective in enhancing both chlorophylls (a & b) and total carotenoids in Sewy date palm leaves, rather than control treatment. This increment was parallel with a gradual increasing of sulfur concentration from 200 to 400 ppm, during the two seasons (2018 and 2019). On the other side, increasing micronized sulfur concentration from 300 to 400 ppm failed to increase significantly neither chlorophylls pigments (a & b) nor total carotenoids, during the two experimental seasons.

The same Table showed that, the palms received 400 ppm micronized sulfur present the highest chlorophyll a (8.5 & 8.6 mg/100g F.W.), chlorophyll b (4.3 & 4.5 mg/100g F.W.) and total carotenoids (4.0 & 4.1 mg/100g F.W.) in their leaves during the two seasons respectively. On the opposite side, untreated palms present the lowest chlorophyll a (6.1 & 6.0 mg/100g F.W.), chlorophyll b (2.6 & 2.7 mg/100g F.W.) and total carotenoids (2.0 & 2.1 mg/100g F.W.) in their leaves, during 2018 and 2019 seasons respectively.

These results are in harmony with those obtained by **Abbas *et al.*, (2015)**, who also reported that spraying sulfur caused a significant increase in leaves chlorophyll a, b and total chlorophyll **of** Barhee and Sayer date palm offshoots. Also, the present findings on enhancing leaves chlorophyll a and b by application different forms of sulfur are in line with the results obtained also by **Awad and Badawi (2017)** in date palm cultivar Neghal tosome grown under sandy calcareous soil. Furthermore, **Salem and Ali (2020)** confirmed the positive effect of sulfur slow fertilizers on Khalas date palm. The previous positive effect of sulfur application as well as their different forms on leaves mane pigments of Sewy date palm trees was attributed mainly to the beneficial effects of this element on reducing soil salinity, soil pH and mineral elements availability in soil media (**Maquieira *et al.*, 1984; Zhao *et al.*, 2008; Elamin *et al.*, 2017** and **Salem and Ali, 2020)**.

Table 3. Effect of micronized sulfur at different concentrations on chlorophyll a, chlorophyll b and total carotenoids (mg/100g. F.W.) of Sewy date palm during 2018 and 2019 seasons.

Treatments	Chlorophyll a (mg/100g. F.W.)		Chlorophyll b (mg/100g. F.W.)		Total Carotenoids (mg/100g. F.W.)	
	2018	2019	2018	2019	2018	2019
Control	6.1	6.0	2.6	2.7	2.0	2.1
Micronized sulfur at 200g/palm	7.5	7.6	3.8	3.7	3.3	3.5
Micronized sulfur at 300g/palm	8.4	8.5	4.3	4.4	3.9	3.9
Micronized sulfur at 400g/palm	8.5	8.6	4.3	4.5	4.0	4.1
LSD at 5%	**0.3**	**0.3**	**0.2**	**0.2**	**0.3**	**0.3**

Yield and its components

Data concerning the effect of different concentration of micronized sulfur on yield expressed in punch weight (kg) and yield (kg/palm) as well as fruit weight (g) of Sewy date palm trees during 2018 and 2019 seasons are presented in Tables (4). It is clearly shown from the data presented in this Table that treating Sewy date palm three times with different concentration of micronized sulfur significantly was accompanied with improving punch weight (kg), yield (kg/palm) and fruit weight (g) rather than control treatment, during both experimental seasons.

In this concern the data also shown clearly that, the palms received the highest concentration of micronized sulfur present the highest punch weight (13.43 & 12.51 kg), yield (132.3 & 128.1 kg) and fruit weight (12.2 and 12.7 g) rather than those received the lower concentrations or untreated palms. These data were true during the two experimental seasons. On the other hand, untreated palms present the lowest punch weight (10.00 & 10.05 kg), yield (100.0 & 100.5 kg) and fruit weight (9.5 & 9.3 g), during the two experimental seasons respectively. Furthermore, non-significant differences were observed between the two highest micronized sulfur concentrations (300 and 400 ppm), neither in the first nor in the second season.In order to improve the punch weight (kg), yield (kg/palm) and fruit weight (g) of Sewy date, it is may be recommend, under this experiment conditions and resampling conditions, spraying Sewy date palm by sulfur at 300 ppm micronized sulfur.

Similar results concerning the positive effect of sulfur on yield and its component were observed by certain authors in date palm or other fruit trees, such as; **Maquieira *et al.*, (1984)** who studied the effect of sulfur-coated urea on yield and fruit quality of Washington Navel orange trees; **Abbas *et al.*, (2015)** when o studied the effect of sulfur application at 100 and 200 g on Barhee and Sayer date palm offshoots under salinity stress; **Awad and Badawi (2017)** who studied the effect of organic and chemical fertilizers with or without elemental sulfur on date palm cultivar Neghal tosome under sandy calcareous; **Salem and Ali (2020)** mentioned the same findings when studied the effect of some slow fertilizers on Khalas date palm grown under Luxor Governorate conditions; **Moradi *et al.*, (2020)** who studied the effect of foliar application of sulfur on date palm under south of Iran., and **Said *et al.*, (2020)** who spraying of olive (*Olea europaea L.*) by sulfur at 0, 500, 1000, 1500 ppm as foliar application during different physiological stages.

All these previous studies confirmed the positive role of sulfur in increasing fruit trees yield and its components that we found during the present study. In addition, application of sulfur element significantly increased Zn solubility in soil, these lead to increasing their uptake by trees roots, then increasing the synthesis of tryptophan amino acid which participant the structure of indol acetic acid (**Marschner 1995 and Kayser *et al.*, 2001**). Furthermore, **Dilmaghani *et al.*, 2012** mentioned that Fe concentration increased parallel to sulfur applications that may be explained by drop the pH level. Allso, **Kalbasi *et al.*, (1988)** suggested that sulfur application can change the pH of the soil or rhizosphere from alkaline to acidic, this can led to increase of iron availability and its concentration in plants.

Fruit physical properties

Data concerning fruit length (cm) and fruit diameter (cm) of Sewy date palm as a result of spraying micronized sulfur at different concentrations (200, 300 and 400 ppm) during 2018 and 2019 seasons are illustrated in Table 5. It is noticed from the obtained data that the physical characteristics of the Sewy date palm fruit were gradually and significant increased as a result of increasing the concentration used from 200 ppm to 400 ppm. These data were true during the two experimental seasons. Data illustrated in Table (8) showed that the palms received the highest concentration of micronized sulfur (400 ppm)

present the highest fruit length (5.8 & 6.1 cm) and fruit diameter (4.3 & 4.4 cm), during the both experimental seasons respectively. Contrary of this, untreated palms present the lowest fruit length (3.4 & 3.6 cm) and lowest fruit diameter (2.5 & 2.6 cm), during the two experimental seasons respectively. on the opposite side, untreated palms present the lowest fruit length (3.4 & 3.5 cm) and fruit diameter (2.5 & 2.6 cm), during the two experimental seasons respectively.

On the line with our results, concerning the effect of different sources of sulfur treatments on fruit physical properties were the findings of **Muhammad *et al.*, (2007)** who compared the effect of three different sources of sulfur namely; gypsum ($CaSO_4$. $2H_2O$), elemental sulfur (S) and ammonium sulfate $\{(NH_4)_2\ SO_4\}$ on fruit physical properties of *Citrus limon*; **Kassem (2012**) on Zaghloul date palm grown in calcareous soil; **Chun *et al.*, (2012)** they studied the effect of lime sulfur at 1% or 2% on 'Fuji'/M.9 and 'Hongro'/M.9 apple cultivars; and **Said *et al.*, (2020)** they examined the effect of sulfur at 0, 500, 1000, 1500 ppm as foliar application on physical and chemical properties of olive (*Olea europaea L.*).

Table 4. Effect of micronized sulfur at different concentrations on Bunch weight (kg), Yield (kg/palm) and fruit weight (g) of Sewy date palm, during 2018 and 2019 seasons

Treatments	Bunch weight (kg)		Yield (kg/palm)		Fruit weight (g)	
	2018	2019	2018	2019	2018	2019
Control	10.00	10.05	100.0	100.5	9.5	9.3
Micronized sulfur at 200g/palm	12.10	11.92	121.0	119.2	11.3	11.5
Micronized sulfur at 300g/palm	12.99	13.09	128.2	126.2	11.9	12.5
Micronized sulfur at 400g/palm	13.43	12.51	132.3	128.1	12.2	12.7
New LSD at 5%	**0.65**	**0.50**	**5.5**	**5.0**	**0.5**	**0.6**

Table 5. Effect of micronized sulfur at different concentration on fruit length (cm) and fruit diameter (cm) of Sewy date palm during 2018 and 2019 seasons

Treatments	Fruit length (cm)		Fruit diameter	
	2018	2019	2018	2019
Control	3.4	3.6	2.5	2.6
Micronized sulfur at 200g/palm	5.1	5.3	3.9	3.9
Micronized sulfur at 300g/palm	5.6	5.8	4.2	4.3
Micronized sulfur at 400g/palm	5.8	6.1	4.3	4.4
New LSD at 5%	**0.3**	**0.4**	**0.3**	**0.2**

Fruit chemical properties

Data concerning the effect of different concentrations of micronized sulfur on total soluble solids%, reducing sugars & total sugars%, total acidity%, total soluble tannin% and total crude fibers% of Sewy date palm during 2018 and 2019 seasons are illustrated in Tables (6 and 7).

Table (6) shows that, all sulfur concentrations were capable of causing significant promotion in T.S.S and sugars contents (reducing, and total sugar %) in Sewy date palm over the control palms, during the two experimental seasons. Furthermore, both TSS% and sugars contents (reducing and total sugars %) gradual and significant increased as a result of increasing the concentration of sulfur from 200 ppm to 400 ppm, however non-significant differences were observed between the two highest concentrations namely 300 ppm and 400 ppm. The highest TSS% (73.4 & 74.7 %), Reducing sugar % (33.2 & 33.7 %) and total sugars (71.7 & 63.0 %) were obtained from the palms received the micronized sulfur at highest concentrations, during the two experimental seasons respectively. Contrary of this, untreated palms present the lowest TSS% (65.0 & 65.6 %), Reducing sugar % (29.5 & 30.0 %) and total sugars (58.0 & 58.5 %) during the two seasons respectively.

On the opposite side, gradual and significant decrease in fruit total acidity %, total tannins % and crude fibers% during the two experimental seasons as a result of spraying micronized sulfur at different concentrations (200 to 400 ppm) were observed,

compared to untreated palms (Table 7). These increments were parallel with increasing micronized sulfur concentrations 200 to 400 ppm. However, the palms received the highest concentration 400 ppm present the lowest total acidity (0.217 & 0.232 %), total soluble tannins (0.82 & 0.83%) and total crude fibers (1.33 & 1.23 %) in their fruits, during the two seasons respectively. Other words, untreated palms present the highest total acidity % (0.356 & 0.350 %), total soluble tannins (1.10 & 1.12 %) and total crude fibers (2.44 & 2.37 %) in their fruits, during the two seasons respectively.

Regarding all chemical properties studied, non-significant differences were observed between the two highest concentrations, neither in the first season nor in the second season. Then, we can recommend treated in this respect was spraying sulfur at 300 ppm in form of micronized sulfur to improve fruit chemical properties of Sewy date palm.

The role of spraying sulfur in improving the chemical characteristics of Sewy date palm in terms increasing the T.S.S% total sugars%, and Reducing sugar % as well as decreased total acidity %, total tannins % and total crude fibers % of Sewy date palm fruits was previously illustrated by certain authors such as: **Kassem (2012**) on Zaghloul date palm; **Chun *et al.*, (2012)** on apple trees; **Al-Obeed *et al.*, (2013)** on Khalas date palm; **Abbas *et al.* (2015)** on yield and quality of Barhee date palm and **Said *et al.*, (2020)** on olive trees.

Table 6. Effect of micronized sulfur at different concentrations on total soluble solids (%), total sugars (%) and reducing sugars (%) of Sewy date palm during 2018 and 2019 seasons

Treatments	TSS (%)		Total sugars (%)		Reducing sugars (%)	
	2018	2019	2018	2019	2018	2019
Control	65.0	65.6	58.0	58.5	29.5	30.0
Micronized sulfur at 200g/palm	68.9	69.5	70.6	61.7	32.4	32.6
Micronized sulfur at 300g/palm	72.9	73.7	71.2	62.4	32.9	33.2
Micronized sulfur at 400g/palm	73.4	74.5	71.7	63.0	33.2	33.7
New LSD at 5%	**0.8**	**0.9**	**0.6**	**0.7**	**0.5**	**0.6**

Table 7. Effect of micronized sulfur at different concentrations on total acidity (%), total soluble tannins and total crude fibers of Sewy date palm during 2018 and 2019 seasons.

Treatments	Total acidity (%)		Total soluble tannins (%)		Total crude fibers (%)	
	2018	2019	2018	2019	2018	2019
Control	0.356	0.350	1.10	1.12	2.44	2.37
Micronized sulfur at 200g/palm	0.252	0.270	0.90	0.92	1.61	1.57
Micronized sulfur at 300g/palm	0.230	0.250	0.85	0.86	1.46	1.33
Micronized sulfur at 400g/palm	0.217	0.232	0.82	0.83	1.33	1.23
New LSD at 5%	**0.02**	**0.02**	**0.05**	**0.04**	**0.21**	**0.22**

Conclusion

In order to improve Sewy date palm growth, production and fruit physic-chemical characteristics, bases on the obtained results during this field experiment, we can recommended by spraying Sewy date palms grown in sandy soil under New Valley Governorate conditions with micronized sulfur at 300 ppm three times just after fruit sett, one month after fruit setting and one month later.

REFERENCES

A.O.A.C., (1995). Association of official Analytical Chemists: Official Methods for Analysis 16th Ed. AOAC, Washington, D.C.

Abbas, M.F; Jasim, A.M. and Shareef, H.J. (2015). Role of Sulphur in salinity tolerance of Date Palm (*Phoenix dactylifera L.*) offshoots cvs. Berhi and Sayer. Intern. J. of Agric. & Food Sci. 2015; 5(3): 92-97.

Abd-Allah, A.M. (2016). Evaluation of some varieties and seedlings of date palm grown at Bahriya oasis. Master of Sci. Fac. of Agric. Cairo Univ., Egypt.

Ahmed, F.F. and Morsy, M.H. (1999). A new method for measuring leaf area in different fruit species. Minia j. of agric. Res. & develop. Vol. (19):97- 105.

Al-Obeed, R.S; Kassem, H.A. and Ahmed, M.A. (2013). Effect of levels and methods of potassium and phosphorus fertilization on yield, fruit quality and chemical composition of "Khalas" date palm cultivar. Life Sci. J., 10(4): 1111-1118.

Annual Reports of Statistical and Agricultural Economics in Arab Republic of Egypt, "A.R.E" **(2018)**.

Awad, M.A, and Badawi, M.A. (2017). Effect of elemental sulfur, chemical and organic fertilization on nutrient uptake, yield and fruit quality of date palm trees (Phoenix dactylifera L.) cv. Neghal. Seventh Ann. U.A.E. Univ. Res. Conf. pages 1-6.

Belikova, H.; Meszaros, M.; Varga, L.; Arvay, J.; Kielian, B.W.; Gondek, K.; Antonkiewicz, J.; Torma, S.; Lazarevic, B.; Bennewitz, E.V. and Losak, T. (2019). The effect of different forms of sulphur on incidence of apple ecab on apple tree (*Malus domestica Borkh*) gloster CV. Ecol. Chem. Eng. 2019; 26(1):199-208.

Chun, I.J; Zheng, W.W.; Choi, C.; Song, Y.Y.; Kwang, I.K and Hirst, P. (2012). Multiple Applications of Lime Sulfur for Fruit Thinning of 'Fuji' and 'Hongro' Apple Trees. J. of Bio-Environ. Control, 21(4):445-451

Dilmaghani, M.R.; Hemmaty, S. and Naseri, L. (2012). Effects of Sulfur Application on Soil pH and Uptake of Phosphorus, Iron and Zinc in Apple Trees. J. of Plant Physiology & Breeding, 2(1): 1:10.

Elamin, A.H.; Elsadig E.H;. Aljubouri, H.J. and Gafar, M.O. (2017). Improving fruit quality and Yield of Khenazi date palm (*Phoenix dactilifera L.*) grown in sandy soil by application of nitrogen, phosphorus, potassium and organic manure. Intern. J. of Develop. & Sustain. 6 (8): 862-875.

FAO (2016). Date production and protection. Food and Agriculture Organization of the United Nation. Rome, Italy.

Hodel, D.R. and Johnson, D.V. (2007). Imported and American varieties of dates in USA. California Univ., Agric. & Natural Resources 112 pp.

Hussein, F. A.A. (2005). Date palm, life tree, between past, present and future. Arbic version, Arab House for Publishing & Distribution, Cairo – Egupt. Pages 64:66.

Kacar, B. and Katkat, A.V. (2007). Plant Nutrition. 3th Edn. Nobel Press; Ankara, Turkey.

Kalbasi, M.; Filsoof, F. and Rezai, N. (1988). Effect of sulphur treatments on yield and uptake of Fe, Zn and Mn by corn sorghum and soybeans. J. Plant Nutr. 11:1353-1360.

Kassem, H. A. (2012). The response of date palm to calcareous soil fertilization. J of Soil Sci. & Plant Nut., 12 (1): 45-58.

Kayser, A.; Schroder, T.J.; Grunwald, A. and Schulin, R. (2001). Solubilization and plant uptake of zinc and cadmium from soils treated with elemental sulfur. Int. J. Phytorem. 3:381- 400.

Krauze, A. and Bowszys, T. (2000). Effect of applying different technologies of sulfur fertilizer application on yield and quality of winter and spring rape. Fol. Univ. Stetin., Agric., 204(81): 133-142. (in Polish)

Kulczycki, G. (2003). The influence of elemental sulphur fertilization on yield chemical composition of plants and chemical soil properties. Fertilizers and Fertilization, 4(17): 151-159. (in Polish).

Leustek, T., and Saito, K. (1999). Sulfate transport and assimilation in plants, Plant Physiology, 120 (3): 637–643.

Maathuis, F.J.M. (2009): Physiological functions of mineral macronutrients. Current Opinion in Plant Biology 12: 250-258.

Maquieira, A.; M. D. Climent, M.D.; Puchades, R. and Yufera, E.P. (1984). Fertilization of orange trees with sulfur-coated urea. Nitrogen levels in leaves and fruits. Plant and Soil 80, 247-254 (1984).

Marschner, H. (1995). Mineral nutrition of higher plants. Second Edition, Academic Press, Harcourt Brace & Company Publishers, New York. Pp 985.

Martin-Préval, P.; Gagnard, J. and Gautier, P. (1984). L'analyse végétale dans le contrôle de l'alimentation des plantes tempères et tropicales. 2nd Ed. pp 810. Technique et Documentation – Lavoisier, Paris, France.

Moradi, R.; Mahmoud, D.; Madandoust, M.; Mohajeri, F. (2020). Effects of sulfur foliar application on the yield, yield components, and contents of oil and protein in different sesame cultivars in the south of Iran. International J. of Pharma. & Phytopharmacological Res., 2020, 10(5): 216-225.

Muhammad, A.J.; Rafiq, M.; Baqi, A.; Rahman, H. and Wahab, F. (2017). Effect of different sources of sulfur on soil properties and physio-chemical characteristics of *Citrus Limon L.* (*cv*. Lisbon) grown on alkaline soil in Fata. Sarhad J. Agric., 23 (1): 75-100.

Neilsen, D.; Hogue, E.J.; Hoyt, P.B. and Drought, B.G. (1993). Oxidation of elemental sulfur and acidification of calcareous orchard soils in southern British Columbia. Can. J. Soil Sci. 73:103-114.

Podlesna, A. (2003). Preliminary estimation of sulfur fertilization requirements of winter oilseed rape. Rośl.Oleiste - Oilseed Crops, 24(2): 641-649. (in Polish).

Ranganna, S. (1977). Manual analysis of fruit and vegetable products. Edition Tata Mc Grow-Hill Publishing Company, New Delhi India, 634 P.

Said, Z.; Ali, Y.; Alam, M.; Ahmad, N and Awan, A, A. (2020). Influence of Foliar Application of Sulfur at Various Stages on Yield and Oil Content of Olive (*Olea eurapaea* L.). Acta Sci. Agric., 4 (7): 114-122.

Salem, E. H. and Ali H.A. M. (2020). Effect of slow release fertilizers on growth and fruiting of Khalas date palm. SVU-Intern. J. of Agric. Sci. 2 (2): 30- 44, 2020.

Shivay, Y.S.; Pooniya, V.; Prasad, M. and Bansal, R. (2016). Sulphur-coated urea as a source of sulphur and an Enhanced Efficiency of nitrogen fertilizer for spring wheat. Cereal Res. Communication 44(3): 513-523.

Snedecor, G. W. and Cochran, W. G. (1977). Statistical analysis Methods. 9th Ed. The Iowa state Univ. Press Amers. Iowa, U.S.A, pp: 593-596.

Turrell, F.M. (1950). A Study of the Physiological Effects of Elemental Sulphur Dust on Citrus Fruits. Plant Physiology, 25(1): 13-62.

Vargas, L.M.T. Guzmán, A.L.; Pérez, A.H.; Andrade, H.G. (2014). Organic nutrition of avocado cv. "Hass" and nutritional and agronomic effect. Revista Mexicana de Ciencias Agrícolas,5 (3): 463-472.

Walsh, L.M. and Beaton, J.D. (1986). Soil testing and plant analysis. 6th Edition. Editor, Soil Science Society of America, Inc. pp 489.

Ward, G.M. and Johnston, F.B. (1962). Chemical methods of plant analysis. Canada Department of Agriculture, Publication 1064.

Wielebski, F. and Musnicki, C. (1998). Effect of increasing doses of sulphur and its application method on the yield and content of glucosinolates in seeds of two winter oilseed rape cultivars in field experiments. Rocz. AR Poznan, Rol., 51: 129-147. (in Polish).

Wilde, S.A.; Corey, R.B.; Layer, J.G. and Voigt, G.K. (1985). Soil and plant analysis for tree culture. 3rd Ed, Oxford and New Delhi- India Publishing. Pp: 529-546.

Zhao, F.J.; Tausz, M.; Kok, L.J. (2008). Role of Sulfur for Plant Production in Agricultural and Natural Ecosystems. Chapter 21 in Sulfur Metabolism in Phototropic Organisms by Rudiger Hell, *et al.* (eds.), pp: 425–443.

RESEARCH ARTICLE

Effect of Spraying Micronized Sulfur On Growth and Fruiting of Sewy Date Palm Grown in Sandy Soil

Authors' contributions

Author details: Ali H. Ali.; Farouk, H. Abd Elaziz; Moawad A. Mohamed and Atteya K. Abd-El Wahab,
Hort. Dept. (Pomology), Fac. of Agric., Minia Univ., **Egypt**.

Funding: NA

Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable

Competing interests

The authors declare that they have no competing interests.

Received: 14 Feb. 2022 **; Accepted:** 16 April 2022