# BEHAVIOUR OF MANFALOUTY POMEGRANATE TREES GROWN UNDER SANDY SOIL CONDITIONS TO SPRAYING SILICON AND SELENIUM

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## ABSTRACT

This study was carried out during 2015 and 2016 seasons to examine the effect of spraying potassium silicate at 0.025 to 0.1% with or without the application of selenium at 50 ppm on fruit splitting %, fruit coloration %, yield and fruit quality of Manfalouty pomegranate trees grown in sandy soil. The trees received three sprays of silicon and selenium at the first of March and at two month intervals.

Using potassium silicate at 0.025 to 0.1% with or without selenium at 50 ppm was very effective in improving the leaf area, N, P, K, total chlorophylls in the leaves, fruit retention%, gross and marketable yields and both physical and chemical characteristics of the fruits. Fruit splitting, fruit peel weight%, fruit peel thickness, total acidity% and total soluble tannins were remarkably reduced with using silicon alone in combination with selenium.

The effect was depended on increasing concentrations of potassium silicate. Increasing concentrations of potassium silicate from 0.05 to 0.1% had negligible effect on the investigated parameters.

For controlling fruit splitting and improving fruit coloration %, yield and fruit quality of Manfalouty pomegranate trees grown under sandy soil, it is suggested to use a mixture of potassium silicate at 0.05% plus selenium at 50 ppm three times at the first week of March and at two month intervals.

**Keywords**: Potassium silicate, Selenium, Manfalouty pomegranate, Fruit splitting, Fruit colouration, Yield and fruit quality.

## INTRODUCTION

The highest values of fruit splitting and irregular fruit colouration as well as the great decline on the yield of Manfalouty pomegranate trees grown under sandy soil are considered serious problems facing pomegranate growers.

Irregular irrigation especially during fruit development, malnutrition, imbalancing nutrient application and the deficiency of B, Zn and natural hormones are considered the main causes of these problems. Recently, many attempts were accomplished for using silicon and selenium for solving these problems of fruit crops grown under unfavourable conditions. Both silicon and selenium are considered important antioxidants. They are beneficial for

preventing reactive oxygen species (ROS) and enhancing the antioxidant defense system. Their beneficial effects in enhancing the tolerance of fruit crops to biotic and abiotic stresses has been documented (**Seppanen *et al*., 2003 and Neumann and Zur-Nieden, 2011**).

The results of **Abd El-Hameed, (2012); Abdel-Aal and Oraby-Mona, (2013); Ahmed *et al*., (2013a) and (2013b); El-Khawaga, (2014); El-Khawaga and Mansour, (2014); Omar, (2015); Nagy-Dina, (2015); Mohamed, (2015); Wassel *et al*., (2015a) and (2015b); Mohamed *et al.*,(2015), Mohamed, (2016); Habasy-Randa et *al*., (2016); Akl *et al*., (2016); Mahmoud, (2016) and Youssef, (2017)** confirmed the great benefit of using silicon on yield and fruit quality of different fruit crops. **Ibrahim and Al-Wasfy, (2014) and Gad El-Kareem *et al*., (2014)** reached the same conclusion for selenium application.

The target of this study was examining the effect of using silicon alone or in combination with selenium on growth, nutritional status, fruit splitting, yield, fruit coloration and fruit quality of Manfalouty pomegranate trees grown under sandy soil conditions.

## MATERIAL AND METHODS

This study was carried out during 2015 and 2016 seasons on twenty –one uniform in vigour 10-years old Manfalouty pomegranate trees in a private orchard situated at West-Assiut, Assiut Governorate. The selected trees (21 trees) are planted in sandy soil (**Table 1)** at 4 X 4 meters apart. Drip irrigation system was followed. The tested trees were subjected to regular horticultural practices that were commonly applied in the orchard. Soil analysis was conducted according to the procedures that outlined by **Wilde *et al*., (1985**).

**Table (1): Analysis of the tested soil:**

| Constituents | Values |
|---|---|
| **Particle size distribution:** | |
| Sand % | 89.15 |
| Silt % | 7.15 |
| Clay % | 3.70 |
| Texture | Sandy |
| pH( 1:2.5 extract) | 8.1 |
| EC (1 :2.5 extract) ( $dsm^{-1}$) 1 cm / 25$^{o}$C. | 7.00 |
| O.M. % | 0.64 |
| $CaCO_3$ % | 3.99 |
| Total N % | 0.03 |
| Available P ( Olsen, ppm) | 1.22 |
| Available K ( ammonium acetate, ppm) | 10.1 |

This investigation included the following seven treatments:
1. Control trees (sprayed with water).
2. Spraying potassium silicate (25% Si + 10% $K_2O$) at 0.025%.
3. Spraying potassium silicate at 0.05%.
4. Spraying potassium silicate at 0.1%.
5. Spraying potassium silicate at 0.025% + Selenium at 50 ppm.
6. Spraying potassium silicate at 0.05% + Selenium at 50 ppm
7. Spraying potassium silicate at 0.1% + Selenium at 50 ppm

Each treatment was replicated three times, one tree per each. Silicon and Selenium were sprayed three times during growing seasons at the first week of March and at two month intervals (1st week of May and July).

Triton B as a wetting agent at 0.05% was added to all solutions of silicon and selenium. Spraying was done till runoff (5L/tree). The control trees received water containing Triton B.

The experiment was arranged in a randomized complete block design (RCBD) with seven treatments each was replicated three times, one tree per each.

During both seasons, the following measurements were recorded:
1. Leaf area ($cm^2$) (**Ahmed and Morsy, 1999)**.
2. Chlorophylls a and b for calculating total chlorophylls (mg/100 g F.W) (**Von-Wettstein, 1979)**
3. Percentages of N, P and K in the leaves on dry weight basis **(Cottenie *et al*., 1982 and Summer, 1985)**.
4. Percentage of fruit retention, number of fruit/tree, fruit splitting as well as gross and marketable yields (kg.).
5. Physical and chemical characteristics of the fruits namely fruit weight (g) and percentages of fruit peel weight and grain weight, fruit peel thickness (cm), edible to non-edible portions of fruit, T.S.S. %, total and reducing sugars% (**Lane and Eynon, 1965 and A.O.A.C, 2000**), total acidity% (as g citric acid/100 ml juice) (**A.O.A.C, 2000**), total soluble tannins% (**Balbaa, 1981)** and total anthyocyanins (**Fulcki and Francis, 1968**).

Statistical analysis was done. New L.S.D. at 5% test was used for made all comparisons between treatment means (**Mead *et* al., 1993**).

## RESULTS AND DISCUSSION

### 1. Leaf area and leaf content of total chlorophylls, N, P and K:

It is clear from the obtained data in Table (2) that treating Manfalouty pomegranate trees three times with potassium silicate at 0.025 to 0.1% with or without selenium at 50 ppm significantly stimulated the leaf area, total chlorophylls, N, P and K in the leaves compared the control treatment. The stimulations on these parameters was in proportional to the increase in

concentrations of potassium, silicate. Combined applications of silicon and selenium were significantly superior in enhancing these parameters than using potassium silicate alone. Increasing potassium silicate concentrations from 0.05 to 0.1% alone or with selenium failed to show significant promotion on these parameters. The maximum values were recorded on the trees that received three sprays of a mixture of potassium silicate at 0.1% and selenium at 50 ppm. The untreated trees produced the lowest values. These results were true during both seasons.

**Table (2): Effect of spraying potassium silicate with or without the application of selenium on the leaf area and the percentages of N, P, K and fruit retention and number of fruits/tree of Manfalouty pomegranate tress during 2015 and 2016 seasons.**

| Treatment | Leaf area ($cm^2$) | | Total chlorophylls (mg/100g F.W) | | Leaf N % | | Leaf P % | | Leaf K % | | Fruit retention % | | No. of Fruits/tree | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| **Control** | 5.1 | 5.0 | 15.1 | 16.1 | 1.69 | 1.64 | 0.191 | 0.200 | 1.11 | 1.14 | 18.9 | 18.4 | 105.0 | 104.0 |
| **K-silicate at 0.025%** | 5.4 | 5.5 | 16.0 | 17.1 | 1.79 | 1.71 | 0.200 | 0.211 | 1.20 | 1.25 | 20.9 | 21.3 | 115.0 | 117.0 |
| **K- silicate at 0.05%** | 5.7 | 5.9 | 16.9 | 18.0 | 1.91 | 1.88 | 0.211 | 0.222 | 1.27 | 1.32 | 22.9 | 24.0 | 122.0 | 125.0 |
| **K- silicate at 0.1%** | 5.5 | 6.0 | 17.0 | 18.1 | 1.92 | 1.90 | 0.212 | 0.223 | 1.25 | 1.33 | 23.0 | 24.1 | 123.0 | 126.0 |
| **K- silicate at 0.25% +Se at 50 ppm** | 6.3 | 6.7 | 18.9 | 19.1 | 2.03 | 2.06 | 0.222 | 0.231 | 1.36 | 1.43 | 28.0 | 29.9 | 130.0 | 133.0 |
| **K- silicate at 0.05% +Se at 50 ppm** | 7.0 | 7.1 | 20.0 | 20.9 | 2.19 | 2.16 | 0.231 | 0.241 | 1.46 | 1.50 | 33.6 | 34.0 | 141.0 | 144.0 |
| **K- silicate at 0.1% +Se at 50 ppm** | 7.1 | 7.2 | 20.1 | 21.0 | 2.20 | 2.17 | 0.232 | 0.242 | 1.47 | 1.51 | 34.0 | 34.6 | 142.0 | 145.0 |
| **New L.S.D. at 5%** | **0.2** | **0.3** | **0.4** | **0.5** | **0.06** | **0.07** | **0.004** | **0.005** | **0.05** | **0.06** | **1.5** | **1.6** | **2.0** | **3.0** |

Se= Selenium

**2. Percentage of fruit retention, number of fruit/tree and gross and marketable yields:**

Data in Tables (2&3) clearly show that fruit retention %, number of fruits/tree as well as gross and marketable yields were significantly improved in response to treating the trees three times with potassium silicate at 0.025 to 0.1% with or without selenium at 50 ppm relative to the control treatment. There was a gradual promotion on these parameters with increasing concentrations of potassium silicate from 0.025 to 0.1%. Combined application of silicon and selenium was significantly preferable than using silicon alone in promoting fruit retention and yield. Increasing concentrations from 0.05 to 0.1% failed to show significant promotion on the fruit retention and yield per tree. From economical point of view, treating the trees three times with a mixture of potassium silicate at 0.05% plus selenium at 50 ppm gave the best results with regard to fruit retention and yield. Under such promised treatment marketable, yield/tree reached 55.2 & 57.1 kg while in the untreated trees it was 25.58 & 23.9 kg during both seasons, respectively. Similar trend was noticed during both seasons.

**3. Percentage of fruit splitting:**

Table (3) shows that treating the trees with potassium silicate at 0.025 ppm to 0.1% alone or with selenium at 50 ppm significantly was followed by controlling the percentage of fruit splitting relative to the control treatment. There was a gradual reduction on the percentage of fruit splitting with increasing potassium silicate concentrations either applied alone or when applied with selenium. A slight reduction was noticed among the higher two concentrations (0.05 & 0.1%). Using silicon plus selenium was significantly superior than using silicon alone in controlling fruit splitting. The lowest values of fruit splitting (13.9 & 13.8%) were recorded on the trees that received three sprays of a mixture of potassium silicate at 0.1% plus selenium at 50 ppm. The highest values (25.0 & 26.6%) were recorded on the trees that supplied with water alone (untreated trees). These results were true during both seasons.

**Table (3): Effect of spraying potassium silicate with or without the application of selenium on the percentage of fruit splitting, Gross and marketable yields as well as some physical chemical characteristics of the fruits of Manfalouty pomegranate tress during 2015 and 2016 seasons.**

| Treatment | Fruit splitting % | | Gross yield / tree (kg) | | Marketable yield (kg) | | Fruit weight (g) | | Fruit peel weight % | | Grain weight % | | Fruit peel thickness (cm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| Control | 25.0 | 26.6 | 36.0 | 35.0 | 25.5 | 23.9 | 400.0 | 401.0 | 40.0 | 41.9 | 60.0 | 58.1 | 0.89 | 0.87 |
| K-silicate at 0.025% | 22.0 | 21.8 | 41.0 | 42.0 | 30.6 | 31.5 | 410.0 | 411.7 | 37.0 | 38.0 | 63.0 | 62.0 | 0.83 | 0.84 |
| K- silicate at 0.05% | 19.3 | 19.0 | 51.0 | 53.0 | 41.1 | 43.0 | 421.0 | 422.0 | 33.0 | 34.0 | 67.0 | 66.0 | 0.78 | 0.77 |
| K- silicate at 0.1% | 19.2 | 18.8 | 52.0 | 54.0 | 42.0 | 44.0 | 422.0 | 423.0 | 32.9 | 33.9 | 67.1 | 66.1 | 0.77 | 0.76 |
| K- silicate at 0.25% + Se at 50 ppm | 16.0 | 15.7 | 59.0 | 60.0 | 50.0 | 50.9 | 433.0 | 434.0 | 30.0 | 30.9 | 70.0 | 69.1 | 0.72 | 0.69 |
| K- silicate at 0.05% + Se at 50 ppm | 14.0 | 13.9 | 64.0 | 66.0 | 55.2 | 57.1 | 445.0 | 447.0 | 28.0 | 27.0 | 72.0 | 73.0 | 0.65 | 0.63 |
| K- silicate at 0.1% + Se at 50 ppm | 13.9 | 13.8 | 65.0 | 66.6 | 56.2 | 57.6 | 446.0 | 448.0 | 27.9 | 26.9 | 72.1 | 73.1 | 0.64 | 0.62 |
| New L.S.D. at 5% | 1.9 | 2.0 | 2.0 | 2.3 | 1.9 | 2.1 | 8.8 | 9.1 | 2.0 | 1.8 | 2.0 | 1.8 | 0.04 | 0.05 |

Se= Selenium

**4. Physical and chemical characteristics of the fruits:**

Data in Table (3&4) clearly show that supplying Manfalouty pomegranate trees three times with potassium silicate at 0.025 to 0.1% either alone or in combined with selenium at 50 ppm was significantly very effective in improving quality of the fruits in terms of increasing fruit weight, grain weight% edible to non-edible portions of fruits, T.S.S.%, total and reducing sugars and total anthocyanins and decreasing fruit peel weight and thickness, total acidity% and total soluble tannins % relative to the control treatment. The promotion on fruit

quality was associated with increasing concentrations of potassium silicate with or without application of selenium. Using silicon and selenium together significantly surpassed the application of silicon alone enhancing fruit quality. No significant promotion on fruit quality was observed when potassium silicate concentrations were increased from 0.05 to 0.1%. From economical point of view, it is suggested to use a mixture of potassium silicate at 0.05% plus selenium at 50 ppm for promoting fruit quality of Manfalouty pomegranate trees. Unfavourable fruit quality parameters were reported in the untreated trees. These results were true during both seasons.

**Table(4): Effect of spraying potassium silicate with or without the application of selenium on some physical and chemical characteristics of the fruits of Manfalouty pomegranate tress during 2015 and 2016 seasons.**

| Treatment | Edible to non-edible portion of fruit | | T.S.S% | | Total sugars % | | Reducing sugars % | | Total acidity % | | Total anthocyanins (mg/100g F.W) | | Total soluble tannins % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| **Control** | 1.25 | 1.27 | 13.9 | 14.1 | 12.1 | 11.9 | 11.5 | 11.4 | 1.299 | 1.311 | 71.1 | 69.9 | 1.11 | 1.09 |
| **K-silicate at 0.025%** | 1.33 | 1.35 | 14.2 | 14.4 | 12.4 | 12.5 | 11.8 | 11.7 | 1.250 | 1.291 | 74.0 | 75.5 | 1.05 | 1.04 |
| **K- silicate at 0.05%** | 1.49 | 1.49 | 14.5 | 14.7 | 12.7 | 12.8 | 12.1 | 12.0 | 1.210 | 1.240 | 77.0 | 78.8 | 1.00 | 0.99 |
| **K- silicate at 0.1%** | 1.50 | 1.51 | 14.6 | 14.8 | 12.8 | 12.9 | 12.2 | 12.1 | 1.209 | 1.237 | 77.6 | 79.0 | 0.96 | 0.91 |
| **K- silicate at 0.25% + Se at 50 ppm** | 1.59 | 1.60 | 15.4 | 15.5 | 13.3 | 13.5 | 12.5 | 12.6 | 1.171 | 1.191 | 80.0 | 81.7 | 0.84 | 0.80 |
| **K- silicate at 0.05% + Se at 50 ppm** | 1.71 | 1.74 | 16.0 | 16.1 | 13.7 | 14.0 | 12.8 | 12.9 | 1.151 | 1.150 | 84.0 | 86.0 | 0.71 | 0.69 |
| **K- silicate at 0.1% + Se at 50 ppm** | 1.72 | 1.75 | 16.1 | 16.2 | 13.8 | 14.1 | 12.9 | 13.0 | 1.149 | 1.146 | 84.4 | 86.3 | 0.69 | 0.68 |
| **New L.S.D. at 5%** | **0.06** | **0.05** | **0.2** | **0.2** | **0.3** | **0.3** | **0.2** | **0.2** | **0.019** | **0.018** | **1.9** | **2.0** | **0.04** | **0.03** |

Se= Selenium

## DISCUSSION:

The benefits of silicon and selenium on balancing water uptake and nutrients and enhancing biotic and abiotic stresses tolerance, total anthocyanins and organic acids could explain the present results.

The present beneficial effects of silicon and selenium on controlling fruit splitting and improving fruit coloration, yield and fruit quality might be attributed to their positive action on enhancing the biosynthesis of organic acids, the tolerance of fruit crops to biotic and abiotic stresses and preventing reactive oxygen species (ROS). Their important in enhancing plant pigments especially, total anthocyanins and balancing water uptake could add another explanation (**Seppanen *et al*., 2003 and Neumann and Zur-Nieden, 2011**).

The results of **Abd El-Hameed, (2012); Abdel-Aal and Oraby-Mona, (2013); Ahmed *et al*., (2013a) and (2013b); El-Khawaga, (2014); El-Khawaga and Mansour, (2014); Omar, (2015); Nagy-Dina, (2015); Mohamed, (2015); Wassel *et al*., (2015a) and (2015b); Mohamed *et al*.,(2015) and Ahmed, (2016); Habasy-Randa et *al*., (2016); Akl *et al*., (2016); Mahmoud, (2016) and**

**Youssef, (2017)** confirmed the great beneficial of using silicon on yield and fruit quality of different fruit crops. **Ibrahim and Al-Wasfy, (2014) and Gad El-Kareem *et al*., (2014)** reached in the same conclusion when applied selenium.

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**الملخص العربي**

**سلوك أشجار الرمان المنفلوطى النامية فى التربة الرملية لرش السليكون والسيلينيوم**

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أجريت هذه الدراسةخلال موسمى ٢٠١٥، ٢٠١٦ لاختبار تأثير رش سيليكات البوتاسيوم بتركيز ما بين ٠.٠٢٥ إلي ٠.١% مع أو بدون استخدام السيلينيوم بتركيز ٥٠ جزء فى المليون علي النسبة المئوية لتشقق الثمار وتلوين الثمار وكمية المحصول فى أشجار الرمان المنفلوطى النامية فى التربة الرملية وتم رش الأشجار ثلاث مرات فى الموسم ابتداء من الأسبوع الأول من مارس وبفاصل شهرين.

كان رش الأشار بسليكات البوتاسيوم بتركيز ٠.٢٥ إلي ٠.١% مع أو بدون السلينيوم بتركيز ٥٠ جزء فى المليون فعالا جدا فى تحسين مساحة الورقة والنيتروجين والفوسفور والبوتاسيوم فى الاوراق والكلوروفيل الكلى والنسبة المئوية للثمار الباقية علي الشجرة وكمية محصول الشجرة الكلى والمسوق وكذلك الخصائص الطبيعية والكيميائية للثمار كذلك لوحظ حدوث نقص واضح فى النسبة المئوية لتشقق الثمار ووزن وسمك قشرة الثمرة والكاروتينات الكلية والحموضة الكلية فى العصير وذلك برش السيليكون بمفرده أو مع السيلينيوم وكان التأثير علي هذه الصفات متماشيا مع زيادة التركيز المستخدم من سيليكات البوتاسيوم ولم يؤد زيادة التركيز من ٠.٠٥ إلي ٠.١% إلي حدوث تأثير واضح علي الصفات تحت الدراسة.

لأجل تقليل النسبة المئوية لتشقق الثمار وتحسين النسبة المئوية لتلوين الثمار وكمية المحصول وخصائص الجودة فى أشجار الرمان المنفلوطى النامى فى التربة الرملية فانه يقترح رش الأشجار بمخلوط من سيليكات البوتاسيوم بتركيز ٠.٠٥% والسيليكون بتركيز ٥٠ جزء فى المليون ثلاث مرات ابتداء من الاسبوع الاول من مارس وبفاصل شهرين.

الكلمات الدالة: سيليكات البوتاسيوم - السيلينيوم – الرمان المنفلوطى – تشقق الثمار- تلوين الثمار – كمية المحصول – خصائص الجودة للثمار