



Impacts of foliar spraying with potassium citrate on pomegranate trees

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ABSTRACT:

Pomegranates are grown in upper Egypt, especially in Assiut Governorate, for fresh consumption and juice. Due to increased awareness of pomegranate's health advantages, there is an exponential increase in demand for pomegranate fruit and its by-products. In order to determine the impact of four levels of potassium citrate (100, 200, 300, and 400 ppm) on yield and fruit quality, this study was conducted during the 2021 and 2022 growing seasons on 45 years-old Manfalouty and Hajazy pomegranate trees in the Pomology Orchard at the Faculty of Agriculture, Assiut University. A factorial experiment with three replicates was conducted randomized complete blocked design (RCBD). The results showed that potassium citrate treatment led to significant differences at four concentrations used and the concentration of 200 ppm was the best in increasing leaf area, fruit weight, arils and rind weight, juice volume, total soluble solids (TSS), TSS / total acidity, reducing sugars, while there was a significant decrease in total acidity percentage.

KEYWORDS: Micronutrients, *Punica granatum*, yield, fruit quality.

1.INTRODUCTION:

One of the earliest known edible fruits is pomegranate (*Punica granatum* L.), which is a member of the Punicaceae family. It is also referred to as Chinese apple (Mars, 1994). Pomegranates are mostly grown for fresh consumption as juice or arils, while they are also produced in some countries for the food and beverage sector as flavoring and coloring additives (Gil et al., 2000). With regard to several plant

processes, potassium as a macro-element is crucial for photosynthesis, respiration, ion absorption and transport, protein synthesis, and enzyme activation (Mengel, 2007), with a positive impact on plant growth. Moreover, it enhances the fruit's color, look, form, and flavor. Its major effects are to increase the plant's nutritional value and resistance to pests and diseases.

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Under salt circumstances, potassium may maintain the tissue water content and raise the relative content of the leaf water (Marschner et al., 1996).

In addition, spray treatment makes it simple to treat latent potassium deficit. Potassium absorption through the soil is less effective than potassium uptake through leaf spraying. Potassium levels that are balanced in the plant speed up phloem loading, nutrient exchanges, and sucrose drainage (Lester et al., 2005). K sprays can therefore result in an increase in fruit output and quality. A foliar spray of various types of K boosted the number and quality of mandarin fruit, according to Sarrwy et al. (2012).

In terms of K and P fertilizers, KH_2PO_4 is a reasonably priced fertilizer that may be used quickly to produce P and K (Barranco et al., 2010). K and P fertilizer boosted pomegranate fruit yield, while foliar sprays of K considerably improved pomegranate fruit quality (Khayyat et al., 2012). (Dhillon et al., 2011).

Fattahi et al. (2021) reported that all foliar treatments (250 and 500 mg/l Potassium nitrate; 250 and 500 mg/l Potassium silicate) increased fruit volume and weight, total aril weight, fruit juice.

Tehranifar and Mahmoodi-Tabar's (2009) findings revealed that compared to other trees, those who received the most Potassium had higher titratable acidity and SSC. Pathania et al., (2018) observed that Potassium nitrate sprays at 0.5% in Bhagwa and Phule Arakta is significantly effective in sustaining higher productivity and quality of fruits.

The objective of this study was to assess the effects of different concentrations of

Vegetative measurement:

Leaf area (cm^2): was measured by using the following equation as mentioned by Ahmed and Morsy (1999)

$$\text{Leaf area (cm}^2\text{)} = 0.41 (\text{Length of leaf} \times \text{Width of leaf}) + 1.83$$

potassium citrate foliar treatments on growth and fruit quality of two pomegranate cultivars under Assiut climatic conditions.

2.MATERIALS AND METHODS:

Experiment site:

On 45 years-old pomegranate trees of Manfalouty and Hejazy cultivars, 4*4 m apart, grown in the research farm of the Pomology Department, Faculty of Agriculture, Assiut, Egypt, the current experiment was carried out over two successive seasons; 2021 and 2022.

Plant Materials:

A randomized complete blocked design (RCBD) was used to assess this work and 30 healthy pomegranate trees were chosen from the two cultivars under study (15 trees for each cultivar, 3 trees/treatment), and the following treatments were carried out on them:

- 1- Potassium citrate at 100 ppm
- 2- Potassium citrate at 200 ppm
- 3- Potassium citrate at 300 ppm
- 4- Potassium citrate at 400 ppm
- 5- Control (water only)

potassium citrate was purchased from El-Gomhouria company for medicals, Assiut governorate, Egypt. Trees were sprayed using a Knapsack sprayer (20 L). A total volume of 5 lit. was sufficient for each tree at maximum growth. A surfactant "liquid soap" at 0.5 ml/L. was added to the spraying solutions. The spraying compounds were added two times: at full bloom (mid-May) and a month later. Each treatment consisted of 3 trees (replicates) and horticultural practices such as irrigation, soil management and fertilization have been implemented as proposed.

Physical characteristics:

- 1- Fruit, arils and rind weight (g): by using sensitivity balance with 0.01g accuracy.
- 2- Juice volume (ml): by using a measuring cylinder.

Chemical characters:

- 1- Total soluble solids (TSS %): By using a hand refractometer (ATAGO N-IE).
- 2- Total acidity (T.A) (expressed as % Citric acid): according to **A.O.A.C. (1984)**.

The total acidity was expressed as tartaric acid according to the following equation:

$$\text{Acidity (\%)} = \frac{\text{Equivalent weight of Citric acid} \times \text{Normality of NaOH} \times \text{Sample Volume}}{1000 \times \text{Sample Weight}} * 100$$

Where:

Equivalent weight of Citric acid = 64

NaOH molarity = 0.1M

Sample Vol. = 5 ml.

- 3- TSS / acid ratio was then calculated.

- 4- Reducing sugars (%): According to Lane and Eynon procedure outlined in **A.O.A.C. (1985)**.

Statistical analysis:

The study was designed as a randomized complete blocked design (RCBD) (5 treatments x 2 cultivars) with three replications for each treatment. The treatments were placed in a subplot, whereas the cultivars were placed in the whole plot. ANOVA was performed using Proc Mixed of the SAS software version 9.2 (**SAS, 2008**), and means were compared using the revised L.S.D. test at the 5% level of probability (**Steel and Torrie, 1980**).

3.RESULTS AND DISCUSSION:

- 1- **Leaf area (cm²), fruit and arils weight (g):**

Leaf area increased significantly compared to the control (**Table 1 and Fig.1**). Potassium citrate at 200 ppm recorded the highest values of leaf area (cm²) of Manfalouty and Hejazy Pomegranate cultivars (12.01, 12.03 and 11.41, 11.79 cm²) compared to the check treatment which recorded the lowest values (10.41, 10.44 and 10.81, 10.20 cm²) during 2021 and 2022 seasons, respectively.

Fruit weight increased significantly compared to the control. Potassium citrate at 200 and 400 ppm recorded the highest values of fruit weight of Manfalouty cultivar (390.6

and 393.1 g) compared to the check treatment which recorded the lowest values (328.5 and 326.7 g) during the two seasons, respectively. Where 200 ppm recorded the highest values for Hejazy cultivar (407.9 and 408.0 g) compared to the check treatment which gave the lowest values (349.8 and 345.9 g) during the two seasons, respectively. This finding matches the result found by **Jumaa and Ali. (2016)**,

Arils weight also increased significantly compared to the control. Where 200 ppm recorded the highest value for Manfalouty cultivar (265.2 g) compared to the check treatment which gave the lowest value (228.3 g) during the 1st season, where 300 ppm recorded the highest value (267.7 g) compared to the check treatment which gave the lowest value (227.3 g) during the 2nd season

For the same respect, spraying Potassium Citrate at 300 ppm recorded the highest value for Hejazy cultivar (288.8 g) compared to the check treatment which gave the lowest value (244.5 g) during the 1st season, where 200 ppm recorded the highest value (277.7 g) compared to the check treatment which gave the lowest value (240.8 g) during the 2nd season.

These findings match the results of **Fattahi et al. (2021)** when spraying Potassium Nitrate and Silicate, where **Khayyat et al. (2012)** found a decrease in arils size when spraying Potassium Nitrate.

Table 1. Effect of foliar application with Potassium citrate on leaf area, fruit weight and arils weight of Manfalouty and Hejazy Pomegranate trees during 2021 and 2022 seasons.

cultivars	reatments	leaf area (cm2)*		Fruit weight (g)**		Arils weight (g)**							
		Manfalouty	Hejazy	Manfalouty	Hejazy	Manfalouty	Hejazy						
		2021	2022	2021	2022	2021	2022						
Potassium citrate at 100 ppm		11.98	12.01	11.39	11.77	374.2	369	403.0	389.8	253.5	252.5	269.7	266.0
Potassium citrate at 200 ppm		12.01	12.03	11.41	11.79	390.6	391.8	407.9	408	265.2	264.2	281.4	277.7
Potassium citrate at 300 ppm		11.39	11.57	11.12	11.73	361.6	377.9	406.4	383.3	251.1	267.7	288.8	259.4
Potassium citrate at 400 ppm		11.13	11.28	11.17	11.17	364.4	393.1	388.8	391.4	249.7	264.7	275.4	261.4
Control (water only)		10.41	10.44	10.81	10.20	328.5	326.7	349.8	345.9	228.3	227.3	244.5	240.8
L.S.D 0.05		0.53	0.61	0.23	0.75	24.5	32.7	36.5	27.8	14.7	18.2	19.2	15.7

*The values are means of Three replicates (30 samples/ each replicate)

** The values are means of Three replicates (3 samples/ each replicate).



Fig. 1. Effect of foliar application with Potassium citrate on leaf area, fruit weight and arils weight of Manfalouty and Hejazy Pomegranate trees during 2021 and 2022 seasons.

2- Rind weight (g), juice volume (ml) and TSS (%):

Data in (Table 2 and Fig.2) indicated that **rind weight** increased significantly compared to the control. spraying Potassium Citrate at 200 and 400 ppm recorded the highest values for Manfalouty cultivar (125.4, 128.4 g) compared to the check treatment which gave the lowest values (100.2 and 99.3 g) during the 1st season, where 100 and 200 ppm recorded the highest values (133.3 and 130.3 g) compared to the check treatment which gave the lowest value (105.3 and 105.1 g) during the 2nd season, for Hejazy cultivar.

Juice volume take the same trend of arils weight, as it increased significantly compared to the control. Where 200 ppm recorded the highest value for Manfalouty cultivar (221.4 g) compared to the check treatment which gave the lowest value (182.2 g) during the 1st season, where 300 ppm recorded the highest value (235.8 g) compared to the check treatment which gave the lowest value (186.0 g) during the 2nd season.

For the same respect, spraying Potassium Citrate at 300 ppm recorded the highest value for Hejazy cultivar (239.1g) compared to the check treatment which gave the lowest value (193.2 g) during the

1st season, where 200 ppm recorded the highest value (241.9 g) compared to the check treatment which gave the lowest value (205.3 g) during the 2nd season.

This finding matches the result reported by **Davarpanah et al. (2017)**, **Khayyat et al. (2012)** when spraying Potassium Nitrate.

Likewise, **TSS** increased significantly compared to the control. Potassium Citrate at 300 and 400 ppm recorded the highest values for Manfalouty cultivar (17.11 and 17.13 %) compared to the check treatment which gave the lowest values (16.61 and 16.59 %) during the 1st season, where 300 and 100 ppm recorded the highest values (17.09 and 17.17 %) compared to the check treatment which gave the lowest value (16.61 and 16.88 %) during the 2nd season, respectively.

This finding matches the result reported by **Davarpanah et al. (2017)**, **Fattahi et al. (2021)** when spraying Potassium Nitrate and Silicate, **Khayyat et al. (2012)** when spraying Potassium Nitrate, **Pathania et al., (2018)** when spraying Potassium Nitrate.

Where **Jumaa and Ali. (2016)** when spraying Potassium Nitrate and **Mirdehghan et al., (2012)** found no significant effect on TSS when spraying Potassium Sulphate.

Table 2. Effect of foliar application with Potassium citrate on rind weight, juice volume and TSS of Manfalouty and Hejazy Pomegranate trees during 2021 and 2022 seasons.

cultivars	Treatments	Rind weight (g)				Juice volume (ml)				TSS (%)			
		Manfalouty		Hejazy		Manfalouty		Hejazy		Manfalouty		Hejazy	
		2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
	Potassium citrate at 100 ppm	120.7	116.5	133.3	123.8	218.8	214.3	209.5	334.5	16.90	16.88	16.90	17.17
	Potassium citrate at 200 ppm	125.4	127.6	126.5	130.3	221.4	222.6	232.9	241.9	16.88	16.86	16.88	17.15
	Potassium citrate at 300 ppm	110.5	110.2	117.6	123.9	213.5	235.8	239.1	228.2	17.11	17.09	17.09	17.11
	Potassium citrate at 400 ppm	114.7	128.4	113.4	130.0	209.5	235.1	211.8	233.6	17.09	17.13	17.04	17.16
	Control (water only)	100.2	99.3	105.3	105.1	182.2	186.0	193.2	205.3	16.61	16.59	16.61	16.88
	L.S.D 0.05	7.3	8.5	6.7	14.1	21.0	26.3	16.3	19.6	0.25	0.23	0.25	0.21

The values are means of Three replicates (3 samples/ each replicate).



Fig. 2. Effect of foliar application with Potassium citrate on rind weight, juice volume and TSS of Manfalouty and Hejazy Pomegranate trees during 2021 and 2022 seasons.

3- Acidity (%), TSS/acid and reducing sugars (%):

Data in (Table 3 and Fig.3) showed that acidity decreased significantly compared to the control. Potassium Citrate at 200 ppm recorded the lowest values for Manfalouty and Hejazy cultivars (0.26, 0.29 and 0.29, 0.32 %) compared to the check treatment which gave the highest values (0.46, 0.49 and 0.49, 0.51 %) during the two seasons, respectively.

The findings of acidity did not match those reported by Davarpanah et al. (2017) where Khayyat et al. (2012) found non-significant variation when spraying Potassium Nitrate and Mirdehghan et al., (2012) found no significant effect when spraying Potassium Sulphate

TSS/acid take the same trend of acidity, whereas it increased significantly compared to the control, where Potassium

Citrate at 200 ppm recorded the highest values for Manfalouty and Hejazy cultivars (64.92, 58.14 and 58.21, 54.44) compared to the check treatment which gave the lowest values (36.51, 34.21 and 34.25, 33.10) during the two seasons, respectively.

Reducing sugars, also, increased significantly compared to the control. Potassium Citrate at 300 and 400 ppm recorded the highest values for Manfalouty and Hejazy cultivars (10.10, 10.11 and 10.09, 10.13 %) compared to the check treatment which gave the lowest values (9.49, 9.47 and 9.49, 9.63 %) during the two seasons, respectively.

These findings match the results of Fattahi et al. (2021) when spraying Potassium Nitrate and Silicate, Pathania et al., (2018) when spraying Potassium Nitrate.

Table 3: Effect of foliar application with Potassium citrate on acidity, TSS/ acid and reducing sugars of Manfalouty and Hejazy Pomegranate trees during 2021 and 2022 seasons.

reatments	cultivars	Acidity (%)				TSS/ acid				Reducing sugars (%)			
		Manfalouty		Hejazy		Manfalouty		Hejazy		Manfalouty		Hejazy	
		2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Potassium citrate at 100 ppm		0.28	0.31	0.31	0.34	60.36	54.45	54.52	51.25	9.73	9.72	9.73	9.87
Potassium citrate at 200 ppm		0.26	0.29	0.29	0.32	64.92	58.14	58.21	54.44	9.74	9.73	9.74	9.89
Potassium citrate at 300 ppm		0.40	0.45	0.44	0.46	43.32	38.40	38.84	37.20	10.10	10.09	10.09	10.10
Potassium citrate at 400 ppm		0.40	0.45	0.44	0.46	43.27	38.49	39.17	37.30	10.09	10.11	10.07	10.13
Control (water only)		0.46	0.49	0.49	0.51	36.51	34.21	34.25	33.10	9.49	9.47	9.49	9.63
L.S.D 0.05		0.18	0.17	0.12	0.16	6.21	4.02	4.31	4.05	0.18	0.20	0.21	0.19

The values shown are means of Three replicates (3 samples/ each replicate).



Fig. 3. Effect of foliar application with Potassium citrate on acidity, TSS/ acid and reducing sugars of Manfalouty and Hejazy Pomegranate trees during 2021 and 2022 seasons.

Delgado et al. (2006) shown that adding Potassium to grapes can reduce their tartaric acid content, which can raise pH. Potassium raises the production of the enzyme carboxylation, which in turn stimulates the fixation of CO₂ and boosts photosynthesis (**Almeselmani et al., 2009**). According to **Khayyat et al. (2012)**, the effects of K on carbohydrate influx or the production of plant growth regulators in developing fruits, as well as the activation of enzymes, the photosynthesis process, protein and starch synthesis, could all contribute to the observed increase in yield as a result of K fertilisation (**Hoeft et al., 2000; Vafaie et al., 2013**).

The critical functions of K in plants, in particular its role in cell expansion that results in the creation of a large central vacuole in fruit cells, can be linked to an increase in fruit size following MDPK fertilisation (**Talaie, 2008**). In addition,

Recommendation:

To increase almost growth properties and fruit quality of Manfalouty and Hejazy pomegranate trees under Assiut climatic

another potential explanation for the increase in fruit size caused by K application is the role of K in boosting photosynthesis and transferring assimilates to developing fruits (**Kumar et al., 2006; Baiea et al., 2015**).

The roles of K and P in the translocation and accumulation of sugars and other soluble solids in fruit, and P's involvement in photosynthesis can all be listed as potential explanations for the increase in TSS that results from K and P fertilisation (**Sultenfuss and Doyle, 1999; Thirupathi and Ghosh, 2015**).

As a cofactor and activator of some enzymes, such as UDP galactose: flavanoide-3-o-glicosil transferase, Potassium plays important roles in the formation of anthocyanins by enhancing the translocation of sugars into fruits (**Ju et al., 1999; Delgado et al., 2006**).

conditions, it is recommended to spray Potassium Citrate at 200 ppm during full bloom and a month after full bloom.

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