Assiut J. Agric. Sci., (50) No. (1) 2019(97-106) *ISSN: 1110-0486*
Website: www.aun.edu.eg/faculty_agriculture/journals_issues_form.php *E-mail: ajas@aun.edu.eg*

Effect of Different Levels of Potassium Fertilizer on Yield and Fruit Quality of Old Trees of "Balady" Orange

A: Effect of Different Levels of Potassium Fertilizer on Some Physical Properties and Yield Parameters of "Balady" Orange

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Received on: 16/1/2019 **Accepted for publication on:** 24/2/2019

Abstract

This experiment was carried out during two successive seasons 2015 and 2016 on the orchard of Faculty of Agriculture, Assiut University. This study aimed to investigate the effect of potassium sulfate (K) fertilizer at different rates, application times and method of application on yield parameters and fruit properties of old trees of Balady orange cv. The obtained results showed that all K treatments significantly increased the fruit set (%), number of fruits/tree, total yield/tree (kg), fruit weight (g), fruit height and diameter (cm) as compared with control (untreated trees) during both experimental seasons. Moreover, the three times applications and foliar sprays were more effective than twice applications and ground adding of potassium sulfate (K), respectively.

The lowest values of these parameters, were recorded in control (untreated trees), while the foliar application of 666 g + 90 mlsprays /tree of potassium sulfate (K) three times gave the highest values during both tested seasons.

Keyword: *Balady orange, potassium sulfate, yield parameters.*

Introduction

Citrus are evergreen fruit trees that belong to family rutaceae which contains three genera (Citrus – Kumquates and Trifoliate orange). Citrus is the most important of them which includes orange, mandarins, lemon, grapefruit and sour lime and occupies the second rank of fruit world production.Although orange occupies the greatest planted area among all citrus grown fruit area in Egypt, the exportation of fresh orange fruits to the foreign markets are still limited compared with the produced quantity. Citrus are considered an important fruits in many parts of the world because it has a high nutritional value of vitamins, essential oils, minerals, sugars and salts. Orange is considered as a main source of antioxidants like vitamin C, phenolic compounds and carotenoids, so it has important functions in resistance against many human illnesses (Del-Caro *et al*., 2004; Dhuique *et al*., 2005 and Wu *et al.,* 2007). Fruits are rich in vitamin C and other components such as phenols and flavonoids which are very beneficial for human health (Hand *et al*., 2005).

Potassium was the only element which is low or deficient in different Egyptian soils and suggesting its cossection in Balady mandarin by soil application of either K_2SO_4 or KNO_3 or sprays of both. The selection of the appropriate method depends in large extent on the $CaCO_3$ content of the soil. It was also reported that soil ap-

plication of K failed to raise leaf K content but sprays increased it (El-Darier, 1991).

Potassium is also important in formation and functioning of proteins, fats, carbohydrates and chlorophyll and in maintaining the balance of salts and water in plant cells (Achilea, 1998). Heavy citrus orchards should receive considerable amount of K, nearly at the same level as nitrogen, in order to preserve high yields of fruits with the required qualities. The relatively high acid level caused by application of K can be qualified, in most cases, by briefly delaying the harvest. The physiological functions of potassium and its conspicuous role in plant water relations has long been known and serve to emphasize that there should be adequate K contents in all plant parts (Nijjar, 1985; Hsiao and Lauchli, 1986; Davies and Albrigo, 1994; Boman, 1997; Mostafa and Saleh, 2006 and El-Tanany *et al*., 2011).

Therefore, K sprays can be an effective method to shorten the time required to uptake compared to soil application (Embleton *et al*., 1969). The most common methods of applying potassium to citrus are the traditional broadcasting of granular materials or by injection of liquid nutrient solutions through the irrigation system. Supplemental nutrient sprays have been shown to be effective for correcting potassium deficiencies for citrus (Calevert *et al*., 1972; Erner *et al*., 1993; Achilea, 1998 and Mostafa *et al*., 2005).

This investigation aimed to study the effect of foliar spray or ground application of different rates of K fertilizer on yield parameters and some physical fruit properties of old Balady orange trees under Assiut environmental condition.

Materials and Methods

This experiment was conducted over a period of two successive seasons 2015 and 2016 on Balady orange trees (*Citrus sinensis*) grown at the Experimental Orchard of Faculty of Agriculture, Assiut University, where the soil is a well-drained fertile silty loam. Thirty nine (39) old trees of Balady orange cv. About 45 years old at uniform vegetative vigour were selected for this investigation to study the effect of different methods and concentration of potassium sulfate (K-52%) on yield parameters as well as some physical properties of its fruits.

The chosen trees received the standard agricultural practices that are used in the orchard, except for the tested treatments of K during the two studied seasons.

Thirteen different treatments of potassium sulfate 52% were used for the selected trees as foliar spraying or adding to the soil as follows:

1- Control. (t1)
2- Potassium sulfate (1 kg/ tree) twice adding to soil.
3- Potassium sulfate (666 gm /tree) three times adding to soil.
4- Potassium sulfate (135 ml/ tree) twice foliar sprays.
5- Potassium sulfate (90 ml/ tree) three times foliar sprays.
6- Potassium sulfate (500g/ tree to soil + 67.5 ml spray) twice applications.
7- Potassium sulfate (333g / tree to soil + 45.0 ml spray) three times.

8- Potassium sulfate (2 kg/tree) twice adding to soil.
9- Potassium sulfate (1330 g/tree) three times adding to soil.
10- Potassium sulfate (270 ml/tree) twice sprays.
11- Potassium sulfate (180 ml/tree) three times sprays.
12- Potassium sulfate (1 kg to soil + 135 ml spray) twice applications.
13- Potassium sulfate (666gm/tree +90ml spray) three times applications.

Some treatments of foliar spraying or adding to soil were applied twice(in the first week of each of March and June), where the other were applied three times (in the first week of each of March , June and August).

The experiment was arranged as factorial in complete randomized block design with three replications for each treatment (one tree was devoted for each replicate).

The following measurements were carried out:

A- Yield parameters:

A.1- Fruit set percentage:

Three shoots on each tree (replicate) were randomly selected and tagged to determine the percentage of fruit set as follow:

$$\%\ fruit\ set = \frac{Av.\ number\ of\ \ fruit\ set/shoot}{Av.\ number\ of\ total\ \ flowers/shoot} x100$$

A.2- Number of fruit and yield/tree:

At the harvest date (TSS/acidity ratio) were about 12.8 to 13.6% the number of fruits/tree were counted and the yield (kg) per tree was determined.

B- Fruit properties:

Three uniform fruits were randomly taken at harvest date from each tree (replicate) and transported to the laboratory to determine the following fruit properties.

B-1-Average fruit weight (gm)

B-2-Fruit dimension: A varnier caliper was used to measure the fruit hight (cm) and fruit diameter (cm) then shape index was calculated as:

$$Shape\ \ index = \frac{Fruit\ \ height\ \ (H)}{Fruit\ \ diameter\ (D)}$$

Statistical analysis:

Data were tabulated and statistically analyzed and the differences were tested by analysis of variance (ANOVA) according to Snedecor and Cochran (1989) Means were compared using the least significant difference (LSD) values of 5% level of the probability.

Results and Discussion

A- Yield parameters:

The effect of different methods and concentration of potassium sulfate (K) application on yield parameter of Balady orange namely, fruit set percentage, number of fruits per tree and total yield (kg/tree) are shown in Table (1). In general all applied treatments had positive effect concerning these parameters comparing with control during both tested seasons.

A.1: Fruit set percentage:

The obtained data in Table (1) showed that, all concentrations and methods of K applications significantly increased the percentage of fruit set as compared with control (without K addition) during both experimental seasons. The lowest fruit set % (1.33 and 1.40%) were recorded by control, while the highest

values (5.66 and 6.66%) were found by 666 g + 90 ml of potassium sulfate/tree during both tested seasons, respectively. Moreover, it could be noticed that, the fruit set % was significantly increased by increasing the concentration of potassium sulfate as well as the number of addition (twice or three times) during both seasons 2015 and 2016 seasons.

A.2: Number of fruits/tree:

The obtained results in Table (1) indicated that, all K treatments increased the number of fruits/tree as compared with control during both investigated seasons. These results took approximately the same trend during both seasons, where the significant effect was found from T3 up to T13, while T1 in the first season and T1, T2 in the second season had slight and non-significant increase comparing with the untreated trees (control). In addition, the fertilized trees with 90 ml spray + 666 gm/tree potassium sulfate (T13) gave the highest average number of fruits/tree (336.7 and 378 fruits/tree), while the lowest average number of fruits was recorded by control trees (77.33 and 94.6 fruits/tree) during both tested seasons, respectively. Moreover, it could be noticed that the distribution of the same rate (doses) of potassium sulfate through 3 times application was more effective than those of twice applications during both seasons.

A.3: Yield/tree (kg):

Data in table (1) show the total yield/tree of Balady orange as affected by potassium sulfate (K) fertilization as foliar sprays or adding to the soil during 2015 and 2016 seasons.

The obtained results were positivly correlated with the number of fruits/tree and took approximately the same tendency during both tested seasons.

The total yield/tree (kg) was significantly increased by all the applied treatments of potassium sulfate (K) comparing with untreated trees (control). The highest average yield/tree (55.32 and 61.3 kg/tree) were obtained by application of 666 g + 90 ml of P. sulfate/tree (T13), while the lowest average of yield/tree (8.37 and 11.6 kg) were recorded by untreated trees (T1) during both experimental seasons, respectively. Additionally, three times applications of K. sulfate were more effective than twice applications of the same rates (doses) of K. sulfate during both seasons.

These results took the same line of those obtained by Nijjar, 1985; Hsiao and Lauchli, (1986;) Davies and Albrigo, (1994;) Boman, (1997;) Mostafa and Saleh, (2006), and El-Tanany *et al*., (2011). Muhammad y and Manzoor A (2010).

Table 1. Effect of different levels and methods of fertilization by potassium sulfate (K) on yield parameters of Balady orange cv. during 2015 season.

Treat / param	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	LSD
Yield tree (kg)	8.37	9.34	12.83	13.53	14.33	15.87	21.43	24.06	25.07	27.71	37.46	39.58	55.32	2.69
Fruit number/tree	77	82	102	113	115	117	151	168	175	185	233	232	336	21.9
Initial fruit set	1.33	2.43	3.00	3.46	3.50	4.63	4.83	4.96	5.26	5.46	5.73	5.83	6.66	0.38

Table 2. Effect of different levels and methods of fertilization by potassium sulfate (K) on yield parameters of Balady orange cv. during 2016 season.

Treat / param	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	LSD
Yield tree (kg)	11.6	12.6	13.5	17.7	23.5	26.8	29	27	32.3	36.3	44.9	50.1	61.3	2.23
Fruit number/tree	94	98	104	134	742	193	206	190	224	248	298	312	378	22
Initial fruit set	1.40	1.96	2.4	2.6	3	3.13	3.20	3.50	3.73	4.10	4.50	4.80	5.66	.146

T1: Control.
T2: Potassium sulfate (1 kg tree) twice adding to soil.
T3: Potassium sulfate (666gm tree) three times adding to soil.
T4: Potassium sulfate (135ml tree) twice foliar sprays.
T5: Potassium sulfate (90 ml tree) three times foliar sprays.
T6: Potassium sulfate (500g to soil + 67.5 ml spray) twice applications.
T7: Potassium sulfate (333gm to soil + 45.0 ml spray) three .
T8: Potassium sulfate (2 kg/tree) twice adding to soil.
T9: Potassium sulfate (1330 g/tree) three times adding to soil.
T10: Potassium sulfate (540 ml/tree) twice sprays.
T11: Potassium sulfate (180 ml/tree) three times sprays.
T12: Potassium sulfate (1 kg to soil + 135 ml spray) twice applications.
T13: Potassium sulfate (666 + 90) three times applications.

B- Fruit properties:

B.1: Fruit weight (g):

The response of fruit weights to K fertilization as spraying or ground applying during 2015 and 2016 seasons are presented in Tables (3, 4). It is worth to mention that fruit weight of Balady orange cv. reacted similary and took the same trend during both experimental seasons. All applied K treatments significantly increased fruit weight (g) comparing with control during both seasons. Moreover, the thrice application of K fertilizer were more effective than those of twice as spraying or ground adding. The highest average values of fruit weight were found by thrice application of K-sulfate at 666 g + 90 ml rate (164.0 and 162.0 g), while the lowest values were recorded by control (108.0 and 120.0 g) during both tested seasons, respectively.

B.2: Fruit height (H) and diameter (D):

Data in tables (3, 4) show the effect of sprays or soil adding of potassium sulfate on fruit height (cm) and fruit diameter (cm) of Balady orange cv. during 2015 and 2016 seasons.

It is clear to notice that both fruit properties approximately were affected similarly by all the applied treatments during both investigated seasons. All sprays or soil adding of K treatments at all rates significantly increased both of fruit height and diameter as compared by control during both tested seasons.

The highest values of fruit height were measured by thrice applicate of K (T13) during 2015 and 2016 seasons (6.7 and 6.46 cm), respectively, while the untreated fruits (control) had the lowest height (5.70 and 5.73 cm).

The response of Balady orange fruits to K fertilizer concerning its diameter took approximately the same trend of fruit height. T13 (666 g + 90 ml) produced the highest values of fruit diameter (6.5 and 6.6 cm), while the lowest values of diameter were recorded by control fruits (5.7 and 5.6 cm) during both tested seasons.

B.3: Fruit shape index (H/D):

Data in Tables (3, 4) show the shape index of Balady orange fruits as affected by K-fertilization during 2015 and 2016 seasons.

Table 3. Effect of different levels and methods of fertilization by potassium sulfate (K) on some physical properties of Balady orange fruits cv. during 2015 season.

Treat / param	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	LSD
Fruit weight(gm)	108	114	119	119	124	135	141	142	143	149	161	162	164	1.58
Fruit height(cm)	5.7	6.1	6.3	6.3	6.4	6.4	6.4	6.5	6.5	6.6	6.6	6.6	6.7	0.151
Fruit diameter	5.7	5.7	6.0	6.3	6.3	6.3	6.2	6.2	6.3	6.4	6.5	6.5	6.5	0.261
Shape index	1	1.06	0.99	1.6	1.17	1.17	1.12	1.23	1.03	1.01	1.06	1.06	1.4	0.134

Table 4. Effect of different levels and methods of fertilization by potassium sulfate (K) on some physical properties of Balady orange fruits cv. during 2016 season.

Treat / param	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	LSD
Fruit weight	120	127	130	131	133	134	141	141	144	145	150	160	162	4.90
Fruit height	5.73	5.93	6	6.16	6.20	6.23	6.23	6.30	6.33	6.36	6.40	6.43	6.46	0.239
Fruit diameter	5.6	5.9	6	6.1	6.1	6.2	6.2	6.2	6.3	6.3	6.5	6.6	6.6	0.24
Shape index	1.18	1	1	1	1	0.99	1	1	1	1.1	0.97	0.97	0.97	0.117

T1: Control.
T2: Potassium sulfate (1 kg tree) twice adding to soil.
T3: Potassium sulfate (666gm tree) three times adding to soil.
T4: Potassium sulfate (135ml tree) twice foliar sprays.
T5: Potassium sulfate (90 ml tree) three times foliar sprays.
T6: Potassium sulfate (500g to soil + 67.5 ml spray) twice applications.
T7: Potassium sulfate (333gm to soil + 45.0 ml spray) three
T8: Potassium sulfate (2 kg/tree) twice adding to soil.
T9: Potassium sulfate (1330 g/tree) three times adding to soil.
T10: Potassium sulfate (540 ml/tree) twice sprays.
T11: Potassium sulfate (180 ml/tree) three times sprays.
T12: Potassium sulfate (1 kg to soil + 135 ml spray) twice applications.
T13: Potassium sulfate (666 + 90) three times applications

Generally the calculated shape index was correlated with the changes in both fruit height and diameter as affected by different rates and methods of K treatments during both seasons.

It could be noticed that, all K-treatments slightly or significantly increased the shape index during the first experimental season 2015, while all treatments significantly decreased the shape index of Balady orange fruits during the second season 2016. These obtained results could be due to the increase of fruit diameter during the second season 2016.

These results are in agreement with those found by Boman (1997), Achilea (1998), Mostafa and Saleh (2006), Ashraf *et al*. (2010), El-Tanany *et al*. (2011) and Jose *et al*. (2011).

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تأثير مستويات مختلفه من السماد البوتاسي علي المحصول وجوده الثمار لاشجار البرتقال البلدي المسنه

– تأثير مستويات مختلفة من السماد البوتاسي علي بعض الصفات الطبيعيه للثمار والمحصول في البرتقال البلدي

طلعت كامل المهدي، مها عبد السلام ، رشاد عبد الوهاب ابراهيم ومنال عادل محمود

قسم الفاكهه – كليه الزراعه – جامعة اسيوط

الملخص

أجريت هذه التجربة بمزرعة الفاكهة بكلية الزراعة – جامعة أسيوط خلال موسمي ٢٠١٥ ، ٢٠١٦ علي الأشجار المسنة للبرتقال البلدي. بهدف دراسة تأثير إضافة سماد سلفات البوتاسيوم علي بعض الصفات الطبيعية للثمار وكذلك مواصفات المحصول. ولقد تم إضافة معدلات مختلفة من سماد سلفات البوتاسيوم في صورة صلبة أو سائلة أو كليهما معاً وذلك بمعدل مرتين أو ثلاث مرات كل موسم إما رشاً علي الأوراق أو إضافة للتربة.

وكانت أهم نتائج هذه التجربة ما يلي:

- أدت جميع معاملات سماد سلفات البوتاسيوم إلي زيادة معنوية في النسبه المئويه للعقد، عدد الثمار/ شجرة وكمية المحصول /شجرة (كجم) وكذلك وزن الثمرة (جم) وارتفاع وقطر الثمرة (سم) وذلك مقارنة بالكنترول (أشجار غير معاملة) خلال موسمي الدراسة.
- زادت الصفات السابقة للمحصول والثمار زيادة معنوية بزيادة جرعة السماد وعدد مرات إضافته وكذلك رشه علي الأوراق بالمقارنةً باضافته للتربة وذلك خلال موسمي الدراسة.
- سجلت أقل القيم لهذه الصفات في الأشجار الغير معاملة (الكنترول) بينما أدت المعاملة بإضافه٦٦٦ جم + ٩٠ مل من سماد سلفات البوتاسيوم رشاً علي الأوراق ثلاث مرات للحصول علي أعلي القيم لهذه الصفات خلال موسمي الدراسه.