Using Some Potassium Treatments and Apple Vinegar for Improving Fruit Colouring, Quality of Pomegranate Fruits Wonderful CV under Minia Governorate Conditions

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Abstract: During 2015 and 2016 seasons, Wonderful pomegranate trees received two sprays of three potassium compounds namely mono potassium phosphate, thiosulphate potassium and merstim vesting compound as a source of potassium and apple vinegar. Spraying was done twice at first bloom and again at 5% fruit colouration. The scope was detecting the best source of K as well as the effect of apple vinegar on fruit colouration and physical and chemical characteristics of the fruits. Single and combined applications of K- thiosulphate at 0.4%, mono- K-phosphate at 1.0%, Merstim vesting at 0.3% and apple vinegar at 0.2 to 0.4% were responsible for promoting fruit colouration % and improving fruit quality in terms of increasing T.S.S.%, total and reducing sugars %, T.S.S./ acid, total anthocyanins in fruit peel and aril and ascorbic acid and decreasing total acidity %, juice p H and total phenols and total soluble tannins in fruit peel and aril over the control. The best K compounds in this respect were K-thiosulphae, mono- K phosphate and Merstim vesting in ascending order. Using different K sources materially surpassed the application of apple vinegar in this connection. The best overall treatment was eth application of Merstim vesting at 0.3% besides apple vinegar at 0.4%. Treating Wonderful pomegranate trees twice at first bloom and again at 5% fruit colouration with a mixture of apple vinegar at 0.4% plus mono K phosphate at 1% gave the best results with regard to fruit colouration and fruit physical and chemical characteristics.
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1. Introduction

Pomegranate fruit is a rich source of natural antioxidants. It has wide application in food and pharmaceutical wonderful pomegrane cv. is used worldwide for industrial purposes. Pomegranate fruit and pomegranate juices have taken great attention for their health benefits in the last years. The trees are grown successfully under unfavourable climatic and soil conditions (**Chavan *et al.,* 1995 and Sheets *et al.,* 2004**).

Irregular colouration in such pomegranate cv is considered a serious problem facing Wonderful pomegranate grown under Egypt conditions. This disadvantage caused less keeping quality, unfit for shipment and marketing to Arab and Foreign countries. (**Morton, 1986**).

Potassium absorption has two peaks, the first at fruit setting stage and the second during berry maturation (**Yu *et al.,*1994; Hirastuka *et al.,* 2001 and Ban *et al.,* 2003**). It is effect is related to the source from which it has been taken (**Lester *et al.,* 2005; and Ali *et al.,* 2006**). This is due to the best absorption and the least lost or the effect of carriers within each K source (**Marschner, 1995; Brady and Weil, 1999; Bussakorn *et al.,* 2003 and Zhenming *et al.,* 2008**).

Potassium has announced roles in stimulating the biosynthesis and translocation of carbohydrates and plant pigments, cell division, the resistance to insects, disorders and colds, osmotic pressure of cells, water uptake of roots and cell enlargement. It also aids in regulating water content within plant tissues and enhancing root development. Its role in reducing transpiration rate did not neglect in this respect (**Dass and Srivastava, 1997**).

Previous studies showed that using any source of K was essential in promoting fruit colouration and fruit quality of different fruit crops (**Morton, 1986, Chavan *et al.,* 1995; Huang *et al.,* 2000; Martin *et al.,* 2004; Sheets *et al.,* 2004; Ahmed *et al.,* 2011; Mohamed – Ebtesam, 2012; Mehddy 2014 and Mohamed, 2017**).

The objective of this study was examining the effect of some K sources and apple vinegar on fruit colouration and physical and chemical fruit characteristics of Wonderful pomegranate trees grown under Minia region conditions.

2. Materials and Methods

This experiment was carries out during 2015 and 2016 seasons on thirty- six uniform in vinegar 10- years old Wonderful pomegranate grown in a private orchard situated at Mallawy district, Minia

Governorate. The own rooted pomegranate trees are planted at 3.5 x 3.5 meters apart. Surface irrigation system was followed.

The texture of the soil is sandy and well drained water, since water table depth was more than two meters. Analysis of the soil are shown in Table (1) **(Wilde *et el* 1985).**

Table (1): Analysis of the tested soil

Parameters	Values
Sand %	78%
Silt %	12%
Clay %	10%
Texture	Sandy
pH (1: 2.5 extract)	8.0
EC (1: 2.5 extract) ppm	690
$CaCO_3$ %	4.1
O.M. %	0.20
Total N %	0.04
Available P (Olsen ppm)	2.4
Available K (ammonium acetate) ppm	105.9

The chosen trees received the same and common horticultural practices that already applied in the orchard except those dealing with application of any K compounds and apple vinegar.

This experiment included the following twelve treatments:

1- Control.
2- Foa colour (Apple vinegar) at 0.2%.
3- Foa colour (apple vinegar) at 0.4%.
4- K- thiosulphate at 0.4%.
5- Foa at 0.2% + K- thiosulphate at 0.4%.
6- Foa at 0.4% + K- thiosulphate at 0.4%.
7- Mono K – phosphate at 1.0%.
8- Foa at 0.2 % + mono – K phosphate at 1%.
9- Foa at 0.4 % + mono K- phosphate at 1%.
10- Merestim vesting (46% K + 11 % S + 19 % P) at 3%.
11- Foa colour 2% + Merestim vesting at 0.3%.
12- Foa colour at 0.4% + Merestim vesting at 0.3%.

Each treatment was replicate three times, one tree per each. Both K- compounds and apple vinegar were sprayed twice at first bloom (Middle of Mar.) and again at 5% frit colouration (first week of Sept.) during both seasons. Triton B as a wetting agent was added to solutions of apple vinegar (Foa); thiosulphate potassium (KTS), monopotassium phosphate (MKP) and Merestim, vesting (46% K + 11 % S+ 19% P) before spraying. Spraying was done till runoff. The untreated trees received water and Triton B. Randomized complete block design (RCBD) was adopted.

During both seasons, the following measurements were recorded:

1- Fruit colouration %
2- Chemical fruit characteristics namely T.S.S, %, total and reducing sugars (**Lane and Eynon, 1965 and A.O.A.C., 2000**), total acidity (as malic acid/ 100 ml juice) (**A.O.A.C., 2000**), T.S.S./ acid, pH is the juice, ascorbic acid (as mg/ 100 ml juice), total anthocyanins % in the fruit peels and aril (**Husia *et al.*, 1965**) and total phenals and soluble tannins percentages (**A.O.A.C., 2000**) in the juice.

Statistical analysis was done. The treatment means were compared using new L.S.D. at 5% (**Snedecor and Cochran, 1980**).

3. Results and Discussion

1- Fruit colouration %:

It is clear from the data in Table (2) that single and combined application of thiosulphate – K at 0.4%, mono K phosphate at 1% and Merestim vesting at 0.3 % as well as apple vinegar at 0.2 to 0.4 % were significantly responsible for enhancing fruit colouration % relative to the control. Combined application of these materials were preferable is enhancing fruit colouration % them using each material alone. Increasing apple vinegar concentration from 0.2 to 0.4% had significant promotion on fruit colouration. Using K sources significantly surpassed the application of apple vinegar in this respect. The best K sources in this respect, in decreasing order were thiosulphate, K mono –K phosphate and Merestim vesting. The maximum values were recorded on the trees that sprayed with mono- K- phosphate at 1% plus apple vinegar at 0.4% during both seasons, respectively. Treatment Merestim vesting at 0.3% plus apple vinegar at 0.4% ranked the second position in this respect in which fruit colouration % in this treatment reached 63.3 and 62.5% during 2015 and 2016 seasons, respectively. The control trees produced 39.3 and 40.0 % fruit colouration % during both seasons, respectively. These results were true during both seasons.

2- Fruit physical and chemical characteristics:

Data in Table (2 & 3) clearly show that using K- sources and/ or apple vinegar resulted in significant promotion in fruit quality in terms of increasing T.S.S., total and reducing sugars %, T.S.S./ acid, ascorbic acid and total anthocyanins in the fruit peel and aril and decreasing total acidity, pH and total phenols and total soluble tannins in the fruit peel and aril relative to the control. The best K sources inproving fruit quality were thiosulphate potassium, mono –K- phosphate and Merestim vesting, in ascending order. Increasing apple vinegar concentrations from 0.2 to 0.4% caused a significant

promotion on fruit quality. Using the three K sources was significantly preferable than using apple vinegar in this respect. Combined applications were significantly superior than using each material alone in enhancing fruit quality. The best results with regard to fruit quality were observed on the trees that treated with a mixture of mono- K- phosphate at 1% plus apple vinegar at 0.4% followed by the treatment that included the spray of Merestim vesting at 0.3% and apple vinegar at 0.4% Unfavourable effects on fruit quality was recorded in the untreated trees. Similar trend was noticed during both seasons. Non reducing sugars was significantly unaffected.

Table (2): Effect of some potassium and apple vinegar treatments on some chemical characteristics of the fruits of Wounderful pomegranate fruits during 2015 and 2016 seasons.

Treatment	Fruit colouration %		T.S.S. %		Total sugars %		Reducing sugars %		Non reducing sugars		Total acidity %		T.S.S. /acid		pH.	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control.	39.3	40.0	16.1	16.0	14.3	14.4	13.2	13.3	1.1	1.1	0.711	0.704	22.6	22.7	4.09	4.65
Foa colour (Apple vinegar) at 0.2%.	40.0	41.0	16.5	16.6	14.7	14.7	13.6	13.5	1.1	1.2	0.693	0.786	23.8	24.2	4.47	4.43
Foa colour (apple vinegar) at 0.4%.	41.2	41.9	17.0	16.9	15.2	15.3	14.1	14.0	1.1	1.3	0.675	0.668	25.2	25.3	4.22	4.17
K- thiosulphate at 0.4%	42.0	42.8	17.5	17.4	15.7	15.8	14.6	14.5	1.1	1.3	0.659	0.652	26.6	26.7	4.00	3.97
Foa at 0.2% + K- thiosulphate at 0.4%.	33.9	31.7	18.5	18.6	16.7	16.8	15.6	15.5	1.1	1.3	0.608	0.601	30.4	30.9	3.39	3.35
Foa at 0.4% + K- thiosulphate at 0.4%.	55.0	53.9	18.8	18.7	17.0	16.9	16.0	15.9	1.0	1.0	0.591	0.583	31.8	31.6	3.23	3.20
Mono K – phosphate at 1.0%	43.9	44.1	17.9	18.0	16.1	16.2	15.1	15.2	1.0	1.0	0.640	0.633	28.0	28.4	3.80	3.76
Foa at 0.2 % + mono – K phosphate at 1%	61.4	60.9	19.4	19.5	17.6	17.6	16.5	16.4	1.1	1.2	0.550	0.542	35.3	36.0	2.93	2.88
Foa at 0.4 % + mono K- phosphate at 1%.	71.9	70.8	19.8	19.9	18.0	17.9	16.8	16.7	1.2	1.2	0.515	0.508	38.4	39.2	2.63	2.57
Merestim vesting (46% K + 11 % S + 19 % P) at 3%	48.3	49.0	18.2	18.3	16.4	16.4	15.3	15.4	1.1	1.0	0.624	0.617	29.2	30.0	3.60	3.56
Foa colour 2% + Merestim vesting at 0.3%	58.9	56.9	19.1	19.2	17.3	17.3	16.2	16.2	1.1	1.1	0.571	0.564	33.5	34.0	3.08	3.04
Foa colour at 0.4% + Merestim vesting at 0.3%	63.3	62.5	19.6	19.7	17.8	17.5	16.6	16.5	1.2	1.0	0.534	0.527	35.8	36.4	2.79	2.74
New L.S.D. at 50%	0.6	0.7		0.4	0.3	0.3	0.2	0.3	NS	NS	0.013	0.013	1.1	1.1	0.15	0.13

Table (3): Effect of some potassium and apple vinegar treatments on some chemical characteristics of the fruits of Wounderful pomegranate fruits during 2015 and 2016 seasons.

Treatment	Ascorbic acid (mg 100 juice)		Total anthocyanins % in peel		Total anthocyanins % in Aril		Total phenols % in peel		Total phenols % in Aril		Soluble tannins % in peel		Soluble tannins % in Aril	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control.	6.20	6.19	0.81	0.79	11.41	10.1	0.29	0.33	0.23	0.24	3.11	2.29	0.61	0.66
Foa colour (Apple vinegar) at 0.2%.	6.32	6.34	0.85	0.87	11.40	11.39	0.26	0.27	0.12	0.20	3.00	2.99	0.58	0.57
Foa colour (apple vinegar) at 0.4%.	6.45	6.46	0.91	0.92	11.51	11.52	0.24	0.23	0.19	0.19	2.88	2.86	0.54	0.52
K- thiosulphate at 0.4%	6.60	6.63	0.96	0.97	11.61	11.64	0.22	0.21	0.17	0.17	2.78	2.75	0.50	0.49
Foa at 0.2% + K- thiosulphate at 0.4%.	7.18	7.21	1.20	1.21	12.11	12.20	0.16	0.15	0.11	0.10	2.30	2.29	0.42	0.42
Foa at 0.4% + K- thiosulphate at 0.4%.	7.40	7.41	1.29	1.28	12.31	12.40	0.14	0.13	0.09	0.08	2.21	2.22	0.40	0.39
Mono K – phosphate at 1.0%	6.80	6.79	1.03	1.05	11.71	11.80	0.19	0.18	0.15	0.18	2.50	2.49	0.47	0.46
Foa at 0.2 % + mono – K phosphate at 1%	7.10	7.13	1.50	1.51	12.50	12.60	0.11	0.10	0.07	0.05	2.00	1.99	0.36	0.35
Foa at 0.4 % + mono K- phosphate at 1%.	7.91	7.89	1.64	1.71	13.11	13.80	0.06	0.04	0.01	0.02	1.40	1.39	0.29	0.28
Merestim vesting (46% K + 11 % S + 19 % P) at 3%	7.01	7.04	1.11	1.13	11.80	11.79	0.17	0.17	0.13	0.12	2.40	2.39	0.44	0.43
Foa colour 2% + Merestim vesting at 0.3%	6.95	6.99	1.39	1.40	12.09	12.12	0.12	0.11	0.07	0.06	2.10	2.09	0.40	0.39
Foa colour at 0.4% + Merestim vesting at 0.3%	7.50	7.49	1.56	1.55	12.51	12.60	0.10	0.09	0.05	0.04	1.91	1.90	0.34	0.33
New L.S.D. at 50%	0.10	0.09	0.03	0.04	0.05	0.05	0.02	0.02	0.02	0.02	0.05	0.06	0.03	0.02

4. Discussion

In general, double potassium sprays induced effects that were materially the highest concerning assessed parameters. Previous studies by **Morton (1986); Chavam *et al.*, (1995); Huang *et al.*, 2000, Martin *et al.*, (2004); Omar and Abdelall (2005); Ali *et al.*, (2006) and Abd El- Razek (2011)** pointed out the importance of potassium application at the considered phonological stags i.e. setting and veraison stages. Application of the former stage was found to lead to cell elongation and application at the later stages was found to enhance sugar acculumlation (**Hiratsuka *et al.*, 2001; Very and Sentenac, 2003 and Davies *et al.*, 2006**).

As a general trend all forms of K materially improved the assed quality. Superiority was

dedicated to Merestim vesting as a source of K, S and P. This clarifies that K absorption is related to the source. These findings are in parallel with those obtained by **Sheets *et al.*, (2004); Omar and Abdelaal (2005); Hassan *et al.*, (2007) and Zhenming *et al.*, (2008)** concerning that the source of K effects absorption.

In specific, K mono phosphate improved the berry weight, T.S.S., total and reducing sugars and total anthocyanins which is highly related to the fruit colouration as previously mentioned by **Mohamed *et al.*, (2007); Mohamed- Ebtesam (2012) and Mohamed (2017)** whereas juice acidity was markedly decreased. These findings are similar with those previously attained by **Omar and Abdelaal (2005) and Ali *et al.*, (2006).**

The previous advancement in colouration and fruit quality are basically due to effects induced by higher berry K concentrations as cell enlargements and sugar accumulation (**Gao *et al.*, 2001**). The effects pf S as better K absorption due to lowering the soil pH should be put into our consideration (**Schere, 2010 and Moreira *et al.*, 2002**). In addition to the effects of K on improving the trees tolerance to different stresses (**Marschner, 1995; Ban *et al.*, 2003; Cakmak, 2005 and Lester *et al.*, 2006)**.

Conclusion

Double sprays at both the first bloom and 5% fruit colouration resulted in the utmost K absorption and this was reflected on clear enhancement of fruit quality. Potassium nano phosphate was the better than K thiosulphate. Treatment of Wonderful pomegranate trees twice at first bloom and again at 5% fruit colouration with a mixture of potassium mono phosphate at 1.0% plus apple vinegar at 0.4% was responsible for maximizing fruit colouration and improving fruit quality.

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