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Use of Natural Raw Material Mixture and Natural Raw Potassium as Substitute for Chemical Fertilizers in Feeding Washington Navel Orange Trees under Kafr El Sheikh Conditions.

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ABSTRACT

This study was done in a private orchard at Kafr El-Sheikh governorate, Egypt, during 2012 and 2013 seasons on 18 years old Washington navel orange trees on sour orange rootstock, to study the effect of fertilization with natural raw material mixture and natural raw material of potassium (feldspar) on growth, leaf NPK contents and productivity of trees. Results show that, natural raw material mixture and natural raw material of potassium (feldspar) applications significantly increased growth and leaf NPK contents as compared to regular mineral fertilizers. Moreover, natural raw material mixture and natural raw material of potassium (feldspar) treatments increased yield and improved fruit quality in terms of fruit weight, fruit size, juice size, TSS, acidity, TSS/acid ratio and vitamin C. The application of 4 kg natural raw material mixture/tree + 3 kg/tree natural raw material of potassium (feldspar) +50 kg (MOM) is considered favorable treatment, which gave the best leaf NPK contents , growth, high yield and improving fruit quality of Washington navel orange trees. This treatment is a good substitute for using chemical fertilizers to avoid their deleterious effects on soil, water and human health.

Keywords: *Feldspar, Citrus sinensis, Natural, Raw, Potassium, Rocks, orange.*

INTRODUCTION

Washington navel orange (Citrus sinensis, L.) is considered as one of the most popular cultivar among citrus fruits in Egypt, for being of an excellent flavor, and high nutritional value because of their content from sugars, vitamins and minerals. Citrus fertilization is one of the most important factors for growth, reproductive behavior and ensure economic yield with a good quality. Chemical fertilizers are an indispensible in citrus crop nutrition, but it have some negative points such as: 1) represents more than 40% of citrus production costs, 2) excessive and indiscriminate uses have deleterious effects on soil, water and atmosphere pollution, and reflected on animal and human health, and 3) it adversely affected the soil fertility, water quality, yield and quality of the products (Srivastava, 2012 and Ennab, 2016). In order to improve productivity and access to safe fruits for local consumer and high exportation potential as well as reduce the costs, the farmers should be tend to the use natural raw material mixture and natural raw potassium (feldspar) as a natural sources for Fertilization. Using natural raw material and feldspar have numerous benefits that, its considered slow release fertilizer for macro elements, which make converting them in soluble forms of P, K, Ca and Mg in a long run (Hegazi *et al.,* 2014), it has assumed great importance for sustainable production and to improve the soil physical, chemical and biological properties (Zayan *et al.,* 2016). Also natural raw material mixture and natural raw potassium (feldspar) are a good alternative to reduce uses of chemical fertilizers (Abdel Rahman *et al.,* 2009 and Eman *et al.,* 2010). In this respect, several studies were accomplished for producing organic fruits through avoiding partially the application of chemicals fertilizers and encouraging the application of organic and natural raw material (rocks) fertilizers (El-Boray *et al.,*2007, Abdel-Hak *et al.,* 2012, Shaheen *et al.,* 2013, El-Iraqy 2014, El-Boray *et al* .,2015 and Mostafa and Abdel Rahman 2015).

Therefore, the objective of this study is to evaluate and compare the effect of using natural raw material mixture and natural raw material of potassium (feldspar) as safe substitute for chemical fertilizers on growth, leaf mineral content, yield and fruit quality and fruit shelf life as well as fruit quality during shelf life period of Washington navel orange trees under Kafr El Sheikh conditions.

MATERIALS AND METHODS

The present study was carried out during 2012 and 2013 seasons in a private orchard at Kafr El-Sheikh governorate, Egypt, on eighteen years old Washington navel orange trees (*Citrus sinensis,* L.) budded on sour orange (*Citrus aurantium* L.) rootstock, planted at 5x5 meter apart in clay soil under flood irrigation system. The physical and chemical analysis of the experimental soil were determined according to the method described by Page *et al*. (1982) and shown in Table (1). Also, the used natural raw material mixture and natural raw material of potassium (feldspar) were analyzed as shown in Table (1). Twenty four trees uniform in growth, vigour and productivity were selected, and subjected to the same cultural practices commonly adopted on the orchard, except fertilization. Trees were arranged in a randomized complete block design, each treatment replicated three time with two tree per replicate. The chosen

- T_1: 50 kg (MOM) + 2 kg Natural Raw Material Mixture /tree + 3 kg/tree feldspar
- T_2: 50 kg (MOM) + 4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar
- T_3: 50 kg (MOM) + 6 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar
- Control: Farmer program fertilization was considered as Control

The program fertilization was 1000:250:500 NPK g/tree/year applied as 4.85 kg/tree ammonium sulphate (20.6% N), 1.60 kg/tree super phosphate (15.5% P2O5) and 1.00 kg/tree potassium sulphate (48% K2O). Nitrogen fertilizer was added on three doses, at March, the first of June and at the end of August. Whereas, potassium was applied on two doses, at the first of March and at the end of August with nitrogen fertilization. All fertilizers added as broadcast on the soil surface through the whole area. Natural raw material mixture and natural raw material of potassium (feldspar) were added once at the first week of

December in both seasons. Therefore, mature organic manure was applied at winter service at the first week of December in both seasons, at the same time of applying Natural mixture and Feldspar. Mature organic manure (MOM) was added as 50 kg / tree, to all experimental trees except control trees.

Table 1. Analysis of natural raw material mixture, natural raw potassium (feldspar) and physical, chemical of the experimental soil.

Soil properties	Soil depth cm Before experiment (2013) 0–30	30–60	After experiment (2015) 0–30	30–60	Natural raw material mixture Component	concentration	Natural raw of potassium (feldspar Component	Concentration
pH (1: 2.5 soil suspension)	8.06	8.18	8.02	8.13	SiO_2	36.15 %	SiO_2	70.56
EC, dS/m(1: 5 soil water extract)	3.60	2.40	3.55	2.23	TiO_2	0.76 %	TiO_2	0.02
					Al_2O_3	7.80 %	AL_2O_3	16.23
Soluble cations and anions meq/L					Fe_2O_3	4.88 %	Fe_2O_3	0.17
					MnO	0.72 %	MnO	0.02
					MgO	3.07 %	MgO	0.05
					CaO	13.45 %	CaO	0.26
Na^+	0.84	1.28	0.80	1.24	Na_2O	1.92 %	Na_2O	3.69
K^+	0.91	0.45	0.96	0.48	K_2O	4.37 %	K_2O	8.20
Ca^{++}	2.70	1.60	2.73	1.65	P_2O_5	8.14 %	P_2O_5	0.03
Mg^{++}	2.80	1.60	2.84	1.64	Cl	0.56 %	L.O.I	0.37
Cl^-	0.80	0.60	0.80	1.60	SO_3	5.38 %		
CO_3^-	0.00	0.00	0.00	0.00	L.O.I	9.01 %		
SO_4-	1.40	1.30	1.40	1.30	V	248.1 ppm		
HCO_3	5.05	3.03	5.00	3.00	Cr	339.4 ppm		
					Co	17.5 ppm		
Total N , %	0.15	0.11	0.18	0.13	Ni	25.8 ppm		
Available P, mg/kg soil	15.2	7.90	15.4	7.96	Cu	17.8 ppm		
Available K, mg/kg soil	1154	800	1155	803	Zn	3082.0 ppm		
Organic matter, %	1.31	0.99	1.35	1.20	Rb	46.0 ppm		
Field Capacity, %	45.2	46.1	45.3	46.5	Sr	246.2 ppm		
Wilting point, %	23.8	24.5	23.9	23.5	Y	< 1.5 ppm		
Available water, %	21.4	21.6	21.4	21.6	Zr	54.5 ppm		
Bulk density, Mg / m^3	1.27	1.44	1.29	1.46	Nb	5.7 ppm		
Particle size distribution , %					Mo	2.4 ppm		
					Sn	2.5 ppm		
					Ba	545.0ppm		
Clay	66.5	67.4	66.5	67.4	La	14.7 ppm		
Silt	27.9	27.2	27.9	27.2	Yb	3.9 ppm		
sand	5.6	5.4	5.6	5.4	Hf	2.7 ppm		
					Ta	4.4 ppm		
Texture class	Clay	Clay	Clay	Clay	Pb	1104.0 ppm		

The following data was recorded:

Twenty mature leaves were sampled in September from spring shoot to determining leaf area (cm^2) using a leaf area meter Model Li 3100 area-meter, then leaf samples were washed with tap water followed by distilled water and dried at 70°C to a constant weight, then the dry leaves were ground and digested according to Chapman and Pratt (1961) and Jackson (1967) by using the mixture of concentrated Sulfuric acid (H_2SO_4) + perchloric ($HClO_4$) (5: 1) to determine the elements N, P and K. Total nitrogen % was determined by using the micro-kjeldahl method as described by Pregl (1945), Phosphorus % was determined colorimetrically as described by Murphy and Riley (1962) while, Potassium % was estimated by using flame photometer as described by Brown and Lillelland (1974). At harvest time (15 December in both seasons), yield of each tree was determined as number and weight (kg) of fruits/tree, then 10 fruit samples were taken at random from each replicate and directly transported to laboratory of Horticulture Department, Faculty of Agriculture, Kafr El Sheikh University to determine fruit quality as follow: fruit weight (gm), fruit size (ml), juice size ml/fruit, were measured. Total soluble solids (TSS%) was determined by hand refractometer, total acidity as citric acid according to (AO A C 1990), ascorbic acid as mg/100 ml juice by using 2, 6 dichlorophenol indophenol according to Jacobs (1951). TSS/acid ratio was estimated. The remaining fruit samples (25 fruits) were left in the laboratory at room temperature (21 ± 1°C) and humidity (60 ± 5%) for a period of five weeks to estimate fruit quality and weight loss during shelf life period. The variables were measured every week as follow: Fruit weight loss (%) according to this equation:

$$\text{Weight loss \%} = \frac{\text{Initial weight} - \text{weight at each week} \times 100}{\text{Initial weight}}.$$

Total soluble solid (TSS %), acidity %, vitamin C and TSS/acid ratio according to (AOAC 1990).

Statistical analysis was done as analysis of variance according to the method described by Snedecor and Cochran (1990), and the least significant differences (LSD. at 5% level) was used to compare mean values.

RESULTS AND DISCUSSION

Leaf area (cm^2):

Data reported in Tables 2 and 3 show the effect of natural raw material mixture and natural raw potassium (feldspar) on leaf area and leaf NPK content of Washington navel orange trees. As for leaf area the results in Table 2 indicated that, all treatments increased leaf area

as compared to control treatment. The application of 4 kg natural raw material mixture/tree + 3 kg/tree feldspar +50 kg M.O.M (T2) was significantly increased leaf area compared to the control treatment. T1 (2 kg Natural Raw Material Mixture /tree + 3 kg/tree feldspar +50 kg M.O.M) and T3 (6 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar+50 kg M.O.M) gave approximately the same values of leaf area without significant differences between them. Moreover, the increment over control represented 9.55, 14.40 and 6.81 % for T1, T2 and T3, respectively. These findings are in agreement with those obtained by Barakat *et al.* (2012) on Newhall navel orange and Abdel-Hak *et al.* (2012) on Valencia orange trees. In this respect, Eman *et al.* (2010) using natural raw material mixture and magnetite raw on Le Conte pear trees and found an increasing in vegetative growth in terms of shoot length, shoot diameter, leaf number and leaf area as compared to NPK treated ones. Also, Abdel Rahman *et al.* (2009) revealed that, application of 5 kg natural elements compound per tree significantly improved vegetative growth of navel orange compared to control.

Leaf NPK content:

As for leaf N content, data presented in Table 2 indicate that, all treatments of natural raw material mixture and natural raw potassium (feldspar) were raising leaf nitrogen content compared to control treatment, whereas there are insignificant differences among treatments on this variable. Moreover, leaf N content was increased over control caused by treatments, this increment was higher in T_2 (4 kg natural raw material mixture/tree + 3 kg/tree feldspar +50 kg M.O.M) followed by T_1 (2 kg Natural Raw Material Mixture /tree + 3 kg/tree feldspar +50 kg M.O.M) and T_3 (6 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar +50 kg M.O.M) respectively. These results are similar with those reported by Mohamed (2008) on Superior grapevines grown in a sandy soil and irrigated with drip irrigation system; found that the leaf nitrogen content was higher in vines fertilized with 8kg compost + 400g rock phosphate + 400g feldspar than that on control vines fertilized with chemical sources. Similar results were obtained by Shaheen *et al*. (2013), they indicated that application of 50% compost + 50% P rock phosphate + 50 % K feldspar + 50% of the NPK mineral recommended fertilizers + bio-fertilizer (*Azotobacter chrococcum, Bacillus megaterium and Bacillus circulans*) gave the best leaf nitrogen content of Superior Seedless grapevines.

Table 2. Effect of natural raw material mixture and feldspar on leaf area and leaf nitrogen content of Washington navel orange trees.

Treatments	Leaf area (cm^2)				Leaf nitrogen (%)			
	2012 season	2013 Season	Average	%Increasing or Decreasing than control	2012 Season	2013 Season	Average	%Increasing or decreasing than control
Control	13.90 c	14.58 b	14.24	0.00	2.27 a	2.21 a	2.24	0.00
T_1	15.40 b	15.80 ab	15.60	+ 9.55	2.85 a	2.09 a	2.47	+10.26
T_2	16.26 a	16.32 a	16.29	+14.40	2.50 a	2.50 a	2.50	+11.60
T_3	15.17 b	15.24 ab	15.21	+ 6.81	2.37 a	2.37 a	2.37	+5.80
LSD at 5%	0.551	1.32	--	--	Ns	Ns	--	--

• T_1 50kg M O M + 2 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar
• T_2 50kg M O M + 4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar
• T_3 50kg M O M + 6 kg Natural Raw Material Mixture /tree + 3 kg/tree feldspar
• Control Farmer program fertilization
NS = not significant

Leaf P content in Washington navel orange trees recorded the highest value in T_3 followed by control treatment in both seasons (Table 3). The lowest values were noticed with T_1 in both seasons. The statistical analysis showed that differences were insignificant among treatments in both seasons. Also, data in Table (3) showed that leaf content of phosphorus was decreased by 10 % and 5% of control in T_1 and T_2 respectively, whereas T_3 was increased leaf content of phosphorus by5% of control. Similar results were obtained by Mostafa and Abdel Rahman (2015) on Balady mandarin.

Table 3. Effect of natural raw material mixture and feldspar on leaf phosphorus and Potassium content of Washington navel orange trees.

Treatments	Leaf phosphorus (%)				Leaf potassium(%)			
	2012 Season	2013 Season	Average	%Increasing or decreasing than control	2012 Season	2013 Season	Average	% Increasing or decreasing than control
Control	0.21 a	0.20 a	0.20	0.00	2.29 a	2.66 a	2.48	0.00
T_1	0.18 a	0.17 a	0.18	-10.00	2.10 b	2.44 a	2.27	- 8.47
T_2	0.19 a	0.18 a	0.19	- 5.00	2.21 ab	2.33 a	2.27	- 8.47
T_3	0.22 a	0.20 a	0.21	+5.00	2.28 a	2.61 a	2.45	- 1.21
LSD at 5%	NS	NS	--	--	0.16	NS	--	--

• T_1 50kg M O M + 2 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar
• T_2 50kg M O M + 4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar
• T_3 50kg M O M + 6 kg Natural Raw Material Mixture /tree + 3 kg/tree feldspar
• Control Farmer program fertilization
NS = not significant

Regarding leaf K content, data in Table 3 revealed that control treatment and T_3 gave higher values of leaf potassium content compared to other treatments in both seasons. The differences were significant in the first season only. All treatments reduced of leaf potassium content at different rates of

control. This values were found in treatments of T3, T_1 and T_2 with -1.21, -8.47 and -8.47 %, respectively.

Generally, it is obvious from data in Tables (2 and 3) that, application of natural raw material mixture and natural raw potassium (feldspar) enhanced vegetative growth of Washington navel orange trees. T_2 (4 kg natural raw material mixture/tree + 3 k g/tree feldspar +50kg M.O.M) was more effective as compared to other treatments. In this respect, the results in Tables (2 and 3) revealed that leaf NPK contents was optimal for Washington navel orange growth and productivity under all treatments, these results came true with Embleton *et al.* (1978) and Koo *et al.* (1984). The reduction in leaf P and K content as result of T_1, T_2 and T_3 treatments than control can be attributed to natural raw material and feldspar are considered slow release fertilizer for macro elements which take a long time for converting them in soluble forms (Roy *et al.* 2006). It is worthily to mention that applying these raw materials mixture and feldspar to the experimental soil has been led to improve most of soil properties, in terms of PH., EC, soluble actions and anions values and available P and K as mg/kg soil after the end of this experiment in 2015 as shown in Table 1. In spite of the improving is seemed to be slightly occurred after two years of application, probably, it will be promising in the long term application instead of chemical fertilizers.

Yield as kg/tree and fruit number/tree:

Data in Table 4 showed that, yield as number of fruits and weight (kg/tree) of Washington navel orange trees was significantly increased by all natural raw material mixture and natural raw potassium (feldspar) treatments comparing with control in both seasons. In this respect, the highest yield was observed with fertilization application of T_3 and T_2 in both seasons, respectively. However, trees fertilized with farmer program (control) gave the lowest yield compared to other treatments in both seasons. In addition, T_3, T_2 and T_1 gave highest yield over control, 30.65, 19.47 and 16.47% for yield as kg/tree and 15.90, 12.26 and 11.47% for number of fruits/tree, respectively. These results were in agreement with those obtained by Abdel-Hak et al. (2012), they reported that, feldspar at 1000 g K_2O/tree with two or three doses inoculated with Bacillus circulans as soil application on Valencia orange gave the highest significant fruit number and yield kg/tree as compared with control and other treatments. Similarly, El-Wakeel et al. (2013) observed that feldspar + silicate bacteria enhanced yield of Navel orange trees. In this respect, El-Iraqy (2014) found that olive trees cv. Picual fertilized with 3 kg /tree feldspar plus 134 g Potassium enhanced tree yield as kg/tree compared to the control and other treatments. The increment in yield by using natural raw material mixture and natural raw potassium (feldspar) may be due to their great abilities for providing with various nutrients for the trees needed to increase yield and improving physical and chemical of soil properties. This positive effect most probably due to that the treated trees are not suffering from deficiency of both macro and micro nutrient.

Table 4. Effect of natural raw material mixture and feldspar on yield of Washington navel orange trees.

Treatments	Yield as kg/tree				Yield as fruit number/tree			
	2012 Season	2013 Season	Average	%Increasing or decreasing than control	2012 Season	2013 Season	Average	%Increasing or decreasing than control
Control	59.05 c	61.84 c	60.44	00.00	300.00 b	310.00 b	305.00	00.00
T_1	70.18 b	70.63 b	70.40	+ 16.47	343.70ab	336.33ab	340.01	+ 11.47
T_2	71.90ab	72.52ab	72.21	+ 19.47	339.50ab	345.30a	342.41	+ 12.26
T_3	80.35a	77.60a	78.97	+ 30.65	372.17a	334.83ab	353.50	+ 15.90
LSD at 5%	9.98	3.37	--	--	70.33	29.04	--	--

• T_1 50kg M O M + 2 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar
• T_2 50kg M O M + 4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar
• T_3 50kg M O M + 6 kg Natural Raw Material Mixture /tree + 3 kg/tree feldspar
• Control: Farmer program fertilization

Fruit quality:

Physical characters:

Data in Table 5 show the effect of natural raw material mixture and natural raw potassium (feldspar) on physical fruit quality in terms of fruit weight, size and juice size of Washington navel orange trees in both seasons. The results show significant differences among treatments in both seasons as for fruit size and juice size, while the differences were not significant as for fruit weight in both seasons. All tested treatments increased fruit weight, fruit size and juice size compared to control in both seasons. The highest values of fruit weight, fruit size and juice size were obtained from trees fertilized with T_3 (6 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar +50kg MOM) followed by T_2 (4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar +50kg MOM) as compared with control trees and other treatments in both seasons. On the other hand, control treatment (Farmer program fertilization) gave the least values of fruit weight, fruit size and juice size in both seasons. Moreover, T_3 and T_2 gave higher increasing over control and other treatments. Similar results were obtained by Shaaban *et al*. (2012), and Mostafa and Abdel Rahman (2015). In this respect, Abdel Rahman *et al*. (2009) on Navel orange found that natural elements compound application improved fruit weight and juice volume. On the other hand, Eman *et al* (2010) found no differences between using natural raw material mixture and NPK treatments on physical fruit quality in terms of fruit weight, fruit length and diameter of Le Conte pear trees.

Generally, it is clear from Table 5 that, heaviest and largest fruits were harvested from trees treated with 6 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar + 50kg MOM followed by those treated with 4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar +50kg MOM without significant differences between them in both seasons.

Table 5. Effect of natural raw material mixture and feldspar on fruit weight (g), fruit size (ml) and juice size (ml/fruit) of Washington navel orange trees.

Treatments	Fruit weight (g)				Fruit size (ml)			
	2012 Season	2013 Season	Average	%Increasing or decreasing than control	2012 Season	2013 Season	Average	%Increasing or decreasing than control
Control	196.83a	199.40a	198.11	00.00	174.17b	185.00 d	179.58	00.00
T_1	204.20a	209.20a	206.70	+ 4.33	211.67b	199.00 c	205.33	+ 14.34
T_2	211.80a	218.70a	215.25	+ 8.65	271.67a	222.57 b	247.12	+ 37.61
T_3	215.90a	222.80a	219.35	+ 10.72	279.17a	245.00 a	262.09	+ 45.95
LSD at 5%	NS	NS	--	--	73.23	9.88	--	--

Treatments	Juice volume (ml/fruit)			
	2012 Season	2013 Season	Average	% Increasing than control
Control	62.00 b	58.00 c	60.00	00.00
T_1	63.33 b	62.00 c	62.66	+ 4.43
T_2	73.33 a	67.50 b	70.41	+ 17.35
T_3	80.33 a	82.00 a	81.16	+ 35.26
LSD at 5%	9.98	2.99	--	--

- **T_1 50kg M O M + 2 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar**
- **T_2 50kg M O M + 4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar**
- **T_3 50kg M O M + 6 kg Natural Raw Material Mixture /tree + 3 kg/tree feldspar**
- **Control: Farmer program fertilization**

NS = not significant

Chemical characters:

Data in Tables 6 and 7 show the effect of soil application of natural raw material mixture and natural raw potassium (feldspar) on chemical fruit quality in terms of TSS%, acidity%, TSS/acid ratio and vitamin C of Washington navel orange trees in both seasons. As for TSS, it is clear from Table 6 that, T_3 gave the lowest values of TSS with significant differences between T_3 and other treatments in both seasons. Whereas, T_1, T_2 and control gave high values of TSS and found to be at par without significant differences among them in both seasons. Regarding acidity, control treatment gave the lowest values of acidity compared to other treatments in both seasons. the differences were insignificant in most cases in both seasons. Generally, T_2 (4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar +50kg MOM) produced fruits with better TSS% and acidity values than control .

The results in Table 7 revealed that, T_2 and control treatments gave the highest values of TSS/acid ratio compared to other treatments in both seasons. The differences were insignificant in most cases in both seasons. Moreover, all tested treatments led to increase fruit value of vitamin C compared to control treatment in both seasons. Trees treated with T_2 (4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar) gave the highest vitamin C in fruits followed by those treated with T_3 (6 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar), respectively.

Table 6. Effect of natural raw material mixture and feldspar on TSS% and acidity % of Washington navel orange trees.

Treatments	TSS %				Acidity %			
	2012 Season	2013 Season	Average	% Increasing or decreasing Than control	2012 Season	2013 Season	Average	% Increasing or decreasing than control
Control	11.63 a	12.00 a	11.81	0.00	0.82a	0.81 b	0.81	0.00
T_1	12.07 a	11.80 ab	11.93	+ 1.01	0.87a	0.85 ab	0.86	+ 6.17
T_2	11.90 ab	12.00 a	11.95	+ 1.18	0.83a	0.96 a	0.89	+ 9.87
T_3	10.97 c	11.60 b	11.28	- 4.48	0.84a	0.94 ab	0.89	+ 9.87
LSD at 5%	0.36	0.35	--	--	NS	0.14	--	--

Table 7. Effect of natural raw material mixture and feldspar on TSS/acid ratio and vitamin C (mg/100 ml juice) of Washington navel orange trees.

Treatments	TSS/acid ratio				Vitamin C (mg/100 ml juice)			
	2012 Season	2013 Season	Average	%Increasing or decreasing than control	2012 Season	2013 Season	Average	% Increasing or decreasing than control
Control	14.28 a	14.89 a	14.58	00.00	47.25 b	47.21 c	47.23	00.00
T_1	13.84 a	13.90ab	13.87	- 4.86	52.50 a	59.25 b	55.87	+ 18.29
T_2	14.34 a	12.59 b	13.46	- 7.68	48.30 ab	68.62 a	58.46	+ 23.77
T_3	13.01 a	12.39 b	12.70	- 12.89	51.10 ab	63.75 b	57.42	+ 21.57
LSD at 5%	Ns	1.81	--	--	4.65	9.17	--	--

- **T_1: 50kg M O M + 2 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar**
- **T_2 50kg M O M +:4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar**
- **T_3: 50kg M O M + 6 kg Natural Raw Material Mixture /tree + 3 kg/tree feldspar**
- **Control: Farmer program fertilization**

NS = not significant

Generally, it is obvious from Tables 5, 6 and 7 that, fertilization with natural raw material mixture and natural raw potassium (feldspar) are able to consistently improve fruit quality in terms of fruit weight, fruit size,

juice size, TSS, acidity, TSS/acid ratio and vitamin C of Washington navel orange trees compared to control. In this respect, T_2 (4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar) and T_3 (6 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar) produced the best fruit quality without significant differences between them. These results agree with those obtained by Abdel Rahman *et al.* (2009). Also, El- Wakeel *et al.* (2013) indicated that the best values of fruit weight, fruit volume, TSS and TSS/acid ratio of Navel orange fruits were obtained by the highest levels from potassium (600 g K_2O) as K- feldspar + silicate bacteria treatments. Similarly, Baiea *et al.* (2015) revealed that the highest values of total soluble solids and TSS/acid ratio of banana cv. Grande Naine were scored by 8Kg feldspar +10 ml Potassin as compared to control.

Fruit quality and weight loss during shelf life period:

Data in Table 8 show the effect of soil application of natural raw material mixture and natural raw potassium (feldspar) on fruit loss and chemical fruit quality of Washington navel orange fruits stored at room temperature (21 ± 1 °C) with humidity (60 ± 5%). As for fruit weight loss, data in Table 8 showed that weight loss percentage was increased by increasing storage period. The highest percentage weight loss was observed in control treatment followed by T_1 (2kg Natural Raw Material Mixture/tree + 3kg/tree feldspar+50kg MOM) and T_2 (4kg Natural Raw Material Mixture/tree + 3kg/tree feldspar+50kg MOM) in both seasons, respectively. On the other hand, T3(6 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar +50kg MOM) gave the lowest fruit weight loss percentage during storage period as compared to the other treatments. The differences between fertilization treatments and control were significant in both seasons, while, the differences among treatments were insignificant in most cases. Weight loss of citrus fruits is related to fruit moisture loss; it is also an important factor of fruit quality. Moisture loss during storage shows a shriveled fruit of citrus and dry appearance, and it increased as increasing storage time and temperature (Nunes, 2008).

Table 8. Effect of natural raw material mixture and feldspar on weight loss % and chemical fruit quality during storage at room temperature (21 ± 1 °C) with humidity (60 ± 5%) of Washington navel orange trees.

Treatments	Weight loss (%)											
	Season 1						Season 2					
	0	7d	14d	21d	28d	35d	0	7d	14d	21d	28d	35d
Control	00.0	3.15	6.18	9.32	12.65	14.36	00.0	3.36	5.99	8.20	11.15	13.32
T_1	00.0	2.37	4.53	7.45	10.07	11.70	00.0	3.08	5.80	7.92	10.76	12.69
T_2	00.0	2.44	4.52	7.11	9.56	11.48	00.0	3.02	5.23	7.20	9.55	11.33
T_3	00.0	2.09	4.04	6.38	9.03	10.43	00.0	2.94	5.49	7.44	10.40	12.50
LSD at 5%	00.0	0.50	0.91	1.38	1.66	1.85	00.0	0.40	0.71	1.05	1.39	1.57
Treatments	**TSS (%)**											
	Season 1						Season 2					
	0	7d	14d	21d	28d	35d	0	7d	14d	21d	28d	35d
Control	11.63	12.03	12.13	12.20	12.93	13.03	11.27	11.67	12.00	12.13	12.13	12.67
T_1	11.70	12.07	12.60	13.07	13.07	13.33	11.40	11.47	11.67	11.80	12.27	12.4
T_2	11. 70	11.90	12.27	12.70	12.53	12.73	11.80	12.00	12.20	12.27	12.33	12.67
T_3	10.97	11.13	11.80	12.13	12.47	13.00	11.00	11.43	11.47	11.60	12.07	12.27
LSD at 5%	0.31	0.35	0.22	0.32	0.17	0.32	0.32	0.17	0.17	0.49	0.27	0.25
Treatments	**Acidity (%)**											
	Season 1						Season 2					
	0	7d	14d	21d	28d	35d	0	7d	14d	21d	28d	35d
Control	0.82	0.82	0.85	0.83	0.83	0.81	0.81	0.82	0.84	0.82	0.79	0.78
T_1	0.87	0.92	0.96	0.92	0.85	0.82	0.85	0.92	0.87	0.87	0.86	0.84
T_2	0.83	0.91	0.95	0.87	0.85	0.82	0.86	0.91	0.94	0.90	0.84	0.82
T_3	0.84	0.91	0.89	0.82	0.81	0.80	0.86	0.91	0.86	0.86	0.82	0.80
LSD at 5%	0.03	0.03	0.02	0.03	0.81	0.01	0.01	0.03	0.03	0.03	0.03	0.02
Treatments	**TSS/acid ratio**											
	Season 1						Season 2					
	0	7d	14d	21d	28d	35d	0	7d	14d	21d	28d	35d
Control	14.20	14.67	14.28	14.70	15.58	16.10	12.91	13.12	14.29	14.80	15.36	16.17
T_1	13.41	13.12	13.13	14.21	15.38	16.27	13.42	11.95	13.36	13.57	14.21	14.78
T_2	14.06	13.03	12.91	14.56	14.75	15.53	13.72	12.50	12.94	13.58	14.68	15.46
T_3	13.06	12.19	13.28	14.74	15.39	16.18	12.79	12.08	13.33	13.79	14.66	15.27
LSD at 5%	0.85	0.87	0.22	0.80	.052	0.71	0.52	0.71	0.56	0.97	0.43	0.74
Treatments	**Vitamin C (mg/100 ml juice)**											
	Season 1						Season 2					
	0	7d	14d	21d	28d	35d	0	7d	14d	21d	28d	35d
Control	47.25	46.45	45.71	34.45	30.33	25.47	47.21	46.24	44.04	32.16	29.14	25.71
T_1	48.56	47.73	45.90	34.45	29.67	25.31	47.67	47.05	44.34	33.84	30.08	27.89
T_2	48.30	47.52	45.54	37.30	29.42	27.11	47.89	47.21	44.53	34.32	31.40	28.48
T_3	49.87	48.16	46.81	37.85	29.01	27.33	49.24	48.44	45.64	35.28	32.28	29.27
LSD at 5%	1.04	0.65	0.26	0.51	0.90	0.36	0.62	0.64	0.58	0.38	0.24	0.48

- **T_1: 50kg M O M + 2 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar**
- **T_2: 50kg M O M + 4 kg Natural Raw Material Mixture/tree + 3 kg/tree feldspar**
- **T_3: 50kg M O M + 6 kg Natural Raw Material Mixture /tree + 3 kg/tree feldspar**
- **Control: Farmer program fertilization**
- **d: day**

The results in Table 8 indicate that total soluble solid (TSS) in Washington navel orange fruits increases gradually as storage time progressed. The treatments of T_1 and T_2 gave the highest values of total soluble solid (TSS) without significant differences between them in most cases as compared to control and other treatments in both seasons. Thus, using natural raw material mixture and natural raw potassium (feldspar) as fertilizers maintain high level of total soluble solids (TSS) during storage period. The increase in total soluble solids in fruits maybe related to the hydrolytic activities in starch, the increased activity of enzymes responsible for the hydrolysis of starch to soluble sugars, and the conversion of starch to sugar, which indicates that the fruits are at the ripening process (Ghosh and Sen, 1984).

Regarding fruit acidity, it increased in the first and second week with all treatments when compared with control and the differences were significant among them in most cases, and then began to decline from the third week until the fifth week. Control fruit was the lowest in the percentage of acid followed by treatments T_3, T_2 and T_1 respectively, with significant differences among them in most cases.

Regarding TSS/ Acidity, data in Table 8 indicate that, the values were approximated from the harvest time until the second week for all treatments. The values of the control were the highest with significant differences between them and the other treatments. The values increased in the third, fourth and fifth weeks respectively compared to the values at the harvest time with all treatments. TSS/Acidity values started to increase with all treatments without insignificant differences among them and control in most cases in the first season, this is due to the decrease in acidity and increase the value of TSS in fruit as a result of the loss water content as a result of breathing and evaporation.

As for VC, data in table 8 show that, the values of VC increased from the harvest time until the fifth week with all treatments and the highest values were found with the third treatment and the differences were significant when compared to the control and the other treatments .

Generally, data in table 8 clear that, the values of TSS, TSS / Acidity and loss in fruit weight were increased from the beginning of shelf life until the fifth week, while the values of VC and percentage of acid were decreased from one week to the next. The use of a natural mineral mixture of 4 kg with 3 kg potassium (Feldspar) increased the values of TSS and TSS / acidity compared to control, except for VC values and the loss of fruit weight. The treatment of chemical fertilizer (control) led to an increase in the percentage of loss in weight of fruit during the storage period**.**

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استخدام مخلوط المعادن الطبيعيه و خام البوتاسيوم الطبيعى كبديل للأسمده الكيماويه فى تغذيه اشجار البرتقال ابو سره تحت ظروف كفر الشيخ

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تمت هذة الدراسة فى مزرعة خاصة بمحافظه كفر الشيخ خلال موسمى ٢٠١٢و٢٠١٣ على اشجار برتقال بسره عمرها ١٨ سنه مطعومه على أصل النارنج فى ارض طينيه على مسافه ٥X٥ وذلك لدراسه تأثير التسميد بمخلوط المعادن الطبيعيه و البوتاسيم الطبيعى (الفلسبار) على النمو و محتوى الورقه من NPK و المحصول وجوده الثمار. وقد اظهرت النتائج الأتى : * أدى إستخدام مخلوط المعادن الطبيعيه إلى زياده معنويه فى النمو ممثله بمساحه الورقه مقارنه بالكنترول و أعطت المعامله (٢) أعلى القيم بفروق معنويه بينها وبين المعاملات الأخرى بينما أعطت المعاملات (١ و٣) قيماً متقاربه و بدون فروق معنويه بينهما ..* بالنسبه لمحتوى الاوراق من NPK فقد اظهرت النتائج تقارب قيم NPK فى الاوراق بالنسبه لكل المعاملات ولم يكن هناك فروق معنويه بين المعاملات وبين الكنترول فى معظم الحالات. * أدى استخدام مخلوط المعادن الطبيعيه إلى زياده معنويه فى المحصول كما حسنت من جودة الثمار من حيث وزن الثمرة ، حجم الثمره ، حجم العصير ، TSS، الحموضة ، نسبة TSS / Acidity وفيتامين C. * تعتبر المعامله الثانيه (٥٠ كجم من السماد العضوى+٤كجم من مخلوط المعادن الطبيعيه + ٣كجم من البوتاسيوم الطبيعى / شجره هى الأفضل حيث اعطت افضل النتائج بالنسبه للمحصول وجوده الثمار و محتوى الاوراق من NPK مقارنه بالمعاملات ألأخرى وتعتبر بديلاً أفضل من إستخدام الأسمده الكيميائيه.. * اظهرت النتائج ان قيم TSS وTSS/ Acidity و نسبه الفقد فى وزن الثمره زادت من بدايه التخزين حتى الاسبوغ الخامس فى حين انخفضت قيم V.C ونسبه الحموضه تدريجيا من اسبوع لأخر. * أدى استخدام المعامله الثانيه (٥٠ كجم من السماد العضوى +٤كجم من مخلوط المعادن الطبيعيه + ٣كجم من البوتاسيوم الطبيعى (فلسبار)/ شجره الى زياده قيم كل من TSS و TSS/Acidity مقارنه بالكنترول بينما ادت المعامله بالاسمده الكيماويه (الكنترول) الى زياده النسبه المئويه للفقد فى وزن الثمره خلال فترة التخزين .