



# **Influence of New Humex, Olivine, Potassium Silicate and Magnetic Iron on Growth of Washington Navel Orange Transplants Budded on Two Citrus Rootstocks**

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## **Authors' contributions**

*This work was carried out in collaboration between all authors. Authors ARA, FMAEL and SFEG designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript and managed the analyses of the study. Author FAN managed the literature searches. All authors read and approved the final manuscript.*

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## **ABSTRACT**

This investigation was carried out on potted transplants of Washington navel orange budded on two citrus rootstocks grown at nursery of Horticulture Department, Faculty of agriculture, Benha University, at Moshtohor, Touchk region Kalubia Governorate, Egypt during two successive 2014 and 2015 experimental seasons in this investigation the influence of two citrus rootstocks, namely: a. Sour orange "*Citrus aurantium*" b. Volkamer lemon "*Citrus volkameriana*". Also, the influence of nine treatments as follow: (T1) Control: Mineral N, P and K fertilization program as control, (T2) New humex 5 mL/L, (T3) New humex (5 mL/L) + potassium Silicate (10 mL/L), (T4) New humex (5 mL/L) + Magnetic iron 250 g/ transplant, (T5) + potassium silicate (10 mL/L) + Magnetic iron (250 g per transplant). (T6) olivine (3 mL/L), (T7) olivine (3 mL/L) + potassium silicate (10 mL/L), (T8) Olivine (3 mL/L) + Magnetic iron, (T9) Olivine (3 mL/L) + potassium silicate (10 mL/L) + Magnetic iron. on growth measurements (1- Transplant height (cm) 2- Stem diameter (cm). 3- the number of leaves per transplant. 4- Leaf area. 5- Total assimilation area/transplant 6- Leaves fresh weight (g).

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7- Leaves dry weight (g). 8- Root fresh weight (g). 9- Root dry weight (g). 10- Stem fresh weight (g). 11- Stem dry weight (g). 12- Total transplant fresh weight (g). 13- Total transplant dry weight (g). 14- Top dry weight. 15- Top/root ratio.) of Washington navel orange transplants budded on two citrus rootstocks. Uniform and healthy one-year-old transplants were used in this experiment. The influence was evaluated through the response of growth to the specific and interaction effects of both investigated factors. Concerning the interaction effect of the two investigated factors i.e., rootstock type and different fertilization treatments on growth of Washington navel orange transplants, data showed that the highest growth measurements were obtained with the combination between Washington orange transplants budded on Volkamer lemon rootstock and fertilized by (T9) Olivine + SiO<sub>2</sub> + Fe Mag and/or (T5) New humex + SiO<sub>2</sub> + Fe Mag during the two seasons of study.

*Keywords: Citrus; Volkamer lemon; Sour orange; rootstocks; potassium silicate; magnetite iron.*

## 1. INTRODUCTION

Citrus is considered one of the most important fruit crops grown in many tropical and subtropical countries. At the moment there are about 1.5 million hectares of Citrus species cultivated at a commercial scale in the world yielded nearly 40 million metric tons of oranges, lemons, limes, etc... [1].

Oranges are a winter fruit well-suited to the Egyptian climate. Orange production accounts for half the total fruit production in Egypt. Cultivation is centered in two large geographic regions: The fertile Delta area and the newly reclaimed lands. Navel oranges are the predominant variety. Smaller amounts of local (Balady), Sweet, Valencia, and other varieties are also produced. The harvest of Navel oranges begins in October but starts later for other cultivars in November, December up to March / April.

Humic acid (polymeric polyhydroxy acid) was the most dominant component of organic substances in an aquatic system. Humic acid is highly beneficial to plants and soil, increase microbial activity, a plant growth bio-stimulant, an effective soil enhancer, promote nutrient uptake (chelating agent) and increase yield.

Potassium silicate is a source of highly soluble potassium and silicon. It is used in agricultural production systems primarily as a silica amendment and has the added benefit of supplying small amounts of potassium. The NOP has no prior ruling on the use of this substance. The National List allows the use of some synthetic silica-based fertilizers, but they are allowed only as micronutrient amendments as a means to deliver trace metals and are not intended as silica fertilizers per se.

Magnetite is a natural rock that has very high iron content, Magnetite has a black or brownish-red, and it has hardness about 6 on the Mohs hardness scale, it is one of two natural rocks in the world that is naturally magnetic [2]. Application of magnetic iron increased vegetative growth, yield and on pepper plant grow under saline irrigation conditions, [3]. Also, magnetic iron increased plant growth and leaf mineral content on cauliflower [2].

In citrus production, the rootstocks utilization is beneficial for solving the problems caused by soil, climates, pests and diseases, as well as achieving higher productivity and quality, earlier and later fruit productions. Therefore, citrus producers almost exclusively utilize rootstocks [4].

Citrus rootstocks differ in their degree of compatibility and adaptability to a scion under a set of climate and soil conditions. A number of studies have been conducted to find out suitable rootstocks for various commercial cultivars of citrus throughout the world [5-8].

The present study aimed to utilize some transplant growth stimulants as NPK mineral alternative and their impact on the growth of Washington navel orange transplants budded on two citrus rootstocks.

## 2. MATERIALS AND METHODS

This investigation was carried out on potted one-year old Washington navel orange transplants budded on two citrus rootstocks grown at nursery of Horticulture department, faculty of agriculture, Benha University, at Moshtohor, Touckh region Kalubia Governovate during two successive 2014 and 2015 experimental seasons. In this investigation Sour orange "*Citrus aurantium*" and

Volkamer lemon" *Citrus volkameriana* "were used.

## 2.1 Experiment Layout

In mid of March 2014 and 2015 seasons, 180 one-year-old uniform and healthy Washington navel orange transplanted budded on two citrus rootstocks species were planted individually in a plastic pot of 35 cm in diameter, filled with about (10 Kg of culture mixture media of sand and clay at equal proportions by volume).

Before the experiment had been conducted in the first season both physical and chemical analysis of the culture medium was done as shown in Table 1 according to the methods described by [9].

Irrigation was carried out twice weekly along the season by adding one litre of tap water for each pot. control transplants were fertilized with NPK mineral fertilizers (ammonium sulphate  $(NH_4)_2SO_4$ , Calcium phosphate  $Ca_3(PO_4)_2$  and potassium sulphate  $K_2SO_4$ ) at the rate of 12,6 and 6 g /pot/season respectively. Which were added at three equal doses in March, May and July during both seasons of study.

**The Transplant growth stimulants which were suggested to build up the skeleton of this investigation were as follows:**

### 1 – New humex (commercial name):

Contains (humic acid 15%, fulvic acid 5%, N 5%, P 5%, K 5% and mixture of Fe, Zn and Mn at the rate of 1, 0.5 and 0.5% respectively such substance was added every other week started from mid-April to mid-August as soil application at 5 m / L.

### 2 – Olivine contains (commercial name):

Contains ( $SiO_2$  27.64%,  $K_2O$  0.88%,  $Al_2O_3$  6.75%,  $Na_2O$  1.84%,  $Fe_2O_3$  7.21%,  $TiO_2$  0.45%,  $CaO$  16.53%,  $MnO_2$  0.03%,  $MgO$  1.66%,  $P_2O_5$  1.11%,  $SO_3$  10.47%,  $Cl$  0.46% and

Loi 24.97%) + amino acids such substance was added every other week started from mid-April to mid-August as soil application at 3 cm<sup>3</sup> / L.

### 3- Potassium silicate:

Was added every other week as foliar spray and soil application at 10 m<sup>3</sup>/L.

### 4- Magnetic Iron:

Was added once in mid of April for both seasons at 250 g / pot.

Those abovementioned growth stimulants were arranged to form eight treatments besides the control. Thus the investigated growth stimulants for Washington navel orange transplants budded on both citrus rootstocks were as follow:

- 1- (T1) Control: N, P, K Mineral fertilizer at the rate of 12,6,6 respectively.
- 2- (T2) New humex 5ml/L.
- 3- (T3) New humex (5ml/L) + potassium Silicate (10ml/L) as soil application and foliar spray, respectively.
- 4- (T4) New humex (5ml/L) + Magnetic iron 250g/ transplant.
- 5- (T5) New humex (5ml/L) + potassium silicate (10ml/L) as a foliar spray + Magnetic iron (250g per transplant).
- 6- (T6) Olivine (3 cm/L).
- 7- (T7) Olivine (3cm/L) + potassium silicate (10ml/L) as soil application and foliar Spray.
- 8- (T8) Olivine (3 mL/L) + Magnetic iron (250g/Transplant)
- 9- (T9) Olivine (3mL/L) + potassium silicate (10ml/L) added as a foliar spray + Magnetic iron (250g/transplant).

The methodology which has been followed in this investigation was determined as follows:

After the experiment had been terminated in early October of 2014 and 2015 the impact of the investigated treatments was evaluated through determining the following measurements:

**Table 1. Physical and chemical analysis of culture medium**

### A – Physical analysis

Partial distribution		
Total sand %	Silt %	Clay %
60.00	10.00	30

## B- Chemical analysis

Soluble cations meq/L				Soluble anions meq/L				CaCo3	PH	EC
Mg <sup>++</sup>	Ca <sup>++</sup>	K <sup>+</sup>	Na <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	CO <sub>3</sub> <sup>--</sup>	SO <sub>4</sub> <sup>--</sup>	Cl <sup>-</sup>			
2.13	8.77	0.50	7.80	3.01	-	9.19	6.70	1.50	8.70	1.01

**Vegetative growth measurements:** In this regard some growth measurements of Washington navel orange transplants budded on two citrus rootstocks (Sour orange and Volkamer lemon) were carried out:

- 1- Transplant height (cm)
- 2- Stem diameter (cm).at 10 above union zone.
- 3- Number of leaves per transplant.
- 4- Number of lateral shoots.

### 5- Leaf area:

Four mature leaves from the middle position of the stem/transplant were taken at the last week of September and then leaf area average was estimated according to the following equation [10].

Leaf Area (cm<sup>2</sup>) = 2/3 (leaf length x leaf width).

6- Total assimilation area/transplant = number of leaves per transplant x average leaf area.

7- Leaves fresh weight (g).

8- Leaves dry weight (g).

9- Root fresh weight (g).

10- Root dry weight (g).

11- Stem fresh weight (g).

12- Stem dry weight (g).

13- Total transplant fresh weight (g).

14- Total transplant dry weight (g).

15- Top dry weight.

16- Top/root ratio.

## 2.2 Statistical Analysis

The complete randomized block design with five replicates was employed for arranging the abovementioned investigated growth stimulants, whereas each replicate was represented by two transplants so, ninety Washington navel orange transplants budded on each of the two considered citrus rootstocks (Sour orange and Volkamer lemon) were required for investigating

the tested growth stimulants. Those transplants were classified according to their growth vigour into five categories each included 18 transplants. Nine investigated treatments were arranged within the transplants of each category at the rate of two transplants per every treatment.

All data obtained during both seasons were subjected to analysis of variance and significant differences among means were determined according to [11]. In addition, significant differences among means were differentiated according to the Duncan's, multiple ranges [12]. Where capital letters were used for distinguishing means of different treatments for each investigated characteristic.

## 3. RESULTS AND DISCUSSION

The following results and discussion will include specific and interaction effects of two factors i.e., a) citrus rootstocks type (Volkamer lemon & sour orange) and b) some growth-stimulants (New humex, potassium silicate, magnetic iron. and Olivine) on some growth measurements, therefore, obtained results in this study dealing with the abovementioned two aspects would be discussed separately during both seasons of study as follows:

### 3.1 Growth Measurements

In this study in transplants height, stem diameter, No. of lateral shoots, No. of leaves/transplant, average leaf area, total assimilation area, transplant leaves, stem, fresh weight of transplant and roots and leaves, stem and roots dry weight and top/ root ratio, were the investigated growth measurements of Washington Navel orange scion pertaining their response to the specific effect of the two investigated factors (Volkamer lemon & sour orange rootstocks) and growth stimulants as well as interactions effect of the combinations between the variables of both investigated factors.

### 3.2 Plant Height (cm)

Data obtained during 2014 and 2015 seasons concerning the specific and interaction effects of

the two investigated factors on transplant height and stem diameter (cm) of Washington Navel orange scion are tabulated in Table 2.

**A. Specific effect:** Regarding the specific effect of rootstock type on transplant height (cm) data presented in Table 2 revealed that (Volkamer lemon) rootstock was better than the other investigated rootstock (Sour orange) in this respect. Concerning the specific effect of the tested growth stimulants (New humex, Olivine, potassium silicate and magnetic iron at 250 g/pot as soil application) on Washington Navel orange transplant height, data tabulated in Table 2 revealed that, fertilizer with Olivine + potassium silicate + magnetic iron was superior in this respect where it was able to increase significantly Washington Navel orange transplant height as compared with the other different investigated treatments, during both 2014 and 2015 seasons of study. However, the lowest value in transplant height was noticed by Washington navel orange budded on Sour orange rootstock and treated with NPK mineral fertilizers during the two seasons of study.

**B. Interaction effect:** Concerning the interaction effect of the two investigated factors i.e., citrus rootstock type and some growth stimulants (New humex, Olivine, potassium silicate and magnetic iron) on height of Washington Navel orange transplants, data presented in Table 2 cleared that a considerable and statistically effect in both seasons of the study, was achieved were the highest height of Washington navel orange transplants was obtained with the combination between citrus Volkamer lemon and fertilization with Olivine + potassium silicate + magnetic iron. Furthermore, the addition of potassium silicate as foliar spray and soil application at 10 m/l (T7) or magnetic iron as soil application at 250 g/pot (T8) to the Olivin enhanced the Washington Navel orange transplants height budded on Volkamer lemon rootstock and came in the second rank in this respect. Whereas the lowest value in transplant height was noticed by Washington Navel orange transplants budded on Sour orange rootstock and was fertilized with (NPK) mineral fertilizer (as a control) during the two seasons of study. The obtained results are in confirmed with [13] and [14].

### 3.3 Stem Diameter (cm)

**A. Specific effect:** With respect to the specific effect of the citrus rootstock species, on stem diameter of Washington navel orange transplants

data obtained during both 2014 and 2015 seasons as shown in Table 2 revealed obviously that stem diameter was significantly influenced by the different investigated treatments. However, the highest value in stem diameter was recorded with Volkamer lemon rootstock, whereas the opposite trend was detected with Sour orange rootstock, which induced the lower value of stem diameter. Also, it could be noticed that differences in stem diameter were significant as the two citrus rootstock species fertilization treatments were compared to each other, such trend was true during the first and second seasons of study.

Referring the response to specific effect of some growth stimulant treatments on stem diameter of Washington Navel orange transplants, it was clear that the stem diameter responded significantly was the different growth stimulant treatments. Whereas, the T9 (Olivine + potassium silicate + magnetic iron) treatment was statistically the superior and more effective than the other investigated growth stimulant treatments. On the other hand, the opposite trend was true with the control treatment which exhibited significantly the least value of stem diameter. Moreover, differences were significant as all growth stimulant treatments were compared to each other in most cases during both 2014 and 2015 seasons of study.

**B- Interaction effect:** Considering the interaction effect of the different combinations between the two investigated factors (Volkamer lemon & Sour orange rootstocks, and some growth stimulants), data tabulated in Table 2 show clearly that the highest value of stem diameter was in closed relationship with those received Washington Navel orange transplants budded on Volkamer lemon rootstock Olivine + potassium silicate + magnetic iron. Furthermore, T7 and T8 occupied the second rank in this respect as both stimulated the stem diameter of Washington Navel orange transplants budded on Volkamer lemon rootstock during both seasons of study. On the other hand, the opposite trend was observed by those Washington Navel orange transplants which subjected to NPK mineral fertilizer and budded on Sour orange rootstock control treatment which exhibited statistically the least values of stem diameter throughout the first and second seasons of study. In addition, other combinations were in between with a tendency of variability in their effectiveness. Such trend was detected during both 2014 and 2015 seasons of study.

**Table 2. Plant height and stem diameter of Washington Navel orange transplants budded on two citrus rootstocks as influenced by specific, interaction effects of citrus rootstock cv., some growth stimulants and their combinations during 2014 and 2015 seasons**

Treatments	Plant height (cm)		Mean**	Stem diameter (cm)		Mean**
	Sour orange	Volkamer lemon		Sour orange	Volkamer lemon	
<b>Season 2014</b>						
T1. Control (mineral NPK)	73.33j	81.00hi	77.17G	1.13cd	0.87fg	1.00B
T2. New humex (5 ml/L)	78.00i	88.00efg	83.00F	1.07cd	0.87fg	0.97BC
T3. New humex + Potassium silicate (10 m/L)	79.33i	84.67gh	82.00F	1.00def	0.77g	0.88C
T4. New humex + Magnetic iron (250 g/L)	85.33fgh	90.33e	87.83E	1.00def	0.90efg	0.95BC
T5. New humex + Potassium silicate + Magnetic iron	88.67efg	92.00de	90.33DE	1.17bc	0.87fg	1.02B
T6. Olivine (3 m/L)	89.67ef	95.33cd	92.50D	1.17bc	0.80g	0.98B
T7. Olivine + Potassium silicate	92.00de	100.67b	96.33C	1.27ab	0.77g	1.02B
T8. Olivine + Magnetic iron	99.00bc	103.33b	101.2B	1.27ab	1.00def	1.13A
T9. Olivine + Potassium silicate + Magnetic iron	101.33b	109.67a	105.5A	1.30a	1.03de	1.17A
Mean *	87.41B	93.89A		1.15A	0.87B	
<b>Season 2015</b>						
T1. Control (mineral NPK)	68.33k	78.00hi	73.17I	0.97cdef	0.87ef	0.92D
T2. New humex (5 ml/L)	73.33j	80.33ghi	76.83H	1.03cde	0.90ef	0.97CD
T3. New humex + Potassium silicate (10 m/L)	77.00i	83.00fg	80.00G	1.13abc	0.97cdef	1.05BC
T4. New humex + Magnetic iron (250 g/L)	81.00gh	89.17de	85.08F	1.07bcd	1.00cde	1.03BC
T5. New humex + Potassium silicate + Magnetic iron	86.00ef	88.83de	87.42E	1.20ab	0.97cdef	1.08B
T6. Olivine (3 m/L)	88.67de	90.83d	89.75D	1.10bc	0.83f	0.97CD
T7. Olivine + Potassium silicate	89.00de	96.10c	92.55C	1.20ab	0.93def	1.07BC
T8. Olivine + Magnetic iron	95.33c	100.03b	97.68B	1.03cde	1.03cde	1.03BC
T9. Olivine + Potassium silicate + Magnetic iron	100.00b	104.67a	102.3A	1.27a	1.10bc	1.18A
Mean*	84.3B	90.11A		1.11A	0.96B	

\*, \*\* refer to specific effect of citrus rootstock species and some growth stimulants, respectively whereas means within each column followed by the same letter/s didn't significantly differ at 5 % level

These results are in agreement with [15], [16], on citrus species and [14] on banana plants.

### 3.4 Number of Lateral Shoots and No. of Leaves/Transplant

**A- Specific effect:** With regard, the specific effect of citrus rootstocks type (Volkamer lemon & Sour orange), data presented in Table 3 revealed clearly that the No. of lateral shoots and No. of leaves/ Washington Navel orange transplant responded specifically to the citrus rootstock species throughout the first and second seasons of study. However, the greatest No. of lateral shoots and No. of leaves/ Washington Navel orange transplant were significantly

exhibited Volkamer lemon rootstock. On the other hand, the opposite trend was detected with the other citrus rootstock i.e., (Sour orange) rootstock which induced significantly the lower No. of lateral shoots and No. of leaves/ Washington Navel orange transplant. Such trend was true during both 2014 and 2015 seasons.

Considering the specific effect of some investigated growth stimulants under study i.e., (New humex, potassium silicate, magnetic iron. and Olivine) added as drench soil, it is quite evident from the tabulated data in the same Table that all tested growth stimulants treatments surpassed statistically the control transplants. Moreover, the T9 (Olivine + potassium silicate +

magnetic iron) was more effective than any other growth stimulants treatments, which induced statistically the greatest value in No. of lateral shoots and No. of leaves/ Washington Navel orange transplant. Furthermore, Olivine at 3 ml/l as foliar application combined with either potassium silicate at 10 ml/l (T7) or magnetic iron at 250 g/ pot as soil application greatly enhanced the two investigated parameters (T8) during both seasons of study. Meanwhile, New humex either alone or combined with the other growth stimulants was less effective in this respect. In addition to that, the control transplants were statistically the inferior one in this respect as exhibited the least value in No. of lateral shoots and No. of leaves/ Washington Navel orange transplant during the two seasons of study. Such trend was true during both 2014 and 2015 seasons.

**B- Interaction effect:** Referring the interaction effect of the different combination treatments between the various variables of both investigated factors on the No. of lateral shoots and No. of leaves/ Washington Navel orange transplant, data represented in Table 3 displayed obviously that the specific effect of each factor i.e., (Volkamer lemon & Sour orange and growth stimulants) was directly reflected in their combinations during the first and second seasons of study. On the other side, the combinations between the (Volkamer lemon rootstock x Olivine + potassium silicate + magnetic iron) (T9) statistically the greatest value in No. of lateral shoots and No. of leaves/ Washington Navel orange transplant. Since T8 (Olivine + magnetic iron) ranked statistically the second. On the other way around, the reverse was true with Washington Navel orange transplants budded on Sour orange and either fertilized with NPK mineral fertilizer (control) or received New humex or 3 ml/l as soil application (T2) as both treatments reflected the least values of both investigated parameters during both seasons of study.

The obtained data regarding the response of No. of lateral shoots and No. of leaves/ Washington Navel orange transplant to the different citrus rootstocks type and some growth stimulants are in general agreement with those found by [17], [18] and [19].

### 3.5 Average Leaf Area (cm) and Total Assimilation Area Transplant (cm<sup>2</sup>)

**A- Specific effect:** Considering the average leaf area and total assimilation area of Washington

Navel orange transplants in response to the specific effect of the (Sour orange and Volkamer lemon), data represented in Table 4 displayed clearly that this growth measurement (average leaf area and total assimilation area) transplant followed typically the same trend during both seasons of study. However, the higher values of such parameters i.e., average leaf area and total assimilation area were significantly in concomitant to the (Volkamer lemon) rootstock. Meanwhile, the lower was found with Washington Navel orange transplants Sour orange rootstock.

Regarding the specific effect of some investigated growth stimulants in this study i.e., New humex, potassium silicate, magnetic iron, and Olivine, data tabulated in the same Table showed obviously that the average leaf area and total assimilation area transplants followed the same trend during both 2014 and 2015 seasons. However, all the growth stimulants tested treatments increased significantly the average leaf area and total assimilation leaf area as compared to the control transplants in the two seasons of study. In addition, it could be observed that the highest values of average leaf area (20.52 & 20.42 cm<sup>2</sup>) and (20.23 & 20.05 cm<sup>2</sup>) were obtained from T7 (Olivine + potassium silicate) and T9 (Olivine + potassium silicate + magnetic iron) treatments in both 2014 and 2015 seasons, respectively followed by T6 and T8 as both treatments came in the second rank in this respect, while T9 was the superior one in relation to total assimilation area followed by T7 (Olivine + potassium silicate). On the other hand, the opposite trend was detected with the control transplants which fertilized with NPK mineral fertilizer gave the as those lowest values of average leaf area and total assimilation leaf area during the two seasons of study.

**B- Interaction effect:** With regard to the interaction effect of the different combinations between the two variables of the investigated factors i.e., Sour orange and Volkamer lemon and some growth stimulants on average leaf area and total assimilation area, data in Table 4 revealed that the specific effect of each studied factor was directly reflected on their interaction effect, whereas the highest values of average leaf area and total assimilation leaf area were inclosed relationship with those transplants of Washington Navel orange budded on Volkamer lemon combined with both T7 (Olivine + potassium silicate) and T9 (Olivine + potassium silicate + magnetic iron) in case of average leaf area parameter, while the highest total

assimilation area/transplants was deselected with those Washington Navel orange transplants budded on Volkamer lemon and treated with Olivine + potassium silicate + magnetic iron) during both seasons of study. In other words, both T7 (Olivine + potassium silicate) and T9 (Olivine + potassium silicate + magnetic iron) combinations treatments exhibited statistically the largest leaf area of two citrus rootstocks, respectively. Differences between the abovementioned two combinations treatments were significant during the first and second seasons of study. On the other hand, the

opposite trend was detected with both (Sour orange x control) treatment which they resulted in statistically the least values of average leaf area and total assimilation leaf area were observed with Washington Navel orange transplants budded Sour orange rootstock and received NPK as mineral fertilizers (control), during both seasons of study. In addition, other combinations were in between with a tendency of variability in their effectiveness.

As similar results were also obtained by [20], [17] and [18].

**Table 3. No. of lateral shoot and no. of leaves/transplant of Washington Navel orange transplants budded on two citrus rootstocks as influenced by specific, interaction effects of citrus rootstock cv., some growth stimulants and their combinations during 2014 and 2015 seasons**

Treatments	No. of lateral shoots		Mean**	No. of leaves/transplants		Mean**
	Sour orange	Volkamer lemon		Sour orange	Volkamer lemon	
<b>Season 2014</b>						
T1. Control (mineral NPK)	3.33k	6.67gh	5.00H	41.67j	60.33g	51.00G
T2. New humex (5 ml/L)	4.33jk	7.67fg	6.00G	50.00i	68.00de	59.00F
T3. New humex + Potassium silicate (10 m/L)	4.67jk	9.00ef	6.83F	57.33gh	73.33cd	65.33E
T4. New humex + Magnetic iron (250 g/L)	5.00ij	10.33e	7.67E	49.67i	76.67c	63.17R
T5. New humex + Potassium silicate + Magnetic iron	5.67hij	11.00d	8.33D	62.00fg	86.00b	74.00C
T6. Olivine (3 m/L)	6.33ghi	13.00c	9.67C	54.67hi	87.00b	70.83D
T7. Olivine + Potassium silicate	7.67fg	13.67bc	10.67B	66.33ef	88.33b	77.33B
T8. Olivine + Magnetic iron	6.67gh	15.00ab	10.83B	69.00de	90.00b	79.50B
T9. Olivine + Potassium silicate + Magnetic iron	7.67fg	16.33a	12.00A	77.33c	101a	89.17A
Mean*	5.70B	11.41A		58.67B	81.19A	
<b>Season 2015</b>						
T1. Control (mineral NPK)	4.33h	5.67fgh	5.00G	43.00j	56.67gh	49.83F
T2. New humex (5 ml/L)	5.33gh	7.00efgh	6.17F	50.33ij	59.33fg	54.83E
T3. New humex + Potassium silicate (10 m/L)	5.67fgh	8.33def	7.00DE	55.67gh	69.33e	62.50D
T4. New humex + Magnetic iron (250 g/L)	4.67h	8.67de	6.67EF	48.33i	74.67d	61.50D
T5. New humex + Potassium silicate + Magnetic iron	6.33efgh	10.00cd	8.17C	59.00fg	82.67c	70.83C
T6. Olivine (3 m/L)	7.00efgh	8.00defg	7.50D	53.67hi	84.33bc	69.00C
T7. Olivine + Potassium silicate	8.33def	12.67bc	10.50B	62.67f	87.67b	75.17B
T8. Olivine + Magnetic iron	7.67defg	14.00ab	10.83B	68.00e	85.00bc	76.50B
T9. Olivine + Potassium silicate + Magnetic iron	8.33def	15.67a	12.00A	74.67d	98.67a	86.67A
Mean*	6.41B	10.00A		57.26B	77.59A	

\*, \*\* refer to specific effect of citrus rootstock species and some growth stimulants, respectively whereas means within each column followed by the same letter/s didn't significantly differ at 5 % level



**Table 4. Average leaf area and total assimilation area of Washington Navel orange transplants budded on two citrus rootstocks as influenced by specific, interaction effects of citrus rootstock cv., some growth stimulants and their combinations during 2014 and 2015 seasons**

Treatments	Average leaf area (cm <sup>2</sup> )		Mean**	Total assimilation area (cm <sup>2</sup> )		Mean**
	Sour orange	Volkamer lemon		Sour orange	Volkamer lemon	
<b>Season 2014</b>						
T1. Control (mineral NPK)	14.33k	18.07ghi	16.20E	597.33j	1089.30f	843.3l
T2. New humex (5 ml/L)	14.67k	18.83fg	16.75D	733.33i	1280.33e	1007.0H
T3. New humex + Potassium silicate (10 m/L)	16.23j	18.50fgh	17.37C	929.47gh	1356.17de	1143.0F
T4. New humex + Magnetic iron (250 g/L)	16.50j	18.67fgh	17.58C	819.33hi	1431.17d	1125.0G
T5. New humex + Potassium silicate + Magnetic iron	17.50i	21.00bc	19.25B	1086.50f	1807.17c	1447.0D
T6. Olivine (3 m/L)	17.83hi	21.17ab	19.50B	974.00fg	1843.17bc	1409.0E
T7. Olivine + Potassium silicate	19.03efg	22.00a	20.52A	1261.87e	1945.00b	1603.0B
T8. Olivine + Magnetic iron	18.53fgh	20.03cd	19.28B	1279.47e	1803.33c	1541.0C
T9. Olivine + Potassium silicate + Magnetic iron	19.17def	21.67ab	20.42A	1482.50d	2187.33a	1835.0A
Mean*	17.09B	19.99A		1018.20B	1638.11A	
<b>Season 2015</b>						
T1. Control (mineral NPK)	14.03k	17.83efg	15.93F	603.83m	1010.92ij	807.4l
T2. New humex (5 ml/L)	15.17j	18.43def	16.80E	764.00l	1093.35hi	928.7H
T3. New humex + Potassium silicate (10 m/L)	15.63ij	18.42def	17.02DE	869.77kl	1277.05ef	1073.0G
T4. New humex + Magnetic iron (250 g/L)	16.20hi	18.53de	17.37D	782.90l	1383.97de	1083.0F
T5. New humex + Potassium silicate + Magnetic iron	17.02gh	20.40c	18.71C	1005.58ij	1687.93c	1347.0E
T6. Olivine (3 m/L)	17.57fg	21.22abc	19.39B	942.03jk	1789.65bc	1366.0D
T7. Olivine + Potassium silicate	18.30def	21.80a	20.05A	1146.07gh	1912.90b	1529.0B
T8. Olivine + Magnetic iron	18.03ef	20.60bc	19.32B	1227.07fg	1751.73c	1489.0C
T9. Olivine + Potassium silicate + Magnetic iron	19.03d	21.43ab	20.23A	1420.83d	2115.13a	1768.0A
Mean*	16.78B	19.85A		973.56B	1558.07A	

\*, \*\* refer to specific effect of citrus rootstock species and some growth stimulants, respectively whereas means within each column followed by the same letter/s didn't significantly differ at 5 % level

### 3.6 Leaves Fresh and Dry Weights (g)

#### 3.6.1 Leaves fresh weights

**A. Specific effect:** Results the dealing with the specific effect of the two factors involved in this

study i.e., rootstock type some growth stimulants on leaves fresh weight (gm) of the Washington navel cultivar, data obtained in Table 5 show that Volkamer lemon (66.72 and 64.06) was better than Sour orange citrus rootstock in this respect. With respect to growth stimulants on leaves fresh

weight (gm), data tabulated in Table 5 cleared that, leaves fresh weight was statistically increased when the Washington Navel orange transplants were fertilized with T9 (Olivine + potassium silicate + magnetic iron) followed by T8 (Olivine + magnetic iron) during 2014 and 2015 seasons of study. On the other hand, the least value of leaves fresh weight of Washington Navel orange transplants was recorded when the transplants received NPK mineral fertilizer (control).

**B. Interaction effect:** Dealing with the interaction effect of the two investigated factor i.e., rootstock type and some investigated stimulants (New humex, potassium silicate, Magnetic iron. and Olivine) on leaves fresh weight of Washington Navel orange transplants, data presented in Tables Table 5 cleared that the maximum improvement in leaves fresh weight parameter was noticed with such combination of Volkamer lemon rootstock fertilized with T9 (Olivine + potassium silicate + magnetic iron.) and T8 (Olivine + magnetic iron). On the other hand, the highest decrease in leaves fresh weight of Washington Navel orange were obtained when sour orange was used as citrus rootstock and the transplants were fertilized with NPK mineral fertilizer the (control) in both seasons of study.

### **3.6.2 Leaves dry weight (mg)**

Dealing with the specific of the two factors involved in this study i.e. rootstock type "Sour orange and Volkamer lemon" and some growth stimulants (New humex, potassium silicate, magnetic iron. and Olivine) on leaves dry weight (g) of the Washington Navel orange, data obtained in Table 5 revealed that non-significant differences between the two rootstocks but Sour orange rootstock had an increase of leaves dry weight (g) than the other investigated rootstock (Volkamer lemon), in the first season.

Regarding the specific effect of tested growth stimulants (New humex, potassium silicate, magnetic iron. and Olivine) on leaves dry weight Washington Navel orange transplants, data presented in Table 5 revealed that, the treatment T9 (Olivine + potassium silicate + magnetic iron) caused the highest significantly increment followed by T8 (Olivine + magnetic iron), T7 (Olivine + potassium silicate) and T5 (new humex + potassium silicate + magnetic iron) in descending order, during both seasons of study. The lowest value in this respect was detected

with that Washington Navel orange transplants fertilized with NPK mineral fertilizer (control). The new humex stimulant was less effective in improving such parameter than Olivine stimulant during both 2014 and 2015 seasons of study.

**Interaction effect:** Concerning the interaction between rootstock type (Volkamer lemon and Sour orange) and different growth stimulants (New humex, potassium silicate, magnetic iron and Olivine) on leaves dry weight of the Washington Navel orange transplants budded on (Sour orange and Volkamer lemon rootstocks), data are recorded in Table 5 it is quite clear from data that, the best result regarding leaves dry weight was obtained with two citrus rootstock (Sour orange and Volkamer lemon) combined with T9 (Olivine + potassium silicate + magnetic iron.) and T8 (Olivine + Magnetic iron), however, the lowest value was recorded with those Washington Navel orange transplants budded on sour orange rootstock and fertilized with NPK mineral fertilizer (control) treatment during both 2014 and 2015 seasons of study.

These results are in harmony with those obtained by [17] and [21].

### **3.7 Stem Fresh and Dry Weights**

**A. Specific effect:** Results the in Table 6 dealing with the specific effect of the two factors involved in this study i.e., two citrus rootstock type (Sour orange and Volkamer lemon) and some growth stimulants and their interaction on stem fresh and dry weights Washington Navel orange transplants, data obtained in Table 6 indicated that, Volkamer lemon rootstock surpassed the other investigated rootstock in fresh weight but the opposite was true when Sour orange dry weight was concerned. With respect to the impact of growth stimulants on stem fresh and dry weights, data tabulated in Table 6 revealed that stem fresh and dry weights Washington Navel orange transplants were statistically increased when compared with control. The highest values of both investigated parameters were detected with T9 (Olivine + potassium silicate + magnetic iron) followed in descending order by T8 (Olivine + magnetic iron); T7 (Olivine + potassium silicate added as foliar spray and soil application) and T6 (Olivine at 3 ml/l alone). The new humex stimulant was less effective in this respect when was added either alone (T2) or combined with the potassium silicate or magnetic iron (T3, T4 and T5). On the contrast, the parameters were recorded with Washington

Navel orange transplants which fertilized with NPK mineral fertilizers (control) during both seasons of study.

**B. Interaction effect:** Dealing with the interaction effect of the two investigated factor i.e., rootstock type and some growth substances (New humex, potassium silicate, magnetic iron and Olivine) on stem fresh and dry weights of Washington Navel orange cultivar, data presented in Table 6 cleared that the maximum improvement in stem fresh weight parameter was noticed with such combination of Volkamer lemon rootstock fertilized with T9 (Olivine + potassium silicate + magnetic iron) but best stem

dry weight of Washington Navel orange transplants was obtained when the scion was budded on sour orange rootstock and stimulated with T9 and T7 (Olivine + magnetic iron).

The minimum stem fresh weight of Washington Navel orange transplants was obtained with those transplants fertilized with NPK mineral fertilizer and budded on sour orange rootstock, while in case of stem dry weight the least values were observed when either of the two investigated rootstocks (Sour orange or Volkamer lemon) was used as rootstock and inorganic fertilizer (NPK-mineral fertilizer-control), during both seasons of study.

**Table 5. Leaves fresh and dry weights of Washington Navel orange transplants budded on two citrus rootstocks as influenced by specific, interaction effects of citrus rootstock cv., some growth stimulants and their combinations during 2014 and 2015 seasons**

Treatments	Leaves fresh weight (g)		Mean**	Leaves dry weight (g)		Mean**
	Sour orange	Volkamer lemon		Sour orange	Volkamer lemon	
<b>Season 2014</b>						
T1. Control (mineral NPK)	45.00k	52.47ij	48.73G	25.00i	29.27h	27.13H
T2. New humex (5 ml/L)	54.67hi	61.73efg	58.20E	32.33efgh	30.98gh	31.66F
T3. New humex + Potassium silicate (10 m/L)	56.33hi	64.90de	60.62D	32.27fgh	34.42efg	33.34E
T4. New humex + Magnetic iron (250 g/L)	54.33hi	61.58efg	57.96E	45.89a	33.69efg	39.79C
T5. New humex + Potassium silicate + Magnetic iron	62.67def	66.83d	64.75C	36.13def	34.39eg	35.26D
T6. Olivine (3 m/L)	48.33jk	57.42gh	52.88F	29.13h	29.82h	29.48G
T7. Olivine + Potassium silicate	58.67fgh	72.63c	65.65C	40.12bc	39.25cd	39.68C
T8. Olivine + Magnetic iron	72.33c	78.77b	75.55B	44.12a	43.32ab	43.72B
T9. Olivine + Potassium silicate + Magnetic iron	75.00bc	84.16a	79.58A	45.71a	46.36a	46.03A
Mean*	58.59B	66.72A		36.75A	35.72A	
<b>Season 2015</b>						
T1. Control (mineral NPK)	42.63j	51.32i	46.98G	23.46j	27.49ghi	25.47F
T2. New humex (5 ml/L)	52.33hi	58.95efg	55.64E	29.87fgh	28.76ghi	29.32E
T3. New humex + Potassium silicate (10 m/L)	55.01fghi	61.51de	58.26D	29.53fgh	31.08ef	30.31E
T4. New humex + Magnetic iron (250 g/L)	52.85hi	58.82efg	55.83E	42.48a	29.77fgh	36.13C
T5. New humex + Potassium silicate + Magnetic iron	59.22ef	63.02de	61.12C	33.05de	30.75efg	31.90D
T6. Olivine (3 m/L)	46.31j	55.92fgh	51.12F	27.27hi	25.64ij	26.45F
T7. Olivine + Potassium silicate	54.66ghi	69.25bc	61.96C	36.86bc	36.06cd	36.46C
T8. Olivine + Magnetic iron	65.73cd	76.80a	71.26B	41.09a	39.77ab	40.43B
T9. Olivine + Potassium silicate + Magnetic iron	71.04b	80.94a	75.99A	42.50a	42.92a	42.71A
Mean*	55.53B	64.06A		34.01A	32.47B	

\*, \*\* refer to specific effect of citrus rootstock species and some growth stimulants, respectively whereas means within each column followed by the same letter/s didn't significantly differ at 5 % level

**Table 6. Stem fresh and dry weights of Washington Navel orange transplants budded on two citrus rootstocks as influenced by specific, interaction effects of citrus rootstock cv., some growth stimulants and their combinations during 2014 and 2015 seasons**

Treatments	Stem fresh weight (g)		Mean**	Stem dry weight (g)		Mean**
	Sour orange	Volkamer lemon		Sour orange	Volkamer lemon	
<b>Season 2014</b>						
T1. Control (mineral NPK)	76.23j	80.47hi	78.35G	51.13k	51.39jk	51.26G
T2. New humex (5 ml/L)	79.49i	84.57gh	82.03F	53.08ij	52.44ijk	52.76F
T3. New humex + Potassium silicate (10 m/L)	79.77i	84.17gh	81.97F	54.19hi	51.81jk	53.00F
T4. New humex + Magnetic iron (250 g/L)	86.51fg	89.70ef	88.10E	59.13ef	54.23hi	56.68E
T5. New humex + Potassium silicate + Magnetic iron	90.01ef	93.64de	91.83D	60.00cd	55.28h	57.64D
T6. Olivine (3 m/L)	91.08de	94.49d	92.79D	58.99ef	55.87gh	57.43D
T7. Olivine + Potassium silicate	91.52de	100.41bc	95.97C	60.61bc	57.33fg	58.97C
T8. Olivine + Magnetic iron	99.14c	103.49b	101.3B	65.38a	59.40de	62.39B
T9. Olivine + Potassium silicate + Magnetic iron	101.56bc	109.10a	105.3A	64.29a	62.16b	63.23A
Mean*	88.37B	93.34A		58.53A	55.55B	
<b>Season 2015</b>						
T1. Control (mineral NPK)	71.95k	74.22j	73.08I	48.71j	48.98ij	48.84G
T2. New humex (5 ml/L)	75.88i	76.58hij	76.23H	49.49hij	50.02ghij	49.76F
T3. New humex + Potassium silicate (10 m/L)	77.33hi	79.55h	78.44G	50.70fgh	49.60hij	50.15F
T4. New humex + Magnetic iron (250 g/L)	84.10g	84.72fg	84.41F	56.49d	50.34ghi	53.41E
T5. New humex + Potassium silicate + Magnetic iron	86.43efg	87.02efg	86.73E	58.14c	51.29efg	54.72D
T6. Olivine (3 m/L)	87.63def	90.24d	88.94D	58.25bc	51.78ef	55.01D
T7. Olivine + Potassium silicate	88.87de	94.29c	91.58C	58.90bc	52.49e	55.70C
T8. Olivine + Magnetic iron	94.87c	99.35ab	97.11B	61.61a	55.95d	58.78B
T9. Olivine + Potassium silicate + Magnetic iron	98.97b	102.10a	100.5A	61.36a	59.82b	60.59A
Mean*	85.11B	87.56A		55.96A	52.25B	

\*, \*\* refer to specific effect of citrus rootstock species and some growth stimulants, respectively whereas means within each column followed by the same letter/s didn't significantly differ at 5 % level

These results are in agreement with those obtained by (17) and (21).

dry weights were (60.42 & 55.92 gm) and (37.32 & 33.52 gm) during both seasons, respectively.

### 3.8 Roots Fresh and Dry Weights (gm)

**A- Specific effect:** With respect to the specific effect of the two citrus rootstock types (Sour orange and Volkamer lemon), on root fresh and dry weights obtained data during both 2014 and 2015 seasons as shown in Table 7 displayed obviously that both roots fresh and dry weights (gm) were significantly influenced. Both root fresh and dry weights (gm) (67.07 & 63.07 gm) and (45.06 & 39.59 gm) were better with "Volkamer lemon rootstock" than those with sour orange rootstock as the values of root fresh and

Referring the roots fresh and dry weights of Washington Navel orange as affected by the specific effect of the tested growth stimulants. Table 7 show clearly that both growth measurements (roots fresh and dry weights) followed topically the same trend during the two seasons of study. Whereas, the highest value of both characteristics was significantly in concomitant to T9. Olivine + potassium silicate + magnetic iron) followed by T5 (New humex + magnetic iron (250g/L) and T8 (Olivine + Magnetic iron.) in descending order during both seasons of study. On the other hand, least

values of both investigated parameters were recorded with those transplants fertilized with NPK mineral fertilizer (control).

**B- Interaction effect:** Regarding the interaction effect of the different combinations treatments between the variables of each investigated factor obtained data in Table 7 indicated clearly that the highest values of root fresh and dry weights were in closed relationship with those transplants budded on "Volkamer lemon" combined with T9 (Olivine + potassium silicate + magnetic iron) or T5 (New humex + potassium silicate + magnetic

iron) followed by T4 (New humex + magnetic iron (250 g/L) or T8 (Olivine + magnetic iron) during the two seasons of study, respectively. On the other hand, Washington Navel orange transplants which received NPK as mineral fertilizer and budded on sour orange rootstock reflected the minimum values of both investigated parameters during both seasons of study.

The present results are in a general agreement with those mentioned by some investigators [17], [20] and [21].

**Table 7. Roots fresh and dry weights of Washington Navel orange transplants budded on two citrus rootstocks as influenced by specific, interaction effects of citrus rootstock cv., some growth stimulants and their combinations during 2014 and 2015 seasons**

Treatments	Roots fresh weight (g)		Mean**	Roots dry weight (g)		Mean**
	Sour orange	Volkamer lemon		Sour orange	Volkamer lemon	
<b>Season 2014</b>						
T1. Control (mineral NPK)	43.53j	51.42i	47.47H	26.53i	34.42g	30.48H
T2. New humex (5 ml/L)	56.10h	64.63e	60.37G	31.58h	41.72e	36.65G
T3. New humex + Potassium silicate (10 m/L)	58.33fg	66.65de	62.49E	34.39g	43.90cd	39.15R
T4. New humex + Magnetic iron (250 g/L)	64.20e	71.38ab	67.79C	41.30e	47.98b	44.64C
T5. New humex + Potassium silicate + Magnetic iron	66.37de	74.03a	70.20B	42.09de	50.88a	46.48B
T6. Olivine (3 m/L)	57.11gh	64.55e	60.83F	33.50gh	43.24cde	38.37F
T7. Olivine + Potassium silicate	60.48f	67.67cd	64.08D	37.38f	44.42c	40.90D
T8. Olivine + Magnetic iron	65.55de	69.71bc	67.63C	41.68e	47.07b	44.37C
T9. Olivine + Potassium silicate + Magnetic iron	72.10ab	73.60a	72.85A	47.41b	51.93a	49.67A
Mean*	60.42B	67.07A		37.32B	45.06A	
<b>Season 2015</b>						
T1. Control (mineral NPK)	41.56i	48.74h	45.15G	23.61h	31.93c-h	27.77H
T2. New humex (5 ml/L)	53.65g	62.25de	57.95E	27.71gh	38.22a-f	32.96G
T3. New humex + Potassium silicate (10 m/L)	55.43g	63.12bcd	59.28D	31.30d-h	40.60a-c	35.95E
T4. New humex + Magnetic iron (250 g/L)	59.19f	66.03b	62.61C	38.19a-f	30.72e-h	34.45F
T5. New humex + Potassium silicate + Magnetic iron	62.39de	69.65a	66.02B	37.99a-f	46.34a	42.17B
T6. Olivine (3 m/L)	53.48g	59.71ef	56.60F	30.44fgh	39.73a-e	35.09F
T7. Olivine + Potassium silicate	54.80g	63.05cd	58.93D	33.77b-g	40.07a-d	36.92D
T8. Olivine + Magnetic iron	59.45ef	65.50bc	62.47C	36.71b-g	42.48ab	39.60C
T9. Olivine + Potassium silicate + Magnetic iron	63.31bcd	69.57a	66.44A	41.95ab	46.20a	44.07A
Mean*	55.92B	63.07A		33.52B	39.59A	

\*, \*\* refer to specific effect of citrus rootstock species and some growth stimulants, respectively whereas means within each column followed by the same letter/s didn't significantly differ at 5 % level

### 3.9 Total Transplant Fresh and Dry Weights (gm)

Regarding the specific effect of the two investigated factors i.e., citrus rootstock type (Sour orange and Volkamer lemon) and some growth stimulants on total fresh and dry weights (gm) of Washington navel orange, data presented in Table 8 indicated that Volkamer lemon rootstock improved the two investigated parameters (total fresh and dry weights and if was better than the other investigated rootstock (Sour orange rootstock) during 2014 and 2015 seasons of study.

Concerning the specific effect of studied growth stimulants (New humex, potassium silicate, magnetic iron and Olivine) on total fresh and dry weights (gm), data presented in Table 9 cleared that, the two investigated parameters took the similar trend, where their values were significantly maximized when the transplants were fertilized with T9 (Olivine + potassium silicate + magnetic iron) followed in descending order by T8 (Olivine + magnetic iron); T7 (Olivine + potassium silicate) and T4 (New humex + magnetic iron) during both seasons of study.

**A. Interaction effect:** Referring the interaction between rootstock type (Sour orange and Volkamer lemon citrus rootstocks) and some growth stimulants (New humex, potassium silicate, magnetic iron and Olivine) on total fresh and dry weights (gm), data are recorded in Table 8 it is quite clear from data that, the best result was obtained with Volkamer lemon citrus rootstock combined with treatment T9 (Olivine + potassium silicate + magnetic iron) followed by T8 (Olivine + magnetic ion). On the other hand, the least values of both parameters were detected with Washington navel orange transplants, fertilized with NPK mineral fertilizer (control) and budded on sour orange rootstock. The other interactions were in between during 2014 and 2015 seasons of study.

The present result is in harmony with those found by [17] and [21].

### 3.10 Top Dry Weights (gm)

Data obtained during 2014 and 2015 seasons concerning the specific and the interaction effects of two investigated factors i.e. citrus rootstock type (Sour orange and Volkamer lemon) and some growth stimulants (New humex, potassium silicate, magnetic iron. and Olivine), on top dry weight (gm) of Washington

Navel orange transplants are presented in Table 9.

**A. Specific effect:** Concerning to the specific effect of rootstocks type (Sour orange and Volkamer lemon) on top dry weight (gm) of Washington Navel orange transplants, data presented in Table 9 revealed that, (sour orange rootstock) surpassed the other investigated rootstock (Volkamer lemon) regarding the investigated parameters it significantly improved top dry weight of Washington Navel orange transplants.

Regarding the specific effect of some growth stimulants on top dry weights (gm) of Washington Navel orange budded on "Sour orange and Volkamer lemon" rootstocks, data tabulated in Table 9 show that, all studied growth stimulants significantly improved top dry weight of Washington Navel orange transplants fertilized with NPK in the form of mineral fertilizer (control).

Meanwhile, there were some investigated growth stimulants surpassed the other investigated ones whereas the transplants which treated with T9 (Olivine + potassium silicate + magnetic iron) highly responded and achieved the highest value of top dry weight, followed in descending order by T8 (Olivine + magnetic iron) and T7 (Olivine + potassium silicate) during both seasons of study.

On the contrast, the least values of top dry weight of Washington Navel orange transplants was recorded with those transplants fertilized with inorganic NPK fertilizer (control).

**B. Interaction effect:** Regarding to the interaction effect of the two investigated factors i.e. the two citrus rootstocks and some growth stimulants on top dry weight (gm) of Washington Navel orange transplants, data presented in Table 9 revealed considerable and statistically effect in both seasons of study, whereas the highest value of top dry weight (gm) of Washington Navel orange budded either on Volkamer lemon or sour orange rootstock and fertilized with treatment T9 (Olivine + potassium silicate + magnetic iron.), however, the lowest value of top dry weights (gm) was noticed with those Washington Navel orange transplants budded on either Sour orange rootstock and fertilized with NPK chemical fertilizer during both seasons of study.

The present result is in harmony with those found by [17] and [21].

**Table 8. Total plant fresh and dry weights of Washington Navel orange transplants budded on two citrus rootstocks as influenced by specific, interaction effects of citrus rootstock cv., some growth stimulants and their combinations during 2014 and 2015 seasons**

Treatments	Total plant fresh weight (g)		Mean**	Total plant dry weight (g)		Mean**
	Sour orange	Volkamer lemon		Sour orange	Volkamer lemon	
<b>Season 2014</b>						
T1. Control (mineral NPK)	164.76i	184.36h	174.56G	102.66i	115.08h	108.87F
T2. New humex (5 ml/L)	190.16gh	210.93ef	200.55F	116.99gh	125.14ef	121.07E
T3. New humex + Potassium silicate (10 m/L)	194.63g	215.72de	205.10E	120.85fg	130.13e	125.49D
T4. New humex + Magnetic iron (250 g/L)	205.04f	222.66d	213.82D	146.32bc	135.90d	141.11C
T5. New humex + Potassium silicate + Magnetic iron	219.05d	234.50c	226.78C	138.22d	140.55d	139.39C
T6. Olivine (3 m/L)	196.52g	216.46de	206.49E	121.62fg	128.93e	125.28D
T7. Olivine + Potassium silicate	210.67ef	240.71c	225.69C	138.11d	141.00cd	139.56C
T8. Olivine + Magnetic iron	237.02c	251.97b	244.50B	151.18b	149.79b	150.49B
T9. Olivine + Potassium silicate + Magnetic iron	248.66b	266.86a	257.76A	157.41a	160.45a	158.93A
Mean*	207.37B	227.13A		132.60B	136.33A	
<b>Season 2015</b>						
T1. Control (mineral NPK)	156.14l	174.28k	167.71G	95.78i	108.40gh	102.09G
T2. New humex (5 ml/L)	181.86j	197.78fg	189.82F	107.07h	117.00f-h	112.04F
T3. New humex + Potassium silicate (10 m/L)	187.77hi	204.18ef	195.98E	111.53f-h	121.28ef	116.41E
T4. New humex + Magnetic iron (250 g/L)	196.14gh	209.57e	202.86D	137.16b-d	110.83gh	124.00D
T5. New humex + Potassium silicate + Magnetic iron	208.04e	219.69d	213.87C	129.18c-e	128.38de	128.78C
T6. Olivine (3 m/L)	187.42ij	205.87e	196.65E	115.96f-h	117.15fg	116.56E
T7. Olivine + Potassium silicate	198.33fg	226.59cd	212.44C	129.53c-e	128.62c-e	129.08C
T8. Olivine + Magnetic iron	220.05d	241.65b	230.85B	139.41ab	138.20bc	138.81B
T9. Olivine + Potassium silicate + Magnetic iron	233.32c	252.61a	242.97A	145.81a	148.94a	147.38A
Mean*	196.32B	214.69A		123.49A	124.31A	

\*, \*\* refer to specific effect of citrus rootstock species and some growth stimulants, respectively whereas means within each column followed by the same letter/s didn't significantly differ at 5 % level

### 3.11 Top/Root Ratio

**A. Specific effect:** Results dealing with the specific effect of the two factors involved in this study i.e., citrus rootstock type and some growth stimulants on top/root ratio of the Washington Navel orange cultivar, data obtained in Table 9 show that, Sour orange rootstock was better than Volkamer lemon citrus rootstock in this respect, where it improved statistically the two investigated parameter for both seasons of study. With respect to the studied growth stimulants on top/root ratio, data tabulated in Table 9 revealed that, top/root ratio parameter

was highly improved and achieved the highest value with these Washington Navel orange transplants fertilized with NPK mineral fertilizer (control), it was clear that all investigated growth stimulants were less effective in this respect, neither new humex nor Olivine had positive impact in relation to the studied parameters. Anyhow, T8 (Olivine + magnetic iron) and T7 (Olivine + potassium silicate) came after the control in this respect, while the least value was related to T5 (New humex + potassium + magnetic iron) as it was the inferior one in this respect.

**B. Interaction effect:** Dealing with the interaction effect of the two investigated factors i.e., citrus rootstock type and some growth stimulants (New humex, potassium silicate, magnetic iron and Olivine) on top/root ratio of Washington Navel orange cultivar on Sour orange and Volkamer lemon citrus rootstocks, data presented in Table 9 cleared that the maximum improvement in both top/root ratio parameter was noticed with such combination Sour orange as rootstock to Washington Navel orange and fertilization with NPK mineral fertilizer, as such combination was in the front followed by those transplant budded on sour

orange and stimulated their growth with either New humex alone (T2) or Olivine alone (T6) or Olivine combined with potassium silicate (T7) or combined with magnetic iron (T8), as that combination came in the second rank in this respect. On the other hand, the least value was recorded with the combination between Volkamer lemon as rootstock and using New humex + potassium silicate + magnetic iron) T5 as treatment growth encouragement mixture during both seasons of study.

The present result is in accordance with those found by [17] and [21].

**Table 9. Top dry weight and top root ratio of Washington Navel orange transplants budded on two rootstocks as influenced by specific, interaction effects treatments, bio-fertilizers and their combinations during 2014 and 2015 seasons**

Treatments	Top dry weight (g)		Mean**	Top/root ratio		Mean**
	Sour orange	Volkamer lemon		Sour orange	Volkamer lemon	
<b>Season 2014</b>						
T1. Control (mineral NPK)	76.13j	80.66ij	78.40G	2.87a	2.34d	2.61A
T2. New humex (5 ml/L)	85.41gh	83.42hi	84.42F	2.70b	1.99gh	2.34C
T3. New humex + Potassium silicate (10 m/L)	86.46gh	86.23gh	86.35E	2.51c	1.96h	2.24E
T4. New humex + Magnetic iron (250 g/L)	105.02bc	87.92gh	96.47C	2.54c	1.83i	2.19F
T5. New humex + Potassium silicate + Magnetic iron	96.13f	89.67g	92.90D	2.28de	1.76i	2.02G
T6. Olivine (3 m/L)	88.12g	85.69gh	86.91E	2.63bc	1.98gh	2.31D
T7. Olivine + Potassium silicate	100.73de	96.58ef	98.66C	2.69b	2.17ef	2.43B
T8. Olivine + Magnetic iron	109.50ab	102.72cd	106.11B	2.63bc	2.18ef	2.41B
T9. Olivine + Potassium silicate + Magnetic iron	110.00a	108.52ab	109.26A	2.32d	2.09fg	2.21F
Mean*	95.28A	91.23B		2.57A	2.02B	
<b>Season 2015</b>						
T1. Control (mineral NPK)	72.17i	76.47h	74.32H	3.06a	2.39d	2.73A
T2. New humex (5 ml/L)	79.36f-h	78.78f-h	79.07G	2.86b	2.06f	2.46C
T3. New humex + Potassium silicate (10 m/L)	80.23fg	80.68fg	80.46G	2.56c	1.99f	2.28E
T4. New humex + Magnetic iron (250 g/L)	98.97b	80.11fg	89.54D	2.59c	2.61c	2.60B
T5. New humex + Potassium silicate + Magnetic iron	91.19c	82.04ef	86.62E	2.40d	1.77h	2.09F
T6. Olivine (3 m/L)	85.82de	77.42gh	81.62F	2.81b	1.95fg	2.38D
T7. Olivine + Potassium silicate	95.76b	88.55cd	92.16C	2.84b	2.21e	2.53B
T8. Olivine + Magnetic iron	102.70a	95.72b	99.21B	2.80b	2.25e	2.53B
T9. Olivine + Potassium silicate + Magnetic iron	103.86a	102.74a	103.30A	2.48cd	2.22e	2.35D
Mean*	90.01A	84.72B		2.71A	2.16B	

\*, \*\* refer to specific effect of citrus rootstock species and some growth stimulants, respectively whereas means within each column followed by the same letter/s didn't significantly differ at 5 % level



#### 4. CONCLUSION

It can be recommended from the results of this study that to increase all growth measurements such (Transplant height - Stem diameter - number of leaves per transplant - Leaf area - Total assimilation area/transplant - Leaves fresh weight - Leaves dry weight - Root fresh weight - Root dry weight - Top dry weight Top/root ratio) using the combination between Washington orange transplants budded on Volkamer lemon rootstock and fertilized by (Olivine + SiO<sub>2</sub> + Magnetic Iron) or (New humex + SiO<sub>2</sub> + Magnetic Iron).

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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