

## Journal of Plant Production

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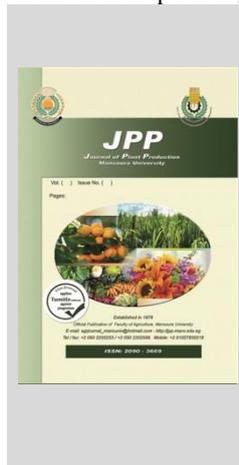
### Effect of some Citrus Rootstocks Types on Growth and Productivity of Gold Nugget Mandarin Trees

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#### ABSTRACT

The present investigation was carried out during two successive seasons (2018/2019; 2019/2020) on almost 12-year old identical Gold Nugget trees (*Citrus reticulata*, Blanco) (Wilking mandarin x Kincy mandarin), grafted on three rootstocks cultivated in a private orchard located in Al Qalyubia Governorate, Egypt. The trees were grown at a distance of 2 × 6 m in silt soil under the Immersion irrigation system. This investigation aimed to study the effect of some citrus rootstocks on Gold Nugget mandarin trees Growth and Productivity. Three citrus rootstocks were: Troyer citrange *Citrus sinensis* 'Washington' x *Poncirus trifoliata* (Tr.), Sour orange (*Citrus aurantium* L.) (SO.) and Volkamer Lemon (*Citrus volkameriana*) (VOL). The experiment was designed as a randomized complete block design with five replications. The obtained results showed that Gold Nugget grafted on Troyer citrange rootstock recorded the highest significant values of chlorophyll a, b, total chlorophylls, total carbohydrates, spring growth cycle, fruit set and yield. Whereas Gold Nugget grafted on Sour orange rootstock recorded the highest significant values of shoot thickness, Leaf surface area, Rate Increasing canopy, vitamin C and TSS/ acid ratio. Regarding Gold Nugget grafted on Volkamer lemon rootstock recorded the highest significant values of dray matter percentage, the number of leaves, tree Canopy, summer growth cycle, flowering, fruit Physical properties and acidity percentage.

**Keywords:** Gold Nugget, Rootstocks, Troyer citrange, Sour orange, Volkamer lemon, Behavior

#### INTRODUCTION

Citrus fruits are considered one of the most important types of fruits in Egypt because of their great economic importance compared to other types of fruits, as it is the first crop in terms of area cultivated and quantity of production, as it is the first export crop and a source of foreign currency, and the cultivated area reached 479656 acres. Citrus fruits occupy 432838 acres. It produced 432303 tons (according to the annual report of the Ministry of Agriculture and Land Reclamation 2018). Citrus fruits are the most famous fruit in the world and have a high nutritional value (rich content of Vitamin A, C, B1, B2 ... etc.) as well as organic acids (citric acid) and dyes (carotenoids, flavonoids, anthocyanins, thiamin, riboflavin, niacin), etc. In additives, fibers, sugars, essential and volatile oils. It also contains mineral elements like calcium, phosphorous, potassium, iron, and sodium. Cheap prices. With the length of the marketing period. In addition to its global reputation in foreign markets, the excellent qualities of fruits give it preference over other fruits.

Gold Nugget *Citrus reticulata* Blanco (Wilking mandarin x Kincy mandarin) is a recently-released mandarin variety developed within the University of California Riverside citrus breeding program. The cross was made at Riverside in the 1950s (the exact date is not known). This hybrid was first selected in 1975 by D.K. Soost and J.W. Cameron and repropagated for additional evaluation. A virus-free bud wood source was established at Lindcove Research and Extension center, Exeter, California in 1986

the tree grows vigorously and is upright in form. It can grow to a moderately-large size at maturity. Gold Nugget fruits are usually medium in size and oblate in the form of a somewhat bumpy orange rind. The aromatic rind is moderately easy to peel. The flesh is bright orange, finely-textured, and seedless (0-6 seed). The flavor is rich and sweet. The fruit usually matures by early March, but holds exceptionally well on the tree, with summer-harvested fruit still being of good quality.

Citrus rootstocks are of vital importance in the quality and quantity of production and survival of citrus plants. As well, Volkamer Lemon (*C. volkameriana*) is a Rangpur type. Fruit quality is slightly better and the rind is of better texture, but fruits commonly do not match the quality standards of those produced onto trifoliolate rootstocks or Sour Orange. Volkameriana seems to be the most vigorous rootstock of all, so requires much more pruning schedules than other stocks. Sour orange (*Citrus aurantium* L.) is a universal rootstock for citrus and is widely used in the Mediterranean region (Ibrahim, 2007). Sour orange rootstock is reported to be suitable for heavy moist soil, gives good yield and quality fruits, but with smaller fruit size, thin and smooth skin, high TSS and acidity (Hemeda, 2014). Troyer citrange is a hybrid of Washington navel orange and *Poncirus trifoliata*, it was later identified as being suitable for use as rootstocks. It was Intolerant of high pH soils with high levels of available calcium and also intolerant of saline conditions. Trees on this stock frequently show micronutrient deficiencies (zinc, iron, manganese), especially in the spring flush. Best results with Troyer

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DOI: 10.21608/jpp.2021.153072

citrange are achieved in well-drained soils and unsuitable for heavy clay soils.

## MATERIALS AND METHODS

This study was conducted during two successive seasons (2018/2019 & 2019/2020) on almost 12-year old identical Gold Nugget trees *Citrus reticulata* Blanco (Wilking mandarin x Kincy mandarin), cultivated in a private orchard located in Al Qalyubia Governorate, Egypt. The trees were grown at a distance of 2 × 6 m in silt soil under the immersion irrigation system. The main goal was to study the effect of some citrus rootstocks on Gold Nugget mandarin trees growth and productivity. The experiment was designed as a randomized complete block design with five replications.

### Three citrus rootstocks were:

1. Troyer citrange *Citrus sinensis* 'Washington' x *Poncirus trifoliata* (Tr).
2. Sour orange (*Citrus aurantium* L.) (SO).
3. Volkamer Lemon (*Citrus volkameriana*) (VOL).

### The following parameters were undertaken:

#### Vegetative growth:

Ten spring shoots/tree were selected and tagged in April and after 6 months (at mid-September) the following parameters were measured:

1. Shoot: length (cm.) & thickness (mm.).
2. The number of leaves/shoot.
3. Leaf surface area (cm<sup>2</sup>) Chou (1966)
4. The number of the growth cycle.
5. Dry matter (g.).
6. Canopy volume (M<sup>3</sup>): was measured twice / season: at the 1<sup>st</sup> week of March " x1" and at the end of September " x2".

The increase of tree growth percentage was calculated as follow:

$$\text{Increasing of tree growth percentage} = (X_2 - X_1) / X_1 \times 100$$

#### Floral parameters:

At the first growth season ( the 1<sup>st</sup> week of March) and before the blooming stage, 4 branches ( about 1 inch in diameter) were selected and tagged around the tree canopy and at 2 M height from the soil surface. The following blooming aspects were recorded:

1. The number of flowers (x1).
2. The number of fruit-lets. (x2).

Whereas, fruit – set percentage was calculated as =  $X_2 / X_1 \times 100$

#### Physiological parameters:

##### Leaf Chlorophylls (a) and (b) and total carotene:

Disks (2.5 cm<sup>2</sup>/ area) from the third leaf at the top of the branch were extracted with di-methyl Formamide (D.M.F.) solution [HCON (CH<sub>3</sub>)<sub>2</sub>] and placed overnight at cool temperature (5°C). Chlorophyll a & b, as well as carotenoids, were measured by Spectrophotometer Beckman Du 7400 at wavelengths 663, 647 and 470 MU, respect., according to the equation described by (Normai 1982) and calculated as (mg/100g FW) as follows:

$$\text{Chl. a} = 12.70 A_{663} - 2.79 A_{647}$$

$$\text{Chl. b} = 20.76 A_{647} - 4.62 A_{663}$$

$$\text{Total Chls} = 17.90 A_{647} + 8.08 A_{663}$$

$$\text{Total carotenoids} = 1000 X A_{470} - 3.72 \text{chl.a} - 104 \text{chl.b} / 229$$

#### Total carbohydrates:

**Total Carbohydrates (g/100g DW):** A known weight (0.1g) of the sample was dried placed in a test tube, then 1N HCl acid (10 ml.) was added. The tube was sealed and

placed for 6 hours in an oven at 100°C. The solution was then filtered and the filtrate was clarified by the leading and de-leading method using lead acetate solution (137 g/l.) and the excess of lead salt was precipitated using potassium oxalate solution. The extract was measured into a measuring flask (50 ml.). The combined filtrate was completed to the mark with distilled water. Total sugars were determined according to the method of Dubois *et al.*, (1956).

#### Tree yield efficiency:

(As Number or kg of fruits / M<sup>3</sup> tree canopy).

#### Fruit Physical and Chemical Properties:

At the harvest stage representative sample of 10 fruits was picked from each replicate and translate to the citrus lab in Hort. Res. Inst. for fruit physical and chemical determination as to the following:

1. Average fruit weight (g).
2. Average fruit size (ml)
3. Dimensions of the fruit (cm), then fruit shape index was calculated as :

$$\text{Fruit shape index} = \text{Fruit height} / \text{Fruit width} = 1 \text{ this mean (Round fruit)}$$

Whereas, F. S. I. > 1 this means (oval fruit), < 1 this mean (flat fruit)

4. Peel thickness (mm)
5. The number of seeds/fruit.
6. Juice weight (g).
7. Juice volume (cm<sup>3</sup>).
8. Juice percentage was calculated as: = Juice weight (g) / Fruit weight (g) x 100 (W/W)
9. Total soluble solids (T.S.S. %)
10. Total acidity percentage (A.O.A.C.1995)
11. TSS/Acid ratio was calculated: TSS/Acid ratio = TSS / Total acidity x 100
12. Vitamin C content (as mg ascorbic acid /100 ml juice).

#### Statistical analysis:

The statistical analysis of the present data was carried out as indicated by Snedecor and Cochran (1980). Significant differences among the means of various treatments were compared by the least significant difference (LSD) at a 5% level of significance. Data were analyzed by MSTAT-C.

## RESULTS AND DISCUSSION

### Vegetative growth behavior:

As for the effect of some citrus rootstocks namely Troyer citrange, Sour orange and Volkamariana on Gold Nugget grafted mandarin tree vegetative growth behavior as Shoot ( length & thickness), number of leaves/ shoot, leaf area, tree size, tree size change percentage, stock/root Index, number of flushes during spring & summer cycles, number of flowers and fruit-set percentage.

Data presented in Tables (1a & b) indicated an insignificant effect of stock type understudy on Gold Nugget shoot length during the two seasons. Whereas, sour orange stock significantly gave the highest Gold Nugget shoot thickness (3.21mm) in comparison to other stocks in the first season Table (1a). On the contrary, all three stocks' understudy had an insignificant effect in the second season. Besides, volkamariana stock significantly gave the highest number of leaves/ shoot (12.80 & 12.87 mm.)

As for leaf area, data illustrated that Gold Nugget on volkamariana stock significantly had the highest leaf area (18.87 cm<sup>2</sup>) in the first season, while which were on sour orange had with the significant difference the highest values

(19.08 & 20.27 cm<sup>2</sup>) for both seasons. Moreover, despite trees on volkamariana stock significantly had the highest canopy volume ( 8.10&8.94 m<sup>3</sup>), nevertheless, both sour

orange stocks had significant differences in increasing % of tree canopy at the end of the growth season (30.94 & 37.57) percentage for both seasons.

**Table 1 a. Effect of some rootstocks type on some vegetative growth behavior of Gold Nugget mandarin during the two seasons (2018/2019 & 2019/2020).**

Aspects Rootstock	Season I					
	Shoot length (Cm.)	Shoot thickness (mm.)	Number of leaves /shoot	Leaf surface area (Cm2.)	Canopy Vol. (M <sup>3</sup> )	canopy change %
Troyer citrange	22.31 NS*	3.08 B	11.33 B	17.58 B	6.31 B	25.28 A
Sour orange	22.49 NS	3.21 A	12.47 A	19.08 A	6.66 B	30.94 A
Volkamariana	22.79 NS	3.11 B	12.80 A	18.87 A	8.10 A	13.48 B
Season II						
Troyer citrange	22.33 NS	3.01 NS	11.40 C	18.41 C	6.26 B	21.41 B
Sour orange	22.36 NS	3.15 NS	12.43 B	20.27 A	6.75 B	37.57 A
Volkamariana	22.57 NS	3.16 NS	12.87 A	19.54 B	8.94 A	14.43 C

Values followed by the same letter (s) are not significantly different at the 5% level

\* NS no significantly different

Data in Table (1b) revealed that Gold Nugget mandarin trees had S/R I > 1 when grafted on the three stocks under study. This means, scion stem growth rate higher than stock stem growth. Whereas, S/R I for sour orange stock significantly gave the highest values (1.34 & 1.37) respectively, for both seasons.

Regarding the number of flushes during the spring cycle data tabulated in (Table 1b) cleared that both Troyer citrange or sour orange stocks recorded the highest with significant differences values ( 50.50) for both in the first season and (50.08 & 49.92 ) respectively, in the second season when compared to volkamariana stock was the lowest. On the opposite, Gold Nugget trees on volkamariana stock significantly gave the highest number of summer flushes (7.42 & 7.00) for both seasons.

Concerning the number of flowers, data presented cleared that trees on volkamariana stock significantly gave the highest values (158.3 & 156.8), while sour orange was in the moderate cause and Troyer citrange was the lowest during the two seasons. Finally, data in Table (1b) indicated that the fruit - set percentage don't affect by rootstock type but trees on Troyer citrange stock gave a high value (3.60 & 3.08%) for both seasons.

**Table 1 b. Effect of some rootstocks type on some vegetative growth and flower behavior of Gold Nugget mandarin during the two seasons (2018/2019 & 2019/2020).**

Aspects Rootstock	Season I					
	S/R I**	spring cycle	Summer cycle	Nu. of flowers	Fruit – set %	
Troyer citrange	1.29 B	50.50 A	4.08 C	131.8 C	3.60 A	
Sour orange	1.34 A	50.50 A	4.75 B	139.8 B	2.62 B	
Volkamariana	1.28 B	43.92 B	7.42 A	158.3 A	2.40 C	
Season II						
Troyer citrange	1.30 B	50.08 A	3.92 C	132.8 C	3.08 NS*	
Sour orange	1.37 A	49.92 A	4.92 B	139.8 B	2.62 NS	
Volkamariana	1.29 B	44.08 B	7.00 A	156.8 A	2.55 NS	

Values followed by the same letter (s) are not significantly different at the 5% level

\* NS no significantly different. \*\* Stock/root Index

However, these rootstocks had an interaction that differs from the other, this will be had a different effect on Gold Nugget mandarin tree vegetative growth behavior. Generally, citrus rootstocks understudy could be descending arranged due to their vegetative growth of Gold Nugget mandarin tree effect: Volkamer lemon, Troyer citrange and Sour orange. These results are in harmony with those

obtained by : Mongi (2000); Alireza *et al.*, (2012); Omima (2013) and Hikal (2014): who agree that citrus trees grown on volkamariana stock were greater in trunk cross-sectional area, canopy volume , spring, summer & autumn flushes. On contrary, Marwa *et al.*, (2019) mentioned that Navel orange scion budded on Sour orange rootstock significantly gave the highest value for all vegetative growth parameters in compared to which budded on Volkamer lemon or Navel orange budded on sour orange inter-stock which grafted on volkamer lemon.

**Physiological parameters:**

**Leaf pigments contents :**

Data in Table (2) illustrated that Gold Nugget leaves grafted on Troyer citrange Stock significantly gave the highest leaf chlorophyll a & b and total chlorophylls values ( 0.78 & 0.79; 0.50 & 0.50 and 1.28 & 1.29 mg/100gf.w) respectively, when compared to other rootstocks understudy for both seasons. Whereas, three rootstocks had an insignificant effect in total carotenoids contents for both seasons.

**Dry matter & total carbohydrates:**

Data in Table (2) showed that Gold Nugget trees grafted on Volkamariana stock gave significantly different high Dry matter percentage values (56.22 & 55.49%) respectively, for both seasons. Whereas both Troyer citrange and Sour orange Stocks significantly gave high leaf carbohydrates contents (71.45 & 70.66 and 70.18 & 70.12) % respectively, and Volkamariana was the lowest for both seasons.

Its well-known leaves with high photosynthesis pigment contents had a positive effect on total carbohydrates and Dry matter percentage. Therefore, these results were in line with those found by Nasser *et al.*, (2014) and Marwa *et al.*, (2019) who found that Volkamer Lemon gave lower values of total carbohydrates consequently gave lower values of C/N Ratio than Sour orange stock. Also, carbohydrates of Navel orange scion stem budded on volkamer lemon inter-stock grafted on sour orange stock significantly gave the highest values. While Navel orange scion budded on sour orange stock achieved the highest carbohydrates in the root.

**Tree productivity and fruiting efficiency:**

Data in Table (3a) illustrated that Gold Nugget trees grafted on Troyer citrange stock significantly gave the highest tree yield as : number of fruit / tree (360.70 & 357..70) & kg/ tree (63.13 & 63.20) and tree yield efficiency

as : number of fruits / M<sup>3</sup>( 57.25 & 57.04) & kg / M<sup>3</sup>(10.01 & 10.10) respectively, for both seasons. Whereas for, number/canopy and kg/canopy Gold Nugget leaves grafted on Troyer citrange Stock significantly gave the highest values (57.25 and 10.01 ) respectively, in the first season.

Whereas, in the second season Gold Nugget grafted on Troyer citrange stock and Sour orange Stock gave significantly number/canopy and kg/canopy values (57.04 &52.28 and 10.10&9.23) respectively.

**Table 2. Effect of some rootstocks type on Physiological behavior of Gold Nugget mandarin during the two seasons (2018/019 & 2019/020).**

Aspects Rootstock	Season I					
	Chl.,a (mg /100 gf.w)	Chl., b(mg/ 100gf.w)	Total chls.,(mg /100gf.w)	Total carotene-oids(mg/100gf.w)	Dry matter %	Total carb-ohydrates%
Troyer citrange	0.78 A	0.50 A	1.28 A	0.17 NS*	53.13 C	71.45 A
Sour orange	0.76 B	0.46 B	1.21 B	0.17 NS	55.42 B	70.18 A
Volkamariana	0.75 B	0.46 B	1.23 B	0.17 NS	56.22 A	58.96 B
Season II						
Troyer citrange	0.79 A	0.50A	1.29 A	0.17 NS	53.77 B	70.66 A
Sour orange	0.74 B	0.46 B	1.21 B	0.17 NS	55.43 A	70.12 A
Volkamariana	0.76 AB	0.47B	1.23 B	0.17 NS	55.49 A	57.93 B

Values followed by the same letter (s) are not significantly different at the 5% level

\* NS no significantly different.

**Table 3a. Effect of some rootstocks type on Gold Nugget mandarin tree yield &efficiency during the two seasons (2018/019 & 2019/020).**

Aspect Rootstock	Season I			
	Tree yield (nu. fruit/ tree)	Tree yield (kg/ tree)	Fruiting efficiency (nu./M3)	Fruiting efficiency (kg/M3)
Troyer citrange	360.7 A	63.13 A	57.25 A	10.01 A
Sour orange	351.7 B	61.50 AB	52.83 B	9.23 B
Volkamariana	341.7 C	60.87 B	42.34 C	7.53 C
Season II				
Troyer citrange	357.7 A	63.20 A	57.04 A	10.10 A
Sour Orange	351.3 B	62.07 B	52.28 A	9.23 A
Volkamariana	340.7 C	60.53 C	38.50 B	6.83 B

Values followed by the same letter (s) are not significantly different at the 5% level

**Fruit Physical and Chemical Properties:**

**Physical properties:**

As for Gold Nugget mandarin fruit: weight, size, shape and fruit Peel Thickness data presented in Table (3b) cleared that there is no effect of citrus stocks type on both fruit weight or fruit shape during the two studied seasons. Besides, Gold Nugget mandarin fruit height < 1 there for it had flat shape. On the other hand, trees on Volkamariana stock had a large fruit size (186.30 &185.70 ml) compared to other stocks understudy for both seasons. while, Gold Nugget trees grafted on both Sour orange or Volkamariana Stocks had significantly fruit Peel Thickness (2.80 &2.82 and 2.85&2.88 mm.) respectively, during the two seasons.

**Table 3b. Effect of some rootstocks type on Gold Nugget mandarin fruit physical properties during the two seasons (2018/019 & 2019/020).**

Aspect Rootstock	Season I			
	Fruit Weight (g)	Fruit Size (cm <sup>3</sup> )	Fruit shape index	Peel Thickness (mm)
Troyer citrange	175.0NS*	174.7 C	0.7 NS	2.72 B
Sour orange	174.8 NS	179.3 B	0.7 NS	2.80 A
Volkamariana	178.2 NS	186.3 A	0.7 NS	2.85 A
Season II				
Troyer citrange	176.7 NS	175.3 B	0.7 NS	2.75 B
Sour orange	176.7 NS	177.7 B	0.7 NS	2.82 AB
Volkamariana	177.7 NS	185.7 A	0.7 NS	2.88 A

Values followed by the same letter (s) are not significantly different at the 5% level

\* NS no significantly different.

Regarding the fruit: pulp fresh weight, juice weight and the number of seeds data in Table (3c) presented cleared that all three citrus stocks under study had an insignificant effect for both seasons. While, Gold Nugget trees grafted on

both Troyer citrange or Sour orange stocks had significant differences fruit juice volume (66.00 &64.70 and 64.80 & 63.70 ml) higher than which grafted on Volkamariana stock (61.60 & 60.50 ml) respectively, for both seasons. Finally, both Troyer citrange or Sour orange stocks significantly increased fruit juice % ( w/w) (38.30 & 37.70) in the first season and all three stocks had an insignificant effect in the second season.

**Table 3c. Effect of some rootstocks type on Gold Nugget mandarin fruit Physical Properties during the two seasons (2018/019 & 2019/020).**

Aspect Rootstock	Season I				
	Pulp Weight (g)	Juice volume (ml)	Juice weight (g)	Juice % (w:w)	Number of seeds/ fruit
Troyer citrange	77.33 NS*	66.0 A	67.0 NS	38.3 A	9.3 NS
Sour orange	78.67 NS	64.8 A	65.7 NS	37.7 A	8.7 NS
Volkamariana	81.33 NS	61.6 B	61.8 NS	35.0 B	10.0 NS
Season II					
Troyer citrange	76.33 NS	64.7 A	65.3 NS	37.3NS	9.0 NS
Sour orange	75.67 NS	63.7 A	63.2 NS	35.7 NS	7.7 NS
Volkamariana	81.33 NS	60.5 B	60.8 NS	34.3 NS	9.3 NS

Values followed by the same letter (s) are not significantly different at the 5% level

\* NS no significantly different.

**Chemical properties:**

As for fruit: Vitamin C, TSS, Acidity and TSS/Acid ratio, data tabulated in Table (3d) revealed that Gold Nugget trees grafted on Sour orange stock significantly had fruit Vitamin C (25.00 mg/100ml juice) higher than the other stocks for both seasons. Whereas, trees that grafted on Troyer citrange significantly had the highest fruit TSS % (11.00) in the first

season and Acidity % (0.81 & 0.83) during the two seasons. Data in Table (3d) indicated that Gold Nugget trees grafted on both Sour orange or Volkamariana stocks had significantly the highest fruit TSS/Acid ratio (14.11 & 14.01) in the first season and for Volkamariana stock (14.27) in the second season.

Concerning the interaction effect of citrus rootstocks under study and Gold Nugget tree yield productivity and fruit, quality is evident as i" stock growth vigorous, ii" its ability to withstand environmental stress factors, as well as iii" scion/ stock compatibility status and their sustainability of the plant with its water and nutrient requirements.

**Table 3d. Effect of some rootstocks type on Gold Nugget mandarin fruit Chemical Properties during the two seasons (2018/019 & 2019/020).**

Season I					
Aspect	Vitamin C	TSS	Acidity	TSS/Acid	
Rootstock	(mg/100 ml Juice)	(%)	(%)	ratio	
Troyer citrange	23.60 B	11.00 A	0.81 A	13.65 B	
Sour orange	25.20 A	10.67 AB	0.76 B	14.11 A	
Volkamariana	22.20 C	10.33 B	0.74 B	14.01 A	
Season II					
Troyer citrange	23.00 B	10.83 NS*	0.83 A	13.12 B	
Sour orange	25.20 A	10.67 NS	0.77 B	13.89 B	
Volkamariana	22.80 B	10.67 NS	0.75 B	14.27 A	

Values followed by the same letter (s) are not significantly different at the 5% level

\* NS no significantly different.

These foundations are similar to those obtained by Mongi (2000); Elham *et al.*, (2006); Muhtaseb *et al.*, (2006); Ali Reza *et al.*, (2012) Ercan *et al.*, (2013); Omima (2013); Nasser *et al.*, (2014); Hikal (2014) and Nadori E.B. *et al.*, (2020) who agree that trees on Volkamer lemon produced the most fruit per tree and the highest yield. On the other hand, it can be explained that trees on 'Troyer' citrange had significantly higher yield efficiency than trees on sour orange and 'Carrizo' citrange, because of the canopy volume of 'Troyer' citrange was lower than the other rootstocks. Also, Fruit from trees on Volkamer lemon was: the largest and heaviest, larger and heavier, had a thicker and coarser peel. Internal qualities of fruit from trees on Swi were superior to those from trees on ML and Volkamer lemon. Percent Brix, Brix/acid Ratio, lb solids and juice per box were all significantly higher for trees on Swi than with those on the lemon rootstocks. Besides, fruits on Volkamer lemon had significantly lower TSS and acidity values when compared with sour orange and 'Troyer' citrange rootstocks. Despite, Percentage of initial and final fruit setting was not affected, fruit shape index value, juice percentage and all chemical parameters of the fruits namely, TSS %, TAC% and the Ratio between them, vitamin C content did not alter with varying citrus rootstocks, nevertheless, Valencia orange trees on Troyer Citrange produced a higher yield than the trees on Sour orange. Besides, 'Salustiana' on *C. macrophylla*, 'Pineapple' on 'Cleopatra' mandarin and 'Hamlin' on both *C. volkameriana* and 'Cleopatra' mandarin gave the highest juice percentage, however, Orange trees on sour orange gave with significant the highest values of juice volume, TSS, TSS/Acid Ratio. While on *C. volkameriana* and *C. macrophylla* it was low. Finally, Volkamer Lemon rootstock significantly gave the highest values of flowering, fruit set, fruit drop and yield and gave

the highest acidity % and ascorbic acid content in comparison to the sour orange rootstock.

Contrary, Zayan *et al.*, (2004); Ali Reza *et al.*, (2012) and Ercan *et al.*, (2013) found that trees on TC, CC, and SO produced similar yield and did not show any significant difference from each to other. Also, yield as a number of fruits/tree and weight (kg/tree) of Washington navel orange was highest on Volkamer lemon, followed by Rangpur lime. Moreover, those budded on Troyer citrange and sour orange gave intermediate values in this respect. Moreover, no significant effects on the juice content of 'Valencia Late' and 'Rhode Red Valencia' oranges. And, the effects of the rootstocks in both scion cultivars on juice content, total acids (TA), Brix: TA ratio, and the number of seeds per fruit were found to be insignificant.

## CONCLUSION

This study was conducted to study the effect of some citrus rootstocks on Gold Nugget mandarin trees Growth and Productivity. Three citrus rootstocks were: Troyer citrange *Citrus sinensis* 'Washington' x *Poncirus trifoliata* (Tr.), Sour orange (*Citrus aurantium* L.) (SO) and Volkamer Lemon (*Citrus volkameriana*) (VOL). Results indicated that Gold Nugget grafted on Troyer citrange rootstock recorded the best values of chlorophyll a,b, total chlorophylls, Total carbohydrates, spring growth cycle, fruit -set and yield. Whereas Gold Nugget grafted on Sour orange rootstock recorded the highest values of shoot thickness, Leaf area, Rate Increasing canopy, vitamin C and TSS/acid ratio. Regarding Gold Nugget grafted on Volkamer lemon rootstock recorded the highest significant values of dray matter percentage, Number of leaves, tree Canopy, summer growth cycle, flowering, Fruit Physical Properties and Acidity percentage.

## ACKNOWLEDGMENT

The authors would like to thank all members of the citrus department for their help and great support in conducting the study experiment.

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### تأثير بعض أنواع أصول الموالح على نمو وإنتاجية أشجار اليوسفي جولد ناجت

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تم إجراء هذه الدراسة خلال موسمين متتاليين (2019/2018 ؛ 2020/2019) على أشجار اليوسفي جولد ناجت متجانسة تقريباً يبلغ عمرها 12 عامًا، مطعمة على ثلاثة أصول زرعت بمزرعة خاصة في محافظة القليوبية ، مصر. تمت زراعة الأشجار على مسافة 2 × 6 م في تربة طمييه تحت نظام الري بالغمر. هدفت هذه التجربة إلى دراسة تأثير بعض أصول الموالح على سلوك أشجار اليوسفي جولد ناجت. ثلاثة أصول من الموالح هي: اصل التروير سترانج ،اصل النارنج واصل الفولكا ماريانا. صممت التجربة بتصميم القطاعات الكاملة العشوائية بخمسة مكررات. أظهرت النتائج المتحصل عليها أن اشجار اليوسفي جولد ناجت المطعومة على اصل التروير سترانج سجلت أعلى قيم معنوية للكوروفيل أ ب ، الكلوروفيل الكلى ، الكربوهيدرات الكلية ، دورة النمو الربيعي ، نسبة عقد الثمار والمحصول. بينما سجلت اشجار اليوسفي جولد ناجت المطعومة على اصل النارنج أعلى قيم معنوية لسماك الفرع ، مساحة الورقة ، معدل زيادة ظل الشجرة ، فيتامين C و نسبة الحموضة / للمواد الصلبة الذائبة . فى حين ان اشجار اليوسفي جولد ناجت المطعومة على اصل الليمون الفولكاماريانا فقد سجلت أعلى قيم معنوية لنسبة المادة الجافة ، عدد الأوراق ، ظل الشجرة ، دورة النمو الصيفية ، الإزهار ، الخصائص الفيزيائية للثمار و نسبة الحموضة.