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

Mohamed, R. F.1*; A. A. R. Atawia2; H. E. M. EL-Badawy2; A. M. Abd- Al-Rahman1 and S.F. EL-Gioushy2

1Horticulture Research Institute, ARC, Giza, Egypt, 2Horticulture Department, Faculty of Agriculture (Moshtohor), Benha University, Egypt

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 trifoliate 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 Citrus rootstocks are of vital importance in the quality and quantity of production and survival of citrus plants.
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 Kinney 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).

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 (cm²) Chou (1966)
  4. The number of the growth cycle.
  5. Dry matter (g).
- 6. Canopy volume (M³): was measured twice / season: at the 1st week of March " x1" and at the end of September " x2". The increase of tree growth percentage was calculated as follow:
  **Increasing of tree growth percentage** = (X2 – X1)/X1 x100

**Floral parameters:**
- At the first growth season ( the 1st 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 =X2/ X1 x 100

**Physiological parameters:**

**Leaf Chlorophylls (a) and (b) and total carotene:**
- Disks (2.5 cm²/ area) from the third leaf at the top of the branch were extracted with di-methyl Formamide (D.M.F.) solution [HCON (CH₃)] 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, respectively, according to the equation described by (Normai 1982) and calculated as (mg/100g FW) as follows:
  - Chl a =12.70 A₆₆₃ - 2.79 A₆₄₇.
  - Chl b = 20.76 A₆₄₇ - 4.62 A₆₆₃.
  - Total Chls =17.90 A₆₄₇ + 8.08 A₆₆₃.
  - Total carotenoids =1000X A₆₄₇ - 3.72chla-a/104chl 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 / M³ 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:
  - **Fruit shape index = Fruit height / Fruit width** x 1 this mean (Round fruit)
  - Whereas, F. S. I. > 1 this mean (oval fruit), < 1 this mean (flat fruit)
  4. Peel thickness (mm)
  5. The number of seeds/fruit.
  6. Juice weight (g).
  7. Juice volume (cm³).
  8. Juice percentage was calculated as: = Juice weight (g) / Fruit weight (g)x 100 (W/W)
  9. Total soluble solids (T.S.S. %)
  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 (3.21 mm) 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 cm²) in the first season, while which were on sour orange had with the significant difference the highest values.
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.

Concerning the number of flowers, data presented cleared that trees on volkamariana stock significantly gave the highest number of summer flushes (7.42 & 7.00) 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).

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Shoot length (Cm.)</th>
<th>Shoot thickness (mm.)</th>
<th>Number of leaves/shoot</th>
<th>Leaf surface area (Cm²)</th>
<th>Canopy Vol (M³)</th>
<th>Canopy change %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rootstock</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Troyer citrange</td>
<td>22.31 NS</td>
<td>3.08</td>
<td>11.33 *</td>
<td>17.58</td>
<td>6.31</td>
<td>25.28 A</td>
</tr>
<tr>
<td>Sour orange</td>
<td>22.49 NS</td>
<td>3.21 A</td>
<td>12.47 A</td>
<td>19.08</td>
<td>6.66</td>
<td>30.94 A</td>
</tr>
<tr>
<td>Volkamariana</td>
<td>22.79 NS</td>
<td>3.11 B</td>
<td>12.80 A</td>
<td>18.87</td>
<td>8.10</td>
<td>13.48 B</td>
</tr>
</tbody>
</table>

Season II

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Shoot length (Cm.)</th>
<th>Shoot thickness (mm.)</th>
<th>Number of leaves/shoot</th>
<th>Leaf surface area (Cm²)</th>
<th>Canopy Vol (M³)</th>
<th>Canopy change %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Troyer citrange</td>
<td>22.33 NS</td>
<td>3.01 NS</td>
<td>11.40 C</td>
<td>18.41 C</td>
<td>6.26</td>
<td>21.41 B</td>
</tr>
<tr>
<td>Sour orange</td>
<td>22.36 NS</td>
<td>3.15 NS</td>
<td>12.43 B</td>
<td>20.27 A</td>
<td>6.75</td>
<td>37.57 A</td>
</tr>
<tr>
<td>Volkamariana</td>
<td>22.57 NS</td>
<td>3.16 NS</td>
<td>12.87 A</td>
<td>19.54 B</td>
<td>8.94</td>
<td>14.43 C</td>
</tr>
</tbody>
</table>

Values followed by the same letter (s) are not significantly different at the 5% level NS no significantly different

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 Hikai (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 comparison to which budded on Volkamener 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 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

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(19.08 & 20.27 cm²) for both seasons. Moreover, despite trees on volkamariana stock significantly had the highest canopy volume (8.108 &8.94 m³), 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 2. Effect of some rootstocks type on Physiological behavior of Gold Nugget mandarin during the two seasons (2018/019 & 2019/2020).

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Rootstock</th>
<th>Season I</th>
<th>Season II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chl,a (mg /100 gf.w)</td>
<td>Total chls. (mg /100gf.w)</td>
<td>Total carotene- olds (mg/100gf.w)</td>
</tr>
<tr>
<td></td>
<td>Troyer citrange</td>
<td>0.78 A 0.50 A 1.28 A 0.17 NS* 53.13 C 71.45 A</td>
<td>1.29 A 0.17 NS 53.77 B 70.66 A</td>
</tr>
<tr>
<td></td>
<td>Sour orange</td>
<td>0.76 B 0.46 B 1.21 B 0.17 NS 55.42 B 70.18 A</td>
<td>1.21 B 0.17 NS 55.43 A 70.12 A</td>
</tr>
<tr>
<td></td>
<td>Volkamariana</td>
<td>0.75 B 0.46 B 1.23 B 0.17 NS 56.22 A 58.96 B</td>
<td>1.23 B 0.17 NS 55.49 A 57.93 B</td>
</tr>
</tbody>
</table>

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 & 2019/2020).

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Rootstock</th>
<th>Season I</th>
<th>Season II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tree yield (kg/tree)</td>
<td>Tree yield (kg/tree)</td>
<td>Fruiting efficiency (w:w)</td>
</tr>
<tr>
<td></td>
<td>Troyer citrange</td>
<td>360.7 A 63.13 A 57.25 A 10.01 A</td>
<td>357.7 A 57.04 A 10.10 A</td>
</tr>
<tr>
<td></td>
<td>Sour orange</td>
<td>351.7 B 61.50 AB 52.83 B 9.23 B</td>
<td>351.7 B 52.28 A 9.23 B</td>
</tr>
<tr>
<td></td>
<td>Volkamariana</td>
<td>341.7 C 60.87 B 42.34 C 7.53 C</td>
<td>340.7 C 38.50 B 6.83 B</td>
</tr>
</tbody>
</table>

Values followed by the same letter (s) are not significantly different at the 5% level *NS no significantly different.

**Physiological 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 & 2019/2020).

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Rootstock</th>
<th>Season I</th>
<th>Season II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fruit Weight (g)</td>
<td>Fruit Size (cm³)</td>
<td>Fruit shape index</td>
</tr>
<tr>
<td></td>
<td>Troyer citrange</td>
<td>175.0 NS* 174.7 C 0.7 NS 2.72 B</td>
<td>174.7 C 0.7 NS 2.72 B</td>
</tr>
<tr>
<td></td>
<td>Sour orange</td>
<td>174.8 NS 179.3 B 0.7 NS 2.80 A</td>
<td>174.8 NS 179.3 B 0.7 NS 2.80 A</td>
</tr>
<tr>
<td></td>
<td>Volkamariana</td>
<td>176.7 NS 175.3 B 0.7 NS 2.75 B</td>
<td>175.3 B 0.7 NS 2.75 B</td>
</tr>
</tbody>
</table>

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 & 2019/2020).

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Rootstock</th>
<th>Season I</th>
<th>Season II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pulp Weight (g)</td>
<td>Juice volume (ml)</td>
<td>Juice weight (g)</td>
</tr>
<tr>
<td></td>
<td>Troyer citrange</td>
<td>77.33 NS* 66.0 A 67.0 NS 38.3 A 9.3 NS</td>
<td>75.67 NS 64.8 A 65.7 NS 37.7 A 8.7 NS</td>
</tr>
<tr>
<td></td>
<td>Sour orange</td>
<td>78.67 NS 64.8 A 65.7 NS 37.7 A 8.7 NS</td>
<td>75.67 NS 64.8 A 65.7 NS 37.7 A 8.7 NS</td>
</tr>
<tr>
<td></td>
<td>Volkamariana</td>
<td>81.33 NS 61.6 B 61.8 NS 35.0 B 10.0 NS</td>
<td>81.33 NS 61.6 B 61.8 NS 35.0 B 10.0 NS</td>
</tr>
</tbody>
</table>

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.
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 it stock growth vigorous, its ability to withstand environmental stress factors, as well as its 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 & 2019/2020).**

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

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); Muthaseb et al., (2006); Ali Reza et al., (2012) Erkan et al., (2013); Orsima et al., (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 Volkamariana 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 Brix and 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 Erkan 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 volkamariana) (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.

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**REFERENCES**


تأثير بعض أنواع الموالح على نمو وانتاجية أشجار اليوسفي جولد ناجت

رجب فتحى الجيوشى

1 معهد بحوث البساتين - مركز الزراعة الإشراعية - الجيزة، مصر

2 قسم البساتين - كلية الزراعة جامعة تanta، مصر

تم إجراء هذه الدراسة خلال موسمين متتاليين (2018/2019، 2019/2020) على أشجار اليوسفي جولد ناجت مطعمة من جامعة مصر تبلغ عمرها 12 عامًا، مطعمة على ثلاثة أصول زرعت بموزع خاصة في محافظة الفيوم، مصر. تم زرع أشجار اليوسفي جولد ناجت على مساحة 2 × 6 م في تربة طبيعية تحت نظام زراعي بالفروع. هذه التجربة تهدف إلى دراسة تأثير بعض أنواع الموالح على نمو محصول أشجار اليوسفي جولد ناجت. ثلاثة أنواع من الموالح هي: أصل التوريس، أصل ستراجين، وصانع التوريس. تم تجميع النتائج المتحولة عليها أن أشجار اليوسفي جولد ناجت المطعمة على أصل التوريس ستراجين سجلت أعلى قيم مغذية للكربوهيدرات التي، الكلي، الفولكانا، الفوتوفيت، دورة النمو الزيتي، نسبة عدم التسخين، المحصول. بينما سجلت أشجار الموالح المطعمة على أصل التوريس أعلى قيم مغذية للكربوهيدرات التي، الكلي، الفولكانا، الفوتوفيت، دورة النمو الزيتي، نسبة عدم التسخين، المحصول. أصل التوريس على قيم سحب، نسبة السحر، سحب العروة، طاقة الضوء. في حين أن أشجار الموالح المطعمة على أصل التوريس نجمت أفضل نتائج في جميع المراحل، مع زيادة نسب الإمحور، ثمرة، نسبة الفاكهة، نسب الفاكهة، نسب الفاكهة، نسب الفاكهة، نسب الفاكهة، نسب الفاكهة.