Influence of clonal rootstocks on leaf nutrient content, vigor and productivity of young ‘Sunraycer’ nectarine trees

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ABSTRACT

Commercial peach and nectarine plantings still include scions budded on seedling rootstocks, which generates unevenness among the plants in many attributes, such as vigor, yield and nutritional state, without the use of benefits that some cutting-propagated rootstock selections and cultivars can provide. Despite the research on Prunus propagation of scions and rootstocks by cuttings, there is little information on the performance of these plants in field conditions. ‘Sunraycer’ was budded on Prunus persica x Prunus davidiana hybrids (‘Flordaguard’, ‘Cadaman’, ‘Barrier’), other interspecific hybrids, as ‘G X N.9’ (P. persica x P. dulcis) and ‘Ishitara’ (P. cerasifera x P. salicina) x (P. cerasifera x P. persica), besides non-hybrids, as ‘Santa Rosa’ (P. salicina), ‘Okinawa’, ‘Tsukuba-1’, ‘Tsukuba-2’, ‘Tsukuba-3’, ‘Nemared’, ‘México Filia 1’ and ‘1-67-52-4’ (P. persica). There was wide variation on the variables analysed among nectarine plants budded on clonal rootstocks or own-rooted trees. ‘Ishitara’, ‘Tsukuba-3’, ‘Barrier’ and ‘Flordaguard’ stand out in terms of higher leaf nutrient contents in ‘Sunraycer’ nectarine trees, rather than the own-rooted trees. ‘Santa Rosa’ provides the majority of the nutritional deficiency cases (nitrogen, potassium, calcium, sulfur, iron and zinc). In addition, ‘Flordaguard’ and ‘Ishitara’ induce greater and lower vigor to the scion, respectively, and also stand out from other treatments in terms of yield, as well as the own-rooted trees, evincing a better nutrient use efficiency, unlike ‘Cadaman’.

1. Introduction

Stone fruits present a remarkable economic importance among temperate climate fruits. Brazil is the thirteenth major producer of peaches and nectarines (FAOSTAT, 2014), with plantings in which scions are budded onto seedling rootstocks (Mayer et al., 2013), without the guarantee of genetic uniformity.

The adoption of clonal rootstocks, which could bring advantages such as the rise or decrease in vigor (Jiménez et al., 2011; Mestre et al., 2015), precocity and increase in production (Comiotto et al., 2013; Yahmed et al., 2016), adaptability to different soil conditions, such as fertility, salinity and water content (Jiménez et al., 2011; Kucukyumuk et al., 2015; Yadollahi et al., 2011), resistance to pathogens (Felipe, 2009), a better use of the soil nutrients (Nawaz et al., 2016), among others, is of great interest for the new cultivations. The use of own-rooted plants from the scion cultivar (Couvillon, 1982) is also an interesting possibility, since it reduces nursery tree production time, exempts the use of rootstocks and excludes the risks of graft incompatibility.

It is emphasized that the genetic material used to compose the plant root system interferes in nutrient absorption and translocation to the scion, influencing the activity of ion transporters, as they differently express the genes responsible for these proteins, either favoring or not the entry of the elements in the roots and in the xylem, even in poor soil conditions (Gonzalo et al., 2011; Huang et al., 2016).

The nutrient content in the leaves is a result of their absorption, translocation and redistribution, being the first factor affected by soil characteristics, such as pH and also by the root, in terms of their architecture, exudate production, hair concentration and vigor, which interferes in their ability to explore the soil (Nawaz et al., 2016; Pérez-Alfocea, 2015). Higher levels of sugars, amino acids and enzymes enable a higher efficiency of the energy metabolism in the roots and the exudation of organic acids which increase nutrient availability in the soil and act as chelates to facilitate their absorption, favoring plant nutrition and defining more efficient rootstocks (Dam and van Bouwmeester, 2016; Jaitz et al., 2011; Jiménez et al., 2011). The technically-based choice of rootstock can result in an optimized use of the nutrients in the case of restrictions to their availability or prevent possible toxicities due to the presence of excessive levels in the soil (Zhang et al., 2010), reflecting in yield gains. More
efficient rootstocks or plants in terms of nutrient absorption and translocation can enable the reduction in the amounts of fertilizers applied, without impairing fruit production and quality.

In this context, the contents of macro- and micronutrients (N, P, K, Ca, Mg, S, Mn, Fe, Zn, Cu and B) present in leaves of ‘Sunraycer’ nectarine trees were determined in this study, as well as the vigor and productivity, aiming at verifying the nutrient efficiency of the clonal rootstocks in comparison with the own-rooted plants.

2. Materials and methods

2.1. Plant material and trial information

The experiment was conducted at “Luiz de Queiroz” College of Agriculture (latitude of 22° 42’ 30” S, longitude of 47° 38’ 30” W; altitude of 546 m; Cwa climate according to Köppen-Geiger classification; Eutrophic Nitosol soil, A moderate, clayey/very clayey texture (Embrapa, 2013)), in Piracicaba, SP, Brazil. Monthly averages of minimum, medium, maximum temperatures (°C), air relative humidity (%) and monthly total rainfall (mm) (Table 1) were obtained by Weather Station of “Luiz de Queiroz” College of Agriculture - USP/ESALQ. The experiment integrates a net of units of observation with clonal rootstocks for stone fruit trees, being part of an interinstitutional project lead by Embrapa Temperate Agriculture.

For rootstock propagation, herbaceous cuttings were obtained from shoots of the parent plants of different cultivars, species and interspecific hybrids, which were at least three years old, belonging to the “Prunus Rootstock Collection” of Embrapa Temperate Agriculture, in November 2012. The following genotypes were used as rootstocks: ‘Flordaguard’ (Prunus persica x Prunus davidiana), ‘Cadaman’ (P. persica x P. davidiana), ‘Barrier’ (P. persica x P. davidiana), ‘G x N.S.’ (P. persica x P.dulcis), ‘Ishbata’ [(P. cerasifera x P. salicina) x (P. cerasifera x P. persica)], ‘Santa Rosa’ (P. salicina), ‘Okinawa’, ‘Tsukuba-1’, ‘Tsukuba-2’, ‘Tsukuba-3’, ‘Nemared’, ‘Mexico Filia 1’ and ‘I-67-52-4’ (P. persica) all with characteristics of interest, mainly related to nematode resistance and waterlogging, provided from ‘Santa Rosa’ plum. ‘Sunraycer’ nectarine [P. persica (L) Batch var. nucipersica] was budded by inverted “T” method on main shoot emitted from the original cutting, in January 2014. Own-rooted nursery trees of cv. Sunraycer were also propagated by herbaceous cuttings (Mayer et al., 2015a).

All nursery trees were planted in the field on July 28th, 2014, with spacing of 6.0 x 3.0 m, without irrigation and trained to an open vase system. After planting, all trees received similar cultural practices as recommended (Aguiar et al., 2014; Raij et al., 1997), being pruned in July 2015 and May 2016, removing excess suckers, poorly located and ill shoots and topping the productive ones. In December 2016, approximately 2 months after the harvest, a renewal pruning was performed, maintaining only the architecture of the trunks, arranged in limbs. The experiment was installed in the randomized block design, with 14 treatments in four single-tree replicates. The total area of the assay was 2160 m².

2.2. Mineral analysis

‘Sunraycer’ nectarine trees were evaluated during the years 2015 and 2016 regarding the leaf contents of macro- and micronutrients (N, P, K, Ca, Mg, S, Fe, Mn, Cu, Zn and B). The most recently, fully expanded leaves including the blade and petiole were sampled in number of 100 per experimental plot. They were removed from the medium portion of branches situated in the middle third of the plant. Sampling occurred 13 weeks after full flowering (Raij et al., 1997), in December 2015 and September 2016, before fruit harvest. The fertilization with N, P and K was performed 43 and 64 days before leaf collection in 2015 and 2016, respectively. The leaves were placed in brown paper packaging, properly identified and sent to Laboratory of Soil Fertility of Agronomic Institute of Campinas (IAC), for the nutrient content quantification in g kg⁻¹ (macronutrients) or mg kg⁻¹ of dry matter (micronutrients) (Bagataglia et al., 1983). The fresh mass removed in the prunings (kg plant⁻¹) of 2015 and 2016 was also determined, as well as the productivity (t ha⁻¹) in 2016, considering the number of fruits per plant, counted after their setting, the mean fruit mass, and the spacing adopted in the experiment, which resulted in a density of 555 plants ha⁻¹.

2.3. Data analysis

The data were subjected to the analysis of variance, and means were compared by the LSD test (P ≤ 0.05), using the statistical program SAS 9.3 (SAS Institute Inc., Cary, North Carolina). To meet the statistical model assumptions, the transformations recommended by the software were adopted. Furthermore, a multivariate cluster analysis was performed to group the stocks according to the leaf nutrient contents.

3. Results

It was observed that the rootstocks differently influenced leaf nutrient content of ‘Sunraycer’ nectarine trees. Own-rooted trees did not provide the highest nutrient levels, except for iron in 2015 and nitrogen in 2016. Therefore, the efficiency of the rootstocks tested for the element uptake is observed. In 2015, ‘I-67-52-4’ and ‘Tsukuba-1’ rootstocks stood out in relation to nitrogen content compared to own-rooted plants. In 2016, ‘Santa Rosa’ was the least efficient rootstock in terms of the absorption of this nutrient (Table 2).

Regarding leaf phosphorus content, ‘Okinawa’ (2.50 g kg⁻¹) in 2015 and ‘Cadaman’ in 2016 (2.20 g kg⁻¹ in 2016) had higher leaf P content.
In 2015, the presence of excessive levels of K was observed in 'Ishtara' (35.48 g kg\(^{-1}\)) and 'Santa Rosa' (3.23 g kg\(^{-1}\)) in 2016, unlike 'Nemared' (1.25 g kg\(^{-1}\) in 2015 and 1.58 g kg\(^{-1}\) in 2016). In terms of macronutrient uptake, 'Ishtara' stayed in the group of the most efficient rootstocks with the highest frequency, compared to the other treatments, unlike 'Santa Rosa' (Table 2).

Table 2

<table>
<thead>
<tr>
<th></th>
<th>N (g kg(^{-1}))</th>
<th>P (g kg(^{-1}))</th>
<th>K (g kg(^{-1}))</th>
<th>Ca (g kg(^{-1}))</th>
<th>Mg (g kg(^{-1}))</th>
<th>S (g kg(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barrier</td>
<td>29.28 ab</td>
<td>32.23 a</td>
<td>2.48 ab</td>
<td>2.00 bc</td>
<td>27.38 d</td>
<td>21.08 c</td>
</tr>
<tr>
<td>Cadaman</td>
<td>29.53 ab</td>
<td>33.18 a</td>
<td>2.28 abc</td>
<td>2.20 a</td>
<td>28.85 bc</td>
<td>23.15 abc</td>
</tr>
<tr>
<td>G x N9</td>
<td>28.00 ab</td>
<td>32.78 a</td>
<td>2.25 abc</td>
<td>2.08 ab</td>
<td>27.90 cd</td>
<td>23.23 abc</td>
</tr>
<tr>
<td>México F. I</td>
<td>27.70 ab</td>
<td>31.50 a</td>
<td>2.15 abc</td>
<td>1.95 bcd</td>
<td>28.70 bc</td>
<td>22.38 bc</td>
</tr>
<tr>
<td>1-67-52-4</td>
<td>31.50 a</td>
<td>30.23 a</td>
<td>2.25 abc</td>
<td>1.88 cd</td>
<td>30.13 abcd</td>
<td>24.38 ab</td>
</tr>
<tr>
<td>Tsukino-1</td>
<td>31.83 ab</td>
<td>31.45 a</td>
<td>2.03 c</td>
<td>1.83 cd</td>
<td>32.53 abc</td>
<td>22.90 ab</td>
</tr>
<tr>
<td>Tsukino-2</td>
<td>30.98 ab</td>
<td>31.50 a</td>
<td>2.05 c</td>
<td>1.99 bc</td>
<td>28.40 bc</td>
<td>24.90 ab</td>
</tr>
<tr>
<td>Tsukino-3</td>
<td>30.98 ab</td>
<td>31.08 a</td>
<td>2.28 abc</td>
<td>1.93 bcd</td>
<td>31.43 bc</td>
<td>25.25 a</td>
</tr>
<tr>
<td>Santa Rosa</td>
<td>30.25 ab</td>
<td>25.76 b</td>
<td>2.05 c</td>
<td>1.57 c</td>
<td>31.10 abc</td>
<td>15.87 d</td>
</tr>
<tr>
<td>Flordaguard</td>
<td>30.33 ab</td>
<td>30.80 a</td>
<td>2.03 c</td>
<td>1.97 be</td>
<td>33.90 ac</td>
<td>23.57 abc</td>
</tr>
<tr>
<td>Nemared</td>
<td>27.75 ab</td>
<td>31.36 a</td>
<td>2.33 abc</td>
<td>1.83 cd</td>
<td>32.68 ab</td>
<td>25.28 a</td>
</tr>
<tr>
<td>Ishtara</td>
<td>28.55 ab</td>
<td>29.73 a</td>
<td>2.20 abc</td>
<td>1.78 d</td>
<td>33.15 ab</td>
<td>24.28 ab</td>
</tr>
<tr>
<td>Okinawa</td>
<td>30.28 ab</td>
<td>30.43 a</td>
<td>2.50 a</td>
<td>1.95 bcd</td>
<td>31.60 abcd</td>
<td>24.53 ab</td>
</tr>
<tr>
<td>Own-rooted</td>
<td>27.10 b</td>
<td>32.55 a</td>
<td>2.08 bc</td>
<td>1.88 cd</td>
<td>28.80 bc</td>
<td>21.40 c</td>
</tr>
</tbody>
</table>

The interval of contents considered adequate (in dark gray) for each nutrient is: N (30.0–35.0 g kg\(^{-1}\)), P (1.4–2.5 g kg\(^{-1}\)), K (20.0–30.0 g kg\(^{-1}\)), Ca (18.0–27.0 g kg\(^{-1}\)), Mg (3.0–8.0 g kg\(^{-1}\)) and S (1.5–3.0 g kg\(^{-1}\)) (Raij et al., 1997). The contents highlighted in light gray and white are, respectively, below and above those recommended. Means followed by the same letters, in the columns, do not differ from each other considering the LSD test (P > 0.05).

It is emphasized that the performance of the different genotypes was not consistent for all nutrients between the years of study (Tables 1 and 2). Furthermore, there is a high number of materials isolated (Fig. 1), which demonstrates the variability among the rootstocks regarding these contents.

'Flordaguard' also stood out for providing a higher vigor and productivity to 'Sunraycer' scion (Fig. 2A, B), rather than 'Cadaman', for instance, which led to a lower productivity than the own-rooted 'Sunraycer' (Fig. 2B). 'Sunraycer' scions on 'Ishtara' were less vigorous compared to own-rooted plants, but equally productive, as well as those on 'Flordaguard' (Fig. 2A, B). These rootstocks use the nutrients absorbed in an efficient way.
Fig. 1. Cluster display of the treatments tested, in terms of macronutrient (A) and micronutrient (B) contents in ‘Sunraycer’ leaves, own-rooted or budded on clonal rootstocks, in the years 2015 and 2016. Piracicaba, SP, 2017.

Table 3
Micronutrient contents in leaves of ‘Sunraycer’ nectarine trees, own-rooted or budded on clonal rootstocks, in the years 2015 and 2016. Piracicaba, SP, 2017 (1).

<table>
<thead>
<tr>
<th></th>
<th>Fe</th>
<th>Mn</th>
<th>Cu</th>
<th>Zn</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier</td>
<td>83.20</td>
<td>cd</td>
<td>abc</td>
<td>74.14</td>
<td>b</td>
</tr>
<tr>
<td>Cadamap</td>
<td>100.93</td>
<td>abc</td>
<td>ab</td>
<td>69.25</td>
<td>bc</td>
</tr>
<tr>
<td>G x N 9</td>
<td>87.40</td>
<td>bcd</td>
<td>138.10</td>
<td>62.48</td>
<td>bed</td>
</tr>
<tr>
<td>México F.1</td>
<td>96.15</td>
<td>abed</td>
<td>142.15</td>
<td>36.80</td>
<td>b</td>
</tr>
<tr>
<td>I-67-52-4</td>
<td>85.98</td>
<td>bc</td>
<td>136.43</td>
<td>43.78</td>
<td>fgh</td>
</tr>
<tr>
<td>Tsukuba-1</td>
<td>91.70</td>
<td>abed</td>
<td>141.23</td>
<td>38.03</td>
<td>gh</td>
</tr>
<tr>
<td>Tsukuba-2</td>
<td>100.65</td>
<td>abed</td>
<td>149.03</td>
<td>45.65</td>
<td>fgh</td>
</tr>
<tr>
<td>Tsukuba-3</td>
<td>102.98</td>
<td>abed</td>
<td>141.88</td>
<td>43.60</td>
<td>gh</td>
</tr>
<tr>
<td>Santa Rosa</td>
<td>91.70</td>
<td>abed</td>
<td>131.30</td>
<td>92.02</td>
<td>a</td>
</tr>
<tr>
<td>Floriform</td>
<td>92.73</td>
<td>abed</td>
<td>143.33</td>
<td>60.30</td>
<td>ede</td>
</tr>
<tr>
<td>Nemared</td>
<td>79.25</td>
<td>d</td>
<td>133.28</td>
<td>51.55</td>
<td>deleted</td>
</tr>
<tr>
<td>Ishtara</td>
<td>110.58</td>
<td>a</td>
<td>150.88</td>
<td>57.43</td>
<td>edef</td>
</tr>
<tr>
<td>Ohwawa</td>
<td>101.05</td>
<td>abc</td>
<td>137.43</td>
<td>47.33</td>
<td>fgh</td>
</tr>
<tr>
<td>Own-rooted</td>
<td>110.03</td>
<td>a</td>
<td>131.75</td>
<td>43.78</td>
<td>fgh</td>
</tr>
</tbody>
</table>

Pr-F 0.04 0.42 <0.001 <0.001 <0.001 <0.001 <0.001 0.27 <0.001 C.V. 13.98 8.33 17.45 20.75 6.71 18.85 16.73 20.51 12.75 9.98

The interval of contents considered adequate (in dark gray) for each nutrient is: Fe (100.0–250.0 mg kg⁻¹), Mn (40.0–160.0 mg kg⁻¹), Cu (5.0–16.0 mg kg⁻¹), Zn (20.0–50.0 mg kg⁻¹) and B (20.0–60.0 mg kg⁻¹) (Raij et al., 1997). The contents highlighted in light gray are below those recommended. (1) Means followed by the same letters, in the columns, do not differ from each other considering the LSD test (P > 0.05). (2) The original values were transformed: Copper 2015 = log₁₀(x); Copper 2016 = x²; Zinc 2016 = x².
served in both years of evaluation. Nevertheless, there were differences regarding the leaf contents. The reduction in P content in the second year of evaluation can be explained by the presence of fruits, which are a drain in high demand. Phosphorus is fairly immobile in the soil, mainly in the most porous initial growth of the plants, observed until the first winter pruning. Additionally, because of the higher use of this nutrient in the stage of intense development, the supplies allocated in stem and root during winter was lower, resulting in its lower supply in the spring, until the period of sampling.

After pruning and suitability between aerial part and root system, a better efficiency of this nutrition was achieved, as indicated by the higher level conformity in 2016, except for ‘Santa Rosa’ and ‘Ishihara’, less vigorous (Fig. 2A). Furthermore, the plants also had woody organs and therefore, supplies, which made this nutrient available.

In terms of leaf phosphorus content, the adequate range for peach trees is between 1.4 and 2.5 g kg\(^{-1}\) (Raij et al., 1997). No deficiency was observed in both years of evaluation. Nevertheless, there were differences regarding the leaf contents. The reduction in P content in the second year of evaluation can be explained by the presence of fruits, which are a drain in high demand. Phosphorus is fairly immobile in the soil, mainly in the most clayey ones (Fink et al., 2016), such as the one used in this study, in which absorption depends on the slow P diffusion and its proximity to the roots.

Contents in a range of leaf potassium from 20.0 to 30.0 g kg\(^{-1}\) are considered adequate for peach trees cultivated in the State of São Paulo (Raij et al., 1997). The K content reduction in the second year is also due to its allocation in fruits, which did not occur in the first year. K is the most abundant element in the fruits, providing them an appropriate size, balanced flavor and more intense coloration, being its excess harmful to their conservation (Rombolà et al., 2012). The same authors emphasized that potassium is important to the development of perennial organs, formation of the wood that will be removed in pruning, leaves that fall and fruits (export), with a modest requirement in the first years of planting. According to Leonel et al. (2011), leaf analyses performed in ‘Sun Blaze’ nectarine trees budded on ‘Okinawa’, seven years old, demonstrated that the highest K levels were observed in the conventional sampling period, between thirteen and fifteen weeks after full flowering, before fruit harvest, a period near that adopted in the present study.

The high potassium levels detected in ‘Sunraycer’ scions on some materials might explain a competition between K and Ca (Table 2), as also commented by Reighard et al. (2013), which impairs the absorption of the last, since the contents were below those considered appropriate for peach trees, 18.0–27.0 g Ca kg\(^{-1}\) (Raij et al., 1997). Lower calcium levels in leaves might also occur by a possible preferential allocation of this element in roots or stem, since it is important for the development and structural composition of these organs (Havlín et al., 2014), besides a possible lower efficiency of some rootstocks in absorbing and translocating this nutrient. Like in this study, ‘Flordaguard’ also favored higher calcium contents in ‘Chimarrita’ peach tree, in Porto Alegre region, Rio Grande do Sul, Brazil (Galarça et al., 2015).

The magnesium leaf contents detected in both years of study are in accordance with the range considered appropriate (3.0–8.0 g kg\(^{-1}\)) (Raij et al., 1997). On the other hand, the range of leaf S contents considered adequate is 1.5–3.0 g kg\(^{-1}\) (Raij et al., 1997), occurring deficiencies in 2015. It can be associated to the high immobilization of
this element (Havlín et al., 2014), because of its lower content in the soil in an area that was lying fallow until that moment and with an inferior S supply by cultural residues.

Although Fe content in the soil was high (from 16 mg dm$^{-2}$ in 2015 and from 21 mg dm$^{-2}$ in 2016), according to Raji et al. (1997), deficiencies were observed in some treatments only in 2015, with contents below the range considered adequate for peach trees cultivated in the State of São Paulo, from 100.0 to 250.0 mg kg$^{-1}$ (Raji et al., 1997), probably because of the interaction among the metallic micronutrients, all present in high concentration in the soil, besides the lower absorption and translocation efficiency of some genotypes tested. According to Mestre et al. (2017), rootstocks that benefit this nutrient uptake must be preferred when a calcareous soil is used.

Manganese deficiencies also occurred only in 2015 in scions on some rootstocks, since the range of leaf Mn contents considered appropriate for peach trees cultivated in the State of São Paulo is from 40.0 to 160.0 mg kg$^{-1}$ (Raji et al., 1997). It is believed that, besides a lower efficiency of some genotypes in the first year of growth, the interaction with other metallic micronutrients in high levels in the soil, favored this situation.

The copper contents in leaves were always inside the range considered adequate, 5.0–16.0 mg kg$^{-1}$, in budded plants (Raji et al., 1997). However, it is inferred that its high levels in the soil impaired zinc absorption, due to a competitive inhibition, since the leaf contents of this element remained below the appropriate range, 20.0–50.0 mg kg$^{-1}$ (Raji et al., 1997). A lower efficiency of some Prunus rootstocks in absorbing and translocating Zn is also possible, since deficiencies were observed by Mayer et al. (2015b) and Reighard et al. (2013). It is known that stone fruit trees are sensible to zinc deficiency, with variations among cultivars in terms of their ability to absorb and translocate it, which might also be caused by differences in the roots and susceptibility to mycorrhizal infection (Havlín et al., 2014).

It was observed that in ‘Sunraycer’ nectarine trees, the nutrients that led to a higher variation among the rootstocks, in both years of evaluation of this experiment, were calcium, magnesium, manganese, copper and zinc (Tables 2 and 3). Galarça et al. (2015) also verified similar results for ‘Chimarra’ peach trees on different rootstocks, cultivated in Eldorado do Sul and Capão do Leão, Rio Grande do Sul, Brazil, regarding calcium, magnesium and manganese.

Restrictions of some rootstocks to nutrient translocation are generated by xylem dimension (Tombesi et al., 2011), physiological aspects or those related to root morphology, which alter ion absorption efficiency (Hell and Stephon, 2003). Thus, the final nutrient concentration results from its absorption, transportation, redistribution and use for plant growth (Nawaz et al., 2016), making it possible to choose less efficient rootstocks in capturing and translocating elements present in very high levels in the soil or to enable fertilizer economy by the use of more effective combinations (Savvas et al., 2009), as observed for ‘Ishtara’, which allowed higher levels of some nutrients in leaves and less vigor, showing the possibility of being used for more densified plantings, with advantages in terms of productivity, since it was not different from ‘Flordaguard’, which was prominent in this aspect.

Ion transporters related to nutrient absorption and translocation to aerial part are also affected by the rootstocks, due to a signaling method for gene expression that is still not very well understood, which can vary among genotypes, with the possibility of favoring ions absorption, even if they are in lower concentrations in the soil, as identified in Prunus rootstocks by Gonzalo et al. (2011).

Therefore, it is emphasized that aspects such as proper vigor and productivity provided to the scion must also be considered when choosing the rootstock, combined to the efficiency in absorption and transportation of water and nutrients (Nawaz et al., 2016), as the accumulation of these elements in leaves does not necessarily reflect rises in production (Pérez-Alfocea, 2015).

The low yield obtained in this experiment might result from an insufficient chilling accumulation by the plants, since ‘Sunraycer’ cultivar requires, approximately, 275 h with temperatures between 0° and 7.2°C per year (Sherman et al., 1995). In the place of experiment, zero chill hour was recorded in 2015 and only 47 h were accumulated in 2016 (Table 1), resulting in uneven flowering and competition for photosimulates among flowers, fruits and budding. Moreover, the low air relative humidity during flowering, the water deficit and the low age of the plants were important yield-determining factors. Nonetheless, the potential of some rootstocks must be emphasized, such as ‘Flordaguard’, which was more productive than some of the other stocks tested.

5. Conclusions

- Own-rooted ‘Sunraycer’ trees do not present a satisfactory performance for macro- and micronutrient leaf contents.

- ‘Ishtara’, ‘Tsukuba-3’, ‘Barrier’ and ‘Flordaguard’ clonal rootstocks stand out in terms of leaf nutrient contents for ‘Sunraycer’ nectarine trees, whereas ‘Santa Rosa’ provides the highest number of leaf nutrient deficiency cases.

- The highest yield and vigor of ‘Sunraycer’ nectarine trees occur with the use of ‘Flordaguard’ rootstock, which is also prominent in terms of leaf contents of K, Ca, Fe and Cu, being more efficient than other clonal rootstocks tested in uptaking these elements.

- ‘Ishtara’ reduces ‘Sunraycer’ scion vigor, with an efficient use of nutrients absorbed. This rootstock should be evaluated for more time to check its efficiency in higher density plantings.

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References


Comiotto, A., Fachinello, J.C., Ho, Z.L., 2016. Improving magnesium uptake, photosynthesis and antioxidant enzyme activities in nectarine trees, whereas ‘Flordaguard’ reduces ‘Sunraycer’ scion vigor, with an efficient use of nutrients absorbed. This rootstock should be evaluated for more time to check its efficiency in higher density plantings.

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