Salt balance in substrate cultivated with ‘Sunki’ mandarin x ‘Swingle’ citrumelo hybrids

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Key words: Citrus spp. rootstocks tolerance salinity

A B S T R A C T
During initial plant development stage, an experiment was conducted to evaluate the balance of salts in the substrate used for the production of 10 hybrids from the cross between ‘Sunki’ mandarin (TSKC) and ‘Swingle’ citrumelo (CTSW), all with potential to be used as rootstock. ‘Rangpur Santa Cruz’ lime, ‘Sunki Tropical’ mandarin and the hybrid LVK (‘Volkamer’ lemon) x LCR (‘Rangpur’ lime) - 038 were included as controls, totaling 13 genotypes. Substrate samples were collected in the experiment conducted in a greenhouse at the Federal University of Campina Grande, Campus of Pombal, from December 2015 to June 2016. Two levels of irrigation water salinity were tested, using a 2 x 13 factorial scheme, with 4 replicates. The substrate was a mixture of vermiculite, pine bark and humus (1:1:1). For the salinity level of 3 dS m⁻¹, the substrate is less salinized when cultivated with the hybrids TSKC x CTSW - 044, TSKC x CTSW - 045, TSKC x CTSW - 048, and TSKC x CTSW - 049, as well as for the ‘Rangpur Santa Cruz’ lime. On the other hand, highest salt concentration was obtained in the substrate cultivated with TSKC x CTSW - 042, TSKC x CTSW - 047, TSKC x CTSW - 041, TSKC x CTSW - 053, TSKC x CTSW - 055 and TSKC x CTSW - 057.

Palavras-chave: Citrus spp. porta-enxerto tolerância salinidade

Balânço de sais em substrato de cultivo de híbridos de tangerinea ‘Sunki’ com citrumelo ‘Swingle’

R E S U M O
Em fase inicial de desenvolvimento da planta, objetivou-se avaliar o balanço de sais no substrato de cultivo de 10 híbridos do cruzamento tangerinea ‘Sunki’ comum (TSKC) x citrumelo ‘Swingle’ (CTSW), todos com potencial de uso como porta-enxertos. Como testemunhas incluiu-se o limoeiro ‘Cravo Santa Cruz’, a tangerinea ‘Sunki Tropical’ e o híbrido LVK (limoeiro ‘Volkameriano’) x LCR (limoeiro ‘Cravo’). Foram coletadas amostras do substrato em experimento desenvolvido em ambiente protegido da Universidade Federal de Campina Grande, Pombal, PB, de dezembro de 2015 a junho de 2016. Foram testados dois níveis de salinidade da água de irrigação (0,3 e 3 dS m⁻¹), em esquema fatorial 2 x 13, com 4 repetições, usando-se, como substrato, a casca de pinus, o húmus e a vermiculita na proporção 1:1:1. Para a salinidade de 3 dS m⁻¹, o substrato mostra-se menos salinizado em relação aos híbridos TSKC x CTSW - 044, TSKC x CTSW - 045, TSKC x CTSW - 048 e TSKC x CTSW - 049, assim como para o limoeiro ‘Cravo Santa Cruz’. Por outro lado, a maior concentração de sais foi obtida no substrato em que são cultivados TSKC x CTSW - 042, TSKC x CTSW - 047, TSKC x CTSW - 041, TSKC x CTSW - 053, TSKC x CTSW - 055 e TSKC x CTSW - 057.

Ref. 185679 – Received 22 Sept, 2017 • Accepted 27 Feb, 2018 • Published 28 May, 2018
INTRODUCTION

Salinity of soil and water is among the main problems in agriculture leading to reduction in crop yield (Gheyi et al., 2016). Despite being a global problem, salinity is more evident in arid and semi-arid regions, such as Northeast Brazil, for being characterized by low and irregular rainfall levels (Medeiros et al., 2003).

In addition, the predominance of waters with high levels of electrical conductivity in these regions should also be considered, reflecting in increased risk of salinization, if adequate management practices of plant, soil and water are not adopted (Ararú Neto et al., 2014; Dalasta et al., 2014).

The effects of salinity on agricultural production encompass osmotic effects, reducing water absorption by plants (Willadino & Câmara, 2010), and ionic effects, which can cause phytotoxicity and nutritional imbalance. These effects culminate in reduction of growth and potential of plants considered as sensitive (Taiz et al., 2015), such as citrus, which have mean salinity threshold of 1.4 dS m⁻¹ (Mass, 1993).

Nonetheless, according to the literature, the effects of salts on crops can vary depending on species, cultivar, phenological stage, and intensity and duration of the saline stress (Silva et al., 2012; Sousa et al., 2017). Thus, using salt-tolerant rootstocks can be an alternative to guarantee successful citrus production in Northeast Brazil.

Based on studies conducted with citrus in recent years (Fernandes et al., 2011; Hussain et al., 2012; Silva et al., 2012; Hussain et al., 2015; Sá et al., 2015; Brito et al., 2016; Barbosa et al., 2017; Sá et al., 2017) to obtain genetic materials with potential for tolerance to salinity, it becomes necessary to evaluate new crosses and hybrids, which can be done by studying parameters that can help interpret tolerance mechanisms.

In this context, this study aimed to evaluate the balance of salts in the substrate used for cultivation, under saline water application, of citrus rootstocks considered as tolerant and belonging to the progeny resulting from the cross between 'Sunki' mandarin and 'Swingle' citrumelo.

MATERIAL AND METHODS

The experiment was carried out from December 2015 to June 2016 in a protected environment (greenhouse) at the Center of Sciences and Agri-food Technology (CCTA) of the Federal University of Campina Grande (UFCG), Pombal-PB, Brazil (6º 47’ 20” S, 37º 48’ 01” W, altitude of 194 m). The local climate is classified as BSh (hot and dry semi-arid), with mean annual rainfall of 750 mm and mean annual evapotranspiration of 2000 mm.

Treatments were arranged in randomized blocks, in 2 x 13 factorial scheme, corresponding to two levels of irrigation water salinity (S1 = 0.3 dS m⁻¹ and S2 = 3 dS m⁻¹), which were used to irrigate 13 genotypes of rootstocks, 10 of which from the progeny of the cross between 'Sunki' mandarin and 'Swingle' citrumelo, namely TSKC x CTSW - 041, TSKC x CTSW - 042, TSKC x CTSW - 044, TSKC x CTSW - 045, TSKC x CTSW - 047, TSKC x CTSW - 048, TSKC x CTSW - 049, TSKC x CTSW - 053, TSKC x CTSW - 055 and TSKC x CTSW - 057. 'Rangpur Santa Cruz' lime (C. limonia Osbeck) (LCSRSTC), 'Sunki Tropical' mandarin ('Sunki Tropical') and the hybrid between Volkamer lemon (C. volkameriana V. Ten. & Pasq.) (LVK) and 'Cravo' lemon (LCR) - 038 (LVK x LCR - 038) were included as control, for being salt-tolerant according to Brito (2010) and Barbosa et al. (2017).

All factors combined led to 26 treatments (2 salinity levels x 13 genotypes), repeated in 4 blocks, and each plot consisted of 1 plant, totaling 104 plots.

Seedlings were initially prepared in a protected environment at Embrapa Cassava and Fruits, considering all criteria for the initial production of rootstocks, such as the use of seeds from reputable companies, pest control and selection of nucellar plants.

At 75 days after sowing (DAS), the seedlings were transferred to 2000-mL black polyethylene bags and taken to the protected environment of the CCTA/UFCG, where the experiment was conducted. During growth period in the protected environment at Embrapa until the 90 DAS, the seedlings received public-supply water with low electrical conductivity (ECw = 0.3 dS m⁻¹).

At 90 DAS, solutions with different salinity levels began to be applied and irrigation depths were daily determined based on the water balance, obtained by drainage lysimetry, adding a leaching fraction (LF) of 0.20. In this process, the volume applied per bag (Va) was obtained by difference between the total volume applied in the previous night (Vta) and the volume drained (Vd) in the next morning, applying the leaching fraction, as indicated in Eq. 1 for each treatment.

\[ \text{Va} = \frac{\text{Vta} - \text{Vd}}{(1 - \text{LF})} \ (\text{mL}) \tag{1} \]

Drained water was collected through a hose attached to the bottom of each bag and connected to a container, to measure the drained volume.

Nutritional management and all cautions with respect to weed control, and prevention and control of pests followed the recommendations for citrus seedling production proposed by Mattos Júnior et al. (2005).

Irrigation water of 3.0 dS m⁻¹ was prepared in such a way to obtain an equivalent proportion of 7:2:1, of Na:Ca:Mg, respectively, using NaCl, CaCl₂·2H₂O and MgCl₂·6H₂O salts. This ratio corresponds to the ions present in most water sources used for irrigation in small properties of Northeast Brazil (Audry & Suassuna, 1995; Medeiros et al., 2003).

To prepare the solution with the desired electrical conductivity (ECw), the salts were added to the public-supply water, which had ECw of 0.3 dS m⁻¹, corresponding to the first salinity level studied. After preparation, the solutions were stored in 60 L plastic containers, one for each ECw level, properly protected to avoid evaporation and contamination with materials that could compromise their quality. Every two days, electrical conductivity was measured in the solutions using a portable conductivity meter, with value automatically corrected to 25 °C, and its value was adjusted when necessary.

When the rootstocks had adequate diameter for grafting, about 0.5 to 0.7 cm, which occurred at 210 DAS, plants were...
cut close to the soil and roots were collected. The material (shoots and roots) was packed and dried in a forced-air oven for 72 h to obtain the dry matter or total dry phytomass (TDP), measured with an analytical scale, and the data were expressed in grams per plant.

Then, the substrates filling the bags were collected, dried, sieved, stored and labeled in plastic bags for analyses at the Laboratory of Soil and Plant Nutrition of the CCTA/UFCG, where the ions Ca$^{2+}$, Mg$^{2+}$, Na$^+$ and K$^+$, soluble Cl$^-$ and EC$w$ were determined using the methodologies described in EMBRAPA (1997).

The obtained data were subjected to analysis of variance (ANOVA) by F test. In the cases of significance for the factor genotypes, means grouping test (Scott-Knott, $p < 0.05$) was applied for each water salinity level. To verify the differences between salinity levels in each genotype, the F test was conclusive (Ferreira, 2011).

**Results and Discussion**

Based on the balance of salts (Table 1), the use of saline water caused alterations in soil chemical characteristics, increasing the electrical conductivity of the saturation extract (EC$se$) and Ca$^{2+}$ and Na$^+$ concentrations as the salinity levels increased, which caused the substrate to be classified as saline when irrigated with 3 dS m$^{-1}$ water, resulting in EC$se$ higher than 4 dS m$^{-1}$ in all containers. Lowest EC$se$ values occurred in the substrate cultivated with the genotypes TSKC x CTSW - 044, TSKC x CTSW - 045, TSKC x CTSW - 048, TKSC x CTSW - 049 and LCRSTC, irrigated with high-salinity water. The lowest EC$se$ values also coincided with the lowest Na$^+$ contents in the substrate cultivated with first two hybrids.

Such increase in the concentration of ions was due to the use of Na, Ca and Mg salts to prepare the solution with the desired ionic concentration corresponding to the second salinity level (3 dS m$^{-1}$). These results corroborate those obtained by Brito et al. (2015), studying salt balance in the substrate and growth of 'Tahiti' acid lime grafted with 'Sunki' mandarin hybrids, under saline stress. These authors observed that the increase of salt concentration in the irrigation water led to linear increase in the concentration of ions in the substrate.

Variation of ionic concentration in the substrates, due to the hybrids cultivated in it, can be interpreted as a quantitative difference in the nutritional demand between the genetic materials, i.e., the absorbed contents of nutrients usually vary between genotypes, as mentioned by Epstein & Bloom (2006). In the literature on plant physiology, there are references to the selective permeability of the plasma membrane, adjusting the cell to the incorporation of ions according to plant needs, which vary depending on genetic constitution, development stage and conditions of soil and climate (Meer et al., 2008; Taiz et al., 2015). In addition, plants showed different growths, as can be observed in Table 2, based on the total dry phytomass.

For Mg$^{2+}$ concentrations in the substrate solution (Table 3), there was no statistical difference between salinity levels for TSKC x CTSW - 041, TSKC x CTSW - 042, TSKC x CTSW - 044, TSKC x CTSW - 045 and LVX x LCR - 038, although the hybrids TSKC x CTSW - 041, TSKC x CTSW - 042, TSKC x CTSW - 044, TSKC x CTSW - 045 and TSKC x CTSW - 055 showed different growths, as can be observed in Table 2, based on the total dry phytomass of citrus hybrids under water salinity

### Table 2. Test of means between citrus genotypes and between water salinity levels for total dry phytomass of citrus hybrids under water salinity

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>EC$se$ (dS m$^{-1}$)</th>
<th>Ca$^{2+}$ (mmol dm$^{-3}$)</th>
<th>Na$^+$ (mmol dm$^{-3}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.3</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>TSKC x CTSW - 041</td>
<td>2.326 Ab</td>
<td>6.655 Aa</td>
<td>2.442 Cb</td>
</tr>
<tr>
<td>TSKC x CTSW - 042</td>
<td>1.295 Ab</td>
<td>4.600 Aa</td>
<td>1.951 Cb</td>
</tr>
<tr>
<td>TSKC x CTSW - 044</td>
<td>1.328 Ab</td>
<td>4.793 Ba</td>
<td>2.062 Ab</td>
</tr>
<tr>
<td>TSKC x CTSW - 045</td>
<td>1.560 Ab</td>
<td>5.632 Ba</td>
<td>2.316 Cb</td>
</tr>
<tr>
<td>TSKC x CTSW - 047</td>
<td>1.894 Ab</td>
<td>6.992 Aa</td>
<td>2.292 Ab</td>
</tr>
<tr>
<td>TSKC x CTSW - 048</td>
<td>1.141 Ab</td>
<td>5.168 Ba</td>
<td>2.127 Cb</td>
</tr>
<tr>
<td>TSKC x CTSW - 049</td>
<td>1.525 Ab</td>
<td>4.740 Ba</td>
<td>2.046 Ab</td>
</tr>
<tr>
<td>TSKC x CTSW - 053</td>
<td>0.986 Ab</td>
<td>6.655 Aa</td>
<td>1.818 Cb</td>
</tr>
<tr>
<td>TSKC x CTSW - 055</td>
<td>1.429 Ab</td>
<td>7.432 Aa</td>
<td>2.177 Cb</td>
</tr>
<tr>
<td>TSKC x CTSW - 057</td>
<td>2.377 Ab</td>
<td>6.872 Aa</td>
<td>2.959 Bb</td>
</tr>
<tr>
<td>'Rangpur Santa Cruz' lime</td>
<td>1.355 Ab</td>
<td>5.620 Ba</td>
<td>2.059 Ca</td>
</tr>
<tr>
<td>LVK x LCR - 038</td>
<td>2.923 Ab</td>
<td>6.065 Aa</td>
<td>3.593 Ab</td>
</tr>
<tr>
<td>'Sunki' Tropical mandarin</td>
<td>1.089 Ab</td>
<td>7.296 Aa</td>
<td>1.823 Cb</td>
</tr>
</tbody>
</table>

Different uppercase letters indicate significant difference between hybrids by Scott-Knott test ($p < 0.05$) at a same salinity level, whereas different lowercase letters indicate significant difference between salinity levels by F test ($p < 0.05$) for a same genotype; TSKC - 'Sunki' mandarin (Citrus sunki (Hayata) Hort. ex Tanaka); CTSW - 'Swingle' citrumelo (C. paradisi Macfad. x Poncirus trifoliata (L.) Raf.); LVK - Volkmann lemon (C. volkmanniana V. Ten. & Pasq.); LCR - 'Rangpur Santa Cruz' lime (C. limonia Osbeck); LCRSTC - 'Rangpur Santa Cruz' lime
MgCl₂·6H₂O was added to the water, in the treatment with highest salinity (3 dS m⁻¹), which can be related to greater fixation to soil colloids and/or absorption by the genotypes, which had higher demand for the nutrient.

Regarding K contents in the extract, the increase in salinity raised the concentration in the substrate cultivated with the hybrids TSKC x CTSW - 042, TSKC x CTSW - 047, TSKC x CTSW - 048, TSKC x CTSW - 053, TSKC x CTSW - 055, TSKC x CTSW - 057, as well as 'Sunki Tropical' mandarin, which can be attributed to the reserves (stock) of this nutrient adsorbed to the colloids, besides the fertilizations.

Additionally, greater presence of Ca²⁺, Mg²⁺ and Na⁺ ions, applied through irrigation water, may have consequently increased the competition for the adsorption sites; Na⁺, Ca²⁺ and Mg²⁺ are attracted and bound to the colloids, releasing K⁺ to the solution.

García-Sánchez et al. (2006), cultivating 7-year-old plants of 'Clemenules' mandarin (C. Clementina hort. ex Tanaka) grafted onto two rootstocks ('Cleopatra' mandarin (C. reshni hort. ex Tanaka) and 'Carrizo' citrange (C. sinensis x P. trifoliata)), irrigated with water containing NaCl at the concentrations of 3, 15 and 30 mM, for three years, observed increase of toxic ions (Cl⁻ and Na⁺) and reduction of N, P and K contents in the leaves. Reduction of K⁺ concentration in the plant due to increasing salinity is among the most studied effects, and the selective K⁺ adsorption capacity associated with Na⁺ exclusion is known as the tolerance mechanism of some plants to the saline stress (Willadino & Camara, 2010). In addition, elevated concentrations of Ca²⁺ and Mg²⁺ reduce K⁺ adsorption by competitive inhibition, although low Ca²⁺ concentrations have synergetic effect on the nutrition of a few species (Faquin, 2005).

Chlorine is considered as an essential element to plants, but at toxic concentrations, it is toxic. According to the data in Table 3, there was Cl⁻ accumulation in the substrate under irrigation with EC = 3.0 dS m⁻¹. Nonetheless, even under such conditions and although chlorine is the most harmful element to citrus species, when at high contents (Hussain et al., 2012; Syvertsen & Garcia-Sanchez, 2014; Brito et al., 2015), plants maintained their growth.

As already mentioned previously, besides reducing ECse and Na⁺ content in the substrate cultivated with some genotypes, more evident in TSKC x CTSW - 044 and TSKC x CTSW - 045, in these hybrids and also in TSKC x CTSW - 048, chloride contents were lower when plants were irrigated with high-salinity water.

To survive under these conditions, plants may have used mechanisms of tolerance to the stressful condition because, according to Gheyi et al. (2016), Cl⁻-sensitive plants may exhibit symptoms of toxicity, which consist of burn on tip of the leaves, reaching the edges in advanced stages; in general, premature leaf abscission occurs, and these symptoms appear when chloride concentration reaches 0.3 to 1.0%, based on leaf dry matter. Also according to these authors, the maximum chloride level (in mmol dm⁻³) in the saturation extract for Cleopatra mandarin, bitter orange and sweet orange cannot exceed 25, 15 and 10 mmol dm⁻³, respectively, which are lower than the values observed in the present study, as the contents of Na⁺ ions.

In the same context, Ayers & Westcot (1999) cite 10 mmol dm⁻³ as maximum limit allowed of chloride for citrumelo, which would make the salinity observed in the present study even more harmful, considering the values found in the substrate cultivated with the 'Sunki' x 'Swingle' hybrids (TSKC x CTSW), denoting the tolerance capacity of these genotypes.

Complementing this discussion, phytomass data of the genotypes are presented in Table 2, showing differences between rootstocks at each level of water salinity. Even with the use of water containing low salt concentration (0.3 dS m⁻¹), it is noticeable the difference of vigor between the genotypes, particularly TSKC x CTSW - 047, LVK x LCR - 038, TSKC x CTSW - 055 and TSKC x CTSW - 057. These latter two were affected by salinity when plants were irrigated with saline water (3 dS m⁻¹), but even in this condition they remained in the group of higher phytomass.

Except for the two genotypes cited (TSKC x CTSW - 055 and TSKC x CTSW - 057), the rootstocks TSKC x CTSW - 045 and LVK x LCR – 038 were affected also by the highest salinity, because they remained in an inferior group of tolerance to saline stress.

Table 3. Test of means for potassium (K⁺), magnesium (Mg²⁺) and chloride (Cl⁻) in the substrate cultivated with citrus hybrids subjected to water salinity

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>K⁺ (mmol dm⁻³)</th>
<th>Mg²⁺ (mmol dm⁻³)</th>
<th>Cl⁻ (mmol dm⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.3</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>TSKC x CTSW - 041</td>
<td>6.084 Aa</td>
<td>3.082 Ab</td>
<td>3.121 Aa</td>
</tr>
<tr>
<td>TSKC x CTSW - 042</td>
<td>1.840 Bb</td>
<td>4.701 Aa</td>
<td>2.629 Aa</td>
</tr>
<tr>
<td>TSKC x CTSW - 044</td>
<td>1.529 Bb</td>
<td>2.758 Aa</td>
<td>2.499 Bb</td>
</tr>
<tr>
<td>TSKC x CTSW - 045</td>
<td>2.136 Bb</td>
<td>3.066 Aa</td>
<td>2.317 Bb</td>
</tr>
<tr>
<td>TSKC x CTSW - 047</td>
<td>1.620 Bb</td>
<td>3.744 Aa</td>
<td>3.062 Bb</td>
</tr>
<tr>
<td>TSKC x CTSW - 048</td>
<td>0.808 Bb</td>
<td>3.231 Aa</td>
<td>2.115 Bb</td>
</tr>
<tr>
<td>TSKC x CTSW - 049</td>
<td>1.367 Bb</td>
<td>2.529 Aa</td>
<td>2.245 Bb</td>
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<tr>
<td>TSKC x CTSW - 053</td>
<td>1.168 Bb</td>
<td>3.136 Aa</td>
<td>2.167 Bb</td>
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<tr>
<td>TSKC x CTSW - 055</td>
<td>1.061 Bb</td>
<td>3.733 Aa</td>
<td>1.690 Bb</td>
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<td>TSKC x CTSW - 057</td>
<td>2.098 Bb</td>
<td>4.846 Aa</td>
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<td>'Rangpur Santa Cruz' lime</td>
<td>1.679 Bb</td>
<td>2.749 Aa</td>
<td>2.046 Bb</td>
</tr>
<tr>
<td>LVK x LCR – 038</td>
<td>2.156 Bb</td>
<td>2.803 Aa</td>
<td>3.234 Aa</td>
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<tr>
<td>'Sunki' 'Tropical' mandarin</td>
<td>1.448 Bb</td>
<td>4.077 Aa</td>
<td>2.401 Bb</td>
</tr>
</tbody>
</table>

Different uppercase letters indicate significant difference between hybrids by Scott-Knott test (p < 0.05) at a same salinity level, whereas different lowercase letters indicate significant difference between salinity levels by F test (p < 0.05) for a same genotype; TSKC - 'Sunki' mandarin [Citrus sunki (Hayata) hort. ex Tanaka]; CTSW - 'Swingle' citrumelo [C. paradisi Macfad. x Poncirus trifoliata (L.) Raf.]; LVK - 'Volkamer' lemon [C. volkameriana V. Ten. & Pasq.]; LCR - 'Rangpur' lime [C. limonia Osbeck]; LCRSTC - 'Rangpur Santa Cruz' lime
Among the genetic materials, TSKC x CTSW – 055 stands out in the group of genotypes with higher dry matter accumulation in the treatments of both lower and higher salinity, with EC of 7.43 dS m\(^{-1}\) in the saturation extract of the substrate where it was cultivated (Table 1) and chloride concentration of 103.75 mmol dm\(^{-3}\) (Table 3). The EC value is much higher than that of salinity threshold for citrus plants, and chloride concentration exceeds the respective level of toxicity reported in the literature (Ayers & Westcot, 1999).

The highest ECW level did not affect the phytomass of most rootstocks, an evidence of their potential to be used under saline conditions, particularly TSKC x CTSW - 041, TSKC x CTSW - 047, TSKC x CTSW - 049, TSKC x CTSW - 053, as well as 'Sunki Tropical' mandarin, a difference attributed to the hybrid potential of each material (Fernandes et al., 2011; Barbosa et al., 2017).

**Conclusions**

1. Increasing water salinity modifies the absorption nutrient by the genotypes, which have different nutritional demands.

2. Salinization of the substrate irrigated with 3 dS m\(^{-1}\) water is lower when cultivated with the hybrids TSKC x CTSW - 044, TSKC x CTSW - 045, TSKC x CTSW - 048, TSKC x CTSW - 049, and 'Rangpur Santa Cruz' lime.

3. Higher concentration of salts in the water increases K\(^+\) concentration in the substrate cultivated with the hybrids TSKC x CTSW - 042, TSKC x CTSW - 047, TSKC x CTSW - 048, TSKC x CTSW - 053, TSKC x CTSW - 055 and TSKC x CTSW – 057, indicating lower absorption of K\(^+\).

**Acknowledgments**

To the National Council for Scientific and Technological Development (CNPq), for providing financial resources through the Universal call 014/2014 and research grants; to Embrapa Cassava and Fruits, for the partnership in the study.

**Literature Cited**


