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CITRUS ROOTSTOCK, VARIETIES AND TRIFOLIATE HYBRIDS, UNDER SALINE STRESS

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ABSTRACT: The objective of study was to determine sensitivity of varieties and hybrids of trifoliate to salinity during the rootstock stage. The experiment was carried out in a green house of UAEAg/CTRN of UFCG in a randomized block design, with five repetitions each consisting of four plants, five levels of irrigation water salinity (control, tap water with electrical conductivity (EC_w) of 0.41 dS m^{-1} and water with EC_w of 1.0; 2.0; 3.0 and 4.0 dS m^{-1}) and six genotypes. During 150 days growth and physiological variables were evaluated. Significant effects of genotypes and salinity in the variables were observed. In case of growth variables, more expressive reduction was found for total dry matter with unit increase of EC_w. In lemon Volkameriano with increase in salinity, increase in total dry weight was observed where as a linear reduction was found in citrange Troyer and HTR 069. The lemon Volkameriano is indicated for the formation of rootstock seedlings of citrus under saline conditions due to its lower sensitivity.
KEY WORDS: Citrus sp, salinity stress, growth

INTRODUCION: Brazil occupies the first position in orange juice concentrate and frozen production and export, with a planted area of around 1,300,000 hectares, with the Northeast region, the second largest producing region of the country, accounting for 9% of national production, with more than 110,000 hectares cultivated and production of more than 1.5 million tonnes. However, productivity is still low, due primarily to water deficit (Cruz, 2003) thus requires the use of irrigation therefore special attention is necessary regarding the soil management to prevent salinization, especially when the water source has high concentrations of salts. Under such situations. The generation of knowledge that allows the use of saline waters ensuring their sustainability is very important.
It is known that the salinity tolerance is variable among species and even in the same species, it may vary with stage of development. At each stage the tolerance to salinity is controlled by more than one gene and is highly influenced by environmental factors (Flowers, 2004; Flowers & Flowers, 2005; Munns, 2005). The ability of plant to adapt is very useful and allows the selection of genotypes more tolerant and capable of producing economically when soil salinity can not be kept at low levels (Tester & Davenport, 2003).
In the Brazilian citrus industry, the Rangpur lemon has been used in 80% of the grafted plants (Azevedo, 2003), This preference is understandable, since the characteristics of the 'Rangpur' satisfy both the nurserymen as well as the citrus growers. The risk of emergence of diseases and disorders of other kinds, such as salinity stress are evident which may cause immensurable damages in citrus growth as identified by Singh et al. (2003), hence it is necessary to choose rootstocks tolerant to

salinity. The objective this work is to study the sensitivity of citrus rootstochs, improved varieties and trifoliate hybrids, under salinity during the formation of rootstock.

MATERIAL AND METHODS: The experiment was carried out in protected environment (greenhouse) of the Center of Technology and Natural Resources - CTRN of UFCG, located in Campina Grande-PB (geographical coordinates 7º15'18"S latitude and 35°52'28"W longitude), at an altitude of 550 m. Five levels of electrical conductivity of irrigation water (EC_w) were tested: control (irrigation with municipal supply water, EC_w of 0.41 dS m^{-1}); and waters with EC_w of 1.0 , 2.0, 3.0 and 4.0 dS m^{-1}, combined with six genotypes improved by Embrapa (1. lemon Rangpur 'Santa Cruz', 2. mandarin Sunki Tropical 3. citrange Troyer 4. lemon Volkameriano 5. hybrid trifoliate (HTR) -051; and 6. HTR - 069). The experiment was conducted in randomized blocks, with five replicates, in a factorial (5 levels of salinity x 6 genotypes) design, each experimental unit (replication) consisted of four plants.

The plant height (PH), stem diameter (DIA), leaf area (LA), the relative water content (RWC), and total dry matter (TDM) were evaluated following recommendations of Fernandes (2002).

The data obtained were analyzed by analysis of variance using F test. In cases of significance, polynomial regression analysis of the factor 'salinity of irrigation water' were performed using the software SAEG 9.0.

RESULTED AND DISCUSSION: Linear test decrease for the height of plant in citrange Troyer and in lemon Volkameriano (Table 1), with reduction of 2.68 and 1.39 cm with unit increase of EC_w, respectively were observed. In other genotypes the quadratic behavior with a maximum height estimated at ECw of 1.29, 1.59, 0.14 and 0.13 dS m^{-1} for the lemon Rangpur, mandarin Sunki, HTR-051 and HTR-069, respectively were found. The citrange Troyer although presented highest mean height but showed strong decrease in growth with unit increase of EC_w.

The highest mean stem diameter estimated in regression equations (Table 1), was observed in lemon Volkameriano (0.42 cm), however decrease of 0.0239 cm in diameter with unit increase in EC_w was observed. Strong reduction with unit increase was observed in citrange Troyer. In Rangpur lemon, Sunki mandarin and HTR-051 quadratic behavior was observed with highest diameter estimated at EC_w of 1.6, 2.53 and 1.70 dS m^{-1}. Among genotypes the diameters varied between 0.3 and 0.45 cm, higher than that obtained by Souza et al. (2005) (1.68 mm for hybrid of Trifoliate under different substrates), but below the ideal for the purposes of grafting (0.8 to 1.0 cm).

In citrange Troyer and lemon Volkameriano decreasing linear behavior for leaf area (Table 1), with reduction of 15.46 and 9.69 cm^2 with unit increase in EC_w, respectively. According to regression analysis, the quadratic model fit teed well for Rangpur lemon, Sunki mandarin, HTR-051 and HTR-069, with maximum area at EC_w of 2.06, 1.28, 1.31 and 1.17 dS m^{-1}, respectively. For each genotype a close relation is observed between the leaf area and plant height, indicating predictive relation between these two variables, which indicates importance of leaf area in the formation of compounds for growth (Taiz & Zeiger, 2006).

Table 1: Regression equations for plant height, stem diameter and leaf area. Campina Grande, 2008

Genotype	Plant height (cm)	Stem diameter (cm)	Leaf Area (cm²)
Rangpur Lemon	$y=-0,3855x^2+0,9987x+29,45$ $R^2 = 0,9877^{**}$	$y=-0,0025x^2+0,004x+0,3576$ $R^2 = 0,9033^{**}$	$y=-11,1x^2+45,95x+140,76$ $R^2 = 0,9845^{**}$
Sunki Mandarin Tropical	$y=-2,8026x^2+8,9661x+25,385$ $R^2 = 0,8971^{**}$	$y=-0,0051x^2+0,0258x+0,217$ $R^2 = 0,9795^{**}$	$y=-16,892x^2+43,082x+158,99$ $R^2=0,9159^{**}$
Citrange Troyer	$y=-2,6864x+38,82$ $R^2=0,9354^{**}$	$y=-0,0354x+0,4327$ $R^2=0,9295^{**}$	$y = -15,462x+150,65$ $R^2 = 0,9441^{**}$
Volkameriano Lemon	$y=-1,3889x+33,691$ $R^2=0,8401^{**}$	$y = -0,0239x + 0,443$ $R^2 = 0,9406^{**}$	$y = -9,6982x + 279,41$ $R^2 = 0,8706$
HTR-051	$y=-2,5805x^2+8,607x+25,876$ $R^2=0,9347^{**}$	$y=-0,0118x^2+0,0401x+0,288$ $R^2=0,9009^{**}$	$y=-8,599x^2+22,583x+94,883$ $R^2=0,9043$
HTR - 069	$y=-0,47x^2+1,7355x+29,223$ $R^2= 0,9742^{**}$	$y = -0,0081x + 0,3267$ $R^2 = 0,9001^{**}$	$y=-2,7969x^2+6,552x+109,92$ $R^2= 0,8227$

The relative water content in the leaves decreased linearly with increasing salinity of irrigation water. In Rangpur lemon, Troyer citrange, Volkameriano, HTR-051 and the HTR - 069, its was of the order of 1.37, 1.41, 0.59, 2.68 and 2.05% with unit increase in EC_w, respectively (Table 2), highlighting the Volkameriano with better maintenance of the cellular water content (less decrease with increasing salinity). In mandarin Sunki a quadratic behavior with highest relative water content at 1.27 dS m^{-1} and decrease between this level and the salinity of 4 dS m^{-1} was of 9.17%. The reduction in the relative water content was also observed by Machado (1999) with the decrease in humidity of the substrate.
Comparatively more dry matter was observed in Rangpur lemon, the quadratic equation (Table 2) provided highest total dry material at 1.68 dS m^{-1}, between this level and the 4 dS m^{-1}, the reduction was 26.83% in dry matter; quadratic behavior was also observed in Sunki mandarin and HTR -051 with highest dry matter accumulation at EC_w of 1.65 and 1.67 dS m^{-1}. In Troyer, Volkameriano and HTR-069 decreasing linear regressions were observed, with a reduction of 0.20, 0.23 and 0.09 g, respectively with unit increase in salinity. Peixoto et al. (2006) also noted the decrease in dry matter of citrus genotypes under effect of water stress, and the water stress is a component of salt stress. In this variable reduction with unit increase of ECw, indicating their potential representation of the effect of salt stress on to rootstocks of citrus, except in Volkamerino, with increment in total dry matter.

Table 2: Regression equations for relative water content and total dry matter. Campina Grande, 2008

Genotype	Relative Water Content (%)	Total Dry Matter (g)
Rangpour Lemon	$y=-1,3778x+86,349$ $R^2=0,8732^{**}$	$y=-0,1922x^2+0,6454x+3,3253$ $R^2=0,9959^{**}$
Mandarin Sunki tropical	$y = -1,045x^2 + 2,6672x + 82,781$ $R^2 = 0,8846^{*}$	$y = -0,2919x^2 + 0,9633x + 1,9104$ $R^2 = 0,9873^{**}$
Citrange Troyer	$y = -1,406x + 82,851$ $R^2 = 0,9239^{**}$	$y = -0,2073x + 2,4826$ $R^2 = 0,879^{*}$
Lemon Volkameriano	$y = 0,5915x + 82,135$ $R^2 = 0,8631^{**}$	$y = 0,2386x + 3,8365$ $R^2 = 0,8688^{**}$
HTR-051	$y = -2,6769x + 88,351$ $R^2 = 0,8201^{*}$	$y = -0,2342x^2 + 0,7827x + 1,5145$ $R^2 = 0,9179^{**}$
HTR - 069	$y = -2,0519x + 86,936$ $R^2 = 0,8757^{**}$	$y = -0,0872x + 2,0794$ $R^2 = 0,9199^{**}$

CONCLUSIONS:

- ✓ The salinity decreases linearly the growth of Troyer citrange and HTR 069;
- ✓ The total dry weight is the variable that best represents the evaluation of salinity stress on rootstocks of citrus;
- ✓ The relative water content in plants decreases linearly with increasing salinity, in most genotypes;
- ✓ The lemon Volkamerino genotype is less sensitive to salt stress and Troyer more sensitive.
- ✓ The Volkamerino lemon is indicated for formation of rootstocks citrus

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