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Citrus rootstocks influence the population densities of pest mites

Porta-enxertos cítricos influenciam a densidade populacional de ácaros fitófagos

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ABSTRACT

*Citrus are attacked by pest mites such as the citrus rust mite **Phyllocoptruta oleivora** (Ashmead) (Acari: **Eriophyidae**) and the spider mite **Tetranychus mexicanus** (McGregor) (Acari: **Tetranychidae**). However, little is known on citrus rootstocks influencing pest mites. We aimed to evaluate the influence of rootstocks on population densities of pest mites on the sweet oranges 'Pera CNPMF D-6' and 'Valencia Tuxpan' throughout time. Adults of both mite species were monthly counted during 19 months from June 2011 to February 2013. Rootstocks influenced the populations of pest mites, since lower densities of **P. oleivora** were found on 'Pera CNPMF D-6' sweet orange grafted on the hybrid TSKC × CTTR - 002 and on 'Swingle' citrumelo in comparison with the hybrid LVK × LCR - 010, 'Red' rough lime and 'Santa Cruz' rangpur lime as rootstocks. Similarly, lower densities of **T. mexicanus** were found on 'Valencia Tuxpan' sweet orange grafted on the hybrid HTR-051 in comparison to 'Indio' citrandarin, 'Sunki Tropical' mandarin and LVK × LCR - 010 as rootstocks. We concluded that densities of the mites **P. oleivora** and **T. mexicanus** on the sweet oranges 'Pera CNPMF D-6' and 'Valencia Tuxpan' were affected in some periods of the year by some rootstocks, suggesting influence of some genotypes on these pests.*

Key words: *citrus rust mite, **Phyllocoptruta oleivora**, population fluctuation, **Tetranychus mexicanus**.*

RESUMO

*Os citros são atacados por ácaros-praga como o ácaro-da-falsa-ferrugem **Phyllocoptruta oleivora** (Ashmead) (Acari: **Eriophyidae**) e **Tetranychus mexicanus** (McGregor) (Acari: **Tetranychidae**). No entanto, pouco é conhecido sobre o efeito de porta-enxertos sobre populações de pragas. O objetivo deste trabalho foi avaliar a influência de porta-enxertos nas densidades populacionais de ácaros-praga nas laranjeiras 'Pera CNPMF D-6' e 'Valência Tuxpan' ao longo do tempo. Adultos das espécies de ácaro citadas foram quantificados mensalmente, durante 19 meses, de junho de 2011 a fevereiro de 2013. Os porta-enxertos influenciaram as populações dos ácaros-praga, uma vez que menores densidades de **P. oleivora** foram encontradas em laranjeira 'Pera CNPMF D-6', enxertada no híbrido TSKC × CTTR - 002 e no citrumelo 'Swingle', em comparação com o que se observou em relação aos porta-enxertos LVK × LCR - 010, limoeiro 'Rugoso vermelho' e limoeiro 'Cravo Santa Cruz'. Similarmente, menores densidades de **T. mexicanus** ocorreram em laranjeira 'Valência Tuxpan' enxertada no híbrido HTR-051, em comparação com o que se deu em relação aos porta-enxertos citrandarin 'Indio', tangerineira 'Sunki Tropical' e LVK × LCR - 010. Concluiu-se que as densidades dos ácaros **P. oleivora** e **T. mexicanus** nas laranjeiras 'Pera CNPMF D-6' e 'Valencia Tuxpan' foram afetadas pelo porta-enxerto em determinados períodos do ano, sugerindo influência de alguns genótipos sobre essas pragas.*

Palavras-chave: *ácaro-da-falsa-ferrugem, **Phyllocoptruta oleivora**, flutuação populacional, **Tetranychus mexicanus**.*

INTRODUCTION

The states of Bahia and Sergipe comprise the main citrus producing region in Northeastern Brazil, respectively the second and fourth national producers (AGRIANUAL, 2013). Throughout this region, most farmers cultivate the 'Pera' sweet orange [***Citrus sinensis*** (L.) Osbeck] (***Rutaceae***) grafted either on rangpur lime [hybrid of ***Citrus reticulate*** Blanco ×

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C. cinensis (***Rutaceae***)] or on 'Santa Cruz' rangpur lime [***C. jambhiri*** Lush. (***Rutaceae***)] (PRUDENTE & SILVA, 2009). This low genetic diversity of scion and rootstock varieties may lead to increasing pest and disease problems. Therefore, before introducing new rootstock and scion varieties to this region it is important to evaluate its susceptibility to pests as their attack reduces both yield and orchard longevity besides contributing to higher production costs (MENDONÇA & SILVA, 2009; PRUDENTE & SILVA, 2009).

Plant resistance is an important strategy of integrated pest management (GALLO et al., 2002; CHACÓN et al., 2012) and it contributes for keeping pests bellow economic levels in addition to being nontoxic to the environment and people, acting continuously against pests (GALLO et al., 2002; VENDRAMIM & GUZZO, 2009; 2011). Resistant varieties are less damaged by pests in comparison to susceptible varieties in equal conditions due to their genotype constitution (VENDRAMIM & GUZZO, 2009; 2011). Regarding citrus, it is possible that rootstocks influence pests due to their genetic characteristics. In northeastern Brazil, citrus orchards are attacked by several pests including the citrus rust mite ***Phyllocoptruta oleivora*** (Ashmead) (Acari: ***Eriophyidae***) and the spider mite ***Tetranychus mexicanus*** (McGregor) (Acari: ***Tetranychidae***). Citrus rust mite is a key pest in the main citrus producing regions of Brazil and its attack may lead to yield losses as well as aesthetic changes in fruit appearance and reduction in total soluble solids (CHIARADIA, 2001; MORAES & FLECHTMANN, 2008; MENDONÇA & SILVA, 2009). The mite ***T. mexicanus*** is a leaf pest of several crops including citrus (PRITCHARD & BAKER, 1955; QUIROS-GONZALEZ, 2000; RAZMJOU et al., 2009; VACANTE, 2010).

In this study, we aimed to evaluate the influence of the rootstock on the population densities of the pest mites ***P. oleivora*** and ***T. mexicanus*** on the 'Pera CNPMF D-6' and 'Valencia Tuxpan' sweet oranges over time.

MATERIALS AND METHODS

Evaluations were carried out from June 2011 to February 2013 in a 3 year old citrus orchard located at the experimental area of the Embrapa Coastal Tablelands, in the municipality of Umbaúba, Sergipe State, Brazil (11°22'37" S, 37°40'20" W, 109 m above sea level). The experimental area was managed as a commercial orchard with management practices such as fertilizing, pruning, weed and pest control, since the experiments are part of a greater project aiming to select rootstocks for the region. Pesticide spraying was conducted over the period of pest evaluation using imidacloprid (June, September and December 2011, August and December 2012), deltamethrin (October 2011), vegetal oil (October and December 2012) and mineral oil (February 2013).

The first experiment consisted of the 'Pera CNPMF D-6' sweet orange grafted on 10 rootstocks (treatments) in a completely randomized design with four replicates. Rootstocks were the 'Red' rough lime; 'Santa Cruz' rangpur lime; 'Swingle' citrumelo [***C. paradisi*** Macfad. × ***Poncirus trifoliata*** (L.) Raf. (***Rutaceae***)]; 'Orlando' tangelo [***C. paradisi*** × ***C. tangerina*** hort. ex Tanaka (***Rutaceae***)]; 'Indio' citrandarin; and 'Riverside' citrandarin [both resulting from a cross between ***C. sunki*** (Hayata) hort. ex Tanaka × ***P. trifoliate*** (***Rutaceae***)] and HTR-051 (a trifoliate hybrid); TSKC ('Sunki' mandarin, ***C. sunki***) × CTTR - 002 ('Troyer' citrange, ***C. sinensis*** × ***P. trifoliata***); TSKFL ('Florida Sunki' mandarin) × CTTR - 017 and LVK [***C. volkameriana*** V. Ten. & Pasq. (***Rutaceae***)] × LCR - 010 (rangpur lime). These last four hybrids were obtained by the Citrus Breeding Program of Embrapa Cassava & Fruits, at Cruz das Almas, Bahia State, Brazil. Each experimental unit consisted of two plants and adults of the citrus rust mite were monthly counted on one plant chosen in a $1cm^2$-area. For this, two randomly-selected fruits were evaluated per plant totaling eight fruits per treatment in each evaluation. Care was taken to select only fruits located in the external part of the canopy since this region is the most attacked by ***P. oleivora*** (MENDONÇA & SILVA, 2009).

The second experiment consisted of the 'Valencia Tuxpan' sweet orange grafted on 11 rootstocks (treatments) in a completely randomized design with four replicates. Rootstocks were the 'Red' rough lime; 'Santa Cruz' rangpur lime; 'Swingle' citrumelo; 'Orlando' tangelo; 'Indio'; and 'Riverside' cintradarins, 'Sunki Tropical' mandarin; and the hybrids HTR-051; TSKC × CTTR - 002; TSKFL × CTTR – 017; and LVK × LCR – 010. Each experimental unit consisted of two plants and adults of the pest mite ***T. mexicanus*** were monthly counted on one plant chosen in a $1cm^2$-area. For this, four randomly-collected leaves, one from each quadrant, were evaluated per plant totaling 16 leaves per treatment in each evaluation.

Repeated measures ANOVAs followed by post hoc Fisher tests were carried out to determine the effect of rootstocks on population densities of ***P. oleivora*** and ***T. mexicanus*** over time. ANOVAs followed by post hoc Fisher were performed to compare population densities of either ***P. oleivora*** or ***T. mexicanus*** among rootstocks in each month. Pearson correlations between mean temperature (°C), mean relative humidity (%), rainfall (mm/month) and population densities of ***P. oleivora*** and ***T. mexicanus*** were conducted. Temperature and relative humidity data were obtained from the database of the National Institute of Meteorology (INMET, 2013) and rainfall data were collected in the database of the National Institute for Space Research (INPE, 2013). Data were log x+1 transformed prior to analyses.

RESULTS AND DISCUSSION

Population densities of the citrus rust mite ***P. oleivora*** on 'Pera CNPMF D-6' sweet orange were affected by rootstocks ($F_{9, 30}$=2.299; P=0.042). Lower densities of ***P. oleivora*** were found on combinations of 'Pera CNPMF D-6' sweet orange grafted on TSKC × CTTR - 002 and 'Swingle' citrumelo in comparison with LVK × LCR - 010, 'Red' rough lime and 'Santa Cruz' rangpur lime as rootstocks (Figure 1). Similarly, population densities of the pest mite ***T. mexicanus*** on 'Valencia Tuxpan' sweet orange were influenced by rootstocks ($F_{10, 33}$= 2.237; P=0.041; Figure 2). Lower densities of ***T. mexicanus*** were found on this sweet orange grafted on HTR-051 in comparison to 'Indio' citrandarin, LVK × LCR - 010 and 'Sunki Tropical' mandarin as rootstocks (Figure 2).

Rootstocks influenced population densities of pest mites ***P. oleivora*** and ***T. mexicanus*** so that higher densities of both mites were found on LVK × LCR - 010 as rootstock. This is in line with a study by MORAES et al. (1995) which also found that rootstocks influenced the incidence of the citrus rust mite on leaves of the sweet oranges 'Seleta Franck', 'Hamlin' and 'Valencia'. Antibiosis and antixenosis denote adverse effects of resistant cultivars on biological parameters and on behavior (non-preference for some genotypes) of arthropods, respectively (KOGAN & ORTMAN, 1978; VENDRAMIM & NISHIKAWA, 2001; GALLO et al., 2002). However, additional laboratory studies are necessary to determine the existence of antibiosis and antixenosis as possible mechanisms underlying the resistance of some rootstocks to the pest mites ***P. oleivora*** and ***T. mexicanus***.

There was an interaction between time and rootstocks on densities of ***P. oleivora*** ($F_{90.300}$=1.309; P=0.049) in that higher densities were observed on 'Pera CNPMF D-6' sweet orange grafted on LVK × LCR - 010 than those grafted on 'Swingle' citrumelo and TSKC × CTTR – 002 in January 2012 (Figure 3). Overall, higher population densities of ***P. oleivora*** occurred between January and March 2012 in comparison with other months ($F_{10.300}$ = 16.12; P=0.00) (Figure 3). There was an interaction between time and rootstocks on densities of ***T. mexicanus*** ($F_{130, 429}$=1.535; P=0.0007) so that

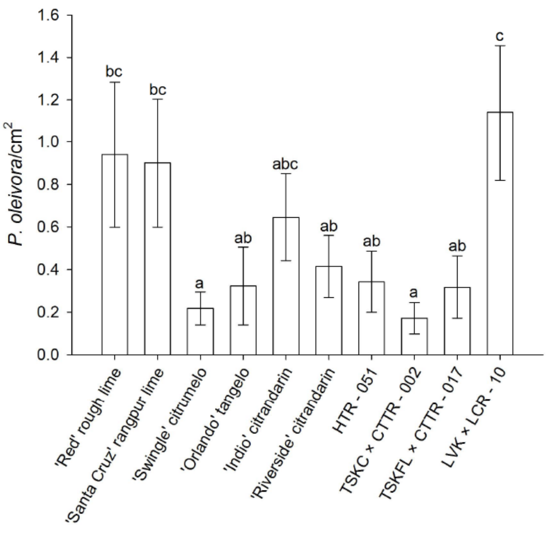

Figure 1 - Population densities of the citrus rust mite ***Phyllocoptruta oleivora*** (Acari: ***Eriophyidae***) on fruits of 'Pera CNPMF D-6' sweet orange [***Citrus sinensis*** (L.) Osbeck] grafted on 10 rootstocks. Means ± standard error are shown (untransformed data).

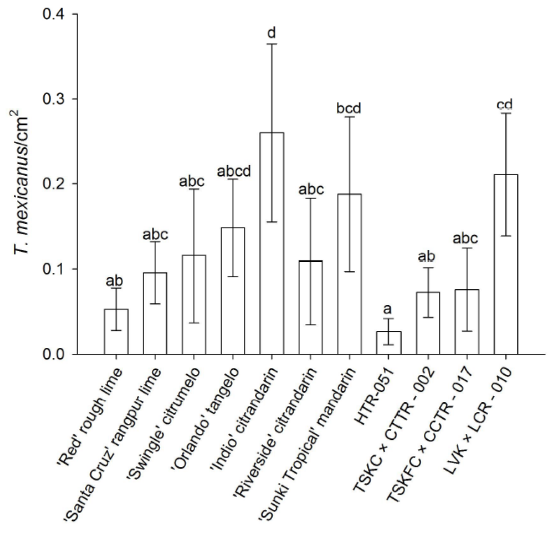

Figure 2 - Population densities of the mite ***Tetranychus mexicanus*** (Acari: ***Tetranychidae***) on leaves of 'Valencia Tuxpan' sweet orange [***Citrus sinensis*** (L.) Osbeck] grafted on 11 rootstocks. Means ± standard error are shown (untransformed data).

higher densities were observed on 'Valencia Tuxpan' sweet orange grafted on Indio citrandarin in January 2013 in comparison with remaining rootstocks. In general, densities of ***T. mexicanus*** peaked in January 2013 in comparison to other months ($F_{13, 429}$=19.592; P=0.000) (Figure 4).

Both pest mites were influenced by time. Higher population densities of ***P. oleivora*** occurred in January and February 2012 during the dry season, which in this region usually starts in October and lasts until March. Densities of ***T. mexicanus*** also peaked in the dry season although a clear peak occurred only in January 2013. However, the abiotic factors temperature, relative humidity and rainfall did not influence densities of either ***P. oleivora*** or ***T. mexicanus***. No correlation among the abiotic factors temperature, relative humidity and rainfall and densities of either ***P. oleivora*** (r_p<0.827; P>0.05) or ***T. mexicanus*** (r_p<0.908; P >0.05) were observed.

Rootstocks interacted with time on densities of pest mites in that higher densities of either ***P. oleivora*** or ***T. mexicanus*** were observed on the scion varieties studied grafted on some rootstocks in certain periods of the year. Therefore, population densities of the pest mites ***P. oleivora*** and ***T. mexicanus*** on the 'Pera CNPMF D-6' and 'Valencia Tuxpan' sweet oranges were influenced only in some periods of the year by some rootstocks, suggesting the presence of putative resistance mechanisms in some genotypes to these pests. However, additional studies are necessary to confirm the existence of resistance and for identifying its type.

As the experiments were carried out as commercial orchards, thereby reflecting the management practices of the region, pesticide sprayings may have negatively influenced evaluations of the populations of ***P. oleivora*** and ***T. mexicanus***. For instance, imidacloprid and deltamethrin sprayings in 2011 possibly prevented ***P. oleivora*** from reaching higher peaks in this period and in early 2012. Densities of this pest remained close to zero from April 2012 onwards and this could be related to pesticide use and high temperatures, as the optimum temperature to ***P. oleivora*** development is around 24ºC (MCCOY et al., 1996) and high temperatures occur in the region where experiments were carried

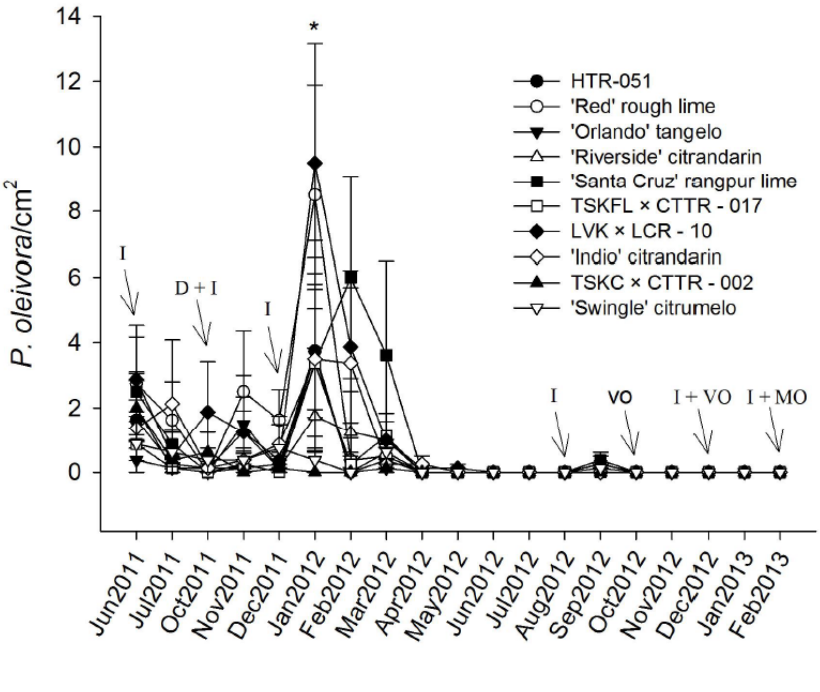

Figure 3 - Temporal changes in population densities of the citrus rust mite ***Phyllocoptruta oleivora*** (Acari: ***Eriophyidae***) on fruits of 'Pera CNPMF D-6' sweet orange [***Citrus sinensis*** (L.) Osbeck] grafted on 10 rootstocks. Means ± standard error are presented (untransformed data). Asterisk represents significant difference in the density of ***P. oleivora*** among rootstocks in January 2012. Arrows indicate spraying with imidacloprid (I), deltamethrin (D), mineral oil (MO) and vegetal oil (VO).

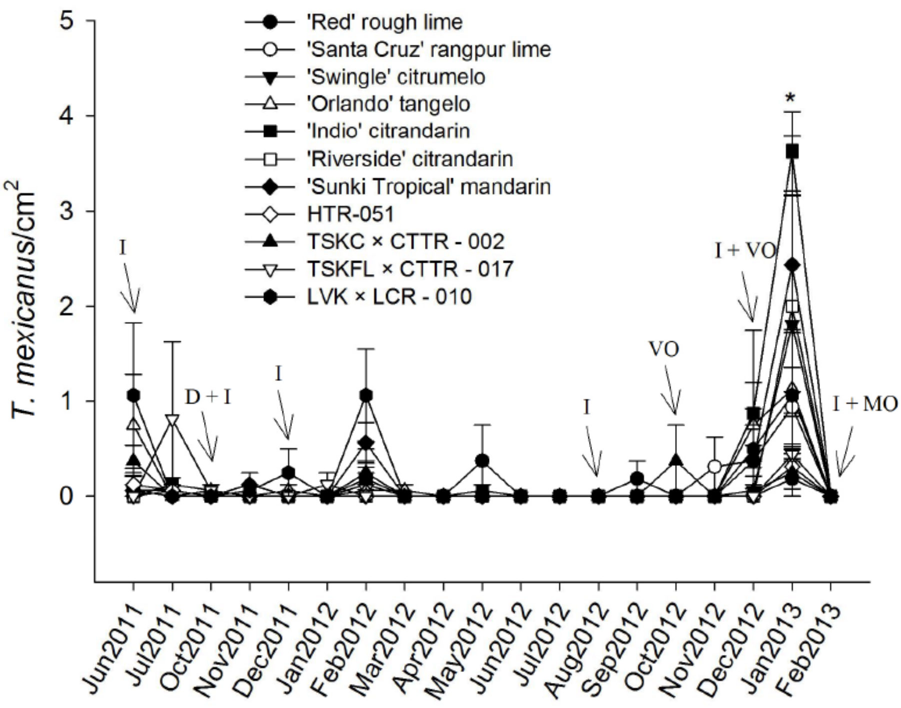

Figure 4 - Temporal changes in population densities of the mite ***Tetranychus mexicanus*** (Acari: ***Tetranychidae***) on leaves of 'Valencia Tuxpan' sweet orange [***Citrus sinensis*** (L.) Osbeck] grafted on 11 rootstocks. Means ± standard error are shown (untransformed data). Asterisk represents significant difference in the density of ***T. mexicanus*** among rootstocks in January 2013. Arrows indicate spraying with imidacloprid (I), deltamethrin (D), mineral oil (MO) and vegetal oil (VO).

out, especially in the dry season. Also, higher densities of ***T. mexicanus*** were observed in February 2012 and January 2013 following previous applications of imidacloprid. Indeed, imidacloprid is associated with population increase of tetranychid mites (SCLAR et al., 1998; SZCZEPANIEC et al., 2011). Lower densities of ***T. mexicanus*** over the evaluation period may be also related to pesticide sprayings. For both mites, population densities peaked only in periods without pesticide applications highlighting that if the studies had been conducted without the application of pesticides the results could have been more consistent, however all pesticides were equally sprayed in all treatments and therefore not invalidating our results. Moreover, pesticide spraying is part of the management practices adopted throughout Sergipe's citrus producing areas and it cannot be disregarded when selecting rootstocks for the regional production system.

CONCLUSION

Rootstocks influence population densities of the pest mites ***P. oleivora*** and ***T. mexicanus*** on the 'Pera CNPMF D-6' and 'Valencia Tuxpan' sweet oranges in some periods of the year. Overall, higher densities of both mites are found on LVK × LCR - 010 in comparison with remaining rootstocks.

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