

## Performance of Parana grapefruit on three different rootstocks in Paraguay

Carlos Roberto Wlosek-Stañgret<sup>1,2</sup>, Blanca Isabel Canteros<sup>3</sup> & Cesar Daniel Venialgo<sup>2</sup>

### SUMMARY

Citrus cultivation in south-eastern Paraguay has increased over the last years. In this area, the climate is favourable for canker disease, which is endemic to this region and limits grapefruit growth. We investigated the performance of the Parana grapefruit (*Citrus paradisi* Macf.), which has shown high field-resistance to canker. The trial was performed on three different rootstocks. Tree growth, yield per tree and per hectare and productivity were determined. The variety presented an excellent adaptation to the ecological and social conditions of south-eastern Paraguay. In addition, it meets the requirements and high standards of juice quality of the international market.

**Index terms:** *Citrus paradisi*, rootstocks, growth, yield.

### Desempenho do pomelo Parana em três porta-enxertos diferentes no Paraguai

### RESUMO

O cultivo de citros no sudeste do Paraguai aumentou nos últimos anos. Nesta área, o clima é favorável à doença cancro cítrico, que é endêmica desta região e limita o crescimento dos pomelos. Avaliou-se o desempenho do pomelo Parana (*Citrus paradisi* Macf.), que mostrou alta resistência ao cancro cítrico, em campo. O ensaio foi realizado em três diferentes porta-enxertos. O crescimento da árvore, o rendimento por árvore e a produtividade por hectare foram determinados. A variedade apresentou uma excelente adaptação às condições ecológicas e sociais do sudeste do Paraguai. Além disso, ele atende aos requisitos e padrões elevados de qualidade de suco do mercado internacional.

**Termos de indexação:** *Citrus paradisi*, porta-enxertos, crescimento, rendimento.

<sup>1</sup> Facultad de Ciencias Agrarias, Universidad Nacional de Asunción, Santa Rosa, Misiones, Paraguay

<sup>2</sup> BTA, Don Constantino Trociuk, Fram, Itapúa, Paraguay

<sup>3</sup> Estación Experimental Bella Vista, Instituto Nacional de Tecnología Agropecuaria, Bella Vista, Corrientes, Argentina

**Corresponding author:** Carlos Roberto Wlosek-Stañgret, Facultad de Ciencias Agrarias, Universidad Nacional de Asunción, Campus Universitario, Facultad de Ciencias Agrarias, Casilla, 1618, Santa Rosa, Misiones, Paraguay. E-mail: cwlosek@hotmail.com

## INTRODUCTION

The Parana grapefruit is one of the main white grapefruit varieties used in the concentrated juice industry of Paraguay. More than 1,500 ha are cultivated across the country, mainly by small farmers due to its rusticity, productivity and canker resistance (Wlosek Staňgret et al., 2015a).

The trees are medium sized and smaller than the 'Duncan' variety. This variety presents an excellent adaptation to the ecological and social conditions of south-eastern Paraguay and meets all requirements and high standards of juice quality for the international market (Rinsdahl-Canavosio et al., 2010; Canteros et al., 2013).

The objective of this work was to study the adaptation and performance of the grapefruit variety Parana, which is a valuable variety due to its field resistance to citrus canker, caused by *Xanthomonas axonopodis* pv. *citri* (Canteros, 1994; Gochez & Canteros, 2008; Wlosek Staňgret et al., 2015a).

The variety has been planted in the region since 2004 and is registered in Paraguay in the SENAVE (Servicio Nacional de Calidad y Sanidad Vegetal y de Semillas) under Resolution 857-2011 in the National Registry of Commercial Cultivars (RNNC) as a grapefruit (*Citrus paradisi*) variety, Parana cultivar (Ávalos-Zorrilla & Canteros, 2011; Canteros et al., 2013).

It can be easily managed in nurseries and orchards, has few thorns, some resistance to frost damage and shows precocity, without alternancy. The harvest is from March to July, fruits are 8.0 to 8.5 cm in diameter, with an average weight of 280 g and a mean of 40 seeds per fruit, a juice yield of 40% and a high ratio (7.5 to 11.5) at harvest.

## MATERIAL AND METHODS

Plants of the Parana grapefruit (*Citrus x paradisi* Macf.) were planted in 2006, using the following rootstocks: Volkamer lemon (*C. volkameriana* Ten & Pasq.), Swingle citrumelo (*C. paradisi* Macf. x *Poncirus trifoliata* L.) and Cleopatra mandarin (*C. reshni* Hort. ex Tan.). The study was arranged in randomised complete-blocks with six plots (replications) and three plants per plot. Planting density was equivalent to 416 trees per ha, with a spacing of 6 × 4 m between rows and plants.

The trial was located at the Experimental Farm of Empresa Trociuk in Fram, Itapúa (between 25° and 27°S), with an elevation of 200 m above sea level. The soil is a latosol of red clay basaltic origin. Mean annual temperature is 21 °C, with a minimum of -2 °C and a maximum of 39 °C. Mean annual rainfall is 1,700 mm.

Trunk cross-section area (TCSA), tree trunk cross-section area increase (TCSAI) and crop efficiency index (CEI) (fruit production per tree/tree trunk cross-section area) were obtained for each plot. Results were analysed by analysis of variance using the INFOSTAT program. Significance of differences between treatment means was determined using Duncan's test.

## RESULTS AND DISCUSSION

Fruits were harvested at the end of July from 2012 to 2016 during one harvesting event. Each plot was harvested separately; weight was expressed per tree and yield per hectare. Fruit production was determined by the crop efficiency index (CEI) using the formula  $CEI = \text{fruit production per tree/tree trunk cross-section area in a given year}$  (Table 1).

Differences between rootstocks were observed in terms of yield and growth. In 2012, the yield parameters of Volkamer lemon were significantly higher than those of the other two rootstocks, while in 2013, 2014, 2015 and 2016, Swingle and Cleopatra obtained highest values. The crop efficiency index was similar for all rootstocks in 2012-2013.

Several rootstocks obtained good results in the trial for the selection of the most appropriate rootstock for the grapefruit variety Parana. However, the cumulative production data and the fructification index of the trees on Cleopatra tangerines showed the highest values (Table 2).

## CONCLUSIONS

The variety presented an excellent adaptation to the ecological and social conditions of south-eastern Paraguay; similar results were obtained in previous years (Wlosek Staňgret et al., 2015b); in addition, it meets the requirements and high standards of juice quality of the international market.

**Table 1.** Influence of rootstocks on tree growth and yield of Parana grapefruit in 2012 and 2016 in south-eastern Paraguay. Growth is expressed as trunk cross-section area (TCSA), tree trunk cross-section area increase (TCSAI) and yield per tree, per ha and as CEI = fruit production per tree/tree trunk cross-section area

	kg tree <sup>-1</sup>	Yield kg ha <sup>-1</sup>	TCSA (cm <sup>2</sup> )	
2012				
Swingle	134 a	55,744 a	92.84 b	
Volkamer	89 b	37,024 b	128.13 a	
Cleopatra	83 c	34,528 b	98.42 b	
				TCSAI (cm <sup>2</sup> )
2013				
Swingle	101 b	42,016 b	142.00 a	14.00 c
Volkamer	111 a	46,176 a	119.00 c	26.00 b
Cleopatra	110 a	45,760 a	127.00 b	29.00 a
2014				
Swingle	110 b	45,760 b	152.33 a	10.67 b
Volkamer	120 a	49,920 a	145.83 a	27.17 a
Cleopatra	123 a	51,168 a	141.00 a	13.67 b
2015				
Swingle	69 c	28,704 c	163.00 a	10.66 b
Volkamer	102 b	42,432 b	174.00 a	28.17 a
Cleopatra	140 a	40,040 a	154.67 a	13.66 b
2016				
Swingle	50 c	20,800 c	163.33 a	0.83 b
Volkamer	94 b	39,104 b	180.83 a	6.80 a
Cleopatra	113 a	47,008 a	162.17 a	7.50 a

Numbers followed by the same letter (in each column) do not differ by the Duncan MR test at  $p = 0.05$  after ANOVA.

**Table 2.** Influence of rootstocks on accumulated tree yield of Parana grapefruit in 2012 and 2016 in south-eastern Paraguay. Yield is expressed per tree, per ha and as CEI = fruit production per tree/tree trunk cross-section area

Accumulation	CEI (kg cm <sup>-2</sup> ) (2012-2016)	kg tree <sup>-1</sup> (2012-2016)	Yield kg ha <sup>-1</sup> (2012-2016)
Swingle	3. 10 b	498 c	207.168 c
Volkamer	3. 15 b	558 b	232.128 b
Cleopatra	3. 75 a	607 a	252.512 a

Numbers followed by the same letter (in each column) do not differ by the Duncan MR test at  $p = 0.05$  after ANOVA.

## REFERENCES

Ávalos-Zorrilla ML & Canteros BI (2011) Evaluación de la relación entre dos tipos de pomelo (*Citrus x paradisi*) mediante marcadores moleculares. *Journal of Basic and Applied Genetics XLI(Supl 2011)*: S70.

Canteros BI, Gochez AM, Lezcano CC, Beltrán VM & Anderson C (2013) Evaluación de un pomelo resistente a cancrisis en Corrientes. *Annals VII Congreso Argentino de Citricultura*, Puerto Iguazú, Misiones, p. S1-20.

Canteros BI (1994) Changes in the resistance of developing citrus fruit to canker. *Proceedings of the International Society of Citriculture* (2): 825-827.

Gochez AM & Canteros BI (2008) Resistance to citrus canker caused by *Xanthomonas axonopodis* pv. *citri* in an accession of *Citrus* sp. similar to grapefruit. *Plant Disease* 92(4): 652.

Rinsdahl-Canavosio MA, Gochez AM, Lezcano A, Soliz J & Canteros BI (2010) Phenology and juice quality of

'Dalan Dan' grapefruit in Corrientes, Argentina. Proceedings International Society of Citriculture I: 55-58.

Wlosek Stañgret CR, Acuña P, Cabral Mendez N & Quintana G (2015a) Crecimiento y fructificación de dos cultivares de pomelo blanco en el Paraguay. Annals VIII Congreso Argentino de Citricultura, Bella Bista, Corrientes, p. G-69.

Wlosek Stañgret CR, Acuña P, Cabral Mendez N & Quintana G (2015b) Aptitud industrial de dos cultivares de pomelo blanco. Annals VIII Congreso Argentino de Citricultura, Bella Vista, Corrientes, p. G-68.

---

*Received: November 10, 2016*

*Accepted: August 19, 2017*