ROOTSTOCKS FOR 'TAHITI' LIME

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ABSTRACT: The 'Tahiti' lime (*Citrus latifolia* Tanaka) is an important commercial citrus cultivar in Brazil. 'Rangpur' lime has being used as its main rootstock, but it is susceptible to root rot caused by *Phytophthora*, reducing tree longevity. An experiment was set up in a randomized block design, with three trees per plot of each rootstock and four replicates, and run for 12 years, aiming to compare the performance of 'IAC-5 Tahiti' lime, budded on 'Rangpur' lime (*Citrus limonia* Osb.); 'C-13' citrange (*Citrus sinensis* (L.) Osb. × *Poncirus trifoliata* (L.) Raf.); 'African' rough lemon (*Citrus jambhiri* Lush.); 'Volkamer' lemon (*Citrus volkameriana* Ten. & Pasq.); trifoliate orange (*Poncirus trifoliata* (L.) Raf.); 'Sunki' mandarin (*Citrus sunki* Hort. ex Tan.) and 'Cleopatra' mandarin (*Citrus reshni* Hort. ex Tan.). Eleven years after the establishment of the orchard, trees with the greatest canopy development were budded on 'C-13' citrange and 'African' rough lemon, and both differed significantly from trees budded on trifoliate orange, 'Sunki' and 'Cleopatra' mandarins, which presented the smallest canopy development. Trees budded on 'Rangpur' lime and 'C-13' citrange had the highest cumulative yields, and were different from trees budded on trifoliate orange, 'Cleopatra' and 'Sunki' mandarins. There was no rootstock effect on mean fruit weight and on the total soluble solid/acid ratio in the juice. The 'Rangpur' lime and the 'Cleopatra' mandarin rootstocks reduced longevity of plants.
Key words: *Citrus latifolia*, 'Rangpur' lime, 'Volkamer' lemon, trifoliate orange, citrange

PORTA-ENXERTOS PARA A LIMEIRA ÁCIDA 'TAHITI'

RESUMO: A lima ácida 'Tahiti' (*Citrus latifolia* Tanaka) é uma importante variedade comercial de citros no Brasil e o limão 'Cravo', seu principal porta-enxerto, apresenta suscetibilidade à gomose de *Phytophthora*, reduzindo a longevidade das plantas. Este experimento foi implantado em blocos ao acaso, contendo sete tratamentos, três plantas por parcela e quatro repetições, e avaliado por 12 anos com o objetivo de comparar o comportamento de plantas de lima ácida 'Tahiti IAC-5', enxertadas em limão 'Cravo' (*Citrus limonia* Osb.), citrange 'C-13' (*Citrus sinensis* (L.) Osb. X *Poncirus trifoliata* (L.) Raf.), limão 'Rugoso da África' (*Citrus jambhiri* Lush.), limão 'Volkameriano' (*Citrus volkameriana* Ten. & Pasq.), Trifoliata (*Poncirus trifoliata* (L.) Raf.), tangerina 'Sunki' (*Citrus sunki* Hort. ex Tan.) e tangerina 'Cleópatra' (*Citrus reshni* Hort. ex Tan.). Onze anos após o plantio, as limeiras com maior volume de copa foram aquelas enxertadas em citrange 'C-13' e limão 'Rugoso da África', sendo que ambos diferiram das plantas em Trifoliata, tangerinas 'Sunki' e 'Cleópatra', que mostraram os menores volumes. Plantas enxertadas em limão 'Cravo' e citrange 'C-13' apresentaram as maiores produções acumuladas, com diferença daquelas em Trifoliata e tangerinas 'Sunki' e 'Cleópatra'. Não houve efeito dos porta-enxertos no peso médio dos frutos e na relação sólidos solúveis totais e acidez do suco dos frutos. O limão 'Cravo' e a tangerina 'Cleópatra' induziram baixa longevidade.
Palavras-chave: *Citrus latifolia*, limão 'Cravo', limão 'Volkameriano', trifoliata, citrange

INTRODUCTION

'Tahiti' lime (*Citrus latifolia* Tanaka), also known as Persian lime or Bearss lime, is a hybrid citrus, one of its parents being the Mexican lime and the other a lemon (*C. limon* (L.) Burm.) or, more likely, a citron (*C. medica* L.) (Hodgson, 1967). This cultivar has been grown especially in Mexico, South America, Central America, USA (Florida), and India (Campbell, 1991). In Brazil, 'Tahiti' lime is an important commercial variety, resistant to citrus canker (Leite Jr., 1992). 'Tahiti' lime fruits are used as replacement for lemon, and are sold fresh in both domestic and foreign retail markets, as well as for the industry, for the production of juice concentrate and essential oils (Figueiredo, 1991).

The most frequently utilized rootstock for the 'Tahiti' lime in the USA is *C. macrophylla* (Castle et al., 1989), whereas in Brazil the preferred rootstock is the 'Rangpur' lime (Pompeu Jr., 1991). Even though the 'Rangpur' lime provides good agronomic characters to 'Tahiti' trees and presents tolerance to the citrus tristeza virus, it is susceptible to root rot caused by *Phytophthora citrophthora* and *P. parasitica*, thus decreasing plant longevity (Salibe & Moreira, 1984).

Reports on rootstocks for 'Tahiti' lime in Brazil are scarce, and no records exist on studies on rootstocks for 'Tahiti' lime in the State of Paraná. Some studies conducted in the State of São Paulo indicated as alternative rootstocks to 'Rangpur' lime for 'IAC-5': 'EEL' trifoliate orange, 'Swingle' citrumelo, 'Orlando' tangelo, 'Morton' citrange, and 'Volkamer' lemon (Figueiredo et al., 2000; 2002). However, the behavior of rootstocks may vary depending on soil type, climate, diseases, and cropping practices. This work had the objective of evaluating the performance of 'Tahiti' lime trees budded on seven rootstocks, in the North of the State of Paraná, during a 12 years period.

MATERIAL AND METHODS

The experiment was set up in Maringá, PR, (23º25'S, 51º25'W; altitude 555 m), in December, 1988, and run for 12 years. The soil is a Typic Hapludox, with 600 g kg^{-1} clay, 70 g kg^{-1} silt, and 330 g kg^{-1} sand in the (0.0 - 0.25 m) soil layer. The climate is classified as a Cfa according to Köppen, with mean annual precipitation of 1,504 mm, concentrated in the Spring and Summer, with a mean annual temperature of 21ºC and relative humidity ranging from 70 to 75% (Caviglione et al., 2000).

The experimental design consisted of randomized blocks, with seven treatments (rootstocks), three trees per plot and four replicates, spaced of 8.0 m × 6.0 m. 'Tahiti' lime trees buded on other rootstocks were used as external border. The following rootstocks were tested: 'Rangpur' lime (*Citrus limonia* Osb.), 'C-13' citrange [(*Citrus sinensis* (L.) Osb. × *Poncirus trifoliata* (L.) Raf.)], 'African' rough lemon (*Citrus jambhiri* Lush.), 'Volkamer' lemon (*Citrus volkameriana* Ten. & Pasq.), trifoliate orange (*Poncirus trifoliata* (L.) Raf.), 'Sunki' mandarin (*Citrus sunki* Hort. ex Tan.), and 'Cleopatra' mandarin (*Citrus reshni* Hort. ex Tan.). Rootstocks were propagated by seeds and the seedlings were budded with 'IAC-5 Tahiti' lime buds. Seeds and buds were obtained from productive, indexed trees of the citrus collection of Instituto Agronômico do Paraná (IAPAR). The trees were grown without irrigation and managed according to technical recommendations for commercial citrus growing (INSTITUTO AGRONÔMICO DO PARANA, 1992).

Tree height and diameter were measured every year, from June/1992 to June/1999. The canopy volume was calculated based on the formula: $V = 2/3\ \pi\ R^2\ H$, where V represents the volume (m^3), R is the canopy radius (m), and H is plant height (m) (Mendel, 1956). Tree size data presented refer to 1992 and 1999. The cumulative yield was obtained by summing up the yields from 1992 through 1999. Fruits were harvested and weighed biweekly, during the period from December to August of each cropping season, due to the multiple bloomings that are characteristic of the 'Tahiti' lime. The average yield efficiency for the studied period was estimated by dividing yield (kg per plant) by the canopy volume (m^3) for each rootstock. Yield fluctuation was expressed as alternate bearing index (I), calculated as $I = 1/(n-1) \times \{|(a_2-a_1)|/(a_2+a_1) + |(a_3-a_2)|/(a_3+a_2)+...+ |(a_{(n)}-a_{(n-1)})|/(a_{(n)}+a_{(n-1)})\}$, where n = number of years, and a_1, a_2, ..., $a_{(n-1)}$, $a_{(n)}$ = yield of the corresponding years (Pearce & Dobersek-Urbanc, 1967). In February, 1995, 30 fruits per plot were harvested for quality evaluation. Fruits were weighed juiced with an electric squeezer, for evaluation of juice yield; total soluble solids (TSS), measured as Brix degrees using a manual refractometer; total titrable acidity (TTA) by titration with NaOH 0.1 mol L^{-1}, expressing results as percentages of citric acid the TSS/TTA *ratio*. The number of dead trees in the experimental period was also counted.

Data on effects of rootstocks on traits of 'Tahiti' lime trees and fruits were analyzed with the aid of SAS statistical software package (SAS Institure, 1989). Means were separated by the Duncan multiple range test ($P = 0.05$).

RESULTS AND DISCUSSION

In 1992, the trifoliate orange and the 'Sunki' mandarin were the rootstocks of smallest height for 'Tahiti' lime trees, with differences in relation to 'African' rough lemon (Table 1). Diameter and canopy volume were smaller for trifoliate orange and 'Sunki' mandarin trees, being different from those budded on 'Rangpur' lime, 'African' rough lemon and 'Volkamer' lemon. In 1999, the shortest trees were those budded on 'Sunki' mandarin, which presented differences in relation to the other rootstocks. With regard to canopy diameter and volume, the 'Sunki' mandarin had also the lowest values, with differences relative to the 'C-13' citrange, 'African' rough lemon, 'Rangpur' lime and 'Volkamer' lemon, which presented greater vigor in descending order, but with no differences among themselves. The trifoliate orange, 'Sunki' mandarin, and 'Cleopatra' mandarin did not show differences among themselves and presented the smallest plant development values. In similar studies with rootstocks for 'Tahiti' lime, trees with great vigor were obtained on 'African' rough lemon (Foguet et al., 1994), 'Volkamer' lemon (Valbuena, 1994), and 'Troyer' and 'Carrizo' citranges (Grisoni et al., 1989). Donadio et al. (1993) reported that 'Tahiti' lime trees of the 'IAC-5' clone had low vigor when budded on 'Cleopatra' mandarin.

Regarding annual yield, evaluated from 1992 to 1999 (Table 2), trees on 'Rangpur' lime, 'C-13' citrange, 'African' rough lemon and 'Volkamer' lemon had the highest yields but did not differ among themselves in most years. The 1998 cropping season had a smaller yield than other years because of premature shedding of young

Table 1 - Plant height, canopy diameter and volume of 'Tahiti' lime trees budded on seven rootstocks.

Rootstock	Plant height		Canopy diameter		Canopy volume	
	1992	1999	1992	1999	1992	1999
	---------- m ----------				---------- m^3 ---------	
'Rangpur' Lime	3.5 ab[z]	4.9 bc	4.3 a	6.8 ab	33.6 a	122.4 ab
'C-13' Citrange	3.3 ab	5.4 a	4.1 ab	7.0 a	29.9 ab	140.3 a
'African' Rough Lemon	3.6 a	5.1 ab	4.3 a	7.0 a	34.3 a	134.0 a
'Volkamer' Lemon	3.5 ab	5.0 bc	4.4 a	6.6 abc	35.0 a	117.3 abc
Trifoliate Orange	3.0 c	4.7 c	3.7 c	6.3 bcd	21.5 c	98.9 bcd
'Sunki' Mandarin	3.2 b	4.3 d	3.8 bc	5.6 d	25.2 bc	74.0 d
'Cleopatra' Mandarin	3.3 ab	4.8 bc	3.9 bc	6.1 cd	27.2 b	93.8 cd
CV (%)	5.0	5.0	5.3	6.6	12.2	15.9

[z]Values in the same column, followed by a common letter, do not differ by Duncan´s multiple range test (P = 0.05).

Table 2 - Mean annual yield for eight cropping seasons (1992 to 1999) of 'Tahiti' lime trees budded on seven different rootstocks.

Rootstock	Annual yield							
	1992	1993	1994	1995	1996	1997	1998	1999
	---------- kg per plant ----------							
'Rangpur' Lime	127.4 a[z]	77.2 a	103.8 a	120.1 a	86.7 a	90.0 ab	31.2 a	164.3 a
'C-13' Citrange	118.8 ab	53.9 abc	101.1 a	129.3 a	79.2 ab	112.4 a	28.9 a	132.3 ab
'African' Rough Lemon	104.8 abc	55.6 abc	97.8 a	93.6 ab	76.2 ab	75.2 bc	21.2 a	106.9 ab
'Volkamer' Lemon	92.4 bcd	64.2 ab	88.4 a	100.9 ab	80.5 ab	59.1 c	20.2 a	102.3 ab
Trifoliate Orange	76.8 cd	42.0 bc	86.8 a	96.2 ab	52.0 c	82.3 bc	18.5 a	116.5 ab
'Sunki' Mandarin	90.6 bcd	74.6 a	87.2 a	68.3 b	64.5 bc	56.2 c	15.3 a	67.2 b
'Cleopatra' Mandarin	61.8 d	34.1 c	77.8 a	83.7 b	57.2 c	71.1 bc	15.6 a	98.7 ab
CV (%)	21.6	25.8	16.9	22.2	16.7	22.0	44.8	36.2

[z]Values in the same column, followed by a common letter, do not differ by Duncan´s multiple range test (P = 0.05).

fruits, caused by *Colletotrichum acutatum*. There were differences between rootstocks regarding cumulative yield, yield efficiency, and alternate bearing index (Table 3). Trees budded on 'Rangpur' lime and 'C-13' citrange presented the highest cumulative yields, without differing among themselves, and were both superior to those budded on trifoliate orange, 'Sunki' mandarin and 'Cleopatra' mandarin, which were less productive. The cumulative yield of trees on 'C-13' citrange did not differ from those on 'African' rough lemon and 'Volkamer' lemon. Figueiredo et al. (2002) also observed low cumulative yields for 'Tahiti' trees of the 'IAC-5' clone budded on 'Cleopatra' and 'Sunki' mandarins, and a high yield for 'Morton' citrange, in an experiment conducted in the State of São Paulo. Similarly, Campbell (1979) also obtained low yield in Florida (USA) when utilizing the 'Cleopatra' mandarin rootstock for 'Tahiti' lime. In spite of their low cumulative yield, trees budded on 'Sunki' mandarin and trifoliate orange obtained the same yield efficiency as those on 'Rangpur' lime and 'C-13' citrange, exceeding those budded on 'African' rough lemon, 'Volkamer' lemon' and 'Cleopatra' mandarin.

The alternate index estimated with the formula proposed by Pearce & Dobersek-Urbanc (1967) can vary between 0 and 1; the closer to zero the values, the smaller the yield fluctuation. As indices ranged from 0.25 to 0.38, no marked tendency for yield alternation was verified in any of the rootstocks. However, trees budded on 'Rangpur' lime, 'Volkamer' lemon and 'Sunki' mandarin presented less alternation, differing from those grafted on 'C-13' citrange, trifoliate orange and 'Cleopatra' mandarin.

There was no effect of rootstocks on mean fruit weight and on the TSS/TTA *ratio* (Table 4). Juice yield was highest for 'Rangpur' lime, differing from 'African' rough lemon, 'Volkamer' lemon, trifoliate orange and 'Cleopatra' mandarin. TSS contents ranged from 6.85 to 7.42 ºBrix, and the highest values were obtained for fruits from trees budded on 'Rangpur' lime, 'C-13' citrange, trifoliate orange and 'Sunki' mandarin, without differences among themselves, differing, however, from 'African' rough lemon and 'Volkamer' lemon, which had the lowest contents without difference between them. The lowest TTA content was found for fruits from trees bud-

ded on 'Volkamer' lemon, which differed from the other rootstocks, except from trifoliate orange. Similar results were obtained by Foguet et al. (1994) in relation to TSS content in 'Tahiti' lime fruit budded on different rootstocks: 7.4 for 'Rangpur' lime, 6.7 for 'African' rough lemon, and 7.3 for 'Cleopatra' mandarin. Iriarte-Martel et al. (1999) also observed that 'Tahiti' lime trees budded on 'Cleopatra' mandarin had smaller mean fruit weight than on 'Rangpur' lime, while rootstocks 'Rangpur' lime, trifoliate orange, 'Sunki' mandarin, 'Cleopatra' mandarin, and 'Volkamer' lemon did not present differences in their ratio values.

From the 6th year forth, mortality of trees budded on trifoliate orange and 'Cleopatra' mandarin started to occur (Figure 1). For trees budded on 'Rangpur' lime, the first deaths were observed on the 8th year. The 'Rangpur' lime and 'Cleopatra' mandarin rootstocks determined greater percentages of dead 'Tahiti' lime trees on the 12th year, and the cause of death of trees grafted on 'Rangpur' lime was root rot. Trees budded on 'Cleopatra' mandarin produced rootstock suckers and presented differences between the diameters of the rootstock and the scion, suggesting inadequate affinity of this rootstock with 'Tahiti' lime was the cause of death of the trees. The 'Cleopatra' mandarin proved to be an inadequate rootstock for 'Tahiti' lime, since the trees had the lowest cumulative yield and a short longevity. Figueiredo et al. (2002) also noticed inadequate affinity of the 'Tahiti' lime budded on 'Cleopatra' mandarin, and observed a high mortality rate of trees on 'Rangpur' lime as well. The 'C-13' citrange and the 'Volkamer' lemon elicit greater longevity when utilized as rootstocks for 'Siciliano' lemon (Porto et al., 1992).

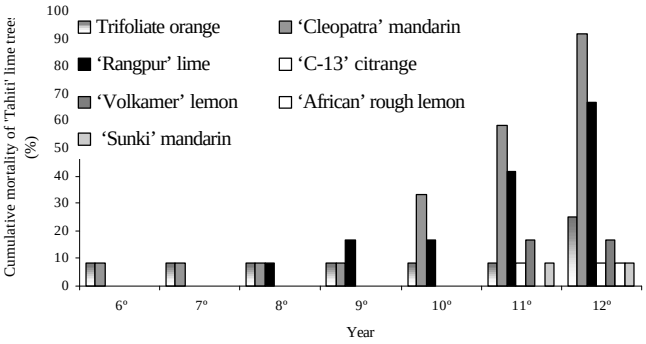

Figure 1 - Cumulative percentage of mortality of 'Tahiti' lime trees budded on seven rootstocks, from the 5th to the 12th year after the planting of 'Tahiti' lime trees. Maringa, PR (1993 to 1999).

Table 3 - Cumulative yield for eight cropping seasons (1992 to 1999), yield efficiency, alternate bearing index and relative cumulative yield of 'Tahiti' lime budded on seven rootstocks.

Rootstock	Cumulative yield	Yield efficiency	Alternate bearing index	Relative cumulative yield
	kg per plant	kg m^{-3}		%
'Rangpur' Lime	800.7 a	1.6 a	0.27 c	160
'C-13' Citrange	756.2 ab	1.6 a	0.35 ab	151
'African' Rough Lemon	631.6 bc	1.2 b	0.30 bc	126
'Volkamer' Lemon	608.0 bc	1.2 b	0.27 c	121
Trifoliate Orange	571.3 c	1.6 a	0.38 a	114
'Sunki' Mandarin	523.9 c	1.8 a	0.25 c	105
'Cleopatra' Mandarin	500.3 c	1.2 b	0.35 ab	100
CV (%)	15.2	9.9	13.9	

[z]Values in the same column, followed by a common letter, do not differ by Duncan´s multiple range test (P = 0.05).

Table 4 - Fruit quality of 'Tahiti' lime trees budded on seven rootstocks (February/1995 harvest).

Rootstock	Mean fruit weight	Juice yield	Total Soluble Solids (TSS)	Total Titrable Acidity (TTA)	TSS/TTA Ratio
	g	%	ºBrix	%	
'Rangpur' Lime	108.0 a[z]	47.3 a	7.25 a	5.8 a	1.2 a
'C-13' Citrange	100.7 a	41.1 ab	7.35 a	5.8 a	1.3 a
'African' Rough Lemon	111.5 a	40.0 b	6.87 bc	5.6 a	1.2 a
'Volkamer' Lemon	113.5 a	36.7 b	6.85 c	5.0 b	1.4 a
Trifoliate Orange	106.7 a	39.9 b	7.42 a	5.3 ab	1.4 a
'Sunki' Mandarin	103.5 a	41.0 ab	7.22 a	5.6 a	1.3 a
'Cleopatra' Mandarin	96.5 a	40.1 b	7.17 ab	5.6 a	1.3 a
CV (%)	13.8	10.0	2.9	5.9	7.5

[z]Values in the same column, followed by a common letter, do not differ by Duncan´s multiple range test (P = 0.05).

REFERENCES

CAMPBELL, C.W. Rootstocks effects of yield of 'Tahiti' lime. **Hortscience,** v.14, p.470, 1979.

CAMPBELL, C.W. Rootstocks for the 'Tahiti' lime. **Proceedings of the Florida State Horticultural Society**, v.104, p.28-30, 1991.

CASTLE, S.W.; TUCKER, D.P.H.; KREZDORN, H.A.; YOUTSEY, C.O. **Rootstocks for Florida citrus**. Gainesville: Institute of Food and Agricultural Sciences, University of Florida, 1989. 47p.

CAVIGLIONE, J.H.; KIIHL, L.R.B.; CARAMORI, P.H.; OLIVEIRA, D. **Cartas climáticas do Paraná**. Versão 1. Londrina: IAPAR. 2000. 1 CD-Rom.

DONADIO, L.C.; CABRITA, J.R.M.; SEMPIONATO, R.O.; PARO, M. Tangerineira Cleópatra: vantagens e desvantagens como porta-enxerto na citricultura. **Laranja**, v.14, p.565-579, 1993.

FIGUEIREDO, J.O. Variedades copa de valor comercial. In: RODRIGUEZ, O.; VIEGAS, F.C.P.; POMPEU JR., J.; AMARO; A.A. (Ed.) **Citricultura brasileira**. 2.ed. Campinas: Fundação Cargill, 1991. v.1, p.228-264.

FIGUEIREDO, J.O.; POMPEU JR., J.; TEÓFILO SOBRINHO, J.; PIO, R.M.; LARANJEIRA, F.F.; LIMA, J.E.O.; SALIBE, A.A. Porta-enxertos para a lima ácida 'Tahiti' na região de Aguaí, SP. **Revista Brasileira de Fruticultura,** v.22, p.435-439, 2000.

FIGUEIREDO, J.O.; STUCHI, E.S.; DONADIO, L.C.; TEÓFILO SOBRINHO, J.; LARANJEIRA, F.F.; PIO, R.M.; SEMPIONATO, O.R. Porta-enxertos para a lima ácida 'Tahiti' na região de Bebedouro, SP. **Revista Brasileira de Fruticultura,** v.24, p.155-159, 2002.

FOGUET, J.L.; BLANCO, A.; VINCIGUERRA, H. La lima en Tucumán. **Avance Agroindustrial**, n.57, p.43-45, 1994.

GRISONI, M.; CABEU, P.; AUBERT, B. Résultats de douze années d'um essai de comportement de cinq porte-greffe em association avec quatre cultivars d'agrumes à l'île de la Réunion. **Fruits**, v.44, p.529-538, 1989.

HODGSON, R.W. Horticultural varieties of Citrus. In: REUTHER, W.; WEBBER, H.J.; BATCHELOR, L.D. (Ed.) **The citrus industry**. Riverside: University of California, 1967. v.1, cap.4, p.431–591.

INSTITUTO AGRONÔMICO DO PARANÁ. **A citricultura no Parana**. Londrina: IAPAR, 1992. 288p. (Circular, 72).

IRIARTE-MARTEL, J.H.; DONADIO, L.C.; FIGUEIREDO, J.O. Efeito de onze porta-enxertos sobre a qualidade dos frutos e desenvolvimento das plantas da lima ácida 'Tahiti'. **Revista Brasileira de Fruticultura**, v.21, p.235-238, 1999.

LEITE JR, R.P. Cultivares copa e porta-enxertos. In: INSTITUTO AGRONÔMICO DO PARANÁ (Ed.) **A citricultura no Paraná**. Londrina: IAPAR, 1992. cap.4, p.91-116.

MENDEL, K. Rootstock-scion relationships in Shamouti trees on light soil. **KTAVIM,** v.6, p.35-60,1956.

PEARCE, S.C.; DOBERSEK-URBANC, S. The measurements of irregularity in growth and cropping. **Journal of Horticultural Science**, v.42, p.295-305, 1967.

POMPEU JR., J. Porta-enxertos. In: RODRIGUEZ, O.; VIEGAS, F.C.P.; POMPEU JR., J.; AMARO; A.A. (Ed.) **Citricultura brasileira**. 2.ed. Campinas: Fundação Cargill, 1991. v.1, p.265-280.

PORTO, O.M.; MORAES, L.A.H.; BRAUN, J. Porta-enxertos para limoeiro 'Siciliano' (*Citrus limon* Burmann) no Rio Grande do Sul. **Revista Brasileira de Fruticultura**, v.14, p.119-124, 1992.

SALIBE, A.A.; MOREIRA, C.S. Performance of rangpur lime as rootstock for citrus in Brazil. **Proceedings of the Internacional Society of Citriculture,** v.1, p.29-33, 1984.

SAS Institute. **SAS/STAT user´s guide**. Version 6. 4.ed. Cary: Statistical Analysis System Institute, 1989.

VALBUENA, M. Comportamiento agronómico de algunas combinaciones copas-patrones de cítricos, en la zona media del río Guasare, Zulia, Venezuela. **Revista de la Faculdad de Agronomia**, v.11, p.1-12, 1994.

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