ISSN 0100-2945 http://dx.doi.org/10.1590/0100-29452016684

PERFORMANCE OF 'TUXPAN VALENCIA' SWEET ORANGE GRAFTED ONTO 14 ROOTSTOCKS IN NORTHERN BAHIA, BRAZIL[1]

NATIANA DE OLIVEIRA FRANÇA[2], MAURICIO DA SILVA AMORIM[2] , EDUARDO AUGUSTO GIRARDI[3] , ORLANDO SAMPAIO PASSOS[3], WALTER DOS SANTOS SOARES FILHO[3]

ABSTRACT – In the State of Bahia, Brazil, the citrus industry is located on the north coast with the prevalence of the combination 'Pera' sweet orange on 'Rangpur' lime. Scion-rootstock diversification may contribute to the increase of yield and the extension of harvest season, as long as to decrease the risk associated to abiotic and biotic stresses. Therefore, the performance of 'Tuxpan Valencia' sweet orange grafted onto 14 rootstocks was evaluated in Rio Real – BA. Planting was performed in 2006 under rainfed cultivation on cohesive ultisol and tree spacing of 6.0 m x 4.0 m. Tree size, yield and fruit quality were evaluated in the period of 2010-2014, in addition to tree survival at nine years old and drought tolerance in the field based on leaf wilting. In the evaluated conditions, 'Sunki Tropical' and 'Sunki Maravilha' mandarins led to the highest scion canopy volume. The highest accumulated yield in five harvests was recorded on 'Santa Cruz Rangpur' lime, 'Volkamer' lemon, 'Riverside' and 'Indio' citrandarins, 'Sunki Tropical' mandarin and the hybrid TSKC x (LCR x TR) – 001. 'Riverside' and TSKFL x CTSW – 049 induced higher yield efficiency on the canopy. The rootstocks did not influence the tree survival nine years after planting except for lower survival of TSKFL x CTSW – 049. Drought tolerance was not affected either. Regarding to the fruit quality of 'Tuxpan Valencia', the rootstocks influenced the juice content, soluble solids and technological index with the citrandarins, 'Santa Cruz Rangpur' lime, 'Volkamer' lemon and 'Sunki Tropical' mandarin presenting higher performance in general.

Index terms: *Citrus* spp., *Poncirus trifoliata*, drought tolerance, fruit quality, yield.

DESEMPENHO DA LARANJEIRA 'VALÊNCIA TUXPAN' SOBRE 14 PORTA-ENXERTOS NO LITORAL NORTE DA BAHIA

RESUMO – No Estado da Bahia, a citricultura concentra-se no litoral norte, com cultivo majoritário da combinação laranjeira 'Pera' sobre limoeiro 'Cravo'. A diversificação de combinações copa e porta-enxerto pode contribuir para a ampliação da produtividade e para a extensão do período de safra na região, bem como reduzir o risco de impactos relativos a estresses abióticos e bióticos. Este trabalho avaliou o desempenho de laranjeira 'Valência Tuxpan' sobre 14 porta-enxertos em Rio Real – BA. O plantio foi de sequeiro, em 2006, em Argissolo Amarelo coeso, com espaçamento de 6,0 m x 4,0 m. Avaliaram-se crescimento de planta, produção e atributos físicos e físico-químicos de frutos em 2010-2014, além da sobrevivência até nove anos e a tolerância à seca, com base no enrolamento foliar. Nas condições estudadas, as tangerineiras 'Sunki Tropical' e 'Sunki Maravilha' induziram maior volume de copa. As maiores produções acumuladas foram observadas sobre limoeiros 'Cravo Santa Cruz' e 'Volkameriano', citrandarineiros 'Riverside' e 'Indio', tangerineira 'Sunki Tropical' e híbrido TSKC x (LCR x TR) – 001. Citrandarineiro 'Riverside' e TSKFL x CTSW – 049 induziram maior eficiência produtiva. Não houve variação de sobrevivência nem de tolerância à seca entre os portas-enxertos avaliados, exceto pela menor sobrevivência de TSKFL x CTSW – 049. Em relação à qualidade dos frutos da laranjeira 'Valência Tuxpan', verificou-se que rendimento de suco, concentração de sólidos solúveis e índice tecnológico foram influenciados pelos porta-enxertos estudados, com citrandarineiros, limoeiros 'Cravo Santa Cruz' e 'Volkameriano' e tangerineira 'Sunki Tropical' apresentando maior rendimento em geral.

Termos para indexação: *Citrus* spp., *Poncirus trifoliata*, produção, qualidade de frutos, tolerância à seca.

[1](Paper 116-15). Received: May 08, 2015. Accepted: August 08, 2016. Research funded by Embrapa's Macroprograma 2.

[2]Agronomist, graduate student at Agricultural Sciences PPG, Federal University of the Recôncavo of Bahia, Cruz das Almas-BA. E-mails: natianafranca@yahoo.com.br; m.s.amorim@hotmail.com

[3]Agronomist, researcher at Embrapa Cassava & Fruits, Cruz das Almas-BA. E-mails: eduardo.girardi@embrapa.br; orlando.passos@embrapa.br; walter.soares@embrapa.br

INTRODUCTION

The area designed to produce oranges in the state of Bahia corresponded to 62,300 hectares in 2014, producing 1,023 million tons, and Rio Real municipality is the largest state producer (IBGE, 2016). This area is concentrated on the northern coast of the state, characterized by soils with low water retention and subsurface densification associated with periods of drought resulting in severe water stress to the plants, with damage to the crop yield (CARVALHO et al., 2002).

In the region, prevails the combination 'Pera' sweet orange [*Citrus sinensis* (L.) Osbeck] grafted on 'Rangpur' lime (*C. limonia* Osbeck), mainly due to the good quality of the fruit and the presence of several blossomings of that scion variety, and drought tolerance of this rootstock (ALMEIDA et al., 2011). However, this situation of low genetic diversity increases the inherent risk in abiotic and biotic stresses, besides restricting the orange crop season. Consequently, the diversification of scion varieties is one of the objectives of citrus breeding programs addressed to the region (SOARES FILHO, 2011).

The 'Tuxpan Valencia' sweet orange is a clone of 'Valencia' sweet orange (*C. sinensis*), introduced from Mexico and characterized by presenting later fruit maturation than the 'Pera' orange, high juice content, excellent flavor, appearance and attractive coloring in tropical regions (PASSOS et al., 2007). Thus, its cultivation can be an alternative in Bahia, either for processing or fresh fruit market.

Essential attributes for alternative rootstocks to 'Rangpur' lime are drought tolerance and good production in rainfed crop, prevalent condition in the region (AZEVEDO et al., 2006), as well as disease resistance and good compatibility with the scion variety, since 'Pera' orange is incompatible with trifoliate orange [*Poncirus trifoliata* (L.) Raf.] and its hybrids, in general, and with 'Volkamer' lemon (*C. volkameriana* V. Ten. & Pasq.) and rough lemon (*C. jambhiri* Lush.) (POMPEU JUNIOR, 2005). Moreover, there is little information regarding the performance of the 'Tuxpan Valencia' orange on the rootstocks used in this study.

Thus, the performance of 'Tuxpan Valencia' orange grafted on 14 rootstocks was evaluated in rainfed cultivation in the North Coast of Bahia.

MATERIAL AND METHODS

The experiment was installed in June 2006 in a citrus commercial area in the municipality of Rio Real-BA (11°29'07" S, 37°56'04" W; 179 m altitude). The climate is classified as transitional Am to Aw (tropical sub-humid to dry), with an average annual temperature of 23.8° C and rainfall annual average of 919 mm, concentrated from April to October. The monthly rainfall in the experimental locality was computed during the evaluation period (Figure 1). The area soil is classified as dystrophic cohesive yellow ultisol and presented, in the final evaluation, the following chemical attributes in 0-20 and 20-40 cm, respectively: pH (H_2O) 5.5 and 5.8; P 26 and 15 (mg dm^{-3}); K 0.07 and 0.06; Ca 1.40 and 2.04; Mg 0.27 and 0.29; Na 0.03 and 0.03; Al 0.0 and 0.0; H + Al 1.87 and 1.76; CEC 3.65 and 4.18 ($cmol_c$ dm^{-3}); V 49 and 58 (%); O.M. 13 and 10 (g kg^{-1}).

The 'Tuxpan Valencia' sweet orange was evaluated on the rootstocks: 'Sunki' mandarin [*C. sunki* (Hayata) hort. ex Tanaka] Tropical and Maravilha selections, 'Cleopatra' mandarin (*C. reshni* hort. ex Tanaka), 'Santa Cruz Rangpur' lime (*C. limonia*) and 'Volkamer' (*C. volkameriana*) lemon, besides the citrandarins (TSK x TRENG) 'Indio' and 'Riverside', and the hybrids CLEO x CTCZ - 226, TSKFL x CTTR - 017, TSKC x CTSW - 028, TSKFL x CTSW – 049, TSKC x (LCR x TR) – 001, TSKC x (LCR x TR) – 018 and LVK x LVA – 009, where TSK is 'Sunki' mandarin; TRENG is *P. trifoliata* 'English', CLEO is 'Cleopatra' mandarin, CTCZ is 'Carrizo' citrange (*C. sinensis* x *P. trifoliata*), TSKFL is Florida 'Sunki' mandarin, CTTR is 'Troyer' citrange, TSKC is the ordinary 'Sunki' mandarin, CTSW is 'Swingle' citrumelo (*C. paradisi* Macfad. x *P. trifoliata*), TR is *P. trifoliata*, LCR is 'Cravo' Rangpur lime, LVK is 'Volkamer' lemon and LVA is 'Valencia' sweet orange (*C. sinensis*). All plant materials were accesses from the Active Germplasm Bank and the hybrids obtained by the Genetic Breeding Program of Citrus from Embrapa Cassava & Fruits in Cruz das Almas, Bahia.

The seedlings were grown in bags in protected nursery and at 12 months old and with an average height of 40 cm, were planted in rainfed in the spacing of 6.0 m x 4.0 m, using pits of 40 x 40 x 40 cm, performing subsoiling of two rods 50 cm deep in the line before planting. Cultural practices have been defined by the producer and have included an annual harrowing between lines, usually between the months of July and August, two annual applications of glyphosate herbicide in the planting row (3 L ha^{-1}), shaping pruning until the second year, application of

limestone covering (500 kg ha^{-1}) and poultry manure (1500 kg ha^{-1}) in the third year, and two annual mowing before harvests. Preventive pests' controls in the experimental area or any other soil and foliar fertilization have not been performed.

Plant size evaluations were performed annually from 2010 to 2014, measuring the canopy height and diameter and the canopy volume (V) (m^3), estimated by $V = 2/3 \times \pi \times Dm^2/4 \times H$, wherein (H) is the height and (Dm)is the canopy medium diameter, calculated by the ratio between the diameters in the direction of the line and in the perpendicular direction to the road. The yield per plant was measured from 2010 to 2014. It was also calculated the average production efficiency for the 2010-2014 period, by the average ratio between the annual productions and the canopy volumes in the respective years. The tree size results were presented just for 2014, when the plants were nine years old.

Drought tolerance was estimated during the critical period of drought occurred in March 2013, using a score scale based on visual symptoms of wilting leaves, ranging from grade 1 (no symptoms), grade 2 (discrete wilting in up to half of the canopy), grade 3 (discrete wilting throughout the canopy) up to grade 4 (intense wilting throughout the canopy and leaf drop), held by four evaluators. The survival was calculated by the percentage of living trees until 2014.

The physico-chemical analysis of the fruits included weight (g), length (cm) width (cm), skin thickness (mm), number of seeds per fruit, juice content (%), titratable acidity (TA,%), determined after titration with NaOH 0.1N, soluble solids (SS), using refractometer (°Brix), ratio (maturity index), calculated by SS/TA, and technological index (TI, kg SS box^{-1} 40.8 kg), calculated by applying the formula: TI = yield x SS x 40.8 / 100. The quality variables were expressed in average terms of the largest harvests realized in 2011, 2012, 2013 and 2014, by sampling 10 fruits per plot.

The experimental design was randomized blocks with 14 treatments, three replicates and two trees in the plot. The results were submitted to variance analysis and the averages grouped by the Scott-Knott test ($P < 0.05$), performing the conversion of data $(x + 0.5)^{\wedge} 0.5$ when necessary to fulfill the variance normality and homogeneity.

RESULTS AND DISCUSSION

The evaluated rootstocks constituted of three canopy size groups of 'Tuxpan Valencia' orange in 2014, with 'Sunki Tropical' and 'Sunki Maravilha' tangerines inducing greater volume, 13.7 and 13.5 m^3, respectively, and the other groups having average between 10.0 and 3.8 m^3 (Table 1). Plants with smaller size and diameter were observed on hybrid CLEO x CTCZ – 226, TSKFL CTTR - 017 and TSKFL x CTSW - 049, especially in the last, as well as smaller diameter in 'Riverside' citrandarin.

Compared to the results obtained in a study with citrumelos as rootstocks for 'Valencia' orange at six years old, in Cordeirópolis-SP (POMPEU JUNIOR and BLUMER 2011), it can be seen that at that location the 'Swingle' citrumelo resulted in volume (9.1 m^3), high (2.5 m) and diameter (2.7 m) higher than those evaluated in this study to trifoliate hybrids in general. Compared to the 'Rangpur' lime, it was observed similar size, being the average productive efficiency (6.2 kg m^{-3}) of both rootstocks higher than that observed in this study. Comparing the canopy volume values of 'Valencia' orange with those found by Pompeu Junior (2001) on potentially dwarfing rootstocks, it is observed that the height and diameter values are higher than those found in that study, with exception of 'Indio' citrandarin that presents high size.

In the accumulated production of 'Tuxpan Valencia' in the period 2010-2014 (fifth to ninth year after planting), it was observed that 'Santa Cruz Rangpur' lime and 'Volkamer' lemon, 'Sunki Tropical' mandarin, 'Indio' and 'Riverside' citrandarins and the hybrid TSKC x (LCR x TR) - 001 induced 142.3 to 102.0 kg $plant^{-1}$, surpassing the others that resulted in less than 82 kg $plant^{-1}$ (Table 2). It was noted production variation among the years, with a significant reduction for some rootstocks in 2013, possibly as a result of a severe drought (average of 877 mm in 2012/2013 compared to 1023.04 mm in 2010-2014) (Figure 1). The rootstocks with higher production in all evaluated years were the 'Santa Cruz' and 'Volkamer' lemon and 'Indio' citrandarin, so the earliest in the beginning of production.

The harvests were accomplished at different times in each season, possibly as a result of alternating periods of drought and rainfall in the locality. In 2010, there was only one production in July; in 2011, the largest production was also in July, with another harvest in October; in 2012 there were four harvests, in January, June, August and November, the largest crop in January; in 2013 two harvests were accomplished in the months of March and August, being March the month of largest production; and in 2014 there were three productions

with the largest in February. Therefore, in the climate conditions one rainfed cultivation evaluated in this study (Figure 1), the 'Tuxpan Valencia' orange had more than on blossom per year, hence up to four harvests per year, without a defined harvest period, as typically occurs in citrus grown in tropical climate (RIBEIRO and MACHADO, 2007).

The rootstocks were grouped into two categories according to production efficiency (PE), 'Riverside' citrandarin and TSKFL x CTSW - 049 with the highest average (5.1 kg fruit m^{-3}) and the others with the lowest average (2.0 kg fruit m^{-3}). These values are inversely related to the ones obtained of canopy volume, since 'Riverside' citrandarin and TSKFL x CTSW - 049 are among the rootstocks which induced lower canopy dimensions (Table 1). For AULER et al. (2008), rootstocks that induce higher production efficiency and that provide smaller canopy volume can be more interesting than those rootstocks with great canopy volume and larger production of fruit per, since they indicate that this production can be offset by increased tree density per area.

TSKF x CTSW - 049 resulted in the death of 33.3% of the plants rootstock at nine years old, while there was no loss of plants over all other rootstocks (Table 1). 'Tuxpan Valencia' plants on that hybrid had, in addition to small size, widespread mineral deficiency and stunting similar to symptoms of incompatibility, which was not observed in other rootstocks. Pompeu Junior and Blumer (2009) in experiment conducted in Itirapina, SP, verified the occurrence of incompatibility between 'Valencia' orange and the trangpur 'Rangpur' x 'Carrizo' (717) 14 years old after a checking in 2002 of gum ring in the grafting line, responsible for modification in the plant nutrition and resulting reduction in fruit production. In this study, however, there was no gum ring formation in the graft region of the 'Tuxpan Valencia' in the hybrid TSKFL x CTSW - 049, and other factors may be associated with the death of plants and their lower growth. Also interesting to point out that this anomaly did not occur in plants of the TSKC x CTSW-028 hybrid, of similar parental to the 049 hybrid.

There was no difference between the rootstocks on the dry grade, i.e. tolerance based on leaf wilting visually evaluated in 2013, expressed in a generalized manner (Table 1), despite the higher fruit production presented by some of these (Table 2). Ramos et al. (2015) evaluated 'Valencia' orange grafted on different citrus hybrids rootstocks in rainfed cultivation in Colombia-SP and observed that 'Sunki Tropical' mandarin, 'Cravo Santa Cruz' lime and 'Indio' and 'Riverside' citrandarins induced high production and great canopy vigour, although citrandarins have resulted in sharp leaf curling due to drought in the region. The results of the production are consistent with those obtained in this study, while the vigour and drought tolerance differences may result from different environmental conditions and corroborate with the need to evaluate the combinations of citrus scions and rootstocks in regional trials.

Carvalho et al. (2012), in an experiment conducted in rainfed in Umbaúba - SE, observed that 'Tuxpan Valencia' orange obtained greater productivity when grafted onto LVK x LCR - 010 hybrid (11.9 t ha^{-1}), 'Cravo Santa Cruz' lime (11.5 t ha^{-1}) and 'Balão' rough lemon (12.6 t ha^{-1}) until the 3rd year of production. Prudente et al. (2004) evaluated the 'Pera' orange clone D6 grafted on five rootstocks in Coastal Plains soil in Umbaúba-SE and found productivity, fruit weight and percentage of juice on 'Volkamer lemon' Palermo and Catania 2 clones and 'Cleopatra' mandarin, similar to those on 'Rangpur' lime and 'Rugoso da Florida' rough lemon, the most used rootstocks in citrus regions of Sergipe, due to their high tolerance to drought.

'Valencia' orange was evaluated for 11 years in Bebedouro-SP, under rainfed, with 'Sunki' mandarin inducing higher production than 'Troyer' citrange, 'Rugoso Nacional' rough lemon, 'Swingle' citrumelo and 'Thornton' tangelo (*C. paradisi* x *C. reticulata* Blanco), but equivalent to the 'Cleopatra' mandarin and 'Valencia Americana' (*C. sinensis*) (STUCHI et al., 2002). In Florida, USA, Castle et al. (2010) have observed higher productivity of 'Valencia' orange grafted on 'Volkamer' and rough lemon in relation to trifoliate hybrids and other species, although at least 50% of the plants on the lemon rootstocks have died for blight at 24 years old. In this study, the good performance of 'Cravo Santa Cruz' lime and 'Volkamer' lemon confirms the results reported by previous authors, in addition to citrandarins and 'Sunki Tropical' mandarin. Until the ninth year of planting, there were no plants with symptoms of blight in any of the evaluated rootstocks.

Considering the adopted tree spacing and the production obtained by the most productive rootstocks in 2014 (fifth season) (Table 2), the estimated yield was 18.2 t ha^{-1}, similar to the average of the state of Bahia (15.7 t ha^{-1}) (IBGE, 2015).

In relation to fruit quality, it was found that the rootstocks did not change the fruit weight, length, diameter, skin thickness, the number of seeds, titratable acidity and the ratio of 'Tuxpan Valencia' orange (Table 3). The attributes juice yield, soluble solids concentration and technological index (TI) were already influenced by the rootstocks studied.

The rootstocks that led to higher yield of fruit juice were 'Riverside' and 'Indio' citrandarins, TSKFL x CTTR-017, TSKC x CTSW-028, 'Cravo

Santa Cruz' lime and 'Volkamer' lemon, 'Sunki Tropical' mandarins, TSKC x (LCR x TR) - 001 and CLEO x CTCZ - 226 (Table 3). Regarding the concentration of SS, the highest value was observed for TSKFL x CTSW-049, followed by the group formed by 'Cravo Santa Cruz' lime, 'Cleopatra' mandarin and 'Riverside' citrandarin. However, like tree death and the small size of plants described above for that hybrid may be related to the incompatibility with the 'Tuxpan Valencia' orange, this anomaly may occur from the grafting, changing the fruits production and their characteristics. This is the first report on the performance of TSKFL x CTSW-049 hybrid as sweet orange rootstock in field conditions and further studies will be needed to confirm this behavior.

There was no difference between the rootstocks for titratable acidity and ratio (Table 3). Auler et al. (2008) did not observe differences in Nova Esperaça-PR in rainfed planting, assessing the 'Valencia' orange over 'Rangpur' lime, 'Cleopatra' and 'Sunki' mandarins, 'Troyer' citrange, 'Caipira' orange (*C. sinensis*) and 'Orlando' tangelo (*C. paradisi* x *C. reticulata*), with acidity ranging from 0.8 to 0.9% and ratio from 12.5 to 13.8, but with a range of values above those observed in this study.

Regarding the technological index (TI), TSKC x (LCR x TR)-018, LVK x LVA -009 and 'Sunki Maravilha' and 'Cleopatra' mandarins presented the lowest results, reflecting their low juice content (Table 3). Stuchi et al. (2002) studied the effect of seven rootstocks on fruit quality of 'Valencia' orange without irrigation in Bebedouro-SP, and found that there were no differences among the rootstocks for acidity, soluble solids, ratio and technological index, which ranged from 2.49 to 2.86 kg SS box^{-1}. This range is above that observed for TI in this study (1.8 to 2.5 kg SS box^{-1}), even for the most efficient rootstocks in this variable.

The average fruit quality attributes of 'Tuxpan Valencia' orange observed in Rio Real-BA (Table 3) were similar to those described for this variety in studies in Cordeirópolis-SP and Brejão-PE, in which the fruits were typically late and with weight exceeding 150 g (BLUMER et al., 2003; MEDEIROS et al, 2013.). The 'Tuxpan Valencia' orange assessed in the present conditions of the northern coast of Bahia presented physical and chemical characteristics of fruits suitable for processing or fresh fruit market, as the usual market requirements (NONINO, 1995; CEAGESP, 2011).

TABLE 1 - Height, diameter and volume of the canopy, production efficiency (PE), tree survival and dry grades of 'Tuxpan Valencia' orange grafted on 14 rootstocks in Rio Real-BA at nine years old. Embrapa, 2014.

Rootstocks	Height		Diameter		Volume		PE*		Survival		Dry grades*	
	------ m -----				m^{-3}		kg m^{-3}		(%)			
'Indio' Citrandarin	2.8	a	1.8	a	9.8	b	2.4	b	100	a	2.8	a
'Riverside' Citrandarin	2.0	a	1.7	b	7.0	c	5.3	a	100	a	2.7	a
CLEO x CTCZ - 226	1.9	b	1.6	b	5.0	c	1.8	b	100	a	3.5	a
TSKFL x CTTR – 017	1.8	b	1.6	b	4.8	c	2.5	b	100	a	3.5	a
TSKC x CTSW – 028	2.1	a	1.7	a	8.2	b	2.0	b	100	a	2.8	a
TSKFL x CTSW – 049	1.4	b	1.4	c	2.3	c	5.0	a	66.7	b	2.7	a
TSKC x (LCR x TR) – 001	2.2	a	1.8	a	9.4	b	2.4	b	100	a	2.7	a
TSKC x (LCR x TR) – 018	2.3	a	1.8	a	9.5	b	2.0	b	100	a	3.0	a
LVK x LVA – 009	2.4	a	1.8	a	9.8	b	1.0	b	100	a	2.7	a
'Sunki Tropical' Mandarin	2.6	a	1.9	a	13.7	a	1.9	b	100	a	3.2	a
'Sunki Maravilha' Mandarin	2.5	a	1.9	a	13.5	a	0.9	b	100	a	3.3	a
'Santa Cruz Rangpur' Lime	2.2	a	1.8	a	10.1	b	3.3	b	100	a	2.5	a
'Volkamer' Lemon	2.3	a	1.8	a	10.7	b	2.6	b	100	a	2.5	a
'Cleopatra' Mandarin	2.4	a	1.8	a	10.9	b	1.8	b	100	a	3.0	a
VC (%)	10.8		9.8		22.4		18.3		7.9		17.0	
F Value	5.4*		7.3		7.6		3.3		4.0*		1.4	

Means followed by the same letter in the column belong to the same group for the Scott- Knott test ($P \leq 5\%$).

* Visual score scale, ranging from grade 1 (no symptoms), grade 2 (discrete leaf wilting in up to half of the canopy), grade 3 (discrete leaf wilting throughout the canopy) up to grade 4 (intense wilting throughout the canopy and leaf drop).

[1]TSK ('Sunki' mandarin), TRENG (*P. trifoliata* 'English'), CLEO ('Cleopatra' mandarin), CTCZ ('Carrizo' citrange), TSKFL (Florida 'Sunki' mandarin), CTTR ('Troyer' citrange), TSKC (ordinary 'Sunki' mandarin), CTSW ('Swingle' citrumelo), TR (*P. trifoliata*), LCR ('Rangpur' lime), LVK ('Volkamer' lemon) and LVA ('Valencia' sweet orange).

TABLE 2 - Fruit production of 'Tuxpan Valencia' orange grafted on 14 rootstocks Real-BA Rio at nine years old. Embrapa, 2010-2014.

Rootstocks	2010-2014		2010		2011		2012		2013		2014	
	kg plant^{-1}											
'Indio' Citrandarin	116.2	a	15.7	a	15.1	a	26.4	a	17.5	a	41.3	a
'Riverside' Citrandarin	140.7	a	8.4	b	18.7	a	38.4	a	19.6	a	55.4	a
CLEO x CTCZ – 226	39.4	b	1.2	c	2.2	b	7.6	b	10.5	b	17.7	b
TSKFL x CTTR – 017	50.3	b	1.7	c	10.2	b	13.0	b	6.1	b	18.2	b
TSKC x CTSW – 028	71.4	b	3.7	c	4.9	b	17.9	b	17.6	a	27.1	b
TSKFL x CTSW – 049	45.0	b	10.3	b	5.9	b	15.2	b	8.1	b	5.3	b
TSKC x (LCR x TR) – 001	102.0	a	10.5	b	11.2	b	25.2	a	14.8	a	40.2	a
TSKC x (LCR x TR) – 018	82.0	b	2.6	c	4.0	b	27.6	a	10.0	b	37.7	a
LVK x LVA – 009	43.7	b	1.0	c	8.4	b	9.0	b	9.1	b	16.1	b
'Sunki Tropical' Mandarin	116.7	a	9.2	b	13.9	a	31.7	a	20.2	a	41.6	a
'Sunki Maravilha' Mandarin	52.8	b	1.6	c	5.6	b	12.2	b	8.9	b	24.3	b
'Santa Cruz Rangpur' Lime	142.3	a	18.5	a	19.5	a	42.7	a	18.5	a	43.0	a
'Volkamer' Lemon	133.7	a	21.6	a	23.96	a	27.4	a	19.6	a	41.5	a
'Cleopatra' Mandarin	74.0	b	2.2	c	5.58	a	31.6	a	7.2	b	27.2	b
VC (%)	27.2		22.1		24.9		19.1		24.2		25.3	
F Value	7.8*		13.0*		5.3		5.1*		2.3*		3.1*	

Means followed by the same letter in the column belong to the same group for the Scott- Knott test ($P \leq 5\%$).
[1]TSK ('Sunki' mandarin), TRENG (*P. trifoliata* 'English'), CLEO ('Cleopatra' mandarin), CTCZ ('Carrizo' citrange), TSKFL (Florida 'Sunki' mandarin), CTTR ('Troyer' citrange), TSKC (ordinary 'Sunki' mandarin), CTSW ('Swingle' citrumelo), TR (*P. trifoliata*), LCR ('Rangpur' lime), LVK ('Volkamer' lemon) and LVA ('Valencia' orange).

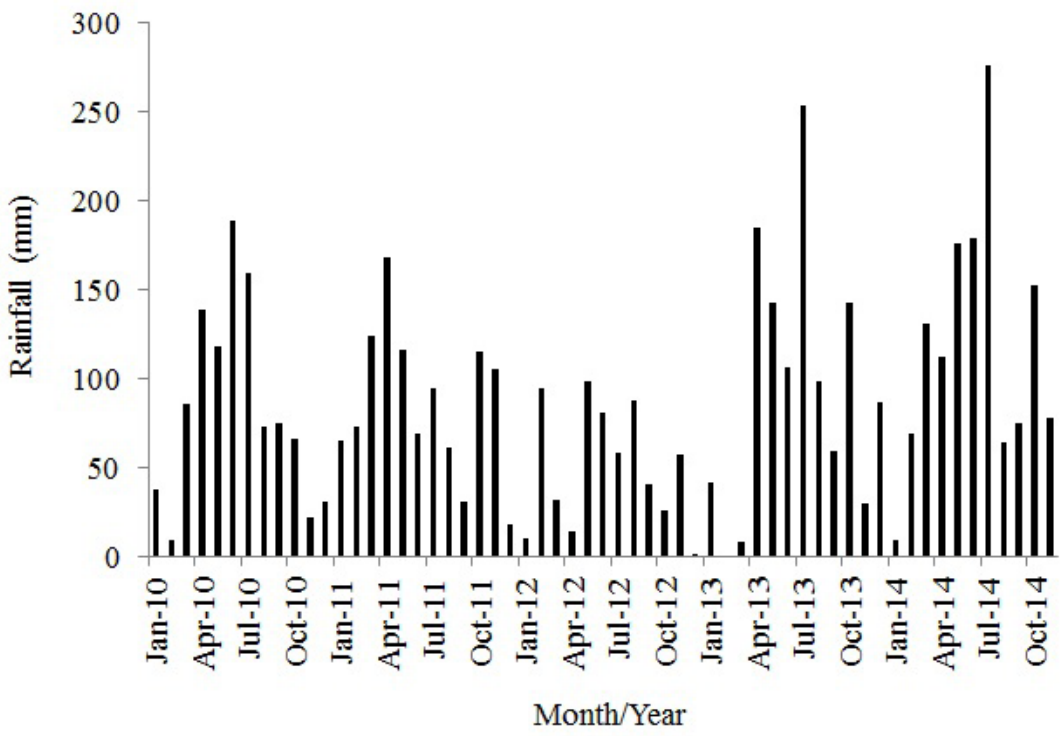

FIGURE 1- Monthly rainfall in the area in 2010 to 2014 period. Rio Real-BA.

TABLE 3- Weight (W), Length (L), diameter (D), skin thickness (ST), juice yield (Y), number of seeds per fruit (NS), titratable acidity (TA), concentration of soluble solids (SS), *ratio* (SS/TA) and technological index (TI) fruits of 'Tuxpan Valencia' orange grafted on 14 rootstocks in Rio Real-BA at nine years old. Embrapa, 2011-2014.

Rootstocks	W (g)	L (cm)	D (cm)	ST (mm)	Y (%)	NS	TA (%)	SS (°Brix)	*ratio*	TI*
'Indio' Citrandarin	169 a	6.8 a	7.1 a	3.6 a	46 a	6 a	1.17 a	10.8 c	9.1 a	2.05 a
'Riverside' Citrandarin	183 a	6.5 a	6.8 a	3.1 a	51 a	7 a	1.22 a	12.0 b	10.0 a	2.53 a
CLEO x CTCZ – 226	169 a	6.8 a	7.3 a	3.2 a	45 a	7 a	1.25 a	11.2 c	9.0 a	2.11 a
TSKFL x CTTR – 017	181 a	6.7 a	7.1 a	3.3 a	51 a	6 a	1.25 a	11.3 c	9.1 a	2.35 a
TSKC x CTSW – 028	176 a	6.9 a	7.2 a	3.0 a	51 a	8 a	1.20 a	10.8 c	8.9 a	2.28 a
TSKFL x CTSW – 049	109 a	6.4 a	6.6 a	3.1 a	42 b	5 a	1.29 a	13.7 a	10.6 a	2.35 a
TSKC x (LCR x TR) – 001	161 a	6.7 a	7.1 a	3.3 a	48 a	6 a	1.34 a	10.9 c	8.1 a	2.17 a
TSKC x (LCR x TR) – 018	190 a	7.1 a	7.5 a	3.0 a	42 b	6 a	1.18 a	10.4 c	8.8 a	1.79 b
LVK x LVA – 009	194 a	7.0 a	7.5 a	4.4 a	42 b	5 a	1.44 a	9.8 c	6.9 a	1.49 b
'Sunki Tropical' Mandarin	176 a	6.9 a	7.4 a	3.5 a	49 a	6 a	1.40 a	10.5 c	7.5 a	2.12 a
Sunki Maravilha Mandarin	169 a	6.5 a	7.1 a	3.3 a	42 b	5 a	1.20 a	10.7 c	9.0 a	1.83 b
'Santa Cruz Rangpur' Lime	173 a	6.6 a	6.9 a	3.0 a	51 a	5 a	1.66 a	11.8 b	7.5 a	2.46 a
'Volkamer' Lemon	168 a	6.8 a	6.9 a	3.3 a	46 a	5 a	1.11 a	10.4 c	10.0 a	2.43 a
Cleopatra Mandarin	177 a	6.5 a	6.9 a	3.4 a	39 b	6 a	1.39 a	11.7 b	8.3 a	1.88 b
VC (%)	11.0	3.7	4.1	16.7	6.7	19.8	19.0	6.9	15.4	11.8
F Value	3.2	1.6	2.1	1.31	5.3*	1.0	1.0	3.6*	1.5	4.1*

Means followed by the same letter in the column belong to the same group for the Scott- Knott test ($P \leq 5\%$).
* kg SS box^{-1} 40.8 kg
[1]TSK ('Sunki' mandarin), TRENG (*P. trifoliata* 'English'), CLEO ('Cleopatra' mandarin), CTCZ ('Carrizo' citrange), TSKFL (Florida 'Sunki' mandarin), CTTR ('Troyer' citrange), TSKC (ordinary 'Sunki' mandarin), CTSW ('Swingle' citrumelo), TR (*P. trifoliata*), LCR ('Rangpur' lime), LVK ('Volkamer' lemon) and LVA ('Valencia' sweet orange).

CONCLUSIONS

In the conditions evaluated in this experiment, the 'Tuxpan Valencia' orange showed superior performance when grafted on 'Santa Cruz' Rangpur lime, 'Volkamer' lemon, 'Indio' and 'Riverside' citrandarins, 'Sunki Tropical' mandarin and TSKC x (LCR x TR) - 001 hybrid. These rootstocks induced similar quality to the fruits of 'Tuxpan Valencia' orange.

The small tree size and the high mortality of plants on TSKFL x CTSW-049 suggest the occurrence of graft incompatibility of the 'Tuxpan Valencia' orange with this hybrid.

ACKNOWLEDGEMENTS

To CAPES, for the scholarship to the first two authors; to Lagoa do Coco Farm and staff and the agronomist Roberto Toyohiro Shibata, by providing the experimental area and technical support; to Embrapa Cassava & Fruits, for the supply of plant materials and support for the fruit quality analysis; and to the agronomist Magno Santos Guimarães, for the technical support.

REFERENCES

ALMEIDA, C.O; PASSOS, O.S.; CUNHA SOBRINHO, A.P.; SOARES FILHO, W.S. **Citricultura brasileira**: em busca de novos rumos, desafios e oportunidades na região Nordeste. Cruz das Almas: EMBRAPA Mandioca e Fruticultura, 2011. 160p.

AULER, P.A.M.; FIORI-TUTIDA, A.C.G.; TAZIMA, Z.H. Comportamento da laranjeira Valência sobre seis porta-enxertos no noroeste do Paraná. **Revista Brasileira de Fruticultura**, Jaboticabal, v.30, n.1, p.229-234, 2008.

AZEVEDO, C.L.L.; PASSOS, O.S.; SANTANA, M.A. **Sistema de produção para pequenos produtores de citros do Nordeste**. Cruz das Almas: Embrapa Mandioca e Fruticultura, 2006. 55p. (Documentos, 157).

BLUMER, S.; POMPEU JUNIOR, J.; GARCIA, V.X.P. Características de qualidade dos frutos de laranjas de maturação tardia. **Laranja**, Cordeirópolis, v.24, n.2, p.423-431, 2003.

CARVALHO, H.W.L. de; MARTINS, C.R.; SOARES FILHO, W. dos S.; PASSOS, O.S.; GIRARDI, E.A.; GESTEIRA, A. da S. Comportamento produtivo de cinco variedades comerciais de laranjas enxertadas em diferentes porta-enxertos de citros cultivados na Região Sul do Estado do Sergipe. In: CONGRESSO BRASILEIRO DE FRUTICULTURA, 22., 2012, Bento Gonçalves. **Anais...** Bento Gonçalves: SBF, 2012. 1 CD-ROM.

CARVALHO, J.E.B. de; SOUZA, L.S.; CALDAS, R.C.; ANTAS, P.E.U.T.; ARAÚJO, A.M.A.; LOPES, L.C.; SANTOS, R.C. dos; LOPES, N.C.M.; SOUZA, A.L.V. Leguminosa no controle integrado de plantas daninhas para aumentar a produtividade da laranja-Pêra. **Revista Brasileira de Fruticultura**, Jaboticabal, v. 24, n. 1, p. 82-85, 2002.

CASTLE, W.S.; BALDWIN, J.C.; MURARO, R.P. Performance of Valencia sweet orange trees on 12 rootstocks at two locations and an economic interpretation as a basis for rootstock selection. **HortScience**, Alexandria, v.45, p.523-533, 2010.

CEAGESP - Companhia de Entrepostos e Armazéns Gerais de São Paulo. **Normas de classificação de citros de mesa**. São Paulo: CEAGESP, 2011. 12p. (Programa Brasileiro para Modernização da Horticultura - PBMH).

IBGE. **IBGE estados Bahia lavoura permanente 2014**. Disponível em: <http://www.ibge.gov.br/estadosat/temas.php?sigla=ba&tema=lavourapermanente2014>. Acesso em: 9 maio 2016.

MEDEIROS, R.C.; MUSSER, R.S.; SILVA, M.M.; SANTOS, J.P.O.; NASCIMENTO JUNIOR, I.R. Análise exploratória das características morfológicas e qualitativas de variedades de laranjeiras de mesa da coleção em Brejão – PE. **Revista Brasileira de Fruticultura**, Jaboticabal, v. 35, n. 2, p. 500-507, 2013.

NONINO, E. Seleções de laranjas para fabricação de sucos. **Revista Laranja**, Cordeirópolis, v.16, n.1, p.119-132, 1995

PASSOS, O.S.; SOARES FILHO, W.S.; CUNHA SOBRINHO, A.P.; SOUZA, A.S.; SANTOS, L.C.; PEIXOUTO, L.S. **Banco ativo de germoplasma de citros da Embrapa Mandioca e Fruticultura Tropical**: passado, presente e futuro. Cruz das Almas: Embrapa Mandioca e Fruticultura, 2007. 61p. (Documentos, 163).

POMPEU JUNIOR, J. Porta-enxertos para citros potencialmente ananicantes. **Revista Laranja**, Cordeirópolis, v.22, n.1, p.147-155, 2001.

POMPEU JUNIOR, J. Porta-enxertos. In: MATTOS JUNIOR, D.; PIO, R.M.; DE NEGRI, J. D.; POMPEU JUNIOR, J. (Ed.). **Citros**. Campinas: Instituto Agronômico de Campinas, Fundag, 2005. p.63-104.

POMPEU JUNIOR, J.; BLUMER, S. Citrumelos como porta-enxertos para a laranjeira Valência. **Pesquisa Agropecuária Brasileira**, Brasília, v.46, p.105-107, 2011.

POMPEU JUNIOR, J.; BLUMER, S. Híbridos de trifoliata como porta-enxertos para a laranjeira Valência. **Pesquisa Agropecuária Brasileira**, Brasília, v.44, n.7, p.701-705, 2009.

PRUDENTE, R.M.; SILVA, L.M.S.; CUNHA SOBRINHO, A.P. da. Comportamento da laranjeira Pera D6 sobre cinco porta-enxertos em ecossistema de tabuleiros costeiros. Umbaúba-SE. **Revista Brasileira de Fruticultura**, Jaboticabal, v.26, n.1, p. 110-112, 2004.

RAMOS, Y.C.; STUCHI, E.S.; GIRARDI, E.A.; LEAO, H.C.; GESTEIRA, A.S.; PASSOS, O.S.; SOARES FILHO, W.S. Dwarfing rootstocks for Valencia sweet orange. **Acta Horticulturae**, Leuven, v.1065, p. 351-354, 2015.

RIBEIRO, R.V.; MACHADO, E.C. Some aspects of citrus ecophysiology in subtropical climates: re-visiting photosynthesis under natural conditions. **Brazilian Journal of Plant Physiology**, Londrina, v.19, n.4, p.393-411, 2007.

SOARES FILHO, W.S. **Reunião técnica**: obtenção, seleção e manejo de variedades porta-enxerto de citros adaptadas a estresses abióticos e bióticos. Cruz das Almas: Embrapa Mandioca e Fruticultura, 2011. (Documentos, 200). 1 CD-ROM.

STUCHI, E.S.; DONADIO, L.C.; SEMPIONATO, O.R. Qualidade industrial e produção de frutos de laranjeira Valência enxertada sobre sete porta-enxertos. **Laranja**, Cordeirópolis, v.23, n.2, p.453-471, 2002.