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Propagation

Initial production and fruit quality of fifty-seven sweet orange varieties on four rootstocks in Southern state of Bahia

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Abstract -Prior knowledge of scion/rootstock combinations is essential for establishing appropriate citrus orchard management strategies. The objective of this work was to assess the initial yield and fruit quality among 228 scion/rootstock combinations set up in the municipality of Ibirapuã, extreme south of the state of Bahia in 2015. Harvests were carried out from April to August 2019, when trees reached 4 years of age. Number, total mass and cross-sectional diameter of fruits, productive efficiency, pulp yield, soluble solids content, titratable acidity and SS/AT ratio were evaluated. Statistical difference for all characteristics related to production and fruit quality regarding factors studied and their combinations was observed. Among 'Pera' orange clones, 'Pera CNPMF A-15'/'San Diego' citrandarin and 'Pera CNPMF D-3'/'Riverside' citrandarin combinations stood out. 'Sincorá' orange, in combination with 'San Diego' and 'Indio' citrandarins presented potential to be recommended to producers who wish to anticipate their harvests, as well as 'Natal Ipeal' orange in combination with 'Indio' citrandarin, in the sense of postponing them.
Index terms: *Citrus sinensis*; citrandarin; *Citrus sunki*; *Poncirus trifoliata*.

Produção inicial e qualidade de frutos de cinquenta e sete copas de laranjeira-doce sobre quatro porta-enxertos no extremo Sul da Bahia

Resumo- O conhecimento prévio de combinações copa/porta-enxerto é fundamental para o estabelecimento de estratégias adequadas de manejo de pomares de citros. O objetivo deste trabalho foi avaliar a produtividade e a qualidade iniciais de frutos entre 228 combinações copa/porta-enxerto implantadas no Município de Ibirapuã, Extremo Sul da Bahia, em 2015. As colheitas foram realizadas no período de abril a agosto de 2019, quando as plantas atingiram 4 anos. Avaliaram-se o número, a massa total e o diâmetro transversal dos frutos, a eficiência produtiva, o rendimento de polpa, o teor de sólidos solúveis, a acidez titulável e *ratio*. Houve diferença estatística para todas as características relacionadas à produção e à qualidade dos frutos quanto aos fatores estudados e suas combinações. Dentre os clones de laranjeira 'Pera' estudados, as combinações 'Pera CNPMF A-15'/citrandarin 'San Diego' e 'Pera CNPMF D-3'/citrandarin 'Riverside' foram as que mais se destacaram. A laranjeira 'Sincorá', em combinação com os citrandarins 'San Diego' e 'Indio', tem potencial de recomendação aos produtores que desejam antecipar suas colheitas, assim como a laranjeira 'Natal Ipeal', em combinação com o citrandarin 'Indio', no sentido de postergá-las.
Termos para indexação: *Citrus sinensis*; citrandarin; *Citrus sunki*; *Poncirus trifoliata*.

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Citrus are among the most cultivated fruit species in the world, mainly in subtropical and tropical climates. The main citrus product in the Brazilian scenario is intended for industry, for the production of frozen concentrated orange juice for export, of which Brazil accounts for 50% of the total world production, followed by the United States (FAO, 2015). The Brazilian production of sweet oranges [*Citrus sinensis* (L.) Osbeck], in 2019, was approximately 17.6 million tons in an approximate area of 608.2 thousand hectares of harvested area, especially in the states of São Paulo. Paulo, Minas Gerais, Paraná and Bahia, with the highest productions, respectively (IBGE, 2020).

Despite the wide variety of genetic material from sweet oranges, the national citrus industry predominantly uses 'Pera' and 'Valencia' orange cultivars on 'Rangpur' and 'Citrumelo Swingle' rootstocks. This makes crops susceptible to losses due to the onset of diseases such as *Phytophthora* gummosis, citrus tristeza virus and citrus sudden-death (FADEL et al., 2018; RODRIGUES et al., 2016; SOARES; et al., 2015).

With the objective of proposing new rootstock options for the national citrus industry, crosses between 'Sunki' mandarins [*Citrus sunki* (Hayata) hort. ex Tanaka] and 'Cleopatra (*Citrus reshni* hort. ex Tanaka) with trifoliata [*Poncirus trifoliata* (L.) Raf.] have been performed, giving rise to hybrids called citrandarins, which have great potential for use as rootstock. This type of crossing aims to add characteristics present in mandarins, such as less susceptibility to citrus exocortis viroid, citrus decline, citrus tristeza virus and citrus sudden-death. For *P. trifoliata*, studies seek to add resistance to *Phytophthora* gummosis and citrus tristeza virus, adaptation to low temperatures and soils subject to flooding, in addition to inducing size reduction to scion varieties grafted on them, which characteristic is verified particularly in 'Flying Dragon' cultivar (POMPEU JUNIOR; BLUMER, 2009). Among mandarins, 'Tropical Sunki' stands out, which has as main characteristics high number of seeds per fruit, polyembryony degree close to 100% and greater tolerance to *Phytophthora* gummosis, compared to other selections of this mandarin (SOARES FILHO et al., 2002).

To achieve success in the citrus activity, with fruit yield and quality, it is not enough just to analyze the different scions of sweet oranges and rootstocks alone, but their combinations. These interactions can induce behavioral variations, making it necessary to study scion/rootstock combinations. Another factor that suffers interference and is directly linked to the success of the scion/rootstock combination refers to fruit production, which may also vary according to the interaction of the genotype with the environment (SCHÄFER et al., 2001; PRUDENTE; SILVA, 2006). Therefore, prior knowledge of rootstock combinations with orange scions is important to establish crop management strategies. In this sense, the objective of this study was to identify among 228 scion/rootstock combinations those that present the best productive aspects and fruit quality in the extreme south of the state of Bahia.

The experiment was carried out in an experimental area of Fazenda Chão Bello, municipality of Ibirapuã, extreme southern Bahia (17°48'08.1''S, 39°52'09.8''W) and altitude of 95 m a.s.l. The climate is classified as tropical humid or sub-humid (Am), according to the Köppen classification, with average annual temperature of 23.6 °C (ALVARES et al., 2013). Average monthly rainfall was 76.3 mm between January 2018 and December 2019, according to data collected from the rain gauge installed in the experimental area.

The soil chemical characterization in the 0-20 cm layer, according to the soil analysis methodology of Embrapa (2009), was: pH in water = 5.2 (1:2.5 ratio); phosphorus = 12 mg/dm³; potassium = 51 mg/dm³; sodium = 15 mg/dm³; calcium = 1.5 cmol/dm³; magnesium = 0.3 cmol/dm³; aluminum = 0.4 cmol/dm³; H+Al = 3.4 cmolc/dm³; sum of bases = 2.0 cmolc/dm³; effective cation exchange capacity = 2.4 cmolc/dm³; base saturation index = 37%; sodium saturation index = 1.1%; organic matter = 1.88 dag/dm³. For phosphorus, potassium and sodium, the Mehlich-1 extractor was used; for calcium, magnesium and aluminum, KCl at concentration of 1 mol/L and for H+Al, SMP extractor.

A completely randomized design was used. The scheme adopted was a 4 × 57 factorial, consisting of four rootstocks combined with 57 sweet orange varieties, with 3 replicates and 2 plants per plot. Seedlings were produced in nursery at "Embrapa Mandioca e Fruticultura" in Cruz das Almas-BA. The orange cultivars evaluated were: 'Pera' (CNPMF 01, 02, A-15, B-12, C-21, C-32, D-3, D-6, D-9, D-12, D-25 , E-3 and E-6, Olímpia, Bianchi, GE-03, Vacinada, and Ibotirama selections), 'Natal' (CNPMF 01, 02 and 112, Ipeal and Folha Murcha selections), 'Valencia' (CNPMF 01, 02, 03 , 21, 27, 36, F-11, Midknight, Criola, Delta, Late, L. Shaffey, Chapman, L. White, Montemorelos, Registro, Tuxpan selections), 'Bern', 'Jaffa', 'F-Menuda', 'Sincorá', 'Aquiri', 'Early Oblong', 'Russas PS', 'Selecta de Itaboraí', 'Salustiana', 'Pineapple', 'Westin', 'Diva', 'Hamlin CNPMF-20', 'Crescent sweet', 'Melrosa' and 'Flor de Brumadinho'. With the exception of 'Pera' GE-03, Bianchi, Olímpia and Vacinada selections that came from the "Sylvio Moreira" Citriculture Center (IAC), the others came from "Embrapa Mandioca e Fruticultura", with 'Pera', 'Natal' and 'Valencia' selections being nuclear clones obtained and evaluated by the Eastern Agricultural Research Institute (IPEAL), agency preceding Embrapa. Scion varieties were grafted onto 'Sunki Tropical' (TST) mandarins and 'Indio' (IND), 'Riverside' (RIV) and 'San Diego' (SD) citrandarins (*C.*

sunki × *P. trifoliata*), selected by the Citrus Breeding Program at "Embrapa Mandioca e Fruticultura".

The experiment was installed in the field on 04/12/2015 with spacing of 6 m between rows and 3 m between plants. The irrigation system used was microsprinkler with flow of 72 L/h, in two fixed irrigation shifts of 6 mm/day. Fertilization was carried out according to recommendations from the partner citrus grower. For phytosanitary control, fungicides and insecticides registered for the crop were used, according to periodic monitoring in the area. To control weeds in planting rows, herbicides based on glyphosate and glufosinate were applied. Cultural treatments such as mowing between rows and plant pruning were carried out in accordance with the producer's management and to standards recommended for the crop.

In 2018, due to the low yield, harvest was carried out only with the purpose of verifying the harvest time of the different scion/rootstock combinations. Based on 2018 data, harvests were carried out from April to August 2019, evaluating the following morphoagronomic parameters: total number of fruits (NTF, per plant), total fruit weight (MTF, kg/plant), plant height (ALT, m), mean scion diameter in the row direction (DL, m) and between rows (DE, m). Fruits were manually collected, counted, placed in collection boxes suitable for transport and weighed on scale installed in the experimental area. ALT and scion diameters (DL and DE) were measured using measuring tape graduated in centimeters, and data were used to calculate the scion volume (VC, m^3), obtained according to Zekri et al. (2003), by the formula:

$$\mathbf{VC = (\pi/6) \times ALT \times DL \times DE}$$

where: ALT = plant height (m); DL = scion diameter in the row direction; DE = scion diameter (m) perpendicular to the planting row.

Productive efficiency per plant (EP, $kg.m^{-3}$) was obtained by the relationship between MTF and VC.

For physicochemical evaluations, samples of six fruits per experimental plot were used, taken from the middle third of scions, packed in polyethylene bags, identified and taken to the laboratory. The following characteristics were evaluated: cross-sectional diameter (DT, mm) measured with digital caliper; juice yield (REND, %) through industrial blender, measuring the percentage of the difference between sample and waste masses (bagasse and seeds); soluble solids content (SS, °Brix) with digital refractometer; titratable acidity (AT, % citric acid) determined by volumetry and using phenolphthalein solution as indicator; and the SS/AT ratio.

Data were submitted to analysis of variance (ANOVA) and the Scott-Knott test was applied to compare treatments at 5% probability using the R software (R DEVELOPMENT CORE TEAM, 2011).

All characteristics related to fruit production were significant in terms of the interaction between scion and rootstock (Table 1). Thus, it was observed, as reported by Chaparro-Zambrano et al. (2015), that the rootstock has direct influence on the production of sweet orange scions.

Table 1. Summary of the analysis of variance with source of variation (FV), degree of freedom (GL), mean square (QM) and coefficient of variation (CV) for total number of fruits (NTF), total fruit mass (MTF) and productive efficiency (EP) of 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] in combination with four rootstocks.

FV	GL	QM		
		NF	MTF	EP
PE	3	1303045**	75724**	127.747**
E	56	757831**	26488**	39.912**
PE × E	168	7404435**	2094**	3.892**
RES	447	20141	1008	0.849
CV (%)		37.74	33.98	31.59

** Significant at 1% and 5% probability by the F test; PE = Rootstock; E = Graft; RES = Residue.

Scion varieties that presented the highest number of fruits per plant on the 'Sunki Tropical' (TST) mandarin were: 'Pera' CNPMF 01, B-12, D-6, D-9, E-6 and 'Natal' CNPMF 01 (Table 2). On 'San Diego' (SD) citrandarin were 'Pera' CNPMF E-6, E-3, 'Olimpia' and 'Sincorá'. For 'Pera' CNPMF 01, D-3, E-3, 'Olimpia', 'Bianchi', 'GE-03', 'Natal' CNPMF 01 and 02, higher number of fruits per plant was observed on 'Riverside' (RIV) citrandarin and for 'Pera' GE-03 and 'Sincorá' on 'Indio' (IND) citrandarin. Among combinations that most produced fruits, TST and RIV rootstocks stand out, which together accounted for more than 60% of averages. Cultivars with higher NTF in two of the rootstocks were 'Pera' CNPMF 01 and E-6, 'Olimpia', 'GE-03', 'Sincorá' and 'Natal' CNPMF 01.

Table 2. Total number of fruits per plant of 228 scion/rootstock combinations comprising 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] on 'Sunki Tropical' (TST) mandarin rootstocks [*Citrus sunki* (Hayata) hort. ex Tanaka] and 'San Diego' (SD), 'Riverside' (RIV) and 'Indio' (IND) citrandarins [*C. sunki* × *Poncirus trifoliata* (L.) Raf.].

Scion variety	Rootstock			
	TST	SD	RIV	IND
Aquiri	76 Ac	142 Ac	131 Ac	171 Ad
Berna	4 Bc	62 Bc	141 Ac	149 Ad
Crescent sweet	76 Bc	115 Bc	203 Ac	84 Be
Diva	11 Bc	22 Bc	201 Ac	27 Be
Early Oblong	62 Bc	67 Bc	367 Ab	172 Bd
F-Menuda	1 Ac	6 Ac	25 Ad	30 Ae
Flor de Brumadinho	59 Ac	96 Ac	140 Ac	155 Ad
Hamlin CNPMF 20	227 Bb	185 Bc	375 Ab	312 Ac
Jaffa	16 Bc	28 Bc	194 Ac	134 Ad
Mel Rosa	56 Bc	232 Ab	135 Bc	139 Bd
Natal CNPMF 01	387 Aa	253 Bb	442 Aa	315 Bc
Natal CNPMF 02	154 Cc	319 Bb	468 Aa	343 Bc
Natal CNPMF 112	203 Bb	135 Bc	338 Ab	297 Ac
Natal Folha Murcha	3 Ac	42 Ac	3 Ad	18 Ae
Natal Ipeal	240 Bb	299 Bb	397 Ab	270 Bc
Pera Bianchi	300 Bb	299 Bb	497 Aa	397 Ab
Pera CNPMF 01	384 Aa	281 Bb	466 Aa	294 Bc
Pera CNPMF 02	234 Ab	328 Ab	301 Ab	348 Ac
Pera CNPMF A-15	242 Ab	213 Ab	210 Ac	205 Ad
Pera CNPMF B-12	482 Aa	231 Bb	403 Ab	347 Ac
Pera CNPMF C-21	266 Bb	255 Bb	409 Ab	257 Bd
Pera CNPMF C-32	146 Bc	139 Bc	339 Ab	193 Bd
Pera CNPMF D-3	324 Bb	269 Bb	488 Aa	287 Bc
Pera CNPMF D-6	386 Aa	227 Bb	417 Ab	168 Bd
Pera CNPMF D-9	407 Aa	280 Ab	387 Ab	320 Ac
Pera CNPMF D-12	331 Ab	175 Bc	350 Ab	329 Ac
Pera CNPMF D-25	319 Ab	309 Ab	382 Ab	352 Ac
Pera CNPMF E-3	317 Bb	394 Ba	565 Aa	466 Ab
Pera CNPMF E-6	472 Aa	430 Aa	343 Ab	424 Ab
Pera GE-03	346 Bb	334 Bb	455 Aa	561 Aa
Pera de Ibotirama	4 Ac	64 Ac	109 Ad	59 Ae
Pera Olímpia	341 Ab	445 Aa	505 Aa	411 Ab
Pera Vacinada	316 Bb	292 Bb	365 Bb	445 Ab
Pineapple	18 Cc	153 Bc	309 Ab	202 Bd
Russas P.S.	21 Bc	98 Bc	245 Ac	98 Be
Salustiana	3 Ac	71 Ac	136 Ac	16 Ae
Seleta de Itaboraí	24 Ac	145 Ac	168 Ac	145 Ad
Sincorá	277 Bb	456 Aa	393 Ab	519 Aa
Valencia Chapman	232 Ab	242 Ab	205 Ac	165 Ad
Valencia CNPMF	35 Ac	137 Ac	145 Ac	69 Ae
Valencia CNPMF 01	16 Ac	38 Ac	45 Ad	47 Ae
Valencia CNPMF 02	34 Ac	123 Ac	188 Ac	83 Ae
Valencia CNPMF 03	14 Ac	99 Ac	108 Ad	56 Ae
Valencia CNPMF 21	80 Bc	98 Bc	132 Bc	299 Ac
Valencia CNPMF 27	35 Ac	136 Ac	157 Ac	110 Ae
Valencia CNPMF 36	48 Ac	119 Ac	188 Ac	91 Ae
Valencia CNPMF F-11	69 Bc	127 Bc	213 Ac	74 Be
Valencia Criola	17 Ac	152 Ac	145 Ac	86 Ae
Valencia Delta	46 Ac	134 Ac	113 Ad	65 Ae
Valencia L. Shaffey	22 Ac	62 Ac	171 Ac	67 Ae
Valencia L. White	120 Ac	142 Ac	173 Ac	52 Ae
Valencia Late	173 Ac	42 Ac	114 Ad	72 Ae
Valencia Midknight	15 Ac	38 Ac	48 Ad	26 Ae
Valencia Montemorelos	91 Ac	169 Ac	247 Ac	159 Ad
Valencia Registro	119 Bc	102 Bc	331 Ab	201 Bd
Valencia Tuxpan	20 Ac	29 Ac	85 Ad	115 Ae
Westin	8 Bc	157 Ac	142 Ac	111 Ae

Means followed by the same uppercase letter in the row and lowercase in the column do not differ by the Scott-Knott mean cluster test at 5% probability.

The combinations that presented averages above 500 fruits/plant were related to 'Pera Olímpia' and 'Pera CNPMF E-3' cultivars on 'Riverside' citrandarin and 'Pera GE-03' and 'Sincorá' on 'Indio' citrandarin. Among 'Natal' orange selections, 'Natal CNPMF-01' stood out in number of fruits in combination with 'Sunki Tropical' mandarin (387 fruits) and 'Riverside' citrandarin (442), as well as 'Natal CNPMF- 02' also on this citrandarin (468). Although preliminary, these results suggest that 'Pera' and 'Natal' selections are efficient in fruit production, being superior compared to 'Pera' orange evaluated by Rodrigues et al. (2019) in combination with nine rootstocks in the state of Acre.

In relation to total fruit mass (MTF), the combination between 'San Diego' citrandarin and 'Sincorá' orange showed greater expression of this character (Table 3). It is noteworthy that in this scion, higher MTF values were observed in the four rootstocks (Figure 1), with emphasis on 'San Diego' and 'Indio' citrandarins (115.64 and 111.1 kg/plant) with average masses per fruit of 254 and 214 g respectively, superior to results found by Coelho et al. (2019), with average mass for 'Pera Rio' cultivar, in conventional system, of 204 g per fruit. 'Pera Olímpia/ 'Riverside' citrandarin and 'Pera GE-03/ Indio' citrandarin combinations also presented MTF above 100 kg/plant; however, lower averages, of 200 and 184 g per fruit, respectively. Based on observed data, 'Sincorá' orange can be an alternative to 'Pera' and 'Natal' oranges in extreme south of the Bahia. However, future evaluations should be carried out to confirm or not these results.

Taking into account the spacing adopted in this study and according to IBGE (2020), 40.35% of scion/ rootstock combinations evaluated presented yield higher than the national average of 28.96 $t.ha^{-1}$ in 2019, above 52.08 kg/plant. 'Riverside' citrandarin stood out, which induced fruit yields above 60 kg per plant in all 'Pera' orange selections, according to Bastos et al. (2014), justifying its excellent behavior when grafted with sweet orange trees. It is noteworthy that yields presented here were obtained with 4.5-year-old plants.

It should be noted that greater amount of fruits may reflect greater total fruit mass, as observed, since of the 19 combinations that had the highest average NTF, 15 also presented higher MTF than the others. However, these characteristics may not indicate increase in productive gains, since, in their totality, small fruits, non-commercial standard and vigorous plants with excessive growth are taken into account. Thus, NTF and MTF should not be used solely as a way of selecting the most advantageous combinations, requiring evaluating other variables related to fruit production and quality, such as productive efficiency, total acidity and soluble solids content of produced fruits.

The analysis of Table 4 allows verifying that, with regard to productive efficiency (EP), it was found that, on 'Sunki Tropical' mandarin, scion varieties that presented the highest EP were 'Pera CNPMF-01', 'Pera CNPMF B-12', 'Pera CNPMF-D3', 'Pera CNPMF D-6', 'Pera CNPMF D-9', 'Pera CNPMF E-6',' Pera Olímpia' and 'Pera GE-03'. Regarding 'Pera CNPMF-02', 'Pera CNPMF A-15' and 'Pera Olímpia' cultivars, the highest average EP values were verified for 'San Diego' citrandarin. 'Riverside' citrandarin provided higher EP values on 'Pera CNPMF D-3' and 'Pera Olímpia' cultivars, while 'Indio' citrandarin was related to higher yield efficiencies when scion varieties were 'Pera CNPMF E-6', 'Pera Olímpia', 'Pera GE-03' and 'Natal Ipeal'.

Among combinations with the highest EP values, 'Pera CNPMF-02' and 'Pera CNPMF A-15' on 'San Diego' citrandarin stand out, with 9.29 and 10.88 kg of $fruits.m^{-3}$ of scion, respectively. These 'Pera' orange selections did not show statistically significant differences for total fruit mass among rootstocks studied, the same not being true in relation to productive efficiency. This fact, as observed by Carvalho et al. (2016), relates to the effect of the rootstock on the size or volume that induces to scion variety, verifying that smaller scions, which have smaller amount of fruits per plant compared to larger scions, can, on the other hand, show greater fruit production per scion volume unit, that is, high fruit production efficiency.

'Pera Olímpia' orange stood out for presenting the highest EP value on the four rootstocks evaluated, notably in relation to 'San Diego', 'Riverside' and 'Indio' citrandarins, with 9.23, 8.56 and 9. 23 kg of $fruits.m^{-3}$ scion, respectively. These values are in line with those obtained by Carvalho et al. (2016) in 'Pera CNPMF-D6' orange scions on these citrandarins. There is, therefore, evidence that these rootstocks have great potential for commercial use in the extreme south of the state of Bahia in combination with 'Pera' orange.

Table 3. Total fruit mass (kg/plant) of 228 scion/rootstock combinations comprising 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] on 'Sunki Tropical' (TST) mandarin rootstocks [*Citrus sunki* (Hayata) hort. ex Tanaka] and 'San Diego' (SD), 'Riverside' (RIV) and 'Indio' (IND) citrandarins [*C. sunki* × *Poncirus trifoliata* (L.) Raf.].

Scion variety	Rootstock			
	TST	SD	RIV	IND
Aquiri	23.61 Ac	46.12 Ac	44.86 Ac	54.84 Ab
Berna	0.73 Bd	18.38 Bd	38.32 Ac	40.84 Ac
Crescent sweet	9.13 Ad	26.04 Ad	41.95 Ac	17.74 Ad
Diva	3.95 Bd	8.34 Bd	65.44 Ab	10.81 Bd
Early Oblong	15.26 Bd	17.71 Bd	87.02 Aa	39.01 Bc
F-Menuda	0.18 Ad	1.70 Ad	7.61 Ae	8.66 Ad
Flor de Brumadinho	22.75 Ac	23.53 Ad	32.66 Ad	32.01 Ac
Hamlin CNPMF 20	54.19 Bb	50.26 Bc	97.26 Aa	76.40 Aa
Jaffa	5.18 Bd	9.18 Bd	54.42 Ac	40.16 Ac
Mel Rosa	19.65 Ac	43.61 Ac	51.37 Ac	42.69 Ac
Natal CNPMF 01	83.82 Aa	64.48 Ab	94.10 Aa	70.98 Ab
Natal CNPMF 02	35.13 Bc	74.00 Ab	78.63 Ab	99.01 Aa
Natal CNPMF 112	48.09 Bb	39.63 Bc	71.10 Ab	77.88 Aa
Natal Folha Murcha	1.06 Ad	10.54 Ad	1.15 Ae	5.99 Ad
Natal Ipeal	50.25 Ab	54.43 Ac	76.16 Ab	56.55 Ab
Pera Bianchi	62.65 Bb	61.09 Bc	96.23 Aa	81.70 Aa
Pera CNPMF 01	77.83 Aa	63.52 Ab	93.10 Aa	60.93 Ab
Pera CNPMF 02	43.09 Ab	70.68 Ab	62.27 Ab	69.94 Ab
Pera CNPMF A-15	51.63 Ab	42.01 Ac	60.39 Ac	57.14 Ab
Pera CNPMF B-12	92.73 Aa	50.87 Bc	86.10 Aa	71.56 Ab
Pera CNPMF C-21	59.22 Bb	46.70 Bc	82.66 Aa	58.63 Bb
Pera CNPMF C-32	34.78 Bc	34.58 Bd	73.44 Ab	51.42 Bb
Pera CNPMF D-3	63.41 Bb	56.01 Bc	91.67 Aa	69.21 Bb
Pera CNPMF D-6	86.61 Aa	53.17 Bc	85.98 Aa	42.98 Bc
Pera CNPMF D-9	78.70 Aa	58.96 Ac	84.95 Aa	73.68 Aa
Pera CNPMF D-12	61.10 Ab	38.71 Ac	70.13 Ab	67.26 Ab
Pera CNPMF D-25	82.66 Aa	80.34 Ab	94.28 Aa	84.10 Aa
Pera CNPMF E-3	59.60 Bb	77.61 Ab	99.93 Aa	86.26 Aa
Pera CNPMF E-6	87.78 Aa	74.81 Ab	63.97 Ab	80.77 Aa
Pera GE-03	75.01 Ba	68.16 Bb	95.22 Aa	103.28 Aa
Pera de Ibotirama	1.17 Ad	21.96 Ad	31.32 Ad	18.34 Ad
Pera Olímpia	72.44 Aa	84.86 Ab	101.11 Aa	82.93 Aa
Pera Vacinada	60.01 Ab	53.07 Ac	71.32 Ab	91.66 Aa
Pineapple	5.07 Bd	47.51 Ac	79.52 Ab	52.16 Ab
Russas P.S.	5.71 Bd	29.48 Bd	62.77 Ab	25.01 Bd
Salustiana	0.99 Bd	21.82 Ad	38.19 Ac	4.55 Bd
Seleta de Itaboraí	10.42 Bd	49.65 Ac	59.91 Ac	42.10 Ac
Sincorá	73.20 Ba	115.64 Aa	93.41 Ba	111.10 Aa
Valencia Chapman	51.53 Ab	59.99 Ac	47.69 Ac	38.43 Ac
Valencia CNPMF	10.15 Bd	45.13 Ac	43.75 Ac	21.36 Bd
Valencia CNPMF 01	5.27 Ad	13.07 Ad	13.45 Ae	16.31 Ad
Valencia CNPMF 02	9.48 Bd	37.30 Ad	53.98 Ac	27.46 Bd
Valencia CNPMF 03	4.14 Ad	29.75 Ad	30.97 Ad	17.61 Ad
Valencia CNPMF 21	23.67 Bc	34.84 Bd	39.16 Bc	83.75 Aa
Valencia CNPMF 27	9.29 Bd	39.82 Ac	44.66 Ac	32.71 Ac
Valencia CNPMF 36	15.21 Bd	41.91 Ac	54.43 Ac	27.31 Bd
Valencia CNPMF F-11	18.24 Bc	41.18 Ac	59.00 Ac	23.54 Bd
Valencia Criola	4.84 Bd	43.23 Ac	36.41 Ad	24.68 Ad
Valencia Delta	14.36 Ad	45.37 Ac	35.31 Ad	21.02 Ad
Valencia L. Shaffey	6.27 Bd	20.24 Bd	47.33 Ac	20.75 Bd
Valencia L. White	35.12 Bc	49.40 Ac	52.25 Ac	17.37 Bd
Valencia Late	45.81 Ab	13.79 Ad	34.19 Ad	22.39 Ad
Valencia Midknight	6.37 Ad	17.15 Ad	19.92 Ae	11.16 Ad
Valencia Montemorelos	26.98 Bc	50.40 Ac	67.25 Ab	44.16 Ac
Valencia Registro	30.63 Bc	29.51 Bd	78.10 Ab	54.62 Ab
Valencia Tuxpan	5.95 Ad	9.76 Ad	27.26 Ad	37.32 Ac
Westin	2.74 Bd	43.36 Ac	35.01 Ad	27.06 Ad

Means followed by the same uppercase letter in the row and lowercase in the column do not differ by the Scott-Knott mean cluster test at 5% probability.

Table 4. Productive efficiency (kg of fruits.m^{-3} of scion) per plant of 228 scion/rootstock combinations comprising 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] on Sunki Tropical mandarin rootstocks (TST) [*Citrus sunki* (Hayata) hort. ex Tanaka] and 'San Diego' (SD), 'Riverside' (RIV) and 'Indio' (IND) citrandarins [*C. sunki* × *Poncirus trifoliata* (L.) Raf.].

Scion variety	Rootstock			
	TST	SD	RIV	IND
Aquiri	0.77 Ac	2.59 Ad	2.05 Ad	2.33 Ae
Berna	0.03 Ac	0.91 Ae	1.16 Ae	2.13 Ae
Crescent sweet	0.41 Bc	1.32 Be	3.30 Ad	1.31 Bf
Diva	0.23 Bc	0.47 Be	5.41 Ac	0.59 Bf
Early Oblong	0.53 Bc	1.14 Be	5.13 Ac	1.81 Bf
F-Menuda	0.01 Ac	0.05 Ae	0.25 Ae	0.36 Af
Flor de Brumadinho	0.92 Ac	1.74 Ae	1.86 Ae	1.76 Af
Hamlin CNPMF 20	1.92 Cc	4.10 Bd	5.95 Ab	3.99 Bd
Jaffa	0.22 Bc	0.48 Be	2.71 Ad	2.68 Ae
Mel Rosa	0.94 Bc	2.99 Ad	3.22 Ad	2.89 Ae
Natal CNPMF 01	2.95 Bb	3.93 Bd	5.27 Ac	3.75 Bd
Natal CNPMF 02	1.27 Bc	3.55 Ad	4.72 Ac	4.25 Ad
Natal CNPMF 112	1.54 Bc	1.77 Be	4.44 Ac	4.79 Ab
Natal Folha Murcha	0.06 Ac	1.27 Ae	0.12 Ae	0.40 Af
Natal Ipeal	2.93 Db	4.74 Cc	6.16 Bb	8.45 Aa
Pera Bianchi	3.11 Bb	5.48 Ac	6.16 Ab	5.54 Ac
Pera CNPMF 01	4.41 Ba	5.15 Bc	6.59 Ab	6.45 Ac
Pera CNPMF 02	2.14 Cb	9.29 Aa	4.22 Bc	4.57 Bd
Pera CNPMF A-15	2.18 Cb	10.88 Aa	4.01 Bc	5.04 Bd
Pera CNPMF B-12	4.00 Ba	3.01 Bd	5.42 Ac	4.36 Bd
Pera CNPMF C-21	2.65 Bb	4.72 Ac	4.46 Ac	4.92 Ad
Pera CNPMF C-32	1.45 Bc	1.97 Be	4.04 Ac	3.25 Ae
Pera CNPMF D-3	5.21 Ba	5.68 Bc	7.35 Aa	4.70 Bd
Pera CNPMF D-6	3.68 Aa	3.77 Ad	3.97 Ac	3.94 Ad
Pera CNPMF D-9	3.65 Ba	6.62 Ab	5.51 Ac	5.98 Ac
Pera CNPMF D-12	3.22 Bb	1.84 Be	5.17 Ac	5.50 Ac
Pera CNPMF D-25	3.28 Bb	3.86 Bd	4.79 Ac	6.18 Ac
Pera CNPMF E-3	2.72 Bb	5.37 Ac	5.08 Ac	5.41 Ac
Pera CNPMF E-6	5.14 Ba	7.19 Ab	4.33 Bc	8.65 Aa
Pera GE-03	3.72 Ca	7.24 Bb	3.87 Cc	9.71 Aa
Pera de Ibotirama	0.03 Ac	0.89 Ae	1.29 Ae	0.92 Af
Pera Olímpia	4.05 Ba	9.23 Aa	8.56 Aa	9.23 Aa
Pera Vacinada	3.19 Cb	5.85 Bc	5.56 Bc	7.20 Ab
Pineapple	0.22 Bc	3.65 Ad	4.27 Ac	3.20 Ae
Russas P.S.	0.23 Bc	1.76 Ae	3.05 Ad	1.53 Af
Salustiana	0.04 Ac	1.14 Ae	1.42 Ae	0.22 Af
Seleta de Itaboraí	0.36 Cc	4.65 Ac	3.48 Bd	2.70 Be
Sincorá	2.81 Bb	6.15 Ab	4.29 Bc	5.83 Ac
Valencia Chapman	2.15 Ab	3.72 Ad	2.60 Ad	1.92 Af
Valencia CNPMF	0.47 Bc	2.50 Ad	2.21 Ad	0.83 Bf
Valencia CNPMF 01	0.40 Ac	0.82 Ae	0.58 Ae	0.92 Af
Valencia CNPMF 02	0.31 Ac	1.94 Ae	2.13 Ad	1.17 Af
Valencia CNPMF 03	0.15 Ac	1.44 Ae	2.38 Ad	0.98 Af
Valencia CNPMF 21	0.89 Bc	1.75 Be	1.61 Be	4.08 Ad
Valencia CNPMF 27	0.38 Bc	1.87 Ae	2.60 Ad	1.43 Af
Valencia CNPMF 36	0.61 Bc	1.92 Be	3.85 Ac	1.61 Bf
Valencia CNPMF F-11	0.66 Bc	2.28 Ad	2.78 Ad	1.07 Bf
Valencia Criola	0.19 Bc	2.76 Ad	1.82 Ae	1.03 Bf
Valencia Delta	0.52 Bc	2.61 Ad	2.08 Ad	1.12 Bf
Valencia L. Shaffey	0.19 Ac	1.09 Ae	2.01 Ad	0.95 Af
Valencia L. White	1.28 Bc	2.49 Ad	2.70 Ad	0.78 Bf
Valencia Late	1.60 Ac	0.69 Ae	1.32 Ae	1.04 Af
Valencia Midknight	0.41 Ac	1.19 Ae	1.63 Ae	1.47 Af
Valencia Montemorelos	0.96 Cc	2.48 Bd	4.26 Ac	2.65 Be
Valencia Registro	1.26 Bc	1.49 Be	4.19 Ac	3.58 Ae
Valencia Tuxpan	0.23 Ac	0.63 Ae	1.46 Ae	1.70 Af
Westin	0.14 Bc	2.55 Ad	1.78 Ae	1.40 Af

Means followed by the same uppercase letter in the row and lowercase in the column do not differ by the Scott-Knott mean cluster test at 5% probability.

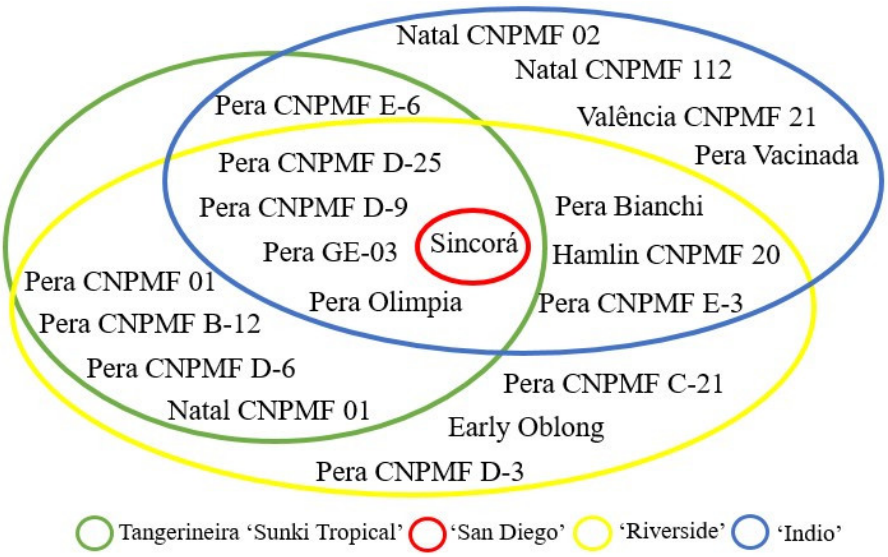

Figure 1. Orange trees that obtained higher fruit masses (kg/plant) according to the Scott-Knott test of means, among the 228 scion/rootstock combinations comprising 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] on 'Sunki Tropical' (TST) mandarin rootstocks [*Citrus sunki* (Hayata) hort. ex Tanaka] and 'San Diego' (SD), 'Riverside' (RIV) and 'Indio' (IND) citrandarins [*C. sunki* × *Poncirus trifoliata* (L.) Raf.].

High productive efficiencies allow for increases in productivity per cultivated area (Lima et al., 2014). Rootstocks inducing high fruit productive efficiency in association with reductions in scion size are suitable for the use of high planting densities, enabling substantial reductions in the planted area without reducing fruit production, which is relevant for large and small producers who want higher yields in their crops. According to Blumer (2005), scion/rootstock combinations with these characteristics are advantageous, since, according to Carvalho et al. (2005), the productive scenario of modern citriculture foresees the use of dense planting spacing, which facilitates harvesting, pesticide application and cultural treatments in general. Santos et al. (2016) corroborate this opinion. On the other hand, as described by França et al. (2016), low productive efficiency may be associated, in some cases, with excess vegetative growth and not with lower fruit production per plant.

Regarding the harvest time, no influence of rootstocks on scions was observed. It was observed that the earliest scion varieties in this study, with harvests recorded from April to June, were 'Sincorá', 'Early Oblong', 'Salustiana', 'Westin', 'Crescent sweet' and 'Flor de Brumadinho'. The latest scion varieties were 'Hamlin CNPMF-20', 'Melrosa' and all 'Natal' and 'Valencia' selections, which had fruits harvested in August. 'Berna', 'Jaffa', 'F-Menuda', 'Aquiri', 'Russas', 'Seleta de Itaboraí' and 'Pineapple' scions, as well as 'Pera' selections, concentrated ripe fruits in the month of June. Due to the large number of combinations, fruit maturation curve analysis was not performed; however, after determining the best scion/rootstock combinations in relation to production and productive efficiency, this analysis will be performed.

Producers who want to scale their production must pay attention not only to production characteristics, but also choose scion/rootstock combinations that meet their planning and quality standards established by the consumer market, whether for fresh fruits or orange juice.

Fruit quality variations were observed, both in relation to scion cultivars and rootstocks, as well as regarding the interaction between them (Table 5). Several environmental factors and cultivation practices can influence the quality of citrus fruits. The relationship between scion and rootstock is among the most important, whose interaction has implications for the absorption of water and nutrients and hormonal effects, with direct influence on juice quality (LIU et al., 2015; LADO et al., al., 2018).

The largest cross-sectional fruit diameters (DT) were observed in 'F-Menuda', 'Seleta de Itaboraí' and 'Melrosa' scion cultivars on 'Sunki Tropical' mandarin and in 'Seleta de Itaboraí', 'Valencia Midknight' and 'Melrosa' scion cultivars on 'San Diego' citrandarin (Table 6). Regarding 'Riverside' citrandarin, the highest values for this variable were found for 'Aquiri', 'Seleta de Itaboraí', 'Diva', 'Valencia Midknight', 'Valencia L. White' and 'Melrosa' cultivars. 'Indio' citrandarin induced higher values in 'Aquiri', 'Pera de Ibotirama', 'Diva', 'Natal Folha Murcha', 'Valencia CNPMF', 'Valencia CNPMF-01', 'Valencia CNPMF-02', 'Valencia CNPMF-03', 'Valencia CNPMF-36', 'Valencia Midknight', 'Valencia Criola' and 'Valencia L. White' varieties, who showed the highest DT values.

Table 5. Summary of the analysis of variance with sources of variation (FV), degrees of freedom (GL), mean squares of the residue (QMR) and coefficients of variation (CV) for variables cross-sectional fruit diameter (DT), soluble solids (SS), titratable acidity (TA), SS/AT ratio and juice yield (REND) of 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] in combination with four rootstocks.

FV	GL	QMR				
		DT	SS	AT	SS/AT	REND
PE	3	76,86**	5,4286**	1,51610**	332,42**	218,189**
E	56	361,73**	6,5032**	0,28424**	96,36**	145,189**
PE × E	168	24,88**	1,1435**	0,04181**	9,47**	13,182*
RES	447	12,38	0,5861	0,01820	3,68	10,643
CV (%)		4,4	8,27	16,71	15,46	6,68

** Significant at 1% and 5% probability by the F test; *Significant at 5% probability by the F test; PE = Rootstock; E = Graft; RES = Residue.

Table 6. Cross-sectional fruit diameter (mm) of 228 scion/rootstock combinations comprising 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] on 'Sunki Tropical' (TST) mandarin rootstocks [*Citrus sunki* (Hayata) hort. ex Tanaka] and 'San Diego' (SD), 'Riverside' (RIV) and 'Indio' (IND) Citrandarins [*C. sunki* × *Poncirus trifoliata* (L.) Raf.].

Scion variety	Rootstock			
	TST	SD	RIV	IND
Aquiri	84.83 Ab	87.52 Ac	90.13 Aa	83.48 Aa
Berna	82.28 Ac	84.77 Ac	83.14 Ab	79.50 Ab
Crescent sweet	75.11 Ae	75.45 Ad	74.00 Ad	72.44 Ac
Diva	85.37 Ab	90.08 Ab	86.87 Aa	90.49 Aa
Early Oblong	78.91 Ad	79.19 Ad	79.40 Ac	74.27 Ac
F-Menuda	98.83 Aa	84.93 Bc	85.15 Bb	80.54 Bb
Flor de Brumadinho	74.10 Ae	77.27 Ad	76.75 Ac	74.94 Ac
Hamlin CNPMF 20	79.45 Ad	79.71 Ad	78.76 Ac	79.62 Ab
Jaffa	87.95 Ab	85.53 Ac	81.28 Ab	81.69 Ab
Mel Rosa	100.28 Aa	96.72 Aa	92.91 Aa	85.05 Ba
Natal CNPMF 01	81.73 Ac	82.14 Ac	81.13 Ab	75.48 Ac
Natal CNPMF 02	77.50 Ad	78.83 Ad	77.28 Ac	77.06 Ac
Natal CNPMF 112	85.67 Ab	80.09 Bd	75.49 Bd	75.48 Bc
Natal Folha Murcha	84.89 Ab	81.26 Ac	86.07 Ab	83.97 Aa
Natal Ipeal	73.32 Ae	72.09 Ae	72.58 Ad	70.99 Ac
Pera Bianchi	75.02 Ae	73.51 Ae	76.15 Ac	76.43 Ac
Pera CNPMF 01	73.70 Ae	74.94 Ad	75.67 Ad	77.56 Ac
Pera CNPMF 02	73.36 Ae	72.33 Ae	74.62 Ad	71.71 Ac
Pera CNPMF A-15	76.36 Ad	68.06 Be	78.77 Ac	77.66 Ac
Pera CNPMF B-12	72.44 Ae	69.79 Ae	75.50 Ad	73.71 Ac
Pera CNPMF C-21	74.34 Ae	70.72 Ae	71.45 Ad	72.56 Ac
Pera CNPMF C-32	76.94 Ad	78.02 Ad	80.19 Ac	74.40 Ac
Pera CNPMF D-3	69.39 Ae	73.08 Ae	74.39 Ad	75.69 Ac
Pera CNPMF D-6	76.66 Ad	79.66 Ad	75.22 Ad	80.22 Ab
Pera CNPMF D-9	71.21 Ae	76.76 Ad	78.90 Ac	75.51 Ac
Pera CNPMF D-12	71.50 Ae	72.39 Ae	71.72 Ad	71.38 Ac
Pera CNPMF D-25	78.21 Bd	77.62 Bd	83.60 Ab	74.39 Bc
Pera CNPMF E-3	70.50 Ae	70.13 Ae	70.30 Ad	70.77 Ac
Pera CNPMF E-6	70.66 Ae	70.78 Ae	71.84 Ad	73.97 Ac
Pera GE-03	75.82 Bd	72.23 Be	80.82 Ab	72.88 Bc

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Pera de Ibotirama	86.28 Ab	86.59 Ac	83.01 Ab	84.72 Aa
Pera Olímpia	78.21 Ad	72.66 Ae	76.44 Ac	79.01 Ab
Pera Vacinada	72.49 Ae	70.50 Ae	71.44 Ad	74.76 Ac
Pineapple	87.62 Ab	83.75 Ac	78.17 Bc	79.31 Bb
Russas P.S.	81.41 Ac	75.04 Ad	78.39 Ac	82.14 Ab
Salustiana	84.93 Ab	80.17 Ad	82.17 Ab	80.70 Ab
Seleta de Itaboraí	103.75 Aa	93.67 Ba	88.81 Ba	89.90 Ba
Sincorá	77.90 Ad	80.05 Ad	74.32 Bd	72.37 Bc
Valencia Chapman	80.08 Ad	82.17 Ac	77.56 Bc	74.01 Bc
Valencia CNPMF	82.95 Ac	80.84 Ac	84.97 Ab	83.87 Aa
Valencia CNPMF 01	81.69 Ac	86.48 Ac	83.34 Ab	86.09 Aa
Valencia CNPMF 02	85.52 Ab	85.12 Ac	83.24 Ab	84.38 Aa
Valencia CNPMF 03	81.48 Ac	80.90 Ac	82.19 Ab	83.57 Aa
Valencia CNPMF 21	84.18 Ac	88.77 Ab	81.25 Bb	78.52 Bc
Valencia CNPMF 27	81.95 Ac	82.70 Ac	82.65 Ab	82.07 Ab
Valencia CNPMF 36	89.15 Ab	89.47 Ab	84.43 Ab	86.81 Aa
Valencia CNPMF F-11	87.16 Ab	84.87 Ac	78.43 Bc	82.93 Ab
Valencia Criola	83.59 Ac	76.61 Bd	79.49 Bc	83.85 Aa
Valencia Delta	83.47 Ac	85.76 Ac	81.60 Ab	81.23 Ab
Valencia L. Shaffey	81.22 Ac	83.40 Ac	78.41 Ac	80.92 Ab
Valencia L. White	83.36 Ac	88.33 Ab	89.95 Aa	84.14 Aa
Valencia Late	81.44 Ac	81.49 Ac	81.61 Ab	81.92 Ab
Valencia Midknight	91.70 Ab	95.70 Aa	92.06 Aa	88.67 Aa
Valencia Montemorelos	82.16 Ac	84.29 Ac	84.67 Ab	82.50 Ab
Valencia Registro	79.64 Bd	86.03 Ac	75.31 Bd	79.41 Bb
Valencia Tuxpan	80.61 Ac	87.07 Ac	81.62 Ab	79.92 Ab
Westin	84.67 Ab	79.80 Bd	79.54 Bc	76.47 Bc

Means followed by the same uppercase letter in the row and lowercase in the column do not differ by the Scott-Knott mean cluster test at 5% probability.

The overall mean for the 26 combinations with the highest DT values was 89.27 mm. 'Seleta de Itaboraí' and 'Melrosa' cultivars presented higher DT values in the four rootstocks. However, according to the Ceagesp classification (2011), regarding the class of sweet and low-acidity oranges, it was observed that more than 94% of combinations evaluated in this study fall into class of 'large' fruits, with DT above 71 mm, rated 'A' and the others rated 'B', with 'intermediate' size, between 65 and 71 mm.

'Indio' citrandarin, in 53% of combinations, was the rootstock that induced the highest average DT value. According to Liu et al. (2015), the diameter of citrus fruits is related to the rootstock used, as it influences plant metabolism, regulating hormonal interactions and cell size. Therefore, in cases where the aim is production to supply the fresh fruit market, both scion variety and rootstock variety must be properly defined for the orchard implantation.

Differences were observed among combinations regarding the soluble solids (SS) content of fruits. Among combinations, 22% had fruits with values equal to or greater than 10 °Brix, which, according to the Ceagesp classification (2011), qualifies them for consumption as good quality fresh fruits (Table 7).

Table 7. Soluble solids (°Brix) of 228 scion/rootstock combinations comprising 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] on 'Tropical Sunki' (TST) mandarin rootstocks [*Citrus sunki* (Hayata) hort. ex Tanaka] and 'San Diego' (SD), 'Riverside' (RIV) and 'Indio' (IND) citrandarins [*C. sunki* × *Poncirus trifoliata* (L.) Raf.].

Scion variety	Rootstock			
	TST	SD	RIV	IND
Aquiri	8.77 Ac	8.70 Ab	8.23 Ac	8.73 Ab
Berna	8.50 Ac	8.23 Ab	8.33 Ac	8.50 Ab
Crescent sweet	10.47 Aa	10.50 Aa	10.07 Ab	10.27 Aa
Diva	8.90 Ac	7.87 Ab	8.60 Ac	8.63 Ab
Early Oblong	8.57 Ac	9.53 Ab	9.17 Ac	10.20 Aa
F-Menuda	10.90 Aa	9.37 Ab	10.03 Ab	8.67 Ab
Flor de Brumadinho	9.43 Ab	8.50 Ab	8.93 Ac	8.77 Ab
Hamlin CNPMF 20	9.23 Ac	8.93 Ab	9.00 Ac	8.60 Ab
Jaffa	9.30 Ac	9.57 Ab	9.23 Ac	9.53 Aa
Mel Rosa	9.10 Ac	9.07 Ab	9.87 Ab	10.17 Aa
Natal CNPMF 01	8.23 Ac	8.37 Ab	9.03 Ac	9.03 Ab
Natal CNPMF 02	9.60 Ab	9.43 Ab	10.07 Ab	9.13 Ab
Natal CNPMF 112	7.50 Bc	9.27 Ab	8.77 Ac	8.87 Ab
Natal Folha Murcha	8.17 Ac	9.00 Ab	8.53 Ac	8.83 Ab
Natal Ipeal	10.30 Aa	10.80 Aa	10.60 Aa	9.71 Aa
Pera Bianchi	10.43 Aa	10.60 Aa	9.53 Bc	9.07 Bb
Pera CNPMF 01	10.30 Aa	9.95 Aa	9.63 Ab	8.77 Ab
Pera CNPMF 02	10.37 Aa	10.30 Aa	10.10 Aa	9.57 Aa
Pera CNPMF A-15	9.90 Bb	11.63 Aa	9.70 Bb	10.07 Ba
Pera CNPMF B-12	10.37 Aa	10.96 Aa	9.87 Ab	9.43 Aa
Pera CNPMF C-21	9.43 Bb	11.20 Aa	10.90 Aa	10.53 Aa
Pera CNPMF C-32	9.73 Ab	10.00 Aa	10.20 Ab	9.03 Ab
Pera CNPMF D-3	11.67 Aa	11.37 Aa	10.60 Aa	8.77 Bb
Pera CNPMF D-6	9.73 Ab	10.50 Aa	10.17 Ab	9.23 Ab
Pera CNPMF D-9	9.93 Ab	10.23 Aa	8.63 Bc	10.30 Aa
Pera CNPMF D-12	11.13 Aa	11.57 Aa	11.03 Aa	10.73 Aa
Pera CNPMF D-25	8.70 Bc	10.60 Aa	8.67 Bc	9.43 Ba
Pera CNPMF E-3	9.33 Bc	11.27 Aa	10.30 Ab	9.17 Bb
Pera CNPMF E-6	9.10 Bc	11.00 Aa	9.90 Ab	8.67 Bb
Pera GE-03	9.77 Bb	11.57 Aa	8.67 Bc	9.50 Ba
Pera de Ibotirama	8.30 Ac	8.37 Ab	7.70 Ac	8.00 Ab
Pera Olímpia	9.80 Ab	10.73 Aa	8.90 Bc	8.57 Bb
Pera Vacinada	9.97 Bb	12.07 Aa	10.90 Aa	9.30 Ba
Pineapple	8.87 Ac	8.77 Ab	9.20 Ac	8.93 Ab
Russas P.S.	9.20 Ac	8.97 Ab	8.60 Ac	8.73 Ab
Salustiana	9.90 Ab	9.03 Ab	8.87 Ac	9.60 Aa
Seleta de Itaboraí	8.43 Bc	10.65 Aa	11.63 Aa	10.27 Aa
Sincorá	9.63 Ab	9.60 Ab	9.40 Ac	9.47 Aa
Valencia Chapman	8.27 Ac	8.10 Ab	9.57 Ab	9.07 Ab
Valencia CNPMF	8.60 Ac	9.23 Ab	8.27 Ac	8.83 Ab
Valencia CNPMF 01	8.27 Ac	8.07 Ab	8.60 Ac	8.13 Ab
Valencia CNPMF 02	8.37 Ac	8.97 Ab	9.07 Ac	7.87 Ab
Valencia CNPMF 03	9.37 Ac	8.07 Ab	7.93 Ac	8.50 Ab
Valencia CNPMF 21	9.00 Ac	8.00 Ab	9.20 Ac	8.70 Ab

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Valencia CNPMF 27	7.90 Ac	8.57 Ab	8.40 Ac	8.40 Ab
Valencia CNPMF 36	8.40 Ac	8.03 Ab	8.87 Ac	8.63 Ab
Valencia CNPMF F-11	9.17 Ac	9.33 Ab	9.60 Ab	8.77 Ab
Valencia Criola	8.10 Ac	9.43 Ab	9.03 Ac	8.07 Ab
Valencia Delta	8.30 Ac	8.93 Ab	8.33 Ac	9.20 Ab
Valencia L. Shaffey	8.07 Ac	8.67 Ab	9.27 Ac	9.17 Ab
Valencia L. White	9.17 Ac	8.90 Ab	7.77 Bc	9.63 Aa
Valencia Late	9.67 Ab	8.80 Ab	8.67 Ac	9.23 Ab
Valencia Midknight	8.20 Ac	8.30 Ab	8.67 Ac	8.10 Ab
Valencia Montemorelos	9.10 Ac	8.33 Ab	7.70 Ac	9.20 Ab
Valencia Registro	9.03 Ac	8.13 Bb	9.60 Ab	7.57 Bb
Valencia Tuxpan	8.47 Ac	8.37 Ab	8.17 Ac	8.17 Ab
Westin	9.23 Ac	10.00 Aa	9.30 Ac	9.70 Aa

Means followed by the same uppercase letter in the row and lowercase in the column do not differ by the Scott-Knott mean cluster test at 5% probability.

'Pera CNPMF-02', 'Pera CNPMF D-12' and 'Natal Ipeal' orange varieties were those with the highest SS levels on the four rootstocks under study. 'Seleta de Itaboraí' scion stood out on 'San Diego', 'Riverside' and 'Indio', while 'Crescent sweet' scion on 'Sunki Tropical', 'San Diego' and 'Indio' rootstocks. The SS content is one of the most important variables in defining fruit quality, as it significantly influences flavor (TARANTINO et al., 2018). According to Couto et al. (2018), small variations, smaller than 1º Brix, in the minimum acceptable value (9 to 10) do not lead to difference in palatability for industrialization; however, this difference can be observed in fresh consumption. Thus, scion/rootstock combinations that produce fruits with higher SS values are more desirable, as they serve both the fresh fruit market and for the juice industry (MORETTO et al., 2019).

Regarding titratable acidity (AT), it was observed in Table 8 that the combinations that presented superior results were those involving 'Sunki Tropical' mandarin and 'Hamlin CNPMF-20', 'Natal CNPMF-02', 'Valencia CNPMF', 'Valencia CNPMF-27', 'Valencia Late', 'Valencia Chapman', 'Valencia L. White', Valencia Montemorelos' and 'Valencia Registro' varieties. 'Pera CNPMF A-15', 'Pera CNPMF B-12', 'Pera CNPMF C-21', 'Pera CNPMF C-32', 'Pera CNPMF D-3', 'Pera GE-03', 'F-Menuda', 'Salustiana', 'Pineapple', 'Hamlin CNPMF-20', 'Natal CNPMF-01', 'Natal CNPMF-02', 'Natal CNPMF-112', 'Natal Folha Murcha, Valencia CNPMF', 'Valencia CNPMF-27', 'Valencia CNPMF F-11', 'Valencia Criola', 'Valencia Late', 'Valencia Chapman', 'Valencia L. White', 'Valencia Montemorelo's, 'Valencia Registro' and 'Valencia CNPMF-21' provided fruits with higher acidity when combined with 'San Diego' citrandarin. On 'Riverside' citrandarin, fruits with higher AT levels were observed in 'Pera CNPMF D-3', 'Pera Vacinada', 'Jaffa', 'Sincorá', 'Early Oblong', 'Russas', 'Salustiana', 'Pineapple', 'Hamlin CNPMF-20', 'Natal CNPMF-01', 'Natal CNPMF-02', 'Natal CNPMF-112', 'Natal Folha Murcha', 'Valência CNPMF-02', 'Valencia CNPMF', 'Valencia CNPMF-03', 'Valencia CNPMF-27', 'Valencia CNPMF F-11', 'Valencia Criola', 'Valencia Late', 'Valencia L. Shaffey', 'Valencia Chapman', 'Valencia Registro' and 'Valencia CNPMF-21' varieties. On 'Indio' citrandarin, 'Valencia CNPMF' showed high AT value.

Table 8. Titratable acidity (%, citric acid) of fruits from 228 scion/rootstock combinations comprising 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] on 'Sunki Tropical' (TST) mandarin rootstocks [*Citrus sunki* (Hayata) hort. ex Tanaka] and 'San Diego' (SD), 'Riverside' (RIV) and 'Indio' (IND) citrandarins [*C. sunki* × *Poncirus trifoliata* (L.) Raf.].

Scion variety	Rootstock			
	TST	SD	RIV	IND
Aquiri	0.64 Ad	0.62 Ab	0.68 Ab	0.89 Ac
Berna	0.51 Bd	0.48 Bb	0.53 Bb	0.78 Ad
Crescent sweet	0.76 Ad	0.65 Ab	0.61 Ab	0.66 Ae
Diva	0.76 Ad	0.64 Ab	0.63 Ab	0.62 Ae
Early Oblong	0.85 Ac	0.74 Ab	0.84 Aa	0.99 Ac
F-Menuda	0.76 Ad	0.88 Aa	0.72 Ab	1.11 Ab
Flor de Brumadinho	0.59 Ad	0.36 Ab	0.42 Ab	0.44 Ae
Hamlin CNPMF 20	1.27 Aa	0.96 Ba	0.93 Ba	0.88 Bd
Jaffa	0.92 Ac	0.70 Bb	1.02 Aa	1.11 Ab
Mel Rosa	0.76 Ad	0.44 Bb	0.57 Bb	0.82 Ad
Natal CNPMF 01	0.97 Ac	1.00 Aa	0.99 Aa	1.01 Ac
Natal CNPMF 02	1.27 Aa	0.98 Ba	0.87 Ba	1.19 Ab
Natal CNPMF 112	1.05 Ab	1.12 Aa	1.10 Aa	0.99 Ac
Natal Folha Murcha	1.01 Ab	0.80 Aa	0.82 Aa	0.91 Ac
Natal Ipeal	0.92 Ac	0.53 Bb	0.52 Bb	0.69 Be
Pera Bianchi	0.72 Ad	0.64 Ab	0.63 Ab	0.61 Ae
Pera CNPMF 01	0.77 Ad	0.49 Ab	0.56 Ab	0.65 Ae
Pera CNPMF 02	0.95 Ac	0.68 Bb	0.52 Bb	0.55 Be
Pera CNPMF A-15	0.88 Ac	1.04 Aa	0.56 Bb	0.50 Be
Pera CNPMF B-12	0.67 Bd	0.84 Aa	0.59 Bb	0.51 Be
Pera CNPMF C-21	1.01 Ab	1.02 Aa	0.71 Bb	0.93 Ac
Pera CNPMF C-32	0.96 Ac	0.89 Aa	0.63 Bb	0.84 Ad
Pera CNPMF D-3	1.08 Ab	0.78 Ba	0.76 Ba	0.86 Bd
Pera CNPMF D-6	0.90 Ac	0.64 Bb	0.65 Bb	0.60 Be
Pera CNPMF D-9	0.95 Ac	0.67 Bb	0.61 Bb	0.64 Be
Pera CNPMF D-12	0.71 Ad	0.59 Ab	0.65 Ab	0.61 Ae
Pera CNPMF D-25	0.90 Ac	0.74 Ab	0.63 Ab	0.80 Ad
Pera CNPMF E-3	0.81 Ac	0.59 Bb	0.52 Bb	0.63 Be
Pera CNPMF E-6	0.70 Ad	0.63 Ab	0.58 Ab	0.61 Ae
Pera GE-03	1.04 Ab	0.78 Ba	0.57 Bb	0.68 Be
Pera de Ibotirama	0.61 Ad	0.45 Ab	0.56 Ab	0.73 Ad
Pera Olímpia	0.78 Ad	0.61 Ab	0.61 Ab	0.67 Ae
Pera Vacinada	0.81 Ac	0.73 Ab	0.77 Aa	0.77 Ad
Pineapple	1.00 Ab	0.91 Aa	0.91 Aa	1.09 Ab
Russas P.S.	0.84 Ac	0.75 Ab	0.80 Aa	0.84 Ad
Salustiana	0.86 Ac	1.06 Aa	0.93 Aa	1.06 Ac
Seleta de Itaboraí	0.60 Ad	0.48 Ab	0.54 Ab	0.74 Ad
Sincorá	0.89 Ac	0.75 Ab	0.85 Aa	0.76 Ad
Valencia Chapman	1.30 Aa	0.95 Ba	0.93 Ba	1.17 Ab
Valencia CNPMF	1.47 Aa	0.85 Ba	0.84 Ba	1.44 Aa
Valencia CNPMF 01	0.83 Ac	0.56 Bb	0.71 Ab	0.52 Be
Valencia CNPMF 02	1.12 Ab	0.69 Bb	0.90 Ba	0.78 Bd
Valencia CNPMF 03	1.15 Ab	0.77 Bb	0.81 Ba	0.71 Bd
Valencia CNPMF 21	1.03 Ab	0.82 Aa	0.89 Aa	0.98 Ac

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Valencia CNPMF 27	1.21 Aa	0.94 Ba	0.86 Ba	0.81 Bd
Valencia CNPMF 36	0.99 Ab	0.70 Bb	0.72 Bb	0.69 Be
Valencia CNPMF F-11	1.00 Ab	0.83 Aa	0.84 Aa	0.83 Ad
Valencia Criola	1.08 Ab	1.04 Aa	0.88 Aa	0.86 Ad
Valencia Delta	0.93 Ac	0.69 Ab	0.73 Ab	0.84 Ad
Valencia L. Shaffey	0.90 Ac	0.70 Ab	0.83 Aa	0.87 Ad
Valencia L. White	1.28 Aa	0.86 Ba	0.74 Bb	0.79 Bd
Valencia Late	1.22 Aa	0.84 Ba	0.87 Ba	0.86 Bd
Valencia Midknight	0.82 Ac	0.64 Ab	0.70 Ab	0.66 Ae
Valencia Montemorelos	1.37 Aa	0.87 Ba	0.70 Cb	0.98 Bc
Valencia Registro	1.43 Aa	0.87 Ba	0.90 Ba	0.86 Bd
Valencia Tuxpan	1.15 Ab	0.72 Bb	0.70 Bb	0.72 Bd
Westin	0.61 Ad	0.69 Ab	0.65 Ab	0.78 Ad

Means followed by the same uppercase letter in the row and lowercase in the column do not differ by the Scott-Knott mean cluster test at 5% probability.

'CNPMF Valencia' cultivar presented higher AT values in the four rootstocks under study. 'Hamlin CNPMF-20', 'Natal CNPMF-02', 'Valencia CNPMF-27', 'Valencia Late', 'Valencia Chapman' and 'Valencia Registro' varieties showed higher fruit acidity levels in 75% of rootstocks. 'San Diego' and 'Riverside' citrandarins, together, participated in 82.76% of scion/rootstock combinations that produced higher-acidity fruits.

AT is considered one of the main variables in identifying the quality and acceptability of citrus fruits by the consumer market. Oranges with desirable citric acid content, AT values must be above 0.5% and 0.75% for industrialization and fresh consumption, respectively (RODRIGUES et al., 2019a). Thus, all combinations showed results above 0.75%, placing fruits within the quality standard required by the market.

Scion varieties that produced fruits with the highest SS/AT ratio, with 'Sunki Tropical' mandarin as rootstock were 'Pera CNPMF-01', 'Pera CNPMF B-12', 'Pera CNPMF D-12', 'Pera Bianchi', 'Berna', 'F-Menuda', 'Aquiri', 'Pera de Ibotirama', 'Seleta de Itaborai', 'Westin', 'Crescent sweet' and 'Flor de Brumadinho' (Table 9). In combination with 'San Diego' citrandarin, varieties whose fruits showed relatively high SS/AT ratio were 'Pera CNPMF-01', 'Pera CNPMF D-12', 'Pera CNPMF E-3', 'Pera de Ibotirama', 'Natal Ipeal', 'Melrosa' and 'Flor de Brumadinho'. Still in relation to the SS/AT ratio on 'Riverside' citrandarin, 'Pera CNPMF-02', 'Pera CNPMF E-3', 'Seleta de Itaboraí', 'Natal Ipeal' and 'Flor de Brumadinho' varieties stood out. Finally, in combination with 'Indio' citrandarin, higher SS/AT ratios were identified in 'Pera CNPMF 02', 'Pera CNPMF A-15', 'Pera CNPMF B-12', 'Pera CNPMF D-12' and 'Flor de Brumadinho varieties. Here, there is confirmation of the influence of rootstock on the quality of citrus fruits, in this context in relation to the SS/AT ratio. Regardless of rootstock used, 'Flor de Brumadinho' showed high values for this variable. This trend was also verified in other varieties, such as 'Pera CNPMF D-12'.

Table 9. SS/AT ratio of fruits from 228 scion/rootstock combinations comprising 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] on 'Sunki Tropical' (TST) mandarin rootstocks [*Citrus sunki* (Hayata) hort. ex Tanaka] and 'San Diego' (SD), 'Riverside' (RIV) and 'Indio' (IND) citrandarins [*C. sunki* × *Poncirus trifoliata* (L.) Raf.].

Scion variety	Rootstock			
	TST	SD	RIV	IND
Aquiri	14.17 Aa	14.50 Ab	12.90 Ac	10.37 Bd
Berna	16.60 Aa	17.77 Ab	16.03 Ab	11.10 Bc
Crescent sweet	13.73 Aa	16.43 Ab	16.60 Ab	15.67 Ab
Diva	11.90 Ab	12.20 Ac	13.70 Ac	14.03 Ab
Early Oblong	10.07 Ac	12.80 Ac	11.00 Ac	10.30 Ad
F-Menuda	14.40 Aa	11.00 Bc	14.83 Ab	8.40 Bd
Flor de Brumadinho	16.37 Ba	23.77 Aa	21.50 Aa	19.97 Aa
Hamlin CNPMF 20	7.37 Ad	9.40 Ac	10.67 Ac	9.43 Ad
Jaffa	10.33 Bc	13.67 Ac	9.50 Bc	8.63 Bd
Mel Rosa	12.13 Bb	20.57 Aa	17.53 Ab	12.43 Bc
Natal CNPMF 01	8.50 Ad	8.57 Ac	9.20 Ac	9.10 Ad
Natal CNPMF 02	7.93 Bd	9.67 Bc	12.13 Ac	7.77 Bd
Natal CNPMF 112	7.47 Ad	8.37 Ac	8.03 Ac	9.53 Ad
Natal Folha Murcha	8.10 Ad	11.20 Ac	10.83 Ac	9.87 Ad
Natal Ipeal	11.30 Bb	20.23 Aa	20.40 Aa	14.13 Bb
Pera Bianchi	14.67 Aa	16.47 Ab	15.10 Ab	15.00 Ab
Pera CNPMF 01	13.50 Ba	20.15 Aa	17.63 Ab	13.50 Bb
Pera CNPMF 02	10.90 Bc	15.43 Ab	19.30 Aa	17.53 Aa
Pera CNPMF A-15	11.37 Bb	11.33 Bc	17.43 Ab	20.50 Aa
Pera CNPMF B-12	15.50 Ba	13.20 Bc	16.77 Ab	18.57 Aa
Pera CNPMF C-21	9.33 Bc	10.97 Bc	15.33 Ab	11.73 Bc
Pera CNPMF C-32	10.23 Bc	11.20 Bc	16.30 Ab	12.43 Bc
Pera CNPMF D-3	10.83 Bc	14.70 Ab	14.00 Ab	11.33 Bc
Pera CNPMF D-6	10.90 Bc	16.47 Ab	15.97 Ab	15.43 Ab
Pera CNPMF D-9	10.70 Bc	15.20 Ab	14.37 Ab	16.40 Ab
Pera CNPMF D-12	15.63 Aa	19.53 Aa	17.33 Ab	17.73 Aa
Pera CNPMF D-25	9.73 Bc	14.33 Ab	13.77 Ac	12.10 Ac
Pera CNPMF E-3	11.50 Bb	19.23 Aa	19.87 Aa	15.07 Bb
Pera CNPMF E-6	13.13 Bb	17.47 Ab	17.07 Ab	14.23 Bb
Pera GE-03	9.40 Bc	14.90 Ab	15.47 Ab	14.13 Ab
Pera de Ibotirama	13.80 Ba	18.63 Aa	13.97 Bb	11.13 Bc
Pera Olímpia	12.67 Bb	17.60 Ab	14.53 Bb	12.80 Bc
Pera Vacinada	12.27 Bb	16.60 Ab	14.20 Bb	12.30 Bc
Pineapple	9.00 Ac	10.20 Ac	10.73 Ac	8.17 Ad
Russas P.S.	11.00 Ac	11.93 Ac	11.17 Ac	10.73 Ac
Salustiana	11.50 Ab	8.57 Ac	9.53 Ac	9.13 Ad

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Seleta de Itaboraí	14.20 Ba	14.80 Bb	21.67 Aa	14.60 Bb
Sincorá	10.83 Ac	12.83 Ac	11.03 Ac	12.87 Ac
Valencia Chapman	6.40 Ad	8.57 Ac	10.20 Ac	7.87 Ad
Valencia CNPMF	5.90 Bd	11.27 Ac	9.97 Ac	6.17 Bd
Valencia CNPMF 01	9.93 Bc	15.07 Ab	13.17 Ac	15.83 Ab
Valencia CNPMF 02	7.70 Bd	13.07 Ac	10.10 Bc	10.23 Bd
Valencia CNPMF 03	8.17 Ad	10.53 Ac	9.90 Ac	12.07 Ac
Valencia CNPMF 21	9.17 Ac	9.93 Ac	10.37 Ac	9.23 Ad
Valencia CNPMF 27	6.90 Ad	9.27 Ac	9.83 Ac	10.40 Ad
Valencia CNPMF 36	8.53 Bd	11.53 Ac	12.23 Ac	12.73 Ac
Valencia CNPMF F-11	9.50 Ac	11.40 Ac	11.43 Ac	10.87 Ac
Valencia Criola	7.60 Ad	9.17 Ac	10.47 Ac	10.17 Ad
Valencia Delta	9.07 Ac	13.13 Ac	11.53 Ac	11.67 Ac
Valencia L. Shaffey	9.13 Ac	12.50 Ac	11.13 Ac	10.77 Ac
Valencia L. White	7.23 Bd	10.37 Ac	10.67 Ac	12.43 Ac
Valencia Late	8.03 Ad	10.67 Ac	10.00 Ac	10.93 Ac
Valencia Midknight	10.27 Ac	12.97 Ac	12.50 Ac	12.30 Ac
Valencia Montemorelos	6.67 Bd	9.37 Ac	9.57 Ac	11.10 Ac
Valencia Registro	6.40 Bd	9.40 Ac	10.77 Ac	9.00 Ad
Valencia Tuxpan	7.37 Bd	11.90 Ac	11.93 Ac	11.57 Ac
Westin	15.07 Aa	14.57 Ab	14.37 Ab	12.40 Ac

Means followed by the same uppercase letter in the row and lowercase in the column do not differ by the Scott-Knott mean cluster test at 5% probability.

It is noteworthy that some of scion varieties under study are of low AT, such as 'Berna', 'Aquiri', 'Pera de Ibotirama', 'Seleta de Itaboraí', 'Westin', 'Diva', 'Crescent sweet', 'Melrosa' and 'Flor de Brumadinho'. These materials are accepted for fresh consumption, exclusively, being especially recommended for children, pregnant women and older adults. In addition, fruits from late maturing orange trees, prematurely harvested, like 'Natal' and 'Valencia' clones did not reach their ideal maturation point, yet more than 80% of the 228 scion/rootstock combinations showed ratio values equal to or greater than 9.5, which is considered as the minimum required for good quality fruits (CEAGESP, 2011). For the orange juice consumer market, according to Pozzan and Triboni (2005), SS/AT ratio values between 14 and 16 are more acceptable, which are values observed in only 15.78% of evaluated combinations. In addition, as previously reported, due to the numerous combinations, the maturation curve was not carried out, which will be carried out after selecting the most productive and with better productive efficiency.

Regarding juice yield (REND), it was observed that combinations differed statistically, with the highest yields being observed in 74 combinations, among them 'Pera CNPMF E-6/ 'Riverside' citrandarin, with 58.11% (Table 10).

Table 10. Juice yield (%) of fruits from 228 scion/rootstock combinations comprising 57 sweet orange varieties [*Citrus sinensis* (L.) Osbeck] on 'Sunki Tropical' (TST) mandarin rootstocks [*Citrus sunki* (Hayata) hort. ex Tanaka] and 'San Diego' (SD), 'Riverside' (RIV) and 'Indio' (IND) citrandarins [*C. sunki* × *Poncirus trifoliata* (L.) Raf.].

Scion variety	Rootstock			
	TST	SD	RIV	IND
Aquiri	14.17 Aa	14.50 Ab	12.90 Ac	10.37 Bd
Berna	16.60 Aa	17.77 Ab	16.03 Ab	11.10 Bc
Crescent sweet	13.73 Aa	16.43 Ab	16.60 Ab	15.67 Ab
Diva	11.90 Ab	12.20 Ac	13.70 Ac	14.03 Ab
Early Oblong	10.07 Ac	12.80 Ac	11.00 Ac	10.30 Ad
F-Menuda	14.40 Aa	11.00 Bc	14.83 Ab	8.40 Bd
Flor de Brumadinho	16.37 Ba	23.77 Aa	21.50 Aa	19.97 Aa
Hamlin CNPMF 20	7.37 Ad	9.40 Ac	10.67 Ac	9.43 Ad
Jaffa	10.33 Bc	13.67 Ac	9.50 Bc	8.63 Bd
Mel Rosa	12.13 Bb	20.57 Aa	17.53 Ab	12.43 Bc
Natal CNPMF 01	8.50 Ad	8.57 Ac	9.20 Ac	9.10 Ad
Natal CNPMF 02	7.93 Bd	9.67 Bc	12.13 Ac	7.77 Bd
Natal CNPMF 112	7.47 Ad	8.37 Ac	8.03 Ac	9.53 Ad
Natal Folha Murcha	8.10 Ad	11.20 Ac	10.83 Ac	9.87 Ad
Natal Ipeal	11.30 Bb	20.23 Aa	20.40 Aa	14.13 Bb
Pera Bianchi	14.67 Aa	16.47 Ab	15.10 Ab	15.00 Ab
Pera CNPMF 01	13.50 Ba	20.15 Aa	17.63 Ab	13.50 Bb
Pera CNPMF 02	10.90 Bc	15.43 Ab	19.30 Aa	17.53 Aa
Pera CNPMF A-15	11.37 Bb	11.33 Bc	17.43 Ab	20.50 Aa
Pera CNPMF B-12	15.50 Ba	13.20 Bc	16.77 Ab	18.57 Aa
Pera CNPMF C-21	9.33 Bc	10.97 Bc	15.33 Ab	11.73 Bc
Pera CNPMF C-32	10.23 Bc	11.20 Bc	16.30 Ab	12.43 Bc
Pera CNPMF D-3	10.83 Bc	14.70 Ab	14.00 Ab	11.33 Bc
Pera CNPMF D-6	10.90 Bc	16.47 Ab	15.97 Ab	15.43 Ab
Pera CNPMF D-9	10.70 Bc	15.20 Ab	14.37 Ab	16.40 Ab
Pera CNPMF D-12	15.63 Aa	19.53 Aa	17.33 Ab	17.73 Aa
Pera CNPMF D-25	9.73 Bc	14.33 Ab	13.77 Ac	12.10 Ac
Pera CNPMF E-3	11.50 Bb	19.23 Aa	19.87 Aa	15.07 Bb
Pera CNPMF E-6	13.13 Bb	17.47 Ab	17.07 Ab	14.23 Bb
Pera GE-03	9.40 Bc	14.90 Ab	15.47 Ab	14.13 Ab
Pera de Ibotirama	13.80 Ba	18.63 Aa	13.97 Bb	11.13 Bc
Pera Olímpia	12.67 Bb	17.60 Ab	14.53 Bb	12.80 Bc
Pera Vacinada	12.27 Bb	16.60 Ab	14.20 Bb	12.30 Bc
Pineapple	9.00 Ac	10.20 Ac	10.73 Ac	8.17 Ad
Russas P.S.	11.00 Ac	11.93 Ac	11.17 Ac	10.73 Ac
Salustiana	11.50 Ab	8.57 Ac	9.53 Ac	9.13 Ad
Seleta de Itaboraí	14.20 Ba	14.80 Bb	21.67 Aa	14.60 Bb

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Sincorá	10.83 Ac	12.83 Ac	11.03 Ac	12.87 Ac
Valencia Chapman	6.40 Ad	8.57 Ac	10.20 Ac	7.87 Ad
Valencia CNPMF	5.90 Bd	11.27 Ac	9.97 Ac	6.17 Bd
Valencia CNPMF 01	9.93 Bc	15.07 Ab	13.17 Ac	15.83 Ab
Valencia CNPMF 02	7.70 Bd	13.07 Ac	10.10 Bc	10.23 Bd
Valencia CNPMF 03	8.17 Ad	10.53 Ac	9.90 Ac	12.07 Ac
Valencia CNPMF 21	9.17 Ac	9.93 Ac	10.37 Ac	9.23 Ad
Valencia CNPMF 27	6.90 Ad	9.27 Ac	9.83 Ac	10.40 Ad
Valencia CNPMF 36	8.53 Bd	11.53 Ac	12.23 Ac	12.73 Ac
Valencia CNPMF F-11	9.50 Ac	11.40 Ac	11.43 Ac	10.87 Ac
Valencia Criola	7.60 Ad	9.17 Ac	10.47 Ac	10.17 Ad
Valencia Delta	9.07 Ac	13.13 Ac	11.53 Ac	11.67 Ac
Valencia L. Shaffey	9.13 Ac	12.50 Ac	11.13 Ac	10.77 Ac
Valencia L. White	7.23 Bd	10.37 Ac	10.67 Ac	12.43 Ac
Valencia Late	8.03 Ad	10.67 Ac	10.00 Ac	10.93 Ac
Valencia Midknight	10.27 Ac	12.97 Ac	12.50 Ac	12.30 Ac
Valencia Montemorelos	6.67 Bd	9.37 Ac	9.57 Ac	11.10 Ac
Valencia Registro	6.40 Bd	9.40 Ac	10.77 Ac	9.00 Ad
Valencia Tuxpan	7.37 Bd	11.90 Ac	11.93 Ac	11.57 Ac
Westin	15.07 Aa	14.57 Ab	14.37 Ab	12.40 Ac

Means followed by the same uppercase letter in the row and lowercase in the column do not differ by the Scott-Knott mean cluster test at 5% probability.

The combinations under study, except for 'F-Menuda'/ 'Sunki Tropical' mandarin, presented desirable juice yield for fresh consumption, according to the Codex Alimentarius (2005), with values equal to or greater than 35%. However, for Ceagesp (2011), the minimum juice yield for 'Pera', 'Natal', 'Valencia' and 'Hamlin' orange varieties must be, respectively, 45%, 44% and 35%. It is noteworthy that for industry use, small variations in this index can lead to large differences in the final juice production.

Although preliminary, the results obtained in this study allowed the identification of promising scion/rootstock combinations, particularly for citrus crops in the extreme south of the Bahia and Espírito Santo.

Variety from mid-season to late ripening, 'Sincorá' stood out in combination with 'San Diego' and 'Indio' citrandarins in relation to fruit production and juice quality, although it did not present acceptable values in terms of soluble solids content, considering recommendations for fruits intended for fresh consumption.

It should be kept in mind; however, that this is a first fruit crop, a situation that can change in later crops, since fruit quality is lower in the first crops than in more advanced ones.

Among late maturing varieties, such as 'Natal' and 'Valencia' selections harvested in August, the 'Natal Ipeal'/ 'Indio' citrandarin combination stood out for its high efficiency in fruit production and pulp yield, despite the low fruit acidity (0.69%, citric acid), acceptable for industry, it reached ratio of 14.13, a desirable characteristic for fresh consumption.

Among scion/rootstock combinations that showed high productive efficiency levels, considering those harvested in June, the most prominent were 'Pera CNPMF A-15/ 'San Diego' citrandarin and 'Pera CNPMF D-3/ 'Riverside' citrandarin, which met criteria established by the market regarding fruit quality: ºBrix of 11.6 and 10.6, total acidity of 1.04% and 0.76%, ratio of 11.33 and 14.00 and juice yield of 55.23% and 50.88%, respectively. However, it was observed that depending on the purpose (industrialization or fresh consumption), growing conditions and harvest time, this indication may vary.

Considering that the results obtained are preliminary, as well as the place where the study was carried out, the following conclusions are listed below:

1. There are indications that 'Pera CNPMF A-15/ 'San Diego' citrandarin and 'Pera CNPMF D-3/ 'Riverside' citrandarin combinations can be used in the production of fruits for both industry and fresh consumption.

2. Both 'Sincorá' variety in combination with 'San Diego' and 'Indio' citrandarins, and 'Natal Ipeal' variety in combination with 'Indio' citrandarin, present strong indications of the possibility of recommendation to citrus growers, the former being of earlier maturation compared to the latter.

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