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ORIGINAL ARTICLE

Agronomic evaluation of potential rootstocks for peach trees

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Abstract – Peach production depends on the appropriate choice of rootstock, which influences phenological behavior, vigor, productivity, and fruit quality. The objective of this study was to evaluate the agronomic performance of the Chimarrita cultivar grafted onto 27 rootstocks. The experiment was conducted in Veranópolis, Rio Grande do Sul, in a completely randomized design with three replications, throughout the growing seasons of 2022, 2023, and 2025. Phenological variables, vegetative vigor, production, fruit weight, soluble solids (SS), titratable acidity (TA) and SS/TA (ratio) were analyzed. Phenological behavior was similar among rootstocks, with slight variations in budburst and flowering. The vigor of the scion cultivar showed greater growth conferred by the Cascata 534 rootstock and a dwarfing effect by Flordaguard. Production was influenced by rootstocks and years of evaluation, with Tsukuba 2, I-67-55-9, and I-93-27 standing out for higher yield and productive stability. Fruit weight varied among genotypes, with a tendency for larger fruits in rootstocks that induced lower productive load. Quality attributes were affected by rootstocks, with an inverse relationship between SS and TA throughout the cycles. Capdeboscq, Chorão, Tsukuba 2 CPACT, and I-67-52-44 showed better balance between sugars and acidity, reflecting fruits with higher ratio values.

Keywords: *Prunus persica*. Phenology. Vegetative vigor. Yield. Fruit quality.

Avaliação agronômica de porta-enxertos potenciais para pessegueiro

Resumo – A produção de pêssegos depende da escolha adequada do porta-enxerto, o qual exerce influência sobre o comportamento fenológico, o vigor, a produtividade e a qualidade dos frutos. O objetivo deste trabalho foi avaliar o desempenho agronômico da cultivar Chimarrita enxertada sobre 27 porta-enxertos. O experimento foi conduzido em Veranópolis, Rio Grande do Sul, em delineamento inteiramente casualizado, com três repetições, ao longo das safras de 2022, 2023 e 2025. Foram analisadas variáveis fenológicas, vigor vegetativo, produção, peso de fruto, sólidos solúveis (SS), acidez titulável (AT) e relação SS/AT (ratio). O comportamento fenológico foi semelhante entre os porta-enxertos, com pequenas variações na brotação e floração. O vigor da cultivar-copa apresentou maior crescimento conferido pelo porta-enxerto Cascata 534 e efeito ananizante pelo Flordaguard. A produção foi influenciada pelos porta-enxertos e pelos anos de avaliação, destacando-se Tsukuba 2, I-67-55-9 e I-93-27 pelo maior rendimento e estabilidade produtiva. O peso dos frutos variou entre os materiais, com tendência de frutos maiores em porta-enxertos que induziram menor carga produtiva. Os atributos de qualidade foram afetados pelos porta-enxertos, com relação inversa entre SS e AT ao longo dos ciclos. Capdeboscq, Chorão, Tsukuba 2 CPACT e I-67-52-44 apresentaram melhor equilíbrio entre açúcares e acidez, refletindo frutos com valores maiores de ratio.

Palavras-chave: *Prunus persica*. Fenologia. Vigor vegetativo. Produtividade. Qualidade de fruto.

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Introduction

Peach production in Brazil integrates a production chain that has a strong socioeconomic impact on the country. Among the Brazilian states, Rio Grande do Sul (RS) stands out as the largest national producer, accounting for approximately 67 % of the total peach production (IBGE, 2024). Peach production in the state of RS is mainly distributed between two regions with distinct productive characteristics: the Serra Gaúcha and the Southern Zone. The Serra Gaúcha concentrates the production of peaches destined for fresh consumption, highlighting the municipalities of Pinto Bandeira, Farroupilha, Caxias do Sul, Antônio Prado, Campestre da Serra, Nova Pádua and Bento Gonçalves. In contrast, the Southern Zone has a production system mainly focused on supplying the processing industry with raw materials for the manufacture of canned peaches, jams, and pulps, with significant participation from the municipalities of Pelotas, Canguçu, and Morro Redondo (IBGE, 2024).

Agricultural research over recent decades has driven the development of peach cultivation in Brazil, with the release of new adapted cultivars, advances in pruning, training and fertilization techniques, as well as the introduction of technologies focused on phytosanitary management (Raseira; Pereira; Carvalho, 2022). Although these advances have improved productive stability, some technical bottlenecks, in selecting and recommending suitable rootstocks for different growing conditions, persist (Mayer *et al.*, 2021).

The rootstock plays a fundamental role in the physiological and productive behavior of the plant, influencing soil adaptation, vigor, resistance to root diseases, root system efficiency, productivity, and fruit quality of the scion cultivar (Hartmann *et al.*, 2011; Kumar *et al.*, 2021; Oliveira *et al.*, 2022). In RS, many nurseries use seeds from the processing industry as a rootstock source, resulting in a large varietal mixture and a lack of genetic and/or sanitary identity. Therefore, there is no precise information about the rootstock used in the production of peach seedlings. This compromises the traceability and standardization of the plant material used in the establishment of commercial orchards (Fachinello *et al.*, 2015). Additionally, it violates federal and state regulations governing the production of certified seedlings and compromises the conformity of the propagative material (Roth, 2017).

The use of rootstocks without a defined genetic identity leads to high variability in the agronomic performance of orchards and hinders phytotechnical management and productive predictability (Fachinello; Hoffmann; Nachtigal, 2013; Raseira; Pereira; Carvalho, 2022). Furthermore, the absence of sanitary control of the rootstock increases the risk of introduction and dissemination of pathogens, compromising the longevity of orchards and increasing production costs (Mayer; Ueno; Antunes, 2009; Hartmann *et al.*, 2011). Thus, there is a clear need to evaluate and recommend rootstocks with known genetic origin, adapted to the edaphoclimatic conditions of the RS, to achieve greater uniformity, sustainability, and productive efficiency in peach cultivation (Mayer *et al.*, 2015). In this way, the qualification of the nursery production sector and the improvement of the productive performance of new orchards can be established.

Due to the low yield of peach orchards in RS (10.9 t ha^{-1}), problems associated with the Peach Tree Short Life syndrome (PTSL), and the tradition of obtaining seed mixtures from the canning industry to produce rootstocks (Mayer; Bianchi; Castro, 2014), there has been increasing interest in evaluating new genotypes for use as rootstocks. Results obtained in different studies show that the performance of scion/rootstock combinations is strongly influenced by edaphoclimatic conditions and the interaction between the genotypes involved (Barreto *et al*., 2017; Mayer *et al.*, 2019). Furthermore, some traditionally used rootstocks present significant phytosanitary limitations, such as the susceptibility of 'Capdeboscq' and 'Aldrighi' to Meloidogyne incognita, and of 'Capdeboscq' to *Meloidogyne ethiopica*, *Mesocriconema xenoplax*, and waterlogging (Mayer *et al*., 2015). In contrast, materials such as 'Okinawa', 'Tsukuba', 'Flordaguard', and 'Nemaguard' have shown promising characteristics, although they still have limited diffusion in the production chain. Knowledge of the bioagronomic characteristics of rootstocks and the evaluation of their compatibility with different scion cultivars are fundamental for defining the most suitable combinations for each growing environment since the adaptation and productive performance of orchards depend directly on this interaction (Reighard; Loreti, 2008; Duval, 2015). Identifying rootstocks adapted to local conditions and capable of imparting desirable agronomic characteristics to the scion is an essential strategy for increasing productivity, fruit quality, and the long-term viability of peach cultivation (Rato *et al*., 2008). The objectives of this study were to evaluate the agronomic performance of 27 potential rootstocks for peach trees, grafted with the Chimarrita cultivar, under the edaphoclimatic conditions of the municipality of Veranópolis-RS, analyzing phenological variables, vegetative vigor, production, and fruit quality.

Materials and Methods

The experiment was conducted at the State Center for Diagnosis and Research in Fruticulture (CEFRUTI), located in the municipality of Veranópolis-RS (28°53'17" S and 51°32'32" W, 707 m.asl), belonging to the Department of Agricultural Diagnosis and Research (DDPA), of the Secretariat of Agriculture, Livestock, Sustainable Production and Irrigation (SEAPI). According to the standard climatological normal 1991–2020, the mean annual temperature of the location is 17.5 °C and the average rainfall is 1.846 mm (Junges; Tonietto, 2022). According to the Köppen classification, the climate of the region is temperate (Cfb) (Moreno, 1961). The soil is classified as a typical dystrophic Red Latosol (LVdf1), according to Streck *et al.* (2002).

In total, 27 peach rootstocks, all grafted with the scion cultivar 'Chimarrita', were used for the agronomic evaluation. The rootstocks tested were: Tsukuba 1, Tsukuba 2, Tsukuba 3, Tsukuba 2 CPACT, Capdeboscq, Okinawa, Aldrighi, *Prunus mandschurica*, *Prunus consuensis*, Cascata 534, Cascata 1005, I-93-27, I-93-30, I-93-38, I-67-52-9, I-67-52-44, I-67-53-5, I-67-55-9, Mexico 1, Tardio 1, Pexn-9, Peguia, Chorão, Bolinha, Farrapos, Turquesa, and Flordaguard. Four-year-old plants were established in the field, with a spacing of 3 m between plants and m between rows, and trained under an open vase system. The distribution of rootstock/scion combinations was randomized, with three replications and one plant per plot.

The rootstocks used in the experiment were produced from seeds sown in plastic bags containing peat-based substrate and kept in a protected environment. Subsequently, the emerged seedlings were transplanted to a nursery. When the rootstocks reached a trunk diameter comparable to a pencil's thickness, grafting was performed using the inverted T-budding method. After the formation of the grafted seedlings, they were transplanted to an experimental field established in a virgin area, whose soil fertility was corrected according to technical recommendations. The experiment evaluations began in the fourth year after

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planting. Rootstock evaluations were conducted over three growing seasons (2022, 2023, and 2025). Phenological monitoring was carried out throughout the growing season, systematically recording the dates of occurrence of the main vegetative and reproductive phases. For each rootstock/scion combination, the date of budburst (when 50 % of the buds were at the green tip stage), the beginning of flowering (when 5 % of the flowers were open), full bloom (when 70 % of the flowers were open), and the end of flowering (when 100 % of the flower petals had fallen) were noted (Anzanello and Menin, 2018). Additionally, aspects related to the vegetative vigor of the plants were evaluated, with plant height measured using a graduated ruler positioned vertically on the trunk, and trunk diameter determined using a caliper, taking the reading 20 cm from ground level.

Productive and qualitative analyses of the fruits were performed during the harvest period. The harvest stage was determined based on visual attributes, fruit firmness, and sensory evaluation. Harvesting was carried out in two stages, separated by an interval of approximately 7 days, with the proportion of fruit harvested at each stage varying according to the rootstock–scion combination. Production per plant was obtained by weighing the total harvested fruits using an electronic scale. For physicochemical analysis, 30 fruits per rootstock/scion combination were sampled and evaluated for fruit weight (in g) using an analytical digital balance; soluble solids content (SS), in °Brix, using a refractometer; and titratable acidity (TA), determined by titration with 0.1 N NaOH, using 0.1 % phenolphthalein as indicator. The results were expressed in g citric acid 100 mL^{-1} of pulp (AOAC, 1997). These results enabled the calculation of the SS/TA ratio, which served as an indicator of the fruit flavor, as proposed by Baldwin (2002). The production and fruit quality data were related to the meteorological conditions of each growing season, obtained from an automatic weather station belonging to CEFRUTI/DDPA/SEAPI and compared with the 1991–2020 climatological normals for the region (Junges; Tonietto, 2021; Junges *et al*., 2024). The phenological and vegetative vigor variables were subjected to descriptive analysis, enabling the characterization of budburst, flowering, and vegetative development patterns of the evaluated rootstocks. Data on quantitative and qualitative production were submitted to analysis of variance (ANOVA). Means were compared using Tukey's test at a 5 % probability level when significant differences were detected using the F test.

Results and Discussion

A temporal concentration was observed within each phenological phase among the evaluated rootstocks (Table 1), with budburst of the scion cultivar occurring predominantly between July 18 and 22, and the beginning of flowering varying from July 17 to 23. Rootstocks such as Cascata 1005, Chorão, and I-67-53-5 induced earlier budburst (July 18). In contrast, Tsukuba 3, Aldrighi, Turquesa, and Flordaguard caused later budburst (July 22). Full flowering was concentrated mainly between July 26 and 28, with little variation among genotypes, while the end of flowering extended from August 6 to 11. Rootstocks such as Tsukuba 2 and Cascata 1005 induced an earlier end to flowering (August 6). In contrast, Cascata 534, Aldrighi, Turquesa, and Pexn-9 resulted in a longer flowering period, reaching its end on either August 10 or 11.

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Table 1. Phenology of the Chimarrita cultivar grafted onto 27 rootstocks, in terms of budburst, beginning, full and end of flowering, considering the mean of three growing seasons (2022, 2023 and 2025). Veranópolis, RS, Brazil.

Cultivar	Budburst	Beginning of flowering	Full flowering	End of flowering
Tsukuba 2	July 19	July 17	July 25	August 6
Tardio 1	July 20	July 19	July 25	August 7
Tsukuba 3	July 22	July 17	July 26	August 8
Tsukuba 2 CPACT	July 20	July 20	July 26	August 9
I-93-38	July 19	July 19	July 26	August 7
Cascata 1005	July 18	July 19	July 26	August 6
Tsububa 1	July 21	July 20	July 26	August 8
I-93-27	July 21	July 19	July 26	August 7
I-93-30	July 21	July 20	July 26	August 7
I-67-55-9	July 20	July 19	July 26	August 8
Peguia	July 19	July 18	July 26	August 7
Chorão	July 18	July 18	July 26	August 7
Cascata 534	July 21	July 19	July 26	August 10
I-67-52-9	July 19	July 19	July 26	August 7
Capdeboscq	July 21	July 19	July 27	August 8
Bolinha	July 21	July 19	July 27	August 9
Prunus mandschurica	July 21	July 19	July 27	August 8
I-67-52-44	July 20	July 20	July 27	August 9
Aldrighi	July 22	July 19	July 28	August 10
I-67-53-5	July 18	July 19	July 28	August 8
Okinawa	July 20	July 19	July 28	August 7
Farrapos	July 21	July 19	July 28	August 8
Turquesa	July 22	July 21	July 28	August 10
Prunus consuensis	July 21	July 21	July 28	August 9
Mexico 1	July 19	July 21	July 28	August 7
Flordguard	July 22	July 21	July 28	August 8
Pexn-9	July 21	July 23	July 29	August 11

The relatively narrow range between budburst and flowering dates indicates homogeneous phenological behavior of the Chimarrita cultivar grafted onto different rootstocks under local edaphoclimatic conditions. However, small differences between rootstocks may reveal intrinsic genetic variation in chilling requirements and in the rate of growth resumption of the genotypes after dormancy. Rootstocks that induced earlier budburst and flowering tend to have lower chilling requirements and may be better adapted to regions with mild winters. In contrast, those with a later phenological cycle may offer greater protection against late frosts and improved flowering synchrony (Yang *et al*., 2021). Results reported in the literature for species of the genus *Prunus* indicate that the rootstock plays a modulatory role on the phenology of the grafted

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plant, influencing the duration of flowering, budburst uniformity and, indirectly, productive performance (Webster, 2004; Hartmann *et al*., 2011; Oliveira *et al*., 2022). Therefore, the phenological characterization of rootstocks constitutes an essential tool for supporting the recommendation of those better adapted to local climatic conditions and specific production systems.

Based on vegetative vigor data, a wide variation was observed among the rootstocks regarding plant height and trunk diameter of the Chimarrita cultivar (Fig. 1), evidencing consistent differences of the genotypes in inducing vegetative growth of the scion cultivar. Cascata 534 had the greatest average height (2.7 m) and high trunk diameter (8.6 cm), characterizing a vigorous behavior. In contrast, Okinawa and *Prunus mandshurica* showed the highest trunk diameters (9.9 and 9.3 cm, respectively), despite exhibiting intermediate plant height, indicating greater stem thickening and elevated cambial activity. Flordaguard presented the lowest values for height (2.0 m) and trunk diameter (5.7 cm), characterizing lower vegetative vigor. In general, rootstocks that conditioned greater plant height tended to present larger trunk diameters, although some materials showed a partial dissociation between height growth and stem thickening, which reflects genetic particularities intrinsic to each rootstock, as previously reported by Mayer *et al*. (2021).

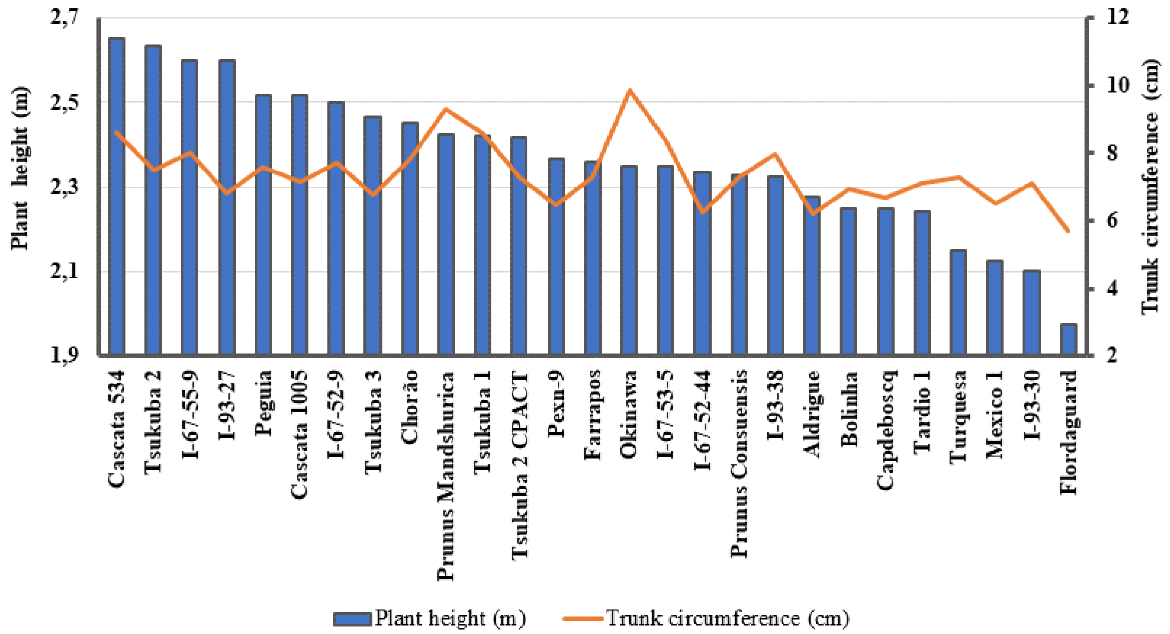

Figure 1. Vegetative vigor, in terms of plant height (m) and trunk circumferences (cm), of the Chimarrita cultivar grafted onto 27 rootstocks, considering the mean of three growing seasons (2022, 2023 and 2025). Veranópolis, RS, Brazil.

These results corroborate previous findings in *Prunus* species, demonstrating that rootstock exerts a direct influence on vigor, plant architecture, and vegetative-reproductive balance of the scion cultivar, thereby affecting orchard management and planting density (Comiotto *et al*., 2012; Moreschi *et al*., 2023). Studies indicate that more vigorous rootstocks favor greater initial growth and plant longevity, whereas less

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vigorous ones may contribute to higher productive efficiency and easier orchard management. This reinforces the importance of vegetative vigor as a fundamental criterion for rootstock selection (Almeida *et al*., 2015; Denardi *et al*., 2015; Hayat *et al*., 2023)

Production results revealed significant differences among rootstocks in all years evaluated, as well as in the overall mean of the period (Table 2). This confirmed a strong genotypic effect on the productive performance of the scion cultivar. In 2022, production ranged from 2.2 to 15.5 kg plant^{-1}, with Cascata 534 (15.5 kg plant^{-1}) and I-93-27 (12.7 kg plant^{-1}) standing out, whereas Pexn-9, I-93-30 and Flordaguard exhibited the lowest yields. A significant increase in production was observed in 2023, reflecting the more advanced development stage of the plants, with Tsukuba 2 (33.9 kg plant^{-1}) and Farrapos (32.8 kg plant^{-1}) figuring among the most productive. The values ranged from 24.4 to 49.6 kg plant^{-1} in 2025, the year with the highest production expression, with I-93-27 (49.6 kg plant^{-1}), I-67-55-9 (48.2 kg plant^{-1}), and Tsukuba 2 (47.7 kg plant^{-1}) showing the highest yields, indicating a high productive potential conferred by these rootstocks in adult plants. The mean across years confirmed this thrend, with Tsukuba 2 (31.0 kg plant^{-1}), I-67-55-9 (29.6 kg plant^{-1}), and I-93-27 (29.4 kg plant^{-1}) forming the group with the highest performance and greater productive stability throughout the evaluated period. The superior production observed in the 2025 season and the higher degree of maturity shown by the plants were also due to the favorable meteorological conditions of autumn/winter, characterized by a higher amount and regularity of accumulated chilling hours (CH) required to overcome dormancy (395 CH in 2025, compared with 234 CH in 2023 and 375 CH in 2022). The CH value recorded in 2025 substantially exceeded the regional climatological normal of 322 CH accumulated between May and August (Junges *et al.*, 2024). This condition, as reported by Anzanello and Lanpugnani (2020), positively influences the budburst rate and promotes adequate flowering of the Chimarrita cultivar, whose chill requirement is approximately 400 CH during the dormancy period.

Due to their higher productive potential (Table 2), rootstocks such as Tsukuba2, I-67-55-9, and I-93-27 demonstrate better adaptation to the edaphoclimatic conditions of the study site and shows promise for cultivation. These genotypes consistently outperformed rootstocks traditionally used in peach cultivation, such as Capdeboscq, Okinawa, and Aldrighi (Raseira; Pereira; Carvalho, 2022), which exhibited intermediate yields. In contrast, rootstocks such as Flordaguard, Pexn-9, and I-93-30 had inferior productive performance and lower yield increment over the years, suggesting reduced productive efficiency or limited adaptation. This pattern is consistent with previous findings in *Prunus* species, in which the rootstock directly influences productivity, crop regularity, and orchard production stability, highlighting the importance of multi-year evaluations to discriminate materials with greater agronomic potential (Roth, 2017; Mayer *et al*., 2021; Oliveira *et al*., 2022). Thus, the combined analysis of annual production and the media of the evaluated period enables the identification of more productive and efficient rootstocks, providing technical support for their recommendation in commercial cultivation (Picolotto *et al*., 2009; Comiotto *et al*., 2012; Almeida *et al*., 2015).

Table 2. Production, in kg plant^{-1}, of the Chimarrita cultivar grafted onto 27 rootstocks, in the 2022, 2023 and 2025 growing seasons and in the mean of the evaluated period. Veranópolis, RS, Brazil.

Rootstock	Production (kg plant^{-1}) 2022	Rootstock	Production (kg plant^{-1}) 2023	Rootstock	Production (kg plant^{-1}) 2025	Rootstock	Mean production (kg plant^{-1})
Cascata 534	15.5 a[1]	Tsukuba 2	33.9 a	I-93-27	49.6 a	Tsukuba 2	31.0 a
I-93-27	12.7 ab	Farrapos	32.8 ab	I-67-55-9	48.2 a	I-67-55-9	29.6 a
I-67-55-9	11.8 ab	I-67-55-9	28.7 bc	Tsukuba 2	47.7 ab	I-93-27	29.4 a
Okinawa	11.5 ab	Cascata 534	28.6 bc	Tsukuba 3	44.1 bc	Farrapos	28.1 ab
Tsukuba 2	11.4 ab	Tsukuba 3	27.5 bc	I-67-53-5	44.0 bc	Cascata 534	27.7 ab
I-67-53-5	11.1 ab	Chorão	26.9 cd	Tsukuba 2 CPACT	42.8 bc	Tsukuba 3	27.0 ab
Farrapos	11.0 ab	Okinawa	26.7 cd	Farrapos	40.5 cd	I-67-53-5	25.6 bc
Chorão	10.8 ab	I-93-27	25.8 cd	Cascata 534	39.0 cd	Chorão	25.5 bc
Capdeboscq	9.8 bc	Tsukuba 1	23.9 de	Chorão	38.9 cd	Tsukuba 2 CPACT	25.4 bc
Tsukuba 2 CPACT	9.4 bc	Tsukuba 2 CPACT	23.9 de	Turquesa	38.5 cd	Okinawa	25.0 bc
Tsukuba 3	9.3 bc	Peguia	22.4 de	Peguia	38.1 cd	Tsukuba 1	23.5 cd
Tsukuba 1	9.1 bc	*Prunus mandshurica*	22.0 de	Tsukuba 1	37.5 de	Peguia	22.6 cd
Prunus mandshurica	8.7 cd	I-67-53-5	21.8 ef	Okinawa	36.7 de	*Prunus consuensis*	21.8 de
Prunus consuensis	7.9 cd	*Prunus consuensis*	21.1 ef	*Prunus consuensis*	36.5 de	*Prunus mandshurica*	21.3 de
Aldrighi	7.8 cd	Cascata 1005	20.4 ef	Bolinha	36.5 de	Turquesa	20.9 de
Cascata 1005	7.8 cd	Capdeboscq	20.3 ef	Aldrighi	36.2 de	Capdeboscq	20.8 de
Peguia	7.3 cd	I-67-52-9	20.3 ef	Tardio 1	35.8 de	Aldrighi	20.8 de
Bolinha	6.9 de	Turquesa	20.1 ef	Cascata 1005	33.3 ef	Bolinha	20.8 de
I-67-52-9	6.9 de	Bolinha	19.0 fg	*Prunus mandshurica*	33.2 ef	Cascata 1005	20.5 de
Tardio 1	6.0 de	Aldrighi	18.5 fg	I-93-30	32.5 ef	Tardio 1	20.0 ef
I-67-52-44	5.8 ef	Tardio 1	18.1 fg	Capdeboscq	32.2 ef	I-67-52-9	19.1 ef
I-93-38	5.7 ef	I-93-30	16.0 gh	I-67-52-9	30.2 fg	I-93-30	17.1 fg
México 1	5.4 ef	I-93-38	15.8 gh	México 1	29.7 fg	México 1	16.3 fg
Turquesa	4.2 fg	Pexn-9	14.4 hi	Pexn-9	25.7 gh	I-93-38	15.3 gh
Flordaguard	4.0 fg	México 1	13.7 hi	I-67-52-44	25.5 gh	I-67-52-44	14.4 gh
I-93-30	2.9 gh	Flordaguard	12.6 hi	Flordaguard	25.0 gh	Pexn-9	14.1 gh
Pexn-9	2.2 h	I-67-52-44	11.8 i	I-93-38	24.4 h	Flordaguard	13.9 h

[1]Means followed by the same lowercase letter in the column, among rootstocks, do not differ significantly by Tukey's test at 5 % probability level.

Notably, the promising Tsukuba 2 rootstock has its origin from Japan, standing out for its tolerance to waterlogging and resistance to *Meloidogyne incognita* race 2 and *Meloidogyne javanica*. The I-67-55-9 and I-93-27 rootstocks originated from selections of the Active Germplasm Bank of Embrapa Clima Temperado and are mainly characterized by their high genetic variability (Mayer *et al.*, 2015).

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Analysis of mean fruit weight revealed significant differences among rootstocks in the 2022, 2023, and 2025 growing seasons, as well as in the overall mean, demonstrating the influence of rootstock on the fruit size of the Chimarrita cultivar. In 2022, values ranged from 96 to 132 g, with I-93-38 (132 g) and Chorão (123 g) standing out, whereas Pexn-9 and I-67-52-9 showed the lowest fruit weights. In 2023, a general increase in fruit weight was observed, with I-93-38, I-67-53-5, I-67-55-9, *Prunus consuensis*, and Cascata 1005 forming the superior group (≈133–137 g). In 2025, the year with the greatest differentiation among genotypes, the highest fruit weights were recorded in Tsukuba 2 (162 g), Tsukuba 3 (153 g), and I-67-55-9 (151 g), while Flordaguard had the lowest (100 g). The mean across years confirmed the superior performance of I-93-38 and I-67-55-9 (135 g), Tsukuba 2 (134 g), and *Prunus mandshurica* (130 g), indicating greater stability in the induction of larger-caliber fruits for these genotypes. These differences are associated with the effect of the rootstock on the absorption and redistribution of water and nutrients, to the vigor induced and in the balance between vegetative growth and crop load, factors already described for species of the genus *Prunus*, in which more efficient rootstocks tend to promote larger mean fruit size and improved their uniformity (Castle, 1995; Fachinello *et al*., 2015; Kumar *et al*., 2021).

Rootstocks characterized by high yield potential, such as Tsukuba 2 and I-93-27 (Table 2), generally presented fruits with intermediate mean weight (Table 3), suggesting a partitioning of photoassimilates between the number of fruits and their growth (Taiz *et al*., 2022). An exception was observed for the rootstock I-67-55-9, which simultaneously induced high production and one of the largest fruit sizes. In contrast, genotypes with lower production, such as I-93-38, had higher mean fruit weight, indicating a reduction in intraspecific competition in the plant, favoring the growth and development of the peaches. In general, rootstocks with high production showed balanced performance, combining high productivity with commercially adequate fruit weight, indicating greater physiological productive efficiency (Webster, 2004; Hayat *et al*., 2023). Adhering to technical recommendations for peach cultivation, such as pruning, thinning, and fertilization, is important to enable genotypes to reach their maximum productive potential (Anzanello; Tedesco, 2017). Notably, fruit size values observed for most rootstocks were within the expected range for the Chimarrita cultivar, which is classified as larger-fruited, with a mean weight generally exceeding 100 g and potentially surpassing 120 g (Raseira; Pereira; Carvalho, 2022).

The SS content was significantly influenced by the different rootstocks and years of evaluation, reflecting variations in the internal quality of the fruits (Table 4). In 2022, Peguia and Tardio 1 showed the highest SS content, while in 2023 a greater homogenization was observed among the materials, with several rootstocks grouped in the upper stratum. In 2025, I-93-38, I-67-52-4, and Tsukuba 2 CPACT stood out. Considering the mean of the years, Tsukuba 2 CPACT, and I-67-52-44 exhibited the highest average SS, while Cascata 534, Tsukuba 2, and Turquesa presented the lowest values. Studies indicate that rootstocks are an important factor in the efficiency of the source-sink relationship and in the transport of carbohydrates to plant organs, directly affecting sugar accumulation in fruits (Oldoni, 2018). Rootstocks that conferred adequate fruit size and high production over the years, such as Tsukuba 2, I-93-27, and I-67-55-9 (Tables 2 and 3), showed lower soluble solids content, indicating a dilution effect of sugars due to the higher productive load (Barreto *et al.*, 2021). In contrast, rootstocks characterized by lower production and smaller fruit size, such as Tardio 1, I-67-52-44, Bolinha, and Peguia, showed higher soluble solids content (Table 4), in accordance with the principle of fewer sinks competing for photoassimilates (Taiz *et al.*, 2022).

Table 3. Fruit weight, in g, of the Chimarrita cultivar grafted onto 27 rootstocks, in the 2022, 2023 and 2025 growing seasons and in the mean of the evaluated period. Veranópolis, RS, Brazil.

Rootstock	Fruit weight (g) 2022	Rootstock	Fruit weight (g) 2023	Rootstock	Fruit weight (g) 2025	Rootstock	Mean fruit weight (g)
I-93-38	132 a[1]	I-93-38	137 a	Tsukuba 2	162 a	I-93-38	135 a
Chorão	123 ab	I-67-53-5	135 a	Tsukuba 3	153 a	I-67-55-9	135 a
Cascata 1005	122 ab	I-67-55-9	133 a	I-67-55-9	151 a	Tsukuba 2	134 a
I-67-55-9	121 ab	*Prunus consuensis*	133 a	*Prunus mandshurica*	149 ab	*Prunus mandshurica*	130 ab
Prunus mandshurica	121 ab	Cascata 1005	133 a	Chorão	149 ab	Chorão	130 ab
Prunus consuensis	120 ab	I-93-27	131 ab	Tsukuba 1	148 ab	*Prunus consuensis*	130 ab
Okinawa	118 bc	Okinawa	130 ab	I-93-27	147 ab	I-67-53-5	130 ab
Tsukuba 2	116 bc	Tsukuba 1	129 ab	Aldrighi	145 ab	Cascata 1005	130 ab
I-67-53-5	116 bc	México 1	127 bc	Cascata 534	141 bc	Tsukuba 1	129 ab
Capdeboscq	116 bc	I-67-52-9	127 bc	Tsukuba 2 CPACT	140 bc	Okinawa	129 ab
Turquesa	115 cd	Tsukuba 2	125 bc	I-67-53-5	139 bc	I-93-27	127 bc
I-93-30	114 cd	Cascata 534	123	Okinawa	139 bc	Capdeboscq	125 bc
Tsukuba 2 CPACT	114 cd	Farrapos	123 bc	Capdeboscq	139 bc	Tsukuba 2 CPACT	124 bc
Farrapos	112 cd	Capdeboscq	121 cd	I-67-52-9	138 cd	Cascata 534	124 bc
Tsukuba 1	111 cd	I-67-52-44	120 cd	*Prunus consuensis*	137 cd	Aldrighi	123 cd
Tardio 1	111 cd	Peguia	119 cd	Peguia	136 cd	Tsukuba 3	123 cd
Cascata 534	111 cd	Tsukuba 2 CPACT	119 cd	I-93-38	136 cd	Farrapos	122 cd
Aldrighi	110 cd	*Prunus mandshurica*	119 cd	Cascata 1005	134 cd	I-67-52-9	122 cd
Peguia	109 de	Chorão	117 cd	Farrapos	132 de	Peguia	121 cd
I-67-52-44	109 de	Flordaguard	117 cd	México 1	130 de	México 1	121 cd
México 1	105 ef	Bolinha	116 de	I-93-30	129 de	I-67-52-44	119 de
Bolinha	105 ef	I-93-30	114 de	I-67-52-44	129 de	I-93-30	119 de
I-93-27	104 ef	Aldrighi	113 de	Bolinha	125 ef	Turquesa	115 de
Flordaguard	103 fg	Tsukuba 3	113 de	Tardio 1	125 ef	Tardio 1	115 de
Tsukuba 3	103 fg	Pexn-9	111 de	Turquesa	119 f	Bolinha	115 de
I-67-52-9	101 fg	Turquesa	110 de	Pexn-9	118 f	Pexn-9	108 e
Pexn-9	96 g	Tardio 1	109 e	Flordaguard	100 g	Flordaguard	107 e

[1]Means followed by the same lowercase letter in the column, among rootstocks, do not differ significantly by Tukey's test at 5 % probability level.

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Table 4. Soluble solids (SS), in °Brix, of fruits of the Chimarrita cultivar grafted onto 27 rootstocks, in the 2022, 2023 and 2025 growing seasons and in the mean of the evaluated period. Veranópolis, RS, Brazil.

Rootstock	SS (ºBrix) 2022	Rootstock	SS (ºBrix) 2023	Rootstock	SS (ºBrix) 2025	Rootstock	Mean SS (ºBrix)
Peguia	12.9 a[1]	I-67-52-44	12.5 a	I-93-38	12.7 a	Tsukuba 2 CPACT	12.4 a
Tardio 1	12.5 ab	Tsukuba 2 CPACT	12.5 a	I-67-52-44	12.4 ab	I-67-52-44	12.2 a
Tsukuba 2 CPACT	12.2 ab	Chorão	12.5 a	Tsukuba 2 CPACT	12.4 ab	Peguia	11.9 ab
Prunus mandshurica	12.1 ab	Tsukuba 3	12.5 a	Flordaguard	12.3 ab	Bolinha	11.8 ab
Prunus consuensis	11.9 ab	Capdeboscq	12.0 ab	I-93-30	12.3 ab	Capdeboscq	11.8 ab
Bolinha	11.8 ab	*Prunus mandshurica*	11.5 bc	I-67-52-9	12.3 ab	Tardio 1	11.7 ab
Okinawa	11.8 ab	I-67-53-5	11.5 bc	*Prunus consuensis*	12.1 bc	*Prunus mandshurica*	11.7 ab
I-67-52-44	11.6 ab	I-67-55-9	11.5 bc	Capdeboscq	12.1 bc	Chorão	11.7 ab
Cascata 1005	11.5 bc	Aldrighi	11.5 bc	Bolinha	12.1 bc	Flordaguard	11.6 bc
I-67-52-9	11.5 bc	Tsukuba 1	11.5 bc	Okinawa	12.1 bc	I-67-52-9	11.6 bc
Capdeboscq	11.4 bc	Flordaguard	11.5 bc	Chorão	12.0 bc	*Prunus consuensis*	11.5 bc
Farrapos	11.2 bc	México 1	11.5 bc	Tardio 1	12.0 bc	I-67-53-5	11.5 bc
Turquesa	11.2 bc	Pexn-9	11.5 bc	I-93-27	12.0 bc	Aldrighi	11.5 bc
Aldrighi	11.1 bc	I-93-38	11.5 bc	I-67-55-9	11.9 bc	México 1	11.5 bc
México 1	11.0 bc	I-67-52-9	11.5 bc	I-67-53-5	11.9 bc	I-93-38	11.4 bc
I-67-53-5	11.0 bc	Bolinha	11.5 bc	Aldrighi	11.9 bc	I-93-30	11.4 bc
Flordaguard	10.9 bc	Tsukuba 2	11.5 bc	México 1	11.9 bc	Tsukuba 3	11.4 bc
I-67-55-9	10.8 cd	I-93-27	11.0 cd	Tsukuba 1	11.9 bc	I-67-55-9	11.4 bc
I-93-30	10.8 cd	Peguia	11.0 cd	Pexn-9	11.9 bc	Okinawa	11.3 cd
Tsukuba 3	10.5 cd	Cascata 534	11.0 cd	Farrapos	11.9 bc	Tsukuba 1	11.2 cd
Chorão	10.5 cd	I-93-30	11.0 cd	Peguia	11.8 bc	Pexn-9	11.2 cd
I-93-27	10.4 cd	Farrapos	10.5 cd	Cascata 1005	11.7 cd	Farrapos	11.2 cd
Tsukuba 2	10.2 d	Cascata 1005	10.5 cd	*Prunus mandshurica*	11.6 cd	Cascata 1005	11.2 cd
Tsukuba 1	10.2 d	Turquesa	10.5 cd	Cascata 534	11.4 cd	I-93-27	11.1 cd
Pexn-9	10.2 d	Tardio 1	10.5 cd	Tsukuba 2	11.3 cd	Tsukuba 2	11.0 de
I-93-38	10.1 d	*Prunus consuensis*	10.5 cd	Turquesa	11.3 cd	Turquesa	11.0 de
Cascata 534	9.7 d	Okinawa	10.0 d	Tsukuba 3	11.2 d	Cascata 534	10.7 e

[1]Means followed by the same lowercase letter in the column, among rootstocks, do not differ significantly by Tukey's test at 5 % probability level.

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Considering the ripening and harvest period of the Chimarrita cultivar in the Serra Gaúcha region, which occurs between the end of November and the beginning of December (Raseira *et al*., 2022), local meteorological conditions differed significantly between the evaluated cycles. A high volume of precipitation was recorded during the critical fruit ripening period (November = 489.4 mm) in the 2023 cycle, while the accumulated rainfall was significantly lower in the 2025 cycle (November = 155.6 mm). This difference in water regime contributed to higher levels of soluble solids in 2025 for most of the evaluated genotypes, while excessive precipitation close to harvest causes a dilution effect on the sugars in the fruits due to greater water absorption by the plants (Souza *et al*., 2010; Taiz *et al*., 2022).

There was also wide variation among rootstocks and years for titratable acidity (TA), with a general trend toward decreasing values over the assessed period (Table 5). In 2022, some rootstocks exhibited higher acidity levels, notably Aldrighi, Pexn-9, and *Prunus consuensis*. In 2023, the highest TA value was recorded for the Tsukuba 2 CPACT rootstock. In the 2025 growing season, lower acidity predominated for most of the evaluated genotypes, possibly reflecting climatic conditions more favorable to organic acid degradation during the ripening period of this crop. The higher mean temperature recorded in November 2025 (Tmean = 19.3 °C) compared to 2023 (Tmean = 18.8 °C) and 2022 (Tmean = 18.3 °C) likely contributed to intensified acid degradation and reduced its content in the fruits. The lower TA observed in 2025 is also associated with higher SS levels, since these parameters tend to vary inversely during the final phase of fruit development and maturation (Chitarra, 2005). Considering the mean of the years, Cascata 1005, Aldrighi, and Tsukuba 2 CPACT obtained the highest TA values, while rootstocks such as Flordaguard and Capdeboscq resulted in fruits with lower acidity. Studies indicate that rootstocks can modulate organic acid metabolism by affecting plant vigor, nutrient uptake, and water balance (Crisosto, 2005; Shahkoomahally *et al*., 2021), thereby influencing the qualitative performance of scion-cultivar fruits grafted onto different rootstocks.

The integration between SS and TA was reflected in the SS/TA ratio values, parameter widely used as an indicator of sensory quality and flavor balance (Table 6). In 2022, higher ratios were observed for I-67-52-9 and Capdeboscq; in 2023, Capdeboscq and Bolinha exhibited the highest ratios; and in 2025, the highest values were recorded for Chorão, Mexico 1, and Flordaguard. The multi-year mean indicated the superiority of Capdeboscq and Chorão (ratios ranging from 39.0 to 40.7), evidencing a favorable combination of high sugar content and moderate acidity. Capdeboscq, one of the most widely used rootstocks in peach cultivation (Raseira; Pereira; Carvalho, 2022), has the advantage of producing sweeter-flavored fruits, an important attribute for its selection in orchard establishment. In contrast, rootstocks such as Cascata 534 and Cascata 1005 showed lower mean ratios, associated with lower SS content and/or higher acidity. According to the literature, higher SS/TA ratios are strongly associated with a greater perception of sweetness and better organoleptic quality of the fruits (Chitarra, 2005; Crisosto, 2005). The most productive rootstocks, such as Tsukuba 2, I-67-55-9, and I-93-27 (Table 2), had intermediate behavior in relation to the ratio (27.8 to 32.6), resulting in a good balance of flavor.

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Table 5. Titratable acidity (TA), in grams of citric acid per 100 mL of pulp of fruits of the Chimarrita cultivar grafted onto 27 rootstocks, in the 2022, 2023 and 2025 growing seasons and in the mean of the evaluated period. Veranópolis, RS, Brazil.

Rootstock	TA (g citric acid 100 mL⁻¹ pulp) 2022	Rootstock	TA (g citric acid 100 mL⁻¹ pulp) 2023	Rootstock	TA (g citric acid 100 mL⁻¹ pulp) 2025	Rootstock	Mean TA (g citric acid 100 mL⁻¹ pulp)
Aldrighi	0.59 a[1]	Tsukuba 2 CPACT	0.56 a	I-93-27	0.40 a	Cascata 1005	0.44 a
Pexn-9	0.56 a	Cascata 534	0.51 ab	Tsukuba 3	0.40 a	Aldrighi	0.43 a
Prunus consuensis	0.55 a	Tsukuba 2	0.50 ab	Farrapos	0.37 ab	Tsukuba 2 CPACT	0.43 a
Peguia	0.51 ab	Tsukuba 3	0.49 ab	I-67-52-44	0.37 ab	Tsukuba 3	0.43 a
Cascata 1005	0.51 ab	Cascata 1005	0.49 ab	Aldrighi	0.36 ab	Pexn-9	0.42 ab
Tardio 1	0.49 bc	Farrapos	0.45 bc	Turquesa	0.36 ab	*Prunus consuensis*	0.40 ab
Prunus mandshurica	0.44 bc	I-67-55-9	0.44 bc	Okinawa	0.35 bc	Peguia	0.40 ab
México 1	0.42 bc	I-93-27	0.44 bc	Pexn-9	0.33 bc	Cascata 534	0.40 ab
Cascata 534	0.41 bc	I-67-52-9	0.43 bc	I-93-30	0.33 bc	I-93-27	0.40 bc
Tsukuba 2 CPACT	0.41 bc	Peguia	0.42 bc	Tsukuba 1	0.33 bc	*Prunus mandshurica*	0.38 bc
Tsukuba 3	0.41 bc	México 1	0.42 bc	Tsukuba 2 CPACT	0.32 bc	Tardio 1	0.37 bc
Okinawa	0.40 bc	Flordaguard	0.41 bc	*Prunus consuensis*	0.32 bc	Farrapos	0.37 bc
Tsukuba 1	0.38 cd	I-93-38	0.41 bc	I-67-55-9	0.31 cd	Tsukuba 2	0.36 bc
Flordaguard	0.38 cd	Turquesa	0.41 bc	Capdeboscq	0.31 cd	Tsukuba 1	0.36 bc
I-67-53-5	0.37 cd	I-67-53-5	0.40 bc	Cascata 1005	0.31 cd	México 1	0.36 bc
I-93-30	0.37 cd	I-67-52-44	0.40 bc	Bolinha	0.31 cd	Okinawa	0.36 bc
I-93-38	0.37 cd	*Prunus mandshurica*	0.40 bc	*Prunus mandshurica*	0.29 cd	I-67-52-44	0.36 bc
I-93-27	0.36 cd	Tsukuba 1	0.38 cd	Cascata 534	0.29 cd	I-93-30	0.36 bc
I-67-52-44	0.33 cd	Chorão	0.37 cd	Tsukuba 2	0.29 cd	Turquesa	0.36 bc
Turquesa	0.31 de	I-93-30	0.37 cd	I-67-53-5	0.28 cd	I-67-55-9	0.35 bc
Bolinha	0.31 de	Pexn-9	0.36 de	I-93-38	0.28 cd	I-67-53-5	0.35 bc
I-67-55-9	0.31 de	Tardio 1	0.36 de	I-67-52-9	0.28 cd	Flordaguard	0.35 bc
Tsukuba 2	0.29 de	Aldrighi	0.35 de	Flordaguard	0.27 d	I-93-38	0.35 bc
Farrapos	0.29 de	*Prunus consuensis*	0.35 de	Peguia	0.27 d	I-67-52-9	0.31 cd
Capdeboscq	0.28 de	Okinawa	0.35 de	Tardio 1	0.27 d	Bolinha	0.31 cd
Chorão	0.28 de	Bolinha	0.33 de	México 1	0.26 d	Chorão	0.30 cd
I-67-52-9	0.23 e	Capdeboscq	0.26 e	Chorão	0.24 d	Capdeboscq	0.29 d

[1]Means followed by the same lowercase letter in the column, among rootstocks, do not differ significantly by Tukey's test at 5 % probability level.

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Table 6. Ratio (SS/TA) of fruits of the Chimarrita cultivar grafted onto 27 rootstocks, in the 2022, 2023 and 2025 growing seasons and in the mean of the evaluated period. Veranópolis, RS, Brazil.

Rootstock	Ratio 2022	Rootstock	Ratio 2023	Rootstock	Ratio 2025	Rootstock	Mean ratio
I-67-52-9	50.0 a[1]	Capdeboscq	46.2 a	Chorão	50.0 a	Capdeboscq	40.7 a
Capdeboscq	40.7 b	Bolinha	34.8 b	México 1	45.8 ab	Chorão	39.0 a
Farrapos	38.6 bc	Chorão	33.8 bc	Flordaguard	45.6 ab	Bolinha	38.1 ab
Bolinha	38.1 bc	Aldrighi	32.9 bcd	I-93-38	45.4 ab	I-67-52-9	37.4 ab
Chorão	37.5 bcd	Pexn-9	31.9 cde	Tardio 1	44.4 abc	I-67-52-44	33.9 bc
Turquesa	36.1 cde	I-67-52-44	31.3 cde	I-67-52-9	43.9 abc	Flordaguard	33.1 bc
I-67-52-44	35.2 cde	Tsukuba 1	30.3 def	Peguia	43.7 abc	I-67-53-5	32.9 bc
Tsukuba 2	35.2 cde	*Prunus consuensis*	30.0 def	I-67-53-5	42.5 bcd	I-93-38	32.6 bc
I-67-55-9	34.8 def	I-93-30	29.7 def	*Prunus mandshurica*	40.0 cde	I-67-55-9	32.6 bc
Tsukuba 2 CPACT	29.8 efg	Tardio 1	29.2 ef	Cascata 534	39.3 cde	México 1	31.9 cd
I-67-53-5	29.7 efg	*Prunus mandshurica*	28.8 efg	Capdeboscq	39.0 cde	I-93-30	31.7 cd
Okinawa	29.5 efg	I-67-53-5	28.8 efg	Bolinha	39.0 cde	Tardio 1	31.6 cd
I-93-30	29.2 fgh	Okinawa	28.6 efg	Tsukuba 2	39.0 cde	Okinawa	31.4 cd
I-93-27	28.9 fgh	Flordaguard	28.0 fg	Tsukuba 2 CPACT	38.8 cde	Tsukuba 1	31.1 cd
Flordaguard	28.7 fgh	I-93-38	28.0 fg	I-67-55-9	38.4 cde	*Prunus mandshurica*	30.8 cd
Prunus mandshurica	27.5 ghi	México 1	27.4 gh	*Prunus consuensis*	37.8 de	Tsukuba 2	30.6 cd
I-93-38	27.3 ghi	I-67-52-9	26.7 gh	Cascata 1005	37.7 de	Turquesa	30.6 cd
Tsukuba 1	26.8 hi	Peguia	26.2 ghi	I-93-30	37.3 de	Farrapos	30.3 cd
México 1	26.2 hij	I-67-55-9	26.1 ghi	Tsukuba 1	36.1 ef	Peguia	29.8 de
Tsukuba 3	25.6 ij	Turquesa	25.6 hi	Pexn-9	36.1 ef	Tsukuba 2 CPACT	28.8 de
Tardio 1	25.5 ij	Tsukuba 3	25.5 hi	Okinawa	34.6 fg	*Prunus consuensis*	28.8 de
Peguia	25.3 ij	I-93-27	25.0 hi	I-67-52-44	33.5 fg	I-93-27	27.8 ef
Cascata 534	23.7 jk	Farrapos	23.3 ij	Aldrighi	33.1 fg	Cascata 534	26.8 ef
Cascata 1005	22.5 jk	Tsukuba 2	23.0 ij	Farrapos	32.2 gh	Aldrighi	26.7 ef
Prunus consuensis	21.6 k	Tsukuba 2 CPACT	22.3 jk	Turquesa	31.4 gh	Pexn-9	26.7 ef
Aldrighi	18.8 l	Cascata 534	21.6 k	I-93-27	30.0 h	Tsukuba 3	26.5 ef
Pexn-9	18.2 l	Cascata 1005	21.4 k	Tsukuba 3	28.0 i	Cascata 1005	25.5 f

[1]Means followed by the same lowercase letter in the column, among rootstocks, do not differ significantly by Tukey's test at 5 % probability level.

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Overall, the results demonstrate that rootstock choice plays a decisive role in the chemical quality of the fruits, influencing the SS and total acidity (TA) individually and, above all, the balance between these attributes throughout the different production cycles. Rootstocks such as Tsukuba 2 CPACT, I-67-52-44, Capdeboscq, and Chorão presented more stable and favorable performance over the years evaluated, reinforcing their suitability for production systems aimed at obtaining fruits with higher sensory quality, predominantly destined for fresh consumption, in which sweeter fruits with lower acidity are preferred. In contrast, for fruits intended for processing, higher acidity levels and, consequently, lower SS/TA ratios are desirable, as they provide better flavor balance after processing, in addition to favoring color and aroma retention (Chitarra, 2005). For the Chimarrita cultivar, destined for fresh consumption, sensory quality tends to be superior in fruits with higher SS/TA ratios. These results are consistent with other studies that highlight the rootstock × scion interaction, together with environmental conditions, as key factors in determining fruit quality in stone fruit trees (Predieri *et al*., 2006; Popova *et al*., 2021).

Although Tsukuba 2, I-67-55-9, and I-93-27 showed superior productive performance and adaptation to the environmental conditions of the study area, practical aspects related to their adoption in commercial orchards should be considered. Unlike traditional rootstocks such as Capdeboscq, Aldrighi, and Okinawa, which are widely available in commercial nurseries and have a long history of use by growers, some of the most promising materials identified in this study remain little known. They may be difficult to obtain on a commercial scale. Therefore, future efforts should focus on their agronomic validation and the establishment of propagation programs and the development of certified nursery production systems to facilitate their adoption by the peach production chain (Fachinello *et al*., 2015; Mayer *et al*., 2021).

Furthermore, rootstocks with superior productive performance may represent valuable alternatives for orchard renewal and replanting areas, where soil-related constraints and biotic stresses frequently limit tree establishment and longevity. Therefore, additional studies are required to evaluate their tolerance to replant disorders, resistance to soil-borne pathogens and nematodes, and long-term compatibility with commercial scion cultivars. No evident symptoms of graft incompatibility, gum exudation (gummosis), or severe phytosanitary disorders associated with specific rootstocks were observed during the evaluation period of the present study. Nevertheless, since several of these materials have not yet been extensively tested under field conditions, the continuation of their evaluations is important and fundamental to confirm their sanitary behavior, compatibility stability, and adaptability to different production environments (Hartmann *et al*., 2011; Kumar *et al*., 2021; Oliveira *et al*., 2022).

Rootstocks exert a slight influence on the phenology of the Chimarrita cultivar, causing small variations in the timing of budburst and flowering. The vegetative vigor of the scion cultivar is influenced by the rootstock, affecting planting density, orchard management, and the feasibility of mechanized operations, with less vigorous combinations potentially favoring greater operational efficiency. The productive performance of the Chimarrita cultivar is influenced by the rootstock, with Tsukuba 2, I-67-55-9, and I-93-27 presenting the highest mean production values. The rootstock influences mean fruit weight, indicating differences in the efficiency of assimilate allocation between genotypes. The fruit quality attributes are modulated by the rootstocks, with a higher sugar/acidity

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ratio observed in fruits from Capdeboscq, Chorão, Tsukuba 2 CPACT, and I-67-52-44.

Conflict of Interest

The authors declare that the research was conducted in the absence of any potential conflicts of interest.

Ethical Statements

The authors confirm that the ethical guidelines adopted by the journal were followed by this work, and all authors agree with the submission, content and transfer of the publication rights of the article to the journal. They also declare that the work has not been previously published nor is it being considered for publication in another journal.

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