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Compatibility of wild rootstocks in the production of cherry tomato seedlings

Antonia Mirian Nogueira de Moura Guerra[1]*, Ítalo José da Silva Rodrigues[1]

[1]Universidade Federal do Oeste da Bahia, Barra– BA, Brazil
*Corresponding author, e-mail: mirianagronoma@hotmail.com

Abstract

Growing tomato crops is a highly significant activity in Brazil; however, several factors limit tomato productivity, mainly soil-borne diseases which, without proper control, can compromise the entire crop production. The proper use of grafting techniques emerges as an alternative to overcome barriers that limit tomato production in regions with unfavorable growth conditions. The use of rootstocks resistant to root diseases is seen as a viable option for tomato production. In this context, the objective of this work was to evaluate the compatibility and efficiency of rootstocks for cherry tomatoes. A randomized block design was used, with five treatments and four replications; each plot consisted of 36 grafted seedlings. The treatments consisted of rootstocks of Eggplant, Jurubeba, Jilo, and Tomato (Intacto; Feltrin Sementes®), and a Control (cherry tomato without grafting). All rootstocks were compatible with cherry tomatoes. Moreover, seedlings grafted onto Jurubeba rootstocks presented results closest to the Control (cherry tomatoes). Seedlings grafted onto Jurubeba and Eggplant rootstocks presented the best results regarding vegetative development and total dry matter accumulation. Jurubeba and Eggplant rootstocks are viable alternatives for grafting cherry tomato seedlings. All utilized rootstocks can be further investigated for their resistance to root diseases affecting tomato crops.

Keywords: Grafting, *Solanum aethiopicum, Solanum melongena*. *Solanum paniculatum*

Introduction

Growing tomato crops is a highly significant activity in global agriculture; Brazil had a production of about 3.76 million Mg in 2020 (FAO, 2022). However, several factors limit tomato productivity, mainly phytosanitary factors related to soil, which can compromise the entire crop production when not properly controlled (Zeist et al., 2014). These problems worsened shortly after the prohibition of using methyl bromide for soil fumigation in greenhouses; without this fumigant, the control of root diseases became costly for growers. Therefore, grafting techniques for vegetables emerges as a solution for controlling soil-related diseases (Lopes & Mendonça, 2016).

In recent years, the number of studies on this technique has increased, mainly due the incentive for its use and the availability of rootstocks, which enhance qualitative characteristics of plants, contributing to increases in production and the expression of quality (Lopes et al., 2015). However, the rootstocks available on the market are expensive, and the use of alternative rootstocks emerges as a solution to improve this technique (Mendonça et al., 2017). Despite grafting is an age-old technique, it is not widely practiced in Brazil, which lags behind Asian countries, where it is commonly utilized, mainly represented by commercial species of Cucurbitaceae and Solanaceae obtained from grafted crops (Lopes & Mendonça, 2016).

Sirtori et al. (2011) reported that grafting brought about a change in the entire table tomato production, completely solving some problems, such as the lack of alternatives for controlling soil-borne pathogens, and led to the breakdown of resistance due to the emergence of new strains of pathogens.

However, several characteristics should be evaluated for selecting suitable rootstocks, including

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disease resistance, compatibility with the desired scion, vigor and hardiness, favorable morphology for grafting, and not negatively altering fruit quality (Sirtoli et al., 2011).

Therefore, the proper use of grafting arises as an alternative to overcome barriers that limit tomato production in regions with unfavorable conditions for its cultivation, such as abiotic stress or incidence of root diseases. Considering the difficulty and expense of eradicating soil pathogens, the use of rootstocks resistant to root diseases is a viable alternative for tomato production, mainly in infested areas (Guimarães et al., 2019).

In this context, the objective of this work was to evaluate the compatibility and efficiency of wild solanaceous species as rootstocks for cherry tomato grafting.

Material and Methods

The experiment was conducted in a greenhouse at the Federal University of Western Bahia (UFOB), Barra Multidisciplinary Center, in Barra, BA, Brazil (11°5'23''S, 43°8'30' W, and an average altitude of 398 m). The region has a BSh climate (Alvares, 2013) and a local steppe climate. The mean annual precipitation is 649 mm and the mean temperature is 25.7 °C. The mean temperature inside the greenhouse during the experiment was 30 °C and the relative humidity was 80%.

A randomized block experimental design was used, with five treatments and four replications; each plot was composed of 36 grafted seedlings. The treatments consisted of rootstocks of Eggplant (*Solanum melongena* L.; cultivar Embu), Jurubeba (*Solanum paniculatum* L.), Jilo (*Solanum aethiopicum* L., cultivar Gigante Jaíba), Tomato (*Lycopersicon esculentum* Mill.; cultivar Intacto from Feltrin Sementes®), and a control with cherry tomatoes (*Lycopersicon esculentum* var. *cerasiforme*) without grafting.

Seedlings were produced in 72-cell expanded polystyrene trays for the rootstocks and in 200-cell trays for the scion. A mixture of coconut fiber, washed sand, and earthworm humus (1:1:1 v:v:v) was used as substrate for seedling production. After filling the trays, two seeds were sown per cell according to the selected rootstock. Jurubeba was sown 40 days before sowing the other treatments and the scion to ensure that all seedlings were suitable for grafting. The seedlings were thinned after seedling emergence, leaving the most vigorous seedling in each cell.

Grafting was performed 30 days after emergence, when both the rootstock and scion had the same diameter (2.0 mm). A simple grafting method was used, which consists of cutting the rootstock seedlings at approximately 5.0 cm above the cotyledons at an approximately 45° angle using a sterilized, sharp blade, and cutting the scion seedlings above the first node, keeping two to three leaves. The grafts were fixed using plastic grafting clips, as recommended for tomatoes, which were removed 10 days after grafting. During this period, the trays were placed in a closed, humid, and dark chamber (with 75% shading screen coverage). The seedlings then kept in a humid chamber with open sides during 5 days for acclimatization.

Evaluations were carried out two days after the removal of the plastic clips. Twenty plants from each plot were sampled for the evaluations.

The following variables were evaluated: seedling height (cm), measured using a ruler; scion and rootstock stem diameters (mm), measured using a digital caliper; percentage of graft success (%), corresponding to the ratio between the number of successfully grafted plants and the total number of grafted plants; root dry matter weight, shoot dry matter weight, and total dry matter weight (g), determined measured by weighing on a digital analytical balance; Leaf length (cm), measured using a ruler; leaf area (cm^2), measured using a digital leaf area meter; root length (cm), measured with a ruler from the stem base to the root tip,; root volume (mL), obtained by the water displacement method in a graduated cylinder; and compatibility.

The compatibility of the rootstocks was defined using a grading scale, modified from that described in Guimarães et al. (2019), with grades ranging from 1 to 5: Grade 1 = healthy plant, with a healed grafting region and vigorous growth; Grade 2 = plant with uneven growth between the rootstock and scion, and a overgrowth in the grafting region or nearby; Grade 3 = plants lacking growth, with curled leaves and overgrowth in the grafting region or nearby; Grade 4 = plants with grafting region rupture and yellowing and defoliation of leaves; and Grade 5 = dead scion or plant, with a brownish color.

These grades were used to classify plants according to their compatibility with the rootstock, considering them as compatible (1 and 2), moderately compatible (3 and 4), or incompatible (5).

The data were subjected to analysis of variance and the means were grouped using the Scott-Knott criterion at a 5% probability level, considering data intervals according to the analyzed variable. The analyses were performed using the SISVAR computational system (Ferreira, 2019).

Results and Discussion

The cherry tomato control treatment showed the best results for scion stem diameter (SSD), rootstock stem diameter (RSD), seedling height (SH), root dry matter weight (RDMW), and shoot dry matter weight (SDMW). Plants in this treatment were not grafted; thus, they were not subjected to stress caused by the grafting process, which induces a slight delay in plant development (Tables 1 and 2).

Considering the evaluated rootstocks, the seedlings grafted onto jurubeba rootstocks presented results closest to those in the control treatment, presenting statistically similar percentage of graft success, compatibility grade (**Table 1**), root volume, RDMW, and SDMW (**Table 2**).

The Jilo rootstock presented lower percentage of graft success than the other rootstocks, which were statistically similar (Table 1). However, despite Jilo rootstocks were inferior to the other rootstocks, the percentage of graft success found for these rootstocks (83.75%) is a good indicator of compatibility with cherry tomato plants (Table 1). These results are consistent with the compatibility grades of these rootstocks with Cherry tomato plants, since Jurubeba and Tomato (Intacto) rootstocks presented the best grades (close to 1), differing from Jilo and Eggplant rootstocks, which were considered suitable rootstocks despite their grades of 1.90 and 1.95, respectively; this is because rootstocks with grades between 1 and 2 are classified as compatible with cherry tomato plants (Table 1).

According to Peil (2003), a high affinity between the rootstock and the scion is necessary to ensure grafting success and excellent attachment rates, considering the tissue homogeneity close to grafting region and botanical compatibility between species, which increases the survival probability for the scion and, consequently, the production.

Pereira et al. (2018) found percentages of graft success of 96.9% and 90.6% for tomato plants grafted onto rootstocks from different accessions of jurubeba species (*Solanum scuticum* 52 and *Solanum subnerme* 207), respectively. Similar results were found for cherry tomato plants grafted onto jurubeba (*Solanum paniculatum*) in the present study, denoting that jurubeba presents good compatibility with tomato plants.

In addition, several studies have evaluated *Solanum sessiliflorum* as a rootstock for tomato plants, as seen in the work of Guimarães et al. (2019).

Studies carried out by Mendonça et al. (2017) showed that some eggplant accessions have a high level of compatibility with Ellen tomato plants and resistance to bacterial wilt and fusarium wilt, including CNPH 171

Table 1. Percentages of rootstock attachment (A), seedling compatibility grade (N), scion stem diameter (SSD), and rootstock stem diameter (RSD), seedling height (SH), and root volume (RV) of cherry tomato seedlings (*Lycopersicon esculentum* var. *cerasiforme*) grafted onto different rootstocks

Rootstock	A (%)**	N**	SSD (mm)**	RSD (mm)**	SH (cm)**	RV (mL)**
Jilo	83.75b	1.90a	2.45c	3.06c	14.04c	3.54b
Eggplant	92.50a	1.95a	2.67b	3.39c	15.25c	3.54b
Jurubeba	99.38a	1.10b	2.78b	3.14c	18.95b	5.34a
Tomato (Intacto)	98.13a	1.16b	2.86b	3.98b	16.65b	1.88c
Cherry tomato	100.00a	1.00b	4.01a	4.32a	25.49a	5.83a
CV (%)	4.59	14.33	5.20	3.72	10.06	10.51

Means followed by the same letter in the columns belong to the same group by the Scott-Knott test at 5% probability level. ** and * = significant at 1% and 5% probability level by the F test, respectively. CV (%) = coefficient of variation.

Table 2. Leaf length (LL), leaf area (LA), root dry matter weight (RDMW), shoot dry matter weight (SDMW), and total dry matter weight (TDMW) of cherry tomato seedlings (*Lycopersicon esculentum* var. *cerasiforme*) grafted onto different rootstocks

Rootstock	LL (cm)**	LA (cm^2)	RDMW (g)**	SDMW (g)*	TDMW (g)**
Jilo	4.02d	47.96d	0.24c	0.25c	0.49c
Eggplant	4.75c	49.46c	0.31b	0.40b	0.71b
Jurubeba	6.13b	98.14b	0.44a	0.58a	1.03b
Tomato (Intacto)	4.05d	47.81d	0.22c	0.27c	0.49c
Cherry tomato	7.67a	157.79a	0.46a	0.67a	1.13a
CV(%)	7.76	11.90	10.07	17.27	11.61

Means followed by the same letter in the columns belong to the same group by the Scott-Knott test at 5% probability level. ** and * = significant at 1% and 5% probability level by the F test, respectively. CV (%) = coefficient of variation.

and Ciça, which are considered potential rootstocks for tomato plants.

Rootstock and scion stem diameters presented significant variation according to the rootstock used; the largest diameters were found for the control (Table 1). Scion stem diameter of seedlings grafted onto Jurubeba, Tomato (Intacto), and Eggplant rootstocks presented no significant difference, with lower results than the control and higher than those of seedlings grafted onto Jilo (Table 1).

Rootstocks and scions exhibited a positive relationship; the stem diameters of all rootstocks were larger than those of the scions, but with no growth imbalance between them or excessive callus development in the grafting region.

These results differed from those of Canizares & Goto (2002), who found

grafted plants with a greater development in the grafting region when compared to stem diameters of non-grafted plants. Cardoso et al. (2006) found that the combination of the commercial rootstock Hawaii 7996 with the scion Santa Cruz Kada resulted in small scion diameters. However, they reported that this difference did not affect plant development, presenting no significant differences in scion and rootstock stem diameters 40 and 80 days after transplanting.

Seedlings grafted onto Jurubeba and Tomato (Intacto) rootstocks presented statistically similar heights, which were higher than those of seedlings grafted onto Eggplant and Jilo rootstocks (Table 1). However, seedlings grafted onto Tomato (Intacto) rootstocks presented lower results for variables related to shoot development, such as leaf length, leaf area, and shoot dry matter weight, similar to seedlings grafted onto Jilo rootstocks, which also resulted in lower responses than the other rootstocks (Table 2).

Seedlings grafted onto Eggplant presented lower heights, but intermediate leaf length, leaf area, and shoot dry matter weight, which were higher than those of seedlings grafted onto Tomato (Intacto) and Jilo rootstocks. Jurubeba rootstocks presented results closest to the control for shoot-related variables, denoting that this rootstock affected positively the seedling development.

Canizares & Goto (2002) found that the height of grafted sweet pepper plants was similar to those of non-grafted plants, however, with differences in number of internodes per plant. They reported that the rootstock is directly related to shoot vigor, leading to a delay in development during the initial phase due to the time required for the reestablishment of the conducting vessels that were sectioned during grafting. Slow growth in grafted seedlings was also reported by Cardoso et al. (2006), with lower shoot development when compared to non-grafted seedlings. These results were expected, as grafted plants underwent an intense tissue healing process for the success of the grafting.

Regarding the root development of rootstocks, seedlings grafted onto Jurubeba rootstocks were in the same group as the control for the variables root volume (RV) and root dry matter weight (RDMW), whereas the Tomato (Intacto) rootstocks had lower RV and RDMW (Table 2). Although Jilo rootstocks were statistically similar to Eggplant rootstocks regarding RV, Jilo rootstocks had lower RDMW, as well as the Tomato (Intacto) rootstocks (Table 2). Consequently, the highest total dry matter weight (TDMW) was found for the control, as expected, followed by plants grafted onto Jurubeba and Eggplant rootstocks, whereas the lowest means of TDMW were found for plants grafted onto Eggplant and Tomato rootstocks (Intacto) (Table 2).

Plants used as rootstocks must exhibit excellent root system development to be considered a good rootstock option. Rootstocks should have several positive characteristics, including resistance to root diseases, good root system development, resistance to abiotic factors, and the ability to provide vigor and hardiness to the scion, as high-vigor rootstocks contribute to the full development of the grafted plant (Sirtoli et al., 2011; Goto et al., 2010). Additionally, Zeist et al. (2017) found that rootstocks from *Solanum pennellii* LA716 provided the best results regarding physicochemical characteristics when using the full cleft grafting method, whereas *Solanum sessiliflorum* rootstocks resulted in the lowest fruit productions.

Moreover, according to Alburquerque et al. (2021), combinations of rootstock and scion should be tested in different regions and climate conditions due to the high genetic variability among pathogen populations. Therefore, information on the compatibility of commercial and wild rootstocks with cherry tomato plants can contribute to compose a database for recommendation of rootstocks for other tomato types and groups and guide further research and maintenance and profitability of tomato crops.

Conclusions

All evaluated rootstocks were compatible with cherry tomato plants. Seedlings grafted onto Jurubeba rootstocks exhibited results closest to those in the control (cherry tomatoes without grafting). Seedlings grafted onto Jurubeba and Eggplant rootstocks presented the best results regarding vegetative development and total dry matter accumulation. Jurubeba and Eggplant rootstocks are viable alternatives for grafting cherry tomato seedlings. All rootstocks used can be further investigated for resistance to root diseases affecting tomato crops.

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