ABSTRACT
There is a lot of information on the peach tree culture. However, it still lacks an efficient system for the seedlings production that guarantees genetic and sanitary quality, resulting in high productivity. The objective of this study was to determine the optimum rooting time for Prunus minicuttings to obtain clonal rootstocks. The installation of an experiment happened to check the viability of propagation by herbaceous minicuttings of the rootstocks, using Flordaguard, Okinawa, and the Capdeboscq canopy cultivar on different evaluation days (20, 30, 40, 50, and 60 days). Each treatment consisted of four replications of 20 minicuttings. The experiment consisted of preparing herbaceous minicuttings of approximately three to five centimeters, containing two buds and a leaf cut in half, with a bevel cut at the apex and transverse at the base of the mini-pile and two superficial lesions on opposite sides of the base. Later, they were immersed in a solution of 2000 mg L⁻¹ of indolebutyric acid (IBA) for 10 seconds and placed in transparent plastic containers containing medium-granulated vermiculite, previously moistened. Afterward, they were placed in greenhouses under controlled temperature. At 50 days, the highest percentage of rooting observed in the cultivar was Flordaguard (70%). The other cultivars resulted in a lower percentage of rooting on different evaluation days.

Keywords: Propagation, cloning, fruit seedlings, propagation techniques, vegetative propagation processes.

INTRODUCTION
The production of fruit seedlings has required changes in production systems, especially regarding the appropriate technologies to obtain high quality propagating material and at compatible costs (Franco, Prado, Braghirolli, & Rozane, 2008). In this context, an alternative would be new propagation techniques. One of them being vegetative propagation, which guarantees the maintenance of the genetic material uniformity and plants' homogeneity. This technique enables the production of identical seedlings to the mother-plant. Moreover, creating homogeneous orchards, increasing their productivity and quality.

In forestry, vegetative propagation is already a reality, especially with Eucalyptus, which is already well established; from the results verified in the field, its implementation was intensively in different regions of the world (Xavier, Wendling, & Silva, 2009). Among the vegetative propagation processes, minicutting is an improvement of cutting technique and has been used in the multiplication of several plant species, such as eucalyptus (Eucalyptus benthamii) (Brondani, Baccarin, Ondas, Gonçalves, & Almeida, 2012), Australian cedar (Toona ciliata) (Silva, Barroso, Souza, Ferreira, & Carneiro, 2012), and also in several fruit trees, such as guava tree (Psidium guajava) (Marinho, Milhem, Altoé, Barroso, & Pommer, 2009; Altoé & Marinho, 2012), araçá (Psidium cattleianum) (Altoé, Marinho, Terra, & Barroso, 2011), sour sop (Annona muricata) (Figueirêdo, Vilasboas, Oliveira, Sodré, & Sacramento, 2013), blueberry tree (Vaccinium spp.) (Fischer, Fachinello, Antunes, Fischer, & Giacobbo, 2013; Yamamoto et al., 2017; Koyama et al., 2018), peach tree (Prunus persica) (Timm, Schuch, Tomaz & Mayer, 2015a; Tomaz, Schuch, Peil, & Timm, 2014; Tomaz, Schuch, Peil, & Pereira, 2016; Ramm, Schuch, Fagundes, Silva, & Moreira, 2017), cherry (Ozelame, Affonso, Cappellaro, Schuch, & Tomaz, 2018), blackberry and raspberry (Sommier et al., 2016; Fagundes et al., 2016), and more recently the olive tree (Olea europaea) (Casarin, Moreira, Raaech, Timm, & Schuch, 2018; Moreira & Schuch, 2018).

The minicutting technique and the rooting time are promising alternatives for homogeneous seedlings production, with low cost, speed, and maintenance of major agronomic characteristics. With optimized facilities, the models that express the rooting of different genetic materials can minimize the costs being propagated in a nursery. Thus, it prevents the seedlings from remaining in the greenhouse for a longer time.
than necessary or the death of minicuttings due to their removal before the rooting process is completed (Melo, Xavier, Paiva, & Borges, 2011). Considering optimization of the nursery facilities, it is possible to adopt as a criterion the optimum time determination of permanence from the propagules in the rooting house.

Given this context, the objective was to determine the optimum rooting time for *Prunus* minicuttings to obtain clonal rootstocks.

**MATERIALS AND METHODS**

The experiment was conducted in a greenhouse in March 2014 with its temperature controlled by a constant air conditioning of 25°C (± 2°C), which belongs to the Department of Fitotecnia (FAEM/UFPel/RS), during winter and summer. The rooting dynamics were carried out in an experiment, and the methodology applied is presented below. A complete randomized design was adopted in a two-factor scheme: cultivars x evaluation days, containing four replications of 20 minicuttings each.

In the experiment were observed cultivars (Okinawa; Flordaguard and Capdeboscq) and evaluation days (20; 30; 40; 50 and 60). The first evaluation occurred after 20 days following the experiment installation, the second after 30 days, and so on, until the 60th day (Final evaluation).

Herbaceous branches of mother-plants were collected and kept in pots with a capacity of 50 L from the germplasm bank belonging to the Fruit Tree Propagation Laboratory. The minicuttings were prepared, containing two buds and a leaf cut in half, with a bevel cut at the apex and transversal at the base of the minicutting. With the help of a knife, two superficial lesions were made at the base of the half-centimeter minicuttle and, then, immersed for 10 seconds in a solution of 2000 mg L\(^{-1}\) of indolebutyric acid (IBA), diluted in 30% ethyl alcohol and the rest of the volume supplemented with distilled water (Figure 1).

![Figure 1. Picture of used herbaceous branch of cultivars and Prunus minicuttings.](image)

Moreover, the minicuttings were grouping in transparent plastic packages. The container’s dimensions were 22x 14 x 10 cm in length, width, and height, respectively. They contained fine expanded vermiculite with the volume of a cubic decimeter (dm\(^3\)) and previously moistened with 500 ml of distilled water (Figure 2).

Proceed with the water spraying whenever necessary, leaving the packages closed to prevent dehydration, and removing the dead minicuttings to avoid contamination of the others. The fungicide Orthocide (3 g. L\(^{-1}\) of the commercial product in water) was applied weekly.

On each date were evaluated the percentage of rooted minicuttings, the number, and the average length of the three largest roots. The minicuttings to be analyzed were removed from the substrate and discarded after the evaluations.
Figure 2. Packaging used and picture of the experiment in the greenhouse.

The data obtained were analyzed for normality using Shapiro-Wilk test, the Hartley test was used for homoscedasticity, and the independence of the residues was verified graphically. Subsequently, the data were subjected to analysis of variance (p≤0.05). With statistical significance, the effects of cultivar were evaluated by the Duncan test (p≤0.05). For the evaluation days factor, a regression analysis was performed to choose the best fit of the data, based on the significance and the regression coefficient.

RESULTS AND DISCUSSION

During the data study from the analysis of variance, was noticed an interaction between cultivars and the evaluation days for the percentage variable of rooted minicuttings and length of roots. As for the root number variable, there was a significant effect on the cultivar. At 50 days, Flordaguard resulted in 70% rooting (Figure 3). While Capdeboscq at 40 days rooted 60%, there was no difference on the other days. Okinawa obtained the highest percentage of rooting at 30 days (55%), but not differing from the 20 and 40 days of evaluation and, still at 20 and 30 days, the other cultivars did not differ statistically (Table 1).

Figure 3. Picture of a Prunus minicutting root.

Flordaguard resulted in a higher percentage of rooting (70%). Different results were observed by Timm, Schuch, Tomaz and Mayer (2015a), at 45 days, where the cultivars Okinawa and Flordaguard resulted in 42% and 28% rooting, respectively. However, Cardoso et al. (2011) found that 68% of Okinawa cuttings were rooted at 108 days. The difference found in adventitious rooting of minicuttings could be influenced by the rooting environment, time of the harvest, the lignification degree, the genetic factors, and handling of the mother-plant. According to Bastos, Scarpate-Filho, Fatinansi and Pio (2009), carbohydrate reserves at
an adequate level not only facilitate the emission of roots and increase the photosynthetic apparatus but also increase photosynthesis, where a large part of the reserves are transferred to the base of the root, contributing to the formation of early roots.

Table 1. Rooting of peach rootstock cultivars due to evaluation days. UFPel, Pelotas, RS, Brazil. 2016.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Evaluation Days</th>
<th>Rooting Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Okinawa</td>
<td>46,5 Aa</td>
<td>55 Aa</td>
</tr>
<tr>
<td>Flordaguard</td>
<td>51,75 Aba</td>
<td>60 Aa</td>
</tr>
<tr>
<td>Capdeboscq</td>
<td>36,5 Aa</td>
<td>55.25 Aa</td>
</tr>
</tbody>
</table>

1Uppercase letters in the column and lowercase letters in the line show a significant difference of 5% probability of error by the Duncan Test.

Determining the permanence length for rooting the vegetative propagules in the greenhouses provides considerable gains, mainly on the production cost in the nurseries, where maintenance and handling operations are relatively high, besides the risks of disease incidence and pests. As a result, reducing the residence time for seedling formation can significantly reduce the final seedling cost.

As for the rooting percentage (Figure 4), the data adequately adjusted to the cubic polynomial regression model for Okinawa and Flordaguard, being the quadratic polynomial regression model for Capdeboscq, and all cultivars decreased on their rooting on the last evaluation date.

Figure 4. Rooting of peach rootstock cultivars due to evaluation days. UFPel, Pelotas, RS, Brazil. 2016.

A significant effect for the variable number of roots was verified between the cultivars and the evaluation days. (Table 2). It was observed that at 60 days of evaluation, Okinawa resulted in 9.66 roots, and Flordaguard, with 5.43 roots and the lowest number of roots (2.8), was observed in Capdeboscq at 50 days of evaluation. Likewise, Chagas et al. (2008), when evaluating Okinawa cuttings, observed the emission of up to 9.0 roots. Still, Timm, Schuch, Tomaz, & Mayer (2015b) observed the same number of roots in Okinawa, when testing AIB. For the root system to develop and result with uniform rooting, we still have no results to compare, but it is observed that the number and length of roots must be equivalent.
Table 2. Number of peach rootstock cultivars roots due to the days of evaluation. UFPel, Pelotas, RS, Brazil. 2016.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Evaluation Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Okinawa</td>
<td>5.67 ac</td>
</tr>
<tr>
<td>Flordaguard</td>
<td>4.25 aa</td>
</tr>
<tr>
<td>Capdeboscq</td>
<td>3.73 aba</td>
</tr>
</tbody>
</table>

1Uppercase letters in the column and lowercase letters in the line show a significant difference of 5% probability of error by the Duncan Test.

Regarding the root length variable, there was an interaction between the treatment factors (Table 3). Capdeboscq showed the longest root length (3.45cm), not differing from Okinawa (3.22cm) at 60 days of cultivation. Flordaguard resulted in a longer root length at 40 and 50 days of cultivation (2.56cm and 2.57cm, respectively).

Table 3. Length of peach rootstock cultivars roots due to the evaluation days. UFPel, Pelotas, RS, Brazil. 2016.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Evaluation Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Okinawa</td>
<td>1.23 Ab</td>
</tr>
<tr>
<td>Flordaguard</td>
<td>1.08 A.b</td>
</tr>
<tr>
<td>Capdeboscq</td>
<td>1.22 Ac</td>
</tr>
</tbody>
</table>

1Uppercase letters in the column and lowercase letters in the line show a significant difference of 5% probability of error by the Duncan Test.

Evaluating the rooting of Okinawa peach cuttings collected in the autumn in different substrates and AIB concentrations, Cardoso, Yamamoto, Preti, Assis de Neves, Roberto (2011), found greater root length (3.80cm) in vermiculite, evaluated at 108 days. The data adequately fit the cubic polynomial regression model for all cultivars tested (Figure 1). When comparing the evaluation days, it was observed that Capdeboscq resulted in an increase of more than 100% between the 20 and 40 evaluation days.

CONCLUSIONS

Under the conditions in which the experiment occurred, 50 evaluation days were sufficient for the maximum rooting for Flordaguard, 40 evaluation days for Capdeboscq, and 30 evaluation days for Okinawa for the maximum rooting.

The highest percentage of rooting was 70%, obtained with the cultivar Flordaguard.

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REFERENCES


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