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Rooting dynamics of *Prunus* minicuttings

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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 2000mg 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), soursop (*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 (Sommer et al., 2016; Fagundes et al., 2016), and more recently the olive tree (*Olea europaea*) (Casarin, Moreira, Raasch, 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.

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 ($p \leq 0.05$). With statistical significance, the effects of cultivar were evaluated by the Duncan test ($p \leq 0.05$). 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, Scarpare-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.

Cultivar	Rooting Percentage				
	Evaluation Days				
	20	30	40	50	60
Okinawa	46,5 Aa[1]	55 Aa	53,5 Aa	41 Ba	34,25Aa
Flordaguard	51,75Aba	60 Aa	52,5 Aba	70 Aa	22 A.b
Capdeboscq	36,5 Aa	55 ,25 Aa	59,75 Aa	56,75 ABa	50 Aa

[1]Uppercase 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.

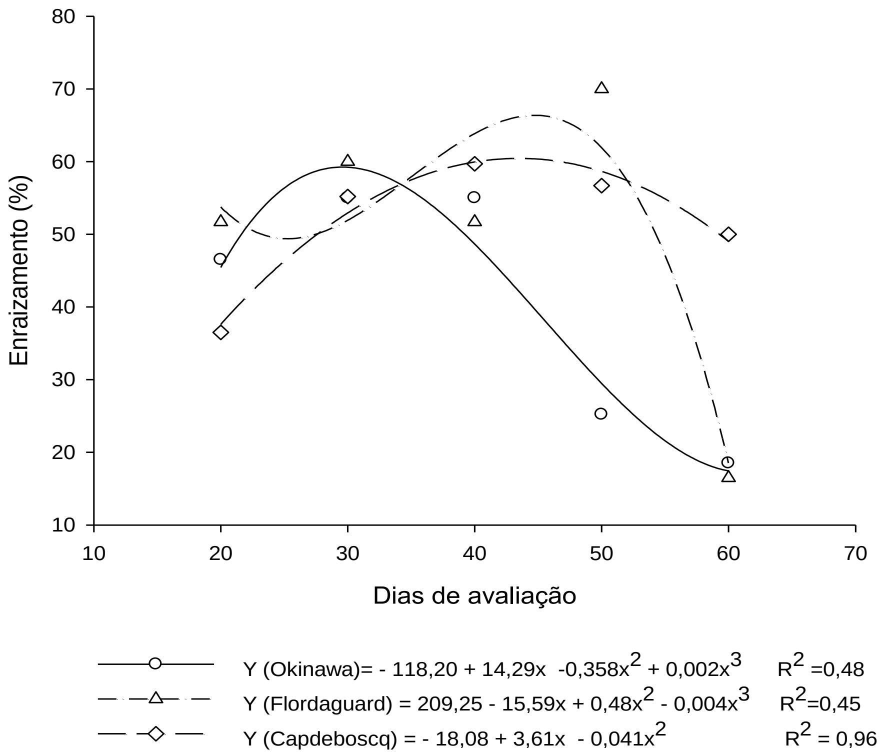

Figure 4. Rooting of peach rootstock cultivars due to evaluation days. UFPel, Pelotas , RS, Brazil. 2016.

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.

Cultivar	Number of Roots				
	Evaluation Days				
	20	30	40	50	60
Okinawa	5,67 ac[1]	4,67 abc	8,31 aba	6,31 abc	9,66 aa
Flordaguard	4,25 aa	4,44 ba	5,42 ba	4,97 aa	5,43 ba
Capdeboscq	3,73 aba	3,61 b	4,67 b	2,50 b	4,68 b

[1]Uppercase 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.

Cultivar	Roots length				
	Evaluation Days				
	20	30	40	50	60
Okinawa	1,23 Ab[1]	1,59 Ab	1,59 Ab	1,11 Bb	3,21 Aa
Flordaguard	1,08 A.b	1,66 Aba	2,56 Aa	2,57 Aa	2,38 Aa
Capdeboscq	1,22 Ac	1,54 Ac	2,52 Ab	1,87 Acb	3,45 Aa

[1]Uppercase 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

Altoé, J. A., & Marinho, C. S. (2012). Miniestaquia seriada na propagação da goiabeira "Paluma." *Revista Brasileira de Fruticultura*, *34*(2), 576–580. https://doi.org/10.1590/S0100-29452012000200032

Altoé, J. A., Marinho, C. S., Terra, M. I. C., & Barroso, D. G. (2011). Propagação De Araçazeiro E Goiabeira Via Miniestaquia De Material Juvenil. *Bragantia*, *70*(2), 312–318. https://doi.org/10.1590/S0006-87052011000200009

Bastos, D, C., Scarpare-Filho, J, A., Fatinansi, J, C., & Pio, R. (2009). Influência da idade biológica da planta matriz e do tipo de estaca caulinar de caramboleira na formaçâo de raízes adventicias. *Ciência e Agrotecnologia*, *33*, 1915–1918. https://www.scielo.br/scielo.php?pid=S1413-70542009000700037&script=sci_abstract&tlng=pt

Brondani, G. E., Baccarin, F. J. B., Ondas, H. W. W., Gonçalves, A. N., & Almeida, M. (2012). Avaliação morfológica e produção de minijardim clonal de Eucalyptus benthamii em relação a Zn e B. *Pesquisa Florestal Brasileira*, *32*(70), 35–48. https://doi.org/10.4336/2012.pfb.32.70.35

Cardoso, C., Yamamoto, L. Y., Preti, E. A., Assis, A. M., Neves, C. S. V. J., & Roberto, S. R. (2011). AIB e substratos no enraizamento de estacas de pessegueiro "Okinawa" coletadas no outono. *Semina:Ciencias Agrarias*, *32*(4), 1307–1314. https://doi.org/10.5433/1679-0359.2011v32n4p1307

Casarin, J. V., Ramm, A., Raasch, C. G., Timm, C. R. F., & Schuch, M. W. (2018). Rooting of olive minicuttings at different seasons grown in clonal minigarden. *Comunicata Scientiae*, *9*(1), 41–49. https://doi.org/10.14295/CS.v9i1.2525

Chagas, E. A., Pio, R., Bettiol-Neto, J. E., Sobierajski, G. R., Dall´Orto, F. A. C., & Signorini, G. (2008). Enraizamento de estacas lenhosas de pessegueiro e clones de umezeiros submetidos à aplicação de AIB. *Ciência e Agrotecnologia*, *32*(3), 986–991. https://doi.org/10.1590/s1413-70542008000300043

Fagundes, C. de M., Moreira, R. M., Timm, C. R. F., Silva, J. B. da, Antunes, L. E. C., & Schuch, M. W. (2017). Collection periods in the in vitro establishment of raspberry tree cultivars. *Agronomy Science and Biotechnology*, *2*(2), 92. https://doi.org/10.33158/asb.2016v2i2p92

Franco, C. F., Prado, R. M., Braghirolli, L. F., & Rozane, D. E. (2008). Marcha de absorção dos micronutrientes para mudas de goiabeiras cultivares Paluma e Século XXI. *Bragantia*, *67*(1), 83–90. https://doi.org/10.1590/S0006-87052008000100010

Figueirêdo, G. R. G., Vilasboas, F. S., Oliveira, S. J. R., Sodré, G. A., & Sacramento, C. K. (2013). Propagação da gravioleira por miniestaquia. *Revista Brasileira de Fruticultura*, *35*(3), 860–865. https://doi.org/10.1590/S0100-29452013000300024

Fischer, D. L. O., Fachinello, J. C., Antunes, L. E. C., Fischer, C., & Giacobbo, C. L. (2013). Rooting of blueberry minicuttings. *Revista de la Facultad de Agronomia*, *112*(1), 1–5. https://dialnet.unirioja.es/servlet/articulo?codigo=5718078

Koyama, R. K., Assis, A., Borges, W., Yamamoto, L., Colombo, R., Zeffa, D., … Roberto, S. (2018). Multiplication of blueberry mini-cuttings in different growth media. *Agronomy Science and Biotechnology*, *4*(1), 28. https://doi.org/10.33158/asb.2018v4i1p28

Marinho, C. S., Milhem, L. M. A., Altoé, J. A., Barroso, D. G., & Pommer, C. V. (2009). Propagação da goiabeira por miniestaquia. *Revista Brasileira de Fruticultura*, *31*(2), 607–611. Retrieved from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-29452009000200042&lng=pt&tlng=pt

Melo, L. A., Xavier, A., Paiva, H. N., & Borges, S. R. (2011). Otimização do tempo necessário para o enraizamento de miniestacas de clones híbridos de Eucalyptus grandis. *Revista Árvore*, *35*(4), 759–767. https://doi.org/10.1590/s0100-67622011000500001

Moreira, R. M., & Schuch, M. W. (2018). Olive tree in vitro establishment under different culture media and explant collection periods. *Agronomy Science and Biotechnology*, *4*(1), 1. https://doi.org/10.33158/asb.2018v4i1p1

Ozelame, G., Affonso, L., Cappellaro, T., Schuch, M., & Tomaz, Z. (2018). Rooting dynamics of Brazilian cherry tree minicuttings. *Agronomy Science and Biotechnology*, *4*(1), 46. https://doi.org/10.33158/asb.2018v4i1p46

Ramm, A., Schuch, M. W., Fagundes, C. de M., Silva, J. B. da S., & Moreira, R. M. (2017). 'Maciel' peach tree development grafted on 'Flordaguard' clonal rootstock in different periods. *Agronomy Science and Biotechnology*, *3*(2), 74. https://doi.org/10.33158/asb.2017v3i2p74

Silva, M.P.S., Barroso, D.G., Souza, J.S., Ferreira, D. A., & Carneiro, J. G. A. (2008). Enraizamento de miniestacas e produtividade de minicepas de cedro-australiano manejadas em canaletões e tubetes. *Ciência Florestal*, *22*(4), 703–713. https://doi.org/http://dx.doi.org/10.5902/198050987552

Sommer, L. R., Camargo, S. S., Silva, J. P. da, Bicca, M. L., Tomaz, Z. F. P., & Schuch, M. W. (2016). Substrates and indolbutyric acid in ex vitro rooting of blackberry and raspberry mini-cuttings. *Agronomy Science and Biotechnology*, *2*(1), 43. https://doi.org/10.33158/asb.2016v2i1p43

Timm, C. R. F., Schuch, M. W., Tomaz, Z. F. P., & Mayer, N. A. (2015a). Enraizamento de miniestacas herbáceas de porta-enxertos de pessegueiro sob efeito de ácido indolbutírico. *Semina:Ciencias Agrarias*, *36*(1), 135–140. https://doi.org/10.5433/1679-0359.2015v36n1p135

Timm, C. R. F., Schuch, M. W., Tomaz, Z. F. P., & Mayer, N. A. (2015b). Enraizamento de miniestacas a partir de ramos herbáceos de porta-enxertos de pessegueiro, em diferentes substratos. *Revista Inova Ciência & Tecnologia*, *1*(1), 18–22. http://periodicos.iftm.edu.br/index.php/inova/article/view/57

Tomaz, Z. F. P., Schuch, M. W., Peil, R. M. N., & Pereira, R. R. (2016). Production of self-rooted peach seedlings. *Agronomy Science and Biotechnology*, *2*(1), 36. https://doi.org/10.33158/asb.2016v2i1p36

Tomaz, Z. F. P., Schuch, M. W., Peil, R. M. N., & Timm, C. R. F. (2014). Desenvolvimento de porta enxertos de pessegueiro obtidos de miniestacas, em duas épocas e sistema de cultivo sem solo. *Revista Brasileira de Fruticultura*, *36*(4), 988–995. https://doi.org/https://doi.org/10.1590/0100-2945-424/13

Yamamoto, L. Y., Assis, A. M. de, Koyama, R., Borges, W. F. S., Favetta, V., Antunes, L. E. C., & Roberto, S. R. (2017). Substrates and IBA concentrations on rooting of herbaceous cuttings of blueberry 'Woodard.' *Agronomy Science and Biotechnology*, *3*(2), 113. https://doi.org/10.33158/asb.2017v3i2p113

Xavier, A., Wendling, I., & Silva, L. (2009). *Silvicultura clonal: princípios e técnicas*. Viçosa, MG: Editora UFV. Retrieved from https://www.bdpa.cnptia.embrapa.br/consulta/busca?b=pc&id=964028&biblioteca=vazio&busca=autoria:%22XAVIER, A.%22&qFacets=autoria:%22XAVIER, A.%22&sort=&paginacao=t&paginaAtual=1

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