Comunicata Scientiae
Horticultural Journal

ORIGINAL ARTICLE
published: 19 June 2023
https://doi.org/10.14295/CS.v14.3783

Rootstocks and twig topping intensity at winter pruning for 'Maciel' peach tree

Caroline Farias Barreto[1], Renan Navroski[2*], Jorge Atílo Benati[3], Newton Alex Mayer[4], Marcelo Barbosa Malgarim[3], Luis Eduardo Corrêa Antunes[4]

[1]University Center IDEAU, Caxias do Sul, Brazil
[2]Federal University of West Para, Juruti, Brazil
[3]Brazilian Agricultural Research Corporation - Temperate Climate, Pelotas, Brazil
[4]Federal University of Pelotas, Pelotas, Brazil
*Corresponding author, e-mail: navroski@outlook.com

Abstract

Winter pruning has been a common practice in peach. Twig topping has been associated with it, but this practice has been used at the same intensity, regardless of the cultivar. Therefore, this study aimed at evaluating productive behavior and quality of 'Maciel' peach grafted on 'Capdeboscq' and 'Okinawa' (*P. persica*) as rootstocks, when they were submitted to different twig topping intensities in winter pruning. The following three pruning intensities were evaluated: short pruning, when 2/3 of the productive twig was removed; long pruning, when 1/3 of the twig was removed; and pruning with no topping, when twigs were kept integral. Effective fructification is lower when 'Maciel' peach trees are submitted to short pruning, but it leads to fruit with higher weight and flesh firmness, besides larger diameters. Pruning with no twig topping and long pruning increased the fruit number and yield per tree. Not only fruit weight, diameter and soluble solid content, but also yield per tree of 'Maciel' peach are affected by 'Capdeboscq' and 'Okinawa', regardless of the intensity of twig topping throughout pruning. Higher concentration of soluble solids was found in peaches grafted in Okinawa. While the highest production was verified with the use of the 'Capdeboscq' rootstock.

Keywords: cultural practices, physicochemical characteristics, *prunus persica*

Introduction

Peach tree crops are economically important in Brazil. About 219 thousand tons was produced in 2018, mainly in the country's southern and southeastern regions, where Rio Grande do Sul (RS) state is the largest producer (146 thousand tons in 2018) (IBGE, 2020). In the south of RS, the cultivar Maciel has stood out because its fruit may be either consumed fresh or processed by the food industry. In order to improve production indexes and satisfy the market demand, its cultivation needs to improve management practices, such as pruning, cultivars and rootstocks.

Peach trees exhibit an excessive number of flower buds and high effective fructification; as a result, they bear an excessive number of fruits which is above their ideal bearing capacity (Farias et al., 2019; Barreto et al. ,2019). Effective fructification is determined by the ratio between number of fruit set and the number of open flowers (Tomaz et al., 2010).

In order to adjust fruit load, peach growers have used fructification pruning and fruit thinning to reach satisfactory production with high percentages of large and marketable fruit, besides avoiding alternate bearing. When fructification pruning is conducted, a certain number of flower buds is removed and balance between vegetative growth and flower and fruit production is favored (Gonçalves et al., 2014). It interferes in the energy balance of plants throughout their development, from the beginning of the growth cycle to the subsequent endodormancy phase (Pereira et al., 2012).

In Brazil, peach growers have used fructification pruning and twig topping in a general way, at the same intensity, regardless of the cultivar (Gonçalves et al., 2014). According to (Pereira & Raseira, 2014), peach tree pruning needs to consider the cultivar, distance among flower buds on twigs that grow in a year and effective

Received: 27 Jule 2021
Accepted: 03 August 2021

fructification capacity of every cultivar. However, in peach trees, these characteristics may be affected by their rootstocks (Picolotto et al., 2009), i. e., to define pruning intensity, the scion/rootstock combination – usually shown by the tree vigor – must be taken into consideration.

In peach trees, rootstocks affect tree growth and development, besides phenology, production indexes and fruit quality (Picolotto et al., 2009; Galarça et al., 2013; Comiotto et al., 2013; Barreto et al., 2017). In general, rootstocks are known to affect characteristics of the scion cultivar; thus, it is recommended to adjust intensity of fructification pruning to the scion/rootstock combination. Therefore, this study aimed at evaluating productive behavior and fruit quality of 'Maciel' peach grafted on 'Capdeboscq' and 'Okinawa', when they were submitted to different intensities of twig topping in winter pruning.

Material And Methods

The trial was carried out in an experimental orchard at the headquarters of the Embrapa Clima Temperado, in Pelotas, RS, Brazil, in 2018. No-irrigated 'Maciel' peach trees grafted on 'Capdeboscq' and 'Okinawa' were used. Vase-shaped trees at 5 m x 2 m spacing had been planted in 2012. According to the Köppen climate classification, climate is subtropical humid (Cfa), i. e., it is temperate humid with hot summers (Alvares et al., 2013).

The trial had a randomized complete block design in a 2x3 factorial scheme (factor A = rootstock; factor B = intensity of twig topping pruning) with four repetitions, each consisting of one plant. Rootstocks under investigation (Factor A levels) were 'Capdeboscq' and 'Okinawa' (both *P. persica*), propagated by seeds. Fructification pruning (or winter fructification) was carried out on August 12th, 2018, when buds were swelling.

In order to define intensities of twig topping (Factor B levels), total length of every twig was observed, as described by (Gonçalves et al., 2014). Intensities of topping on twigs that grew in a year were: a) short pruning, when 2/3 of the productive twig was removed; b) long pruning, when 1/3 of the twig was removed; and c) pruning with no topping, when twigs were kept integral. Tree pruning was completed with the removal of dead twigs, poorly located twigs and suckers in all treatments, according to (Pereira & Raseira, 2014).

The percentage of flowers removed by pruning was evaluated. Four twigs per plant – grown in a year – were randomly marked and the numbers of flowers were counted before and after pruning. Effective fructification (%) was evaluated in the four twigs per plant by counting the flower number per twig at full flowering and the fruit number per twig before thinning. The fruit number per tree (fruit tree^{-1}) and yield per tree (kg tree^{-1}) was determined by counting and weighing all fruit harvested.

Fruit were harvested at once on December 12th, 2018. Afterwards, the following variables were determined in a 20-fruit sample per plot: a) fruit weight, which was determined by a digital scale and expressed as grams (g); b) fruit diameter, which was evaluated by a digital pachymeter and expressed as millimeters (mm); c) epidermis color, which was carried out by a Minolta CR-300® colorimeter, with a D65 light source, to determine "L" (luminosity), "a*", "b*" and the hue or chromatic shade represented by the hue angle (°Hue); d) flesh firmness, which was determined by a TR TURONI-Italy manual penetrometer, model 53205 with a 8-mm tip, on two spots located on opposite sides of the fruit equatorial area, and expressed as Newtons (N); and e) total soluble solids, which were evaluated by an Atago® digital refractometer and expressed as °Brix. Data were submitted to the analysis of variance by the F Test and means were compared by the Tukey's Test, where $p \leq 0.05$. Analyses were carried out by the Sisvar 5.6 software program (Ferreira, 2014).

Results and Discussion

Percentages of removed flowers, effective fructification, fruit number and yield per tree did not exhibit interaction between factors under study (rootstock and pruning intensity) (**Table 1**). Percentages of flowers removed by twig topping throughout 'Maciel' peach tree pruning and of effective fructification did not show any significant difference between rootstocks under investigation.

Even though neither of rootstocks under study showed any difference regarding the fruit number per tree, yield per tree was higher when peach trees were grafted on 'Capdeboscq'. They differed statistically from trees grafted on 'Okinawa' (Table 1) because their fruit were heavier and bigger (**Table 2**). 'Capdeboscq' has traditionally been used in the south of Rio Grande do Sul due to its good seed germination and soil and climate adaptation. Satisfactory production of 'Maciel' grafted on 'Capdeboscq' in conditions found in the south of Brazil was also reported by (Galarça et al.,2013) and (Barreto et al., 2017).

Effective fructification was influenced by the intensity of twig topping; pruning with no topping reached the highest percentage of effective fructification, while short pruning led to the lowest fructification (Table 1).

Table 1. Percentages of flowers removed by twig topping, effective fructification, fruit number per tree and yield per tree of 'Maciel' peach grafted on two rootstocks submitted to different twig topping intensities in winter pruning

Rootstocks	Flowers removed (%)		Effective fructification (%)		Fruit number per tree		Yield per tree (Kg)	
Capdeboscq	31.71 ns		15.44 ns		74.58 ns		12.03	a
Okinawa	29.54		14.22		70.91		9.68	b
$F_{Rootstocks}$	0.168		0.110		0.510		0.166	
Pruning intensities								
Pruning with no twig topping	0.00	c	17.97	a	97.37	a	13.90	a
Long pruning	41.23	b	15.08	b	65.62	b	10.07	a
Short pruning	50.65	a	11.44	c	55.25	b	8.61	b
F_{poda}	0.001		0.001		0.001		0.004	
$F_{Rootstocks\ x\ Pruning}$	0.312		0.062		0.479		0.407	
CV (%)	12.11		12.00		18.38		20.04	

Means followed by different letters in a column differ by the Tukey's Test. ns = non-significant.

Table 2. Fruit weight, fruit diameter and flesh firmness of 'Maciel' peaches grafted on two rootstocks submitted to different twig topping intensities in winter pruning

	Pruning (Factor B)						
Rootstocks (Factor A)	Pruning with no twig topping		Long pruning		Short pruning		$F_{(B\ in\ A)}$
	Fruit weight (g)						
Capdeboscq	152	aB	159	aB	177	aA	0.001
Okinawa	131	bB	131	bB	152	bA	
$F_{(A\ dentro\ de\ B)}$	0.005						
CV (%)	2.71						
	Fruit diameter (mm)						
Capdeboscq	64.90	aC	70.11	aB	71.97	aA	0.001
Okinawa	64.28	aB	65.78	bB	70.27	aA	
$F_{(A\ in\ B)}$	0.002						
CV (%)	1.38						
	Flesh firmness (N)						
Capdeboscq	16.10	bB	14.22	bC	19.34	aA	0.002
Okinawa	18.65	aB	16.04	aB	19.30	aA	
$F_{(A\ in\ B)}$	0.005						
CV (%)	3.69						

The averages followed by the same lower case letters in the column and upper case letters in the row do not differ by Tukey's test at the 5% level of significance.

Yield per tree was higher when peach trees were either pruned with no twig topping or submitted to long pruning, by comparison with results of short twig topping. It may be related to the number of buds and the percentage of effective fructification (Table 1). According to (Gonçalves et al., 2014), who tested different pruning intensities, production decreases as pruning intensities increase in the case of 'Riograndense' and 'Leonense'. Yield in this study was lower than that verified by (Barreto et al., 2020) with the same cultivar. These low production values are due to the low accumulation of cold hours. In 2018 were observed 143 hours below 7.2°C, but according to (Raseira et al., 2014) cultivar needs 200 to 300 hours below 7.2 °C.

Regarding fruit weight, fruit diameter and flesh firmness, there was significant interaction between both factors (rootstocks and twig topping intensities) (Table 2). The highest fruit weight was found in short pruning in the cases of both rootstocks under investigation. The positive effect of short pruning may be due to decrease in the number of buds on twigs, a fact that leads to lower competition for carbohydrates among remaining buds (Locatelli et al., 2012). Fruit with high weight in peach trees submitted to short pruning were also reported by (Kumar et al., 2010) and (Gonçalves et al., 2014).

In this study, high fruit weight and large fruit diameters on trees submitted to short pruning may have happened as the result of the small number of fruits per tree (Tables 1 and 2). Decrease in the fruit number per tree favors balance between source and drain, besides minimizing consumption of supplies and the synthesis of gibberellin; thus, it contributes to the production of large fruit (Costa et al., 2013; Greene & Costa, 2013). Considering that 'Maciel' peach has dual purpose, results of this study suggest that 2/3 twig topping (short pruning) must be applied when larger fruit get better prices, a fact that usually occurs when fruit aim at the fresh produce market.

Regarding flesh firmness, trees on 'Capdeboscq' submitted to short pruning differed from the long pruning

and from pruning with no topping and exhibited the highest mean (Table 2). In trees on 'Okinawa' rootstock, flesh firmness was found to be higher when it was submitted to short pruning. However, (Gonçalves et al., 2014) tested different pruning intensities and did not find any differences in flesh firmness of 'Riograndense' and 'Leonense' peaches.

Skin color of 'Maciel' peaches was not affected neither by rootstocks nor by topping intensities under investigation (**Table 3**). Thus, aspects related to peach skin color may be related to other factors, such as genotypes (Mayer et al. 2008) and light incidence on fruit (Alcobendas et al., 2013).

The rootstock 'Okinawa' bestowed high concentrations of soluble solids to 'Maciel' peaches (Table 3). It also enabled cultivars Talismã, Tropical and Maciel to reach high values of soluble solids (Montes et al., 2008; Barreto et al., 2017). Pruning intensities did not influence soluble solid contents significantly (Table 3). According to (Bussi et al., 2011), pruning does not influence concentrations of soluble solids in 'Alexandra' peach. Therefore, it is believed that the concentration of soluble solids is influenced by the rootstock (Barreto et al. 2017).

Table 3. Skin fruit color and soluble solids contents of 'Maciel' peach trees grafted on two rootstocks and submitted to different twig topping intensities in winter pruning

Rootstocks	Skin fruit color (°Hue)		Soluble solids contents (°Brix)	
Capdeboscq	87.21	ns	12.63	b
Okinawa	86.01		13.85	a
$F_{rootstocks}$	0.097		0.002	
Pruning intensities				
Pruning with no twig topping	86.59	ns	13.35	ns
Long pruning	85.19		13.23	
Short pruning	88.05		13.10	
$F_{pruning}$	0.051		0.559	
$F_{Rootstocks \times Pruning}$	0.291		0.641	
CV (%)	1.94		3.46	

Means followed by different letters in a column differ by the Tukey's Test. ns = non-significant.

Conclusions

Short twig topping in winter pruning led to fruit with high flesh firmness and fruit weight, besides large fruit size, regardless of the rootstock. 'Capdeboscq' increased yield per tree and decreased soluble solid contents in 'Maciel' peaches. 'Capdeboscq' as a rootstock also increased fruit mass, regardless of twig topping carried out throughout at winter pruning.

References

Alcobendas, R., Mirás-Avalos, J.M., Alarcón, J.J., Nicolás, E. 2013. Effects of irrigation and fruit position on size, colour, firmness and sugar contents of fruits in a mid-late maturing peach cultivar. *Scientia Horticulturae* 164: 340-347.

Alvares, C.A., Stape, J.L., Sentelhas, P.C., Gonçalves, J.D.M., Sparovek, G. 2013. Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift* 22: 711-728.

Barreto, C.F., Navroski, R., Benati, J.A., Pereira, J.F.M., Malgarim, M.B., Antunes, L.E. C. 2020. Mechanical thinning of fruits and flowers in peach trees. *Revista de Ciências Agroveterinárias* 19: 230-235.

Barreto, C.F., Antunes, L.E.C., Ferreira, L.V., Navroski, R., Benati, J.A., Pereira, J.F.M. 2019. Mechanical flower thinning in peach trees. *Revista Brasileira de Fruticultura* 41: e-465.

Barreto, C.F., Kirinus, M.B.M., da Silva, P.S., Schiavon, C.R., Rombaldi, C.V., Malgarim, M.B., Fachinello, J.C. 2017. Agronomic performance of the Maciel peach with different rootstocks. *Semina: Ciências Agrárias* 38: 1217-1228.

Bussi, C., Bruchou, C., Lescourret, F. 2011. Response of waters prout growth to fruit load and intensity of dormant pruning in peach tree. *Scientia Horticulturae* 130: 725-731.

Comiotto, A., Fachinello, J.C., Hoffmann, A., Galarça, S.P., Machado, N.P., Prezotto, M.E., Hass, L.B. 2013. Desenvolvimento, produção e qualidade dos frutos de pessegueiros enxertados sobre diferentes porta-enxertos. *Semina: Ciências Agrárias* 34: 3553-3562.

Costa, G., Blanke, M.M., Widmer, A. 2013. Principles of thinning in fruit tree crops – needs and novelties. *Acta Horticulturae* 998: 17-26.

Farias, R.D.M., Martins, C.R., Barreto, C.F., Giovanaz, M.A., Malgarim, M.B., Mello-Farias, P. 2019. Time of metamitron application and concentration in the chemical thinning of 'Maciel' peach. *Revista Brasileira de Fruticultura* 41: e-017.

Ferreira, D.F. 2014. Sisvar: a Guide for its Bootstrap procedures in multiple comparisons. *Ciência e Agrotecnologia* 38: 109-112.

Galarça, S.P., Fachinello, J.C., Betemps, D.L., Hoffmann, A., Marodin, G.A. B., Pretto, A., Nunes, F.S., Dias, F.P. 2013. Crescimento e desenvolvimento de pessegueiros 'Chimarrita' e 'Maciel' sobre diferentes porta-enxertos e locais de cultivo. *Ciência Rural* 43: 219-224.

Gonçalves, M.A., Picolotto, L., Azevedo, F.Q., Cocco, C., Antunes, L.E.C. 2014. Qualidade de fruto e produtividade de pessegueiros submetidos a diferentes épocas de poda. *Ciência Rural* 44: 1334-1340.

Greene, D.W., Costa, G. 2013. Fruit Thinning in Pome- and Stone-Fruit: State of the Art. *Acta Horticulturae* 998: 93-102.

IBGE. Sistema IBGE de Recuperação Automática – SIDRA. Produção Agrícola Municipal. 2020. Disponível em: <http:// https://sidra.ibge.gov.br/Tabela/1613>.

Acessado em: 06 de set. 2020.

Kumar, M., Rawat, V., Rawat, J.M.S., Tomar, Y.K. 2010. Effect of pruning intensity on peach yield and fruit quality. *Scientia Horticulturae* 125: 218-221.

Locatelli, M.C., Nava, G.A., Citadin, I., Pichler, M. 2012. Fenologia e frutificação do pessegueiro 'Granada' sob diferentes práticas de manejo. *Revista Ceres* 59: 684-688.

Mayer, N.A., Mattiuz, B.H., Pereira, F.M. 2008. Qualidade pós-colheita de pêssegos de cultivares e seleções produzidos na microrregião de Jaboticabal-SP. *Revista Brasileira de Fruticultura* 30: 616-621.

Montes, S.M.N.M., Boliani, A.C., Raga, A., Santos, P.C.D., Corrêa, L.D.S., Ferrari, J.T. 2008. Características produtivas, físicas e químicas de frutos de cultivares de pessegueiros sobre dois porta-enxertos no oeste do estado de São Paulo. *Revista Brasileira de Fruticultura* 30: 1065-1070.

Pereira, J.F.M., Raseira A. 2014. Poda. In: Raseira, M.C.B., Pereira, J.F.M., Carvalho, F.L.C. *Pessegueiro*. Embrapa, Brasília, Brasil. 283-308 p.

Pereira, G.P., de Carvalho, R.I., Biasi, L.A., Zanette, F. 2012. Dinâmica da dormência de gemas de pessegueiro, ameixeira e caquizeiro na Fazenda Rio Grande, PR. *Revista Brasileira de Ciências Agrárias* 7: 820-825.

Picolotto, L., Manica-Berto, R., Pazin, D., Pasa, M.D.S., Schmitz, J.D., Prezotto, M.E., Betemps, D., Bianchi, V.J., Fachinello, J.C. 2009. Características vegetativas, fenológicas e produtivas do pessegueiro cultivar Chimarrita enxertado em diferentes porta-enxertos. *Pesquisa Agropecuária Brasileira* 44: 583-589.

Raseira, M.C.B., Nakasu, B.H., Barbosa, W. 2014. Cultivares: descrição e recomendação. In: Raseira, M.C.B, Pereira, J.F.M., Carvalho, F.L.C. *Pessegueiro*. Embrapa Clima Temperado, Brasília, Brasil. 73-142 p.

Tomaz, Z.F.P., Lima, C.S.M., Gonçalves, M.A., Rufato, L., Rufato, A.D.R. 2010. Crescimento vegetativo, floração e frutificação efetiva do pessegueiro 'Jubileu' submetido a diferentes comprimentos de interenxertos. *Pesquisa Agropecuária Brasileira* 45: 973-979.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.