

TIME AND TECHNIQUE OF GREEN PRUNING 'CHARME' PEACHES TO OBTAIN QUALITY FRUITS

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ABSTRACT - One of the management techniques that aim to improve the quality of the fruits is green pruning, which main purpose is to increase the penetration of light in the crown, favoring pigmentation, thus improving the flavor of the fruits. However, it is not always done, since it requires labor. The objective of this work was to evaluate the time and the way of Management green pruning, as well as the practice of thinning associated with it in order to obtain high quality peaches from the 'Charme' cultivar. The work was carried out in a commercial orchard in the Dois Vizinhos (PR) municipality, in three productive cycles. A completely randomized design was used, a 3 x 3 bifactorial scheme (green pruning time x green pruning management technique), with 4 replications of two plants per experimental unit. The times of green pruning or bending were in the third, fourth and fifth weeks before harvest. The techniques were first to remove vertical branches facing the center of the canopy and in the base of the tree with reference to broken and poorly ones and, the second the belding of these. The productive capacity and the physicochemical characteristics of the fruits were evaluated in three productive cycles. The quality of the 'Charme' peach only presented improvements with the green pruning from the third year of its realization.

Keywords: temperate climate fruit trees, orchard management, peaches.

ÉPOCA E TÉCNICA DE PODA VERDE DE PESSEGUEIRO 'CHARME' NA OBTENÇÃO DE FRUTOS DE QUALIDADE

RESUMO - Uma das técnicas de manejo que visam melhorar a qualidade dos frutos é a poda verde, que tem como intuito principal aumentar a penetração da luz na copa, favorecendo a pigmentação, melhorando desta forma o sabor dos frutos. Contudo, a mesma nem sempre é realizada, uma vez que requer mão de obra. O objetivo deste trabalho foi avaliar a época e a forma de manejo da poda verde, bem como, a prática do raleio associada à mesma para obtenção de pêssegos de alta qualidade da cultivar 'Charme'. O trabalho foi conduzido em pomar comercial no município de Dois Vizinhos (PR), em três ciclos produtivos. Foi utilizado delineamento experimental inteiramente casualizado, esquema bifatorial 3 x 3 (época da poda verde x técnica de manejo da poda verde), com 4 repetições de duas plantas por unidade experimental. As épocas de realização da poda verde ou dobramento foram na terceira, quarta e quinta semanas antes da colheita. As técnicas de manejo foram com a poda verde, retirando-se os ramos ladrões do interior da copa, ramos quebrados e mal posicionados; com o dobramento destes, permanecendo os ramos ligados à planta e, sem a realização do manejo. Avaliou-se em três ciclos produtivos a capacidade produtiva e as características físico-químicas dos frutos. A qualidade do pêssego 'Charme' somente apresentou melhorias com a realização da poda verde a partir do terceiro ano de sua realização.

Palavras-chave: Fruteiras de clima temperatura, manejo de pomar, pêssegos.

INTRODUCTION

The cultivation of plants producing stone fruit (*Prunus* sp.) has economic and social importance in the three states of the South region, in addition to the Southeast region of Brazil. The largest producer is Rio Grande do Sul state,

which is responsible for more than 60% of national production (BARBOSA et al., 2010; OLIVEIRA et al., 2011).

In Paraná, the peach culture is a great alternative for the diversification of properties, as it absorbs family labor

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and enables the generation of income in small areas. However, in order to maximize its use in the state, one must be attentive to the market demands, when choosing cultivars adapted to the edaphoclimatic conditions and in the correct management of the plants.

In temperate climate fruit trees, such as peach trees, producers adopt different management practices in their orchards, aiming to increase productivity and also the quality of the fruits produced (RETAMALES, 2011), in addition to adapting the plants to specific management conditions is also important (ZRIG et al., 2011). Fruit quality can be modified due to environmental conditions and management practices (WANG et al., 2011 and CHEN et al., 2012).

The use of adequate management practices in fruit growing is mandatory and necessary since with the adoption of available technologies, it is possible to improve the distribution of solar radiation, reduce competition for photoassimilates, as well as, allocate production to places of interest, which will allow fruit growers the necessary resources to stand out in the market, producing fruits with high commercial quality.

Pruning the branches is one of the practices that can improve light penetration and aeration inside the canopy, thus favoring quality fruits. However, in order to management practices to have the desired effect, it is important that they are carried out correctly and at the appropriate time, mainly recommended according to the cultivar and region of production.

Taiz and Zeiger (2010) reported that the amounts of light and CO₂ determine the photosynthetic responses of the leaves, and in certain situations this biological process is limited by the inadequate supply of both light and CO₂. The quality of the light is also very important, as the red light (600-700 nm) increases the anthocyanin synthesis in the epidermis of the fruits (BASTÍAS and CORELLI-GRAPPADELLI, 2012). This condition can be favored by green pruning, carried out in the period before harvesting.

In this sense, the present work sought to evaluate the time and the way of Management green pruning, as well as the practice of thinning associated to it, in order to obtain high quality peaches from the 'Charme' variety.

MATERIAL AND METHODS

The work was carried out in an eight-year commercial orchard of 'Charme' peach tree grafted on 'Capdebosq', located in the Dois Vizinhas (PR) municipality, Santa Lúcia community (25°51' South latitude, 53°06' West longitude and 594 m altitude), in the 2009/2010, 2010/2011 and 2011/2012 production cycles, with no thinning of the fruits in the first cycle.

The experimental design used was completely randomized, in a 3 x 3 factorial (green pruning time x green pruning management technique), with 4 replications, considering every two plants as repetition. The control treatment did not undergo any type of management related to

green pruning, only the thinning of the fruits was carried out in the second and third productive cycle.

The green pruning seasons were in the third, fourth and fifth weeks before harvest. Among the management techniques of green pruning in peach trees, it was based on the removal of branches that grew vertically inside and at the base of the branches, as well as the removal of broken and poorly positioned branches, as it is already recommended for culture (BRUCKNER, 2003). In the other technique, the bending of these branches was performed, which consisted of arching them, at an angle greater than 90° downwards, until there was a rupture of this branch, however, despite the break it still remained connected to the mother plant.

The fruits, after reaching the point of harvest, were harvested and taken to the Laboratory of Plant Physiology of UTFPR, Dois Vizinhas Campus, for physical-chemical evaluations, which included coloring of the epidermis (% of red of the peel); pulp firmness (Kgf cm⁻²), sutural, equatorial and polar diameters (mm); content of total soluble solids of the fruits (°Brix); pH (2010/2011 and 2011/2012); anthocyanins and flavonoids.

The coloring of the epidermis was evaluated by notes, ranging from 0 to 100% of shades of red (WAGNER JÚNIOR, 2007).

Pulp firmness was determined on opposite sides in the equatorial region of each fruit, after the removal of the epidermis, using a digital penetrometer (Lutron, model FG-5020), an 8 mm diameter tip, placed in an adapted metallic support. The content of total soluble solids of the fruits was analyzed from the juice taken from five fruits, using digital refractometer (RTD-45), the values were expressed in °Brix. The evaluation of the sutural diameter (maximum transverse distance from the fruit) was determined with a digital pachymeter, and twenty fruits were analyzed per repetition (CAILLAVET and SOUTY, 1950). To determine the content of anthocyanins and flavonoids, the methodology described by Lees and Francis (1972) was used.

The results obtained were submitted to the Lilliefors normality test, with no need for transformation. Subsequently, the averages were subjected to analysis of variance and Duncan's test ($\alpha = 0.05$). All analyzes were performed using the SANEST computer application (ZONTA E MACHADO, 1984).

RESULTS AND DISCUSSION

In the 2009/2010 production cycle, with the sutural diameter of the fruits, there was significant interaction for the time of green pruning x management technique, with higher averages in the fruits of plants in which the branch bending and cutting technique was performed with a subsequent removal of the plant. However, with the management during the four weeks before harvest, the sutural diameter showed higher averages in fruits of plants pruned with the removal of the branch of the plant and those

not managed, and for the latter, there was also superiority during the three weeks before harvest (Table 1).

Such results show the influence of green pruning at the right time, once that if managed in an inadequate period it does not bring the same benefits that could be achieved in terms of fruit quality. The fruits harvested from plants in which the branches were bended five weeks before the harvest, had the highest sutural diameter averages, when compared to the fruits harvested in the other two periods of practice. In the pruning practice, the averages did not

differentiate between themselves, when obtained in the three seasons of its realization with the same variable described previously. For the 2010/2011 production cycle, there was no significant effect between the interaction of the factors analyzed, as well as, when isolated. In the 2011/2012 cycle there was a significant effect only for the management factor, those in which the branches were bent there was the largest diameter of the fruits, but not different from those in which the branches were cut.

TABLE 1 - Suture diameter (mm) of 'Charme' peach variety during the 2009/2010, 2010/2011 and 2011/2012 production cycles, according to the management technique and green pruning time.

Cicles	Time	Management practices		
		No practice	Bending	Pruning
2009/2010	5 weeks	53.24 aB*	53.34 aA	53.44 aA
	4 weeks	53.24 aA	52.47 bB	53.48 aA
	3 weeks	54.24 aA	52.13 bC	53.52 aB
	Averages	53.24 A	52.65 B	53.48 A
2010/2011	5 weeks	58.43	57.62	58.68
	4 weeks	58.43	59.85	57.92
	3 weeks	58.43	57.27	58.94
	Averages	58.47 ^{ns}	58.25	58.52
2011/2012	5 weeks	52.15	60.53	55.60
	4 weeks	52.15	58.85	57.54
	3 weeks	52.15	57.52	57.81
	Averages	52.15 B	58.96 A	56.98 AB

*Averages with different letters, lower case in the column and upper case in the row, differ according to the Duncan test ($\alpha = 0.05$),^{ns} = not significant. 2009/2010 - CV = 0.82%; 2010/2011 - CV = 3.51%; 2011/2012 - CV = 6.32%.

For the polar diameter of the fruits in the 2009/2010 cycle, when the practices were carried out five weeks before harvest, there was statistical similarity between the averages. As for the practices in weeks four and three before harvest, the highest values for the polar diameter were obtained with pruning and bending of the branches, followed by the non-performance of these practices, which did not differ statistically from each other. In the other cycles (2010/2011 and 2011/2012), the polar diameters were not significantly influenced for practical interaction of management x time of performance, as well as for each factor separately (Table 2).

For the equatorial diameter of the fruits, in the first two cycles analyzed (2009/2010 and 2010/2011) there was no significant influence on the factors analyzed individually and collectively. However, for the 2011/2012 cycle there was superiority in the averages with the management of the

plant by bending and removing the branches (Table 3). In the case of bending and pruning the branch, the highest average obtained with the polar diameter was in the three and four weeks before harvest, respectively.

However, both practices did not differ statistically from their averages with those not managed. On the other hand, it was noticed that pruning or bending when carried out late, that is, close to harvest, did not influence to obtain fruits with a larger sutural or polar diameter, and should be carried out in the four or five weeks preceding the harvest (Tables 1 and 2, respectively). This fact was proven in the present study with pruning in the fourth and fifth weeks for the polar and sutural diameter, even though this last variable is statistically equal to the averages in the three types of management, as it is assumed that, mainly, pruning allowed greater penetration of light compared to pruned plants.

TABLE 2 - Polar diameter (mm) of ‘Charme’ peach variety during the 2009/2010, 2010/2011 and 2011/2012 production cycles, according to the management technique and green pruning time.

Cicles	Time	Management practices		
		No practice	Bending	Pruning
2009/2010	5 weeks	58.17 aA*	59.04 abA	59.02 abA
	4 weeks	58.17 aAB	57.05 bA	59.43 aB
	3 weeks	58.17 aAB	59.52 aA	57.05 bB
	Averages	58.17 ^{ns}	58.53	58.49
2010/2011	5 weeks	65.65	67.65	67.34
	4 weeks	65.65	65.71	65.20
	3 weeks	65.65	63.35	64.73
	Averages	65.65 ^{ns}	65.58	65.76
2011/2012	5 weeks	61.01	68.92	63.27
	4 weeks	61.01	65.91	66.92
	3 weeks	61.01	63.12	66.18
	Averages	61.01 ^{ns}	65.96	65.45

*Averages with different letters, lower case in the column and upper case in the row, differ according to the Duncan test ($\alpha = 0.05$), ^{ns} = not significant. 2009/2010 - CV = 1.24%; 2010/2011 - CV = 4.76%; 2011/2012 - CV = 5.04%.

TABLE 3 - Equatorial diameter (mm) of ‘Charme’ peach variety during the 2009/2010, 2010/2011 and 2011/2012 production cycles, according to the management technique of green pruning and the time of green pruning.

Cicles	Time	Management practice		
		No practice	Bending	Pruning
2009/2010	5 weeks	51.38	51.30	51.02
	4 weeks	51.38	51.17	53.00
	3 weeks	51.38	51.54	51.56
	Averages	51.38 ^{ns}	51.34	51.85
2010/2011	5 weeks	56.11	54.62	56.45
	4 weeks	56.11	55.95	54.78
	3 weeks	56.11	54.83	54.86
	Averages	56.11 ^{ns}	55.13	55.36
2011/2012	5 weeks	55.42	62.85	58.71
	4 weeks	55.42	61.46	60.80
	3 weeks	55.42	60.07	61.11
	Averages	55.42 B*	61.45 A	60.20 AB

*Averages with different letters, uppercase on the line, differ according to the Duncan test ($\alpha = 0.05$), ^{ns} = not significant. 2009/2010 - CV = 1.60; 2010/2011 - CV = 2.22%; 2011/2012 - CV = 5.42%.

However, this hypothesis of greater illuminance did not reflect on the quality of the fruit in sugar concentration, since the total soluble solids were higher when the plants were not managed in the first two cycles of production (2009/2010 and 2010/2011) (Table 4). It is believed that the higher content of soluble solids obtained with plants that were not managed in the first two cycles is a reflection of the

greater number of leaves present in these plants, generally allowing greater production of photoassimilates. Furthermore, as in the first cycle (2009/2010) there was no thinning of the fruits, it is assumed that this fact has reduced the accumulation of reserves for the second productive cycle (2010/2011), further compromising the performance of these practices.

TABLE 4 - Total soluble solids (^oBrix) of 'Charme' peach variety during the 2009/2010, 2010/2011 and 2011/2012 production cycles, according to the green pruning management technique and green pruning season.

Cycles	Time	Management practice		
		No practice	Bending	Pruning
2009/2010	5 weeks	9.98	7.82	7.70
	4 weeks	9.98	8.40	8.07
	3 weeks	9.98	7.56	7.64
	Averages	9.98 A*	7.92 B	7.80 B
2010/2011	5 weeks	9.41	8.85	8.86
	4 weeks	9.41	8.28	8.80
	3 weeks	9.41	8.94	8.77
	Averages	9.41 A*	8.70 B	8.81 B
2011/2012	5 weeks	9.27	9.75	9.95
	4 weeks	9.27	9.98	10.23
	3 weeks	9.27	10.16	9.34
	Averages	9.27 B*	9.96 A	9.84 A

*Averages with different letters, uppercase on the line, differ according to the Duncan test ($\alpha = 0.05$). 2009/2010 - CV = 9.35%; 2010/2011 - CV = 3.27%; 2011/2012 - CV = 2.31%.

This fact can be partially confirmed when the content of total soluble solids was analyzed in the 2011/2012 cycle, where the managed plants presented a higher content of total soluble solids. Considering this, it may be that the balance of the plant for accumulation and consumption of photoassimilates is already occurring with the management, since in 2010/2011 there was thinning, leaving a higher sugar content for vigorous sprouting, allowing the remaining branches of the pruning to have greater number of leaves,

generating greater production of photoassimilates and, therefore, greater concentration of sugars.

The color of the fruits in the first two cycles was not significantly influenced. However, in the third year of pruning the branches, the fruits had a greater reddish color on their epidermis (Table 5), a fact that can be explained by the greater exposure of these fruits to light. Alcobendas et al. (2012) pointed out that the exposure of fruits to sunlight and their position in the canopy can be affected differently, resulting in different quality values.

TABLE 5 - Reddish color (%) of 'Charme' peach variety during the productive cycles 2009/2010, 2010/2011 and 2011/2012, according to the management technique and green pruning time.

Cycles	Time	Management practice		
		No practice	Bending	Pruning
2009/2010	5 weeks	71.35	66.92	68.36
	4 weeks	71.35	73.40	67.24
	3 weeks	71.35	66.66	68.70
	Médias	71.35 ^{ns}	68.96	68.10
2010/2011	5 weeks	78.84	65.76	71.40
	4 weeks	78.84	70.24	77.32
	3 weeks	78.84	77.62	74.66
	Médias	78.84 ^{ns}	71.12	74.44
2011/2012	5 weeks	68.88	67.16	94.00
	4 weeks	68.88	73.19	90.72
	3 weeks	68.88	74.09	86.87
	Averages	68.88 B*	71.48 B	90.53 A

*Averages with different letters, uppercase on the line, differ according to the Duncan test ($\alpha = 0.05$), ^{ns} = not significant. 2009/2010 - CV = 4.71%; 2010/2011 - CV = 7.29%; 2011/2012 - CV = 12.77%.

The pulp firmness of the fruits was not significantly influenced in the first two cycles evaluated (2009/2010 and 2010/2011) (Table 6), regardless of the management given to

green pruning and the time of implementation. However, in the last cycle, with the pruning of the branches, greater firmness of the fruit pulp was obtained compared to those

from plants with bent and branches that were not managed. Similar results were obtained by Trevisan et al. (2006) when

they used the green pruning technique, with the peach tree, with 'Maciel' cultivar.

TABLE 6 - Pulp firmness (Kgf cm⁻²) of 'Charme' peach variety during the 2009/2010, 2010/2011, 2011/2012 production cycles, according to the green pruning management technique and green pruning season.

Cicles	Time	Management practices		
		No practice	Bending	Pruning
2009/2010	5 weeks	6.88	6.27	6.40
	4 weeks	6.88	5.03	8.54
	3 weeks	6.88	6.60	6.24
	Averages	6.88 ^{ns}	5.95	7.03
2010/2011	5 weeks	4.54	5.08	4.65
	4 weeks	4.54	4.45	4.64
	3 weeks	4.54	4.24	4.43
	Averages	4.54 ^{ns}	4.59	4.57
2011/2012	5 weeks	2.73	1.22	6.41
	4 weeks	2.73	1.67	3.77
	3 weeks	2.73	1.0	5.38
	Averages	2.73 B*	1.29 C	5.18 A

*Averages with different letters, uppercase on the line, differ according to the Duncan test ($\alpha = 0.05$), ^{ns} = not significant. 2009/2010 - CV = 22.90%, 2010/2011 - CV = 5.83%, 2011/2012 - CV = 34.12%.

The plants whose branches were bent, allowed to obtain together with those without management, the highest levels of flavonoids in the fruits (Table 7). This response may be a consequence of the supposed higher production of photoassimilates and energy in their plants, once they did not reduce their number of leaves, because even when the branches were bent, they allowed the circulation of the elaborated sap, which may have generated the greatest

synthesis of this metabolite in the fruits in the 2010/2011 cycle. In 2011/2012, the plants that were not managed, maintained fruits with higher production of flavonoids, which may be related to the fact that the plants managed in this cycle destined their photoassimilates for greater sugar synthesis compared to the synthesis of this secondary metabolite (Table 8).

TABLE 7 - Flavonoids of 'Charme' peach variety during the 2010/2011 and 2011/2012 production cycles, according to the management technique and the time of green pruning.

Cicles	Time	Management practice		
		No practice	Bending	Pruning
2010/2011	5 weeks	34.72	33.13	34.72
	4 weeks	34.72	30.81	29.11
	3 weeks	34.72	30.25	26.97
	Averages	34.72 A*	31.38 AB	28.64 B
2011/2012	5 weeks	26.40	16.51	20.84
	4 weeks	26.40	18.43	19.20
	3 weeks	26.40	14.70	13.04
	Averages	26.40 A*	16.51 B	17.53 B

*Averages with different letters, uppercase on the line, differ according to the Duncan test ($\alpha = 0.05$). 2010/2011 - CV = 7.95%; 2011/2012 - CV = 17.22%.

TABLE 8 - Pulp anthocyanins, from fruits of the 'Charme' cultivar during the 2010/2011 and 2011/2012 production cycles, according to the management technique and the time of green pruning.

Cicles	Time	Management practice		
		No practice	Bending	Pruning
2010/2011	5 weeks	7.13	12.66	5.07
	4 weeks	7.13	14.23	5.01
	3 weeks	7.13	6.01	4.41
	Averages	7.13 AB*	10.66 A	4.82 B
2011/2012	5 weeks	4.03	1.03	1.08
	4 weeks	4.03	0.93	1.93
	3 weeks	4.03	1.43	1.43
	Averages	4.03 A*	1.13 B	1.47 B

*Averages with different letters, lower case in the same column and upper case in the same row, differ according to the Duncan test ($\alpha = 0.05$). 2010/2011 - CV = 36.01%; 2011/2012 - CV = 13.02%.

Anthocyanins (Table 8), in the first productive cycle, had the highest averages in the fruits of plants whose branches were bent and without being managed, repeating this superiority without being handled in the second cycle. As the orchard adopted the "Y" formation system and there is a greater intensity of pruning at the end of winter, it is believed that the subsequent adoption of bending or green pruning will not influence for better solar penetration and, therefore, greater production of anthocyanins.

CONCLUSIONS

The quality of 'Charme' peaches only improved with green pruning from the third year on.

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