Ethephon in the chemical thinning of fruits of peach cultivar Chimarrita

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Abstract

The thinning is one of the main cultural practices of the peach tree, which can be done manually or chemically. This study aimed to evaluate the effect of ethephon as chemical thinnig of peach fruits of the Chimarrita cultivar. The experiment consisted in the application of ethephon at doses of 0, 50, 80, 110 and 140 mg L^{-1}, by spraying to the drip point, and a manual thinning treatment, all performed on 09/10/2015, in commercial orchard located in Veranópolis-RS. The experimental design was completely randomized design with six replicates and one plant per plot. The evaluations occurred in six branches demarcated per plant in a total of 36 branches per treatment. The following parameters were assessed: percentage of flruits thinned, fruiting index, fruit mass, diameter and length, pulp firmness, soluble solids (SS) and titratable acidity (TA). The concentration of ethephon of 80 mg L^{-1} presented rates of fruiting index (21.2%) and fruit thinned (72.1%) close to the treatment manual thinning (management taken as reference), with values obtained of 22.4% and 75.2%, respectively. The physico-chemical characteristics did not differ between the treatment of ethephon 80 mg L^{-1} and the manual thinning, with fruit mass and SS of 104.9g and 8.0°Brix for the dose of 80 mg L^{-1} and 113.1g and 8.1°Brix, for the manual thinning. The application of ethephon in the dosage of 80 mg L^{-1} is efficient for the thinning of peach fruit cv. Chimarrita.

Keywords: *Prunus persica*. Growth regulators. Fruit size. Production.

Resumo

Ethephon no raleio químico de frutos de pessegueiro cultivar Chimarrita

O raleio é uma das principais práticas culturais do pessegueiro, podendo ser realizada de maneira manual ou química. Este estudo objetivou avaliar o efeito de ethephon como raleante químico de frutos da cultivar de pessegueiro Chimarrita. O experimento consistiu na aplicação de ethephon nas doses de 0, 50, 80, 110 and 140 mg L^{-1}, por pulverização até o ponto de gotejo, e de um tratamento de raleio manual, todos realizados em 10/09/2015, em pomar comercial localizado em Veranópolis-RS. O delineamento experimental foi completamente casualizado com seis repetições e uma planta por parcela. As avaliações ocorreram em seis ramos demarcados por planta, totalizando 36 ramos por tratamento. As variáveis analisadas foram: percentual de frutos raleados, *índice* de frutificação, massa, diâmetro e comprimento de fruto, firmeza de polpa, sólidos solúveis (SS) e acidez titulável (AT). A concentração de ethephon de 80 mg L^{-1} apresentou taxas de índice de frutificação (21,2%) e de frutos raleados (72,1%) próximos ao tratamento de raleio manual (manejo tomado como referência), com valores obtidos de 22,4% e 75,2%, respectivamente. As características físico-químicas

não diferiram entre o tratamento de ethephon 80 mg L^{-1} e o raleio manual, com massa de fruto e SS de 104,9 g e 8,0 °Brix para a dose de 80 mg L^{-1} e 113,1 g e 8,1 °Brix para o raleio manual. A aplicação de ethephon a dose de 80 mg L^{-1} mostra-se eficiente para o raleio de frutos de pessegueiro cultivar Chimarrita.

Palavras-chave: *Prunus persica.* Reguladores de crescimento. Tamanho de fruto. Produção.

Introduction

In Brazil, the peach (*Prunus persica* L.) is produced mainly in the South and Southeast regions. The main peach-producing Brazilian states are: RS (65.1%); SP (14.0%); MG (11.8%); PR (7.5%) and SC (1.6%) (FACHINELLO *et al.,* 2011). In Rio Grande do Sul state, most of the peach production is obtained by family agriculture, totaling 117,212 tons in an area of 12,468 ha, with a mean yield of 9.4 ton ha^{-1} (IBGE, 2016).

Peach cultivars are classified, as to their purpose, for fresh fruits for consumption or industrial processing. One of the most important requirements for fruit acceptance in the market, regardless of purpose, is fruit size (TAHERI *et al.,* 2012). Peach cultivars usually show abundant flowering, ranging from 20 to 50 flowers per branch (RASEIRA *et al.,* 2014). Due to this factor, the plants present an excessive load of fruits, which results in low quality productions and damages to the plants (ANZANELLO; TEDESCO, 2017).

The thinning is one of the main cultural practices in peach tree. The thinning technique aims to remove excess fruit in the plant in order to increase the fruit size, color and quality (MEITEI *et al.,* 2013). The lower production load established in the plant by thinning alters the source-drain relationship, increasing the availability of metabolites for the remaining fruits (GIOVANAZ *et al.,* 2016). For Greene and Costa (2013) the higher fruit load in the plant results in greater competition for photoassimilates at the time of cell division. In this case, the leaf area becomes insufficient to supply a large number of fruits, causing fruits with lower mass and diameter.

Fruit thinning can be performed manually or chemically (RASEIRA *et al.,* 2014). In the manual thinning, due to the selection of the fruits, they are well supplied and acquire size and commercial value. However, manual fruit thinning is a time-consuming and expensive operation, requiring excessive labor within a short period of time (TAHERI *et al.,* 2012). Chemical treatment is a key tool to streamline and reduce the operational costs of implementing thinning practice. According to Pavanello and Ayub (2012), the application of chemical thinners causes the abscission of flowers or fruits in the plant, reducing or eliminating the need for manual thinning. Chemicals often used as thinners are: ammonium thiosulfate, ethephon, fertilizers (urea), surfactants Armothin and Tergitol-TMN-6, caustic agents, endothalic acid, pelargonic acid, hydrogen cyanamide, lime sulfur and mineral oil (TURK *et al.,* 2014).

The management of the chemical thinning can be done during flowering or soon after the fixing of the fruits (COSTA; VIZZOTTO, 2000). For Pavanello and Ayub (2013) post-flowering thinning is more recommended because there is knowledge of the fruit load, with definition of the effective fruiting of the plant. According to Anzanello and Tedesco (2017) the production of peach can be compromised by the accomplishment of chemical thinning in the flowering allied to subsequent climatic events that affect the fixation of the fruits.

In studies with stone fruits, Taheri *et al.* (2012); Pavanello and Ayub (2014) have identified the feasibility of using ethephon in the chemical thinning of fruits. For Moreira *et al.* (2011), the ethephon releases ethylene in contact with the plant tissue stimulating its synthesis and causing the fall of fruits. However, it is clear that the choice of the season of application, concentration, environmental conditions, and cultivar are crucial for the success of this practice. This work aimed to evaluate the effect of the different dosages of ethephon for the chemical thinning of fruits of peach cultivar Chimarrita.

Material and Methods

The experiment was conducted in a commercial orchard of cv. Chimarrita in Veranópolis-RS, from June to December 2015. The orchard is located at 29°00'53" South, 51°34'8" West and at an altitude of 705m. The peach plants of cv. Chimarrita were in the field with 7 years of age, grafted on Capdeboscq, managed in pot system, and spaced 5.5m between rows and 3.5m between plants.

The treatments consisted in the application of ethephon at the doses 0, 50, 80, 110, 140 mg L^{-1}, on

09/10/2015, when the fruits presented an average mass of 5.96g; 22.86mm in diameter; 31.22mm in length, and the seed 11.66 mm in lenght. As the source of ethephon (Acid-2-chloroethylphosphonic, precursor of ethylene synthesis) was used Ethrel commercial product, with composition of 24% w/v of the active ingredient. The experimental design was completely randomized design with six replicates and one plant per plot. The evaluations occurred in six branches demarcated per plant in a total of 36 branches per treatment. The product was sprayed in the selected branches to the drip point, using a costal sprayer. Concomitant to the application of ethephon was performed the manual thinning, according to cultural recommendation (RASEIRA *et al*., 2014).

Orchard phenology was monitored according to a scale proposed by Raseira *et al.* (2014), considering the beginning of budburst; initiation, full bloom, and end of flowering; and the beginning and end of harvest. The following variables were analyzed: *i)* fruiting index, comparing the number of fruits harvested with the initial number of total flower buds; *ii)* number of thinned fruits, comparing the number of fruits harvested with the number of fruits counted at the date of application of the treatments; *iii)* quantitative and qualitative variables of the fruits, at the time of harvesting, including the mean fruit mass, in grams, (using an electronic balance), mean fruit length and diameter, in cm, (using a caliper), pulp firmness, in kilograms, (using an 8-mm tip penetrometer, measuring the equatorial region of the fruit), soluble solids (SS), in °Brix (using a manual refractometer) and titratable acidity (TA), in cmol L^{-1} (volumetry with 0.1N NaOH).

The variables were submitted to the regression analysis and analyzed by ANOVA and Scott-Knott's test at $P<0.05$.

Results and Discussion

Chimarrita peach tree cultivar presented an intermediate phenological cycle. For the 2015 harvest, the beginning of flowering occurred on 07/31, reaching full flowering (70% of the total of open flowers) on 07/08 and ending on 08/08. Fruit development occurred from August 15 to November 19, when the harvest occurred. For Simonetto *et al.* (1995), evaluating the phenology of cv. Chimarrita in the period from 1990 to 1995 in the municipality of Veranópolis - RS, observed that the flowering of the cultivar Chimarrita occurred from July 31 to August 27, and the development of the fruits until 28/11, similar temporal bands to those found in the present study under the same soil and climatic conditions.

The application of ethephon promoted fruit thinning in the cultivar Chimarrita for all evaluated concentrations. The increase of the dose of ethephon resulted in the reduction of the effective fruiting index (Figure 1A). In the treatment of manual thinning (reference management), the fruiting index was 22.4%, while the dose of ethephon at the concentration of 80 mg L^{-1} presented effective fruiting of 21.2%, without statistically different between both treatments (Table 1). The 80 mg L^{-1} dosage of ethephon was also effective in the action thinner of fruits of peach cultivar BR-1 obtained by Lucchese *et al.* (1994). The control treatment (0 mg L^{-1} of ethephon) obtained a fruiting index of 39.9% (natural fruiting), being 1.8 times superior to the treatment of manual thinning.

Fruit abscission varied from 52.8% in the control treatment (0 mg L^{-1} of ethephon) to 86.0% in the treatment of 140 mg L^{-1} of ethephon (Figure 1B). Cruz *et al.* (2009) using the chemical thinning with ethephon in the citrus culture and Pavanello and Ayub (2014) in the plum culture also observed an increase in fruit abscission with increasing product dosage. In the treatment of manual thinning, in addition to natural abscission (52.8%) there was a thinning of more 22.5% to obtain fruits of commercial size (□100g), totaling 75.3% of thinned fruits, a percentage similar to that obtained in the treatment with ethephon 80 mg L^{-1} (72.1%) (Table 1). For Giovanaz *et al.* (2016), working with the Jubileu peach cultivar, the application of ethephon at the concentration of 85 mg L^{-1} presented 79% fruit thinning, value close to that observed in the treatments of manual thinning and 80 mg L^{-1} ethephon of the present study (Table 1).

In researches developed with the use of ethephon in peach tree, Costa and Vizzotto (2000) and Byers *et al.* (2003) describe that, in order to obtain a satisfactory result in the chemical thinning, it is necessary to observe the length of the fruit seed. The application of the chemical thinner should be carried out when the seed reaches 12 mm in length for cultivars of fresh purpose and 14 mm for cultivars of industrial purpose. In the present study, fruits of 'Chimarrita' presented a mean seed length of 11.66mm when applying the chemical thinner, indicating that the use of the product occurred at the time favorable to the proposed action.

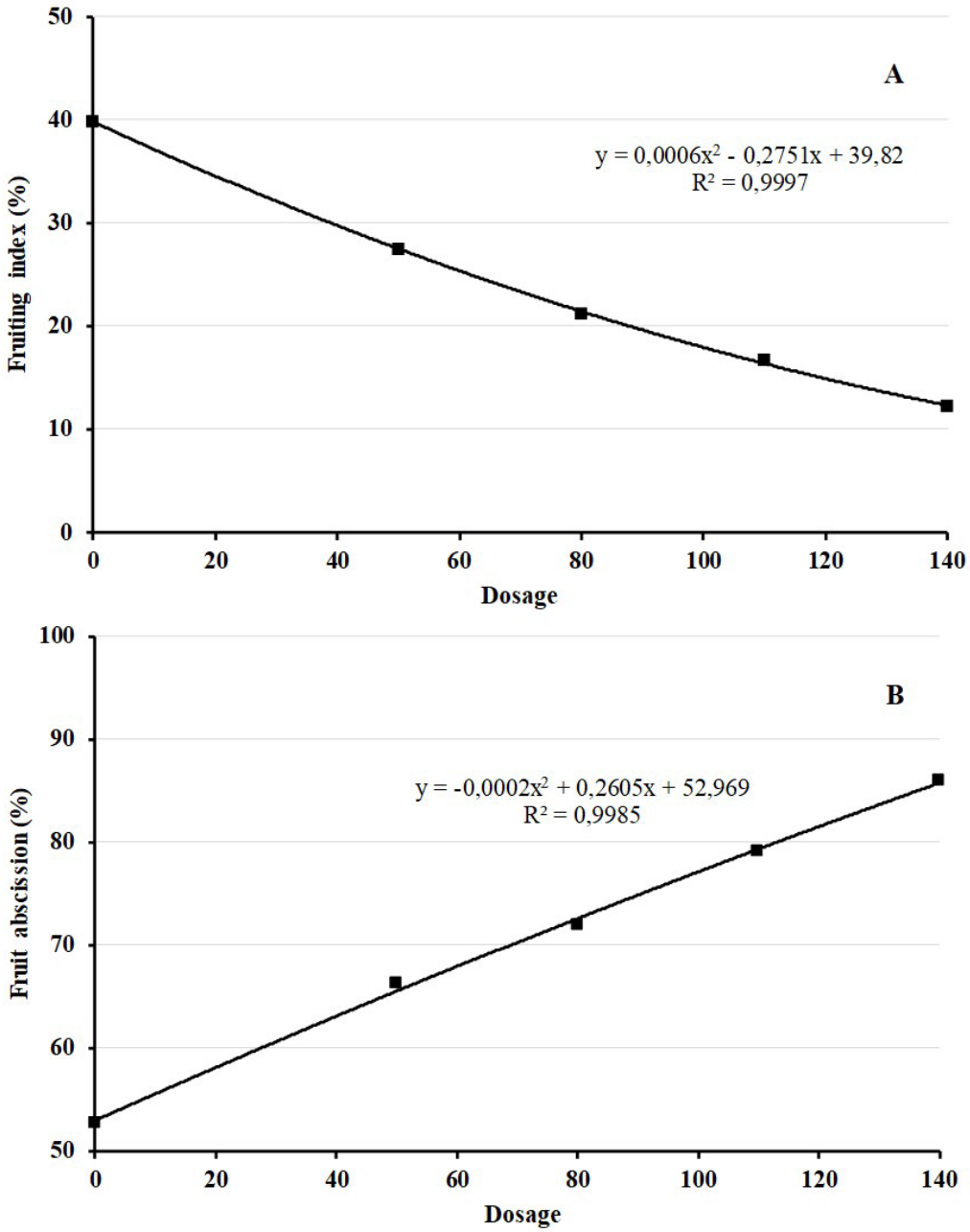

Figure 1
Effective fruiting index (A) and fruit abscission (B) of the peach cultivar Chimarrita after application of ethephon.

Table 1 - Effective fruiting index, thinned fruit, fruit mass, fruit diameter, fruit length, pulp firmness, soluble solids and titratable acidity of the peach cultivar Chimarrita after application of ethephon

Dosages	Fruiting index (%)	Thinned fruit (%)	Fruit mass (g)	Fruit diameter (mm)	Fruit lenght (mm)	Pulp firmes (KgF)	Soluble solids (°Brix)	Titratable acidity ($_c$mol L^{-1})
0	39,9 a**	52,8 d	72,8 c	54,0 c	56,1 c	4,2 a	6,7 d	7,5 a
50	27,4 b	66,3 c	90,3 b	56,7 b	62,3 b	4,2 a	7,9 c	6,9 b
80	21,2 b	72,1 b	104,9 a	58,6 a	64,4 b	4,2 a	8,0 c	7,0 b
110	16,7 c	79,2 b	106,9 a	59,3 a	63,8 b	4,2 a	8,5 b	6,9 b
140	12,2 c	86,0 a	109,6 a	59,9 a	66,1 a	4,2 a	9,6 a	6,6 c
MT***	22,4 b	75,2 b	113,1 a	61,7 a	67,5 a	4,3 a	8,1 c	7,0 b
*CV (%)	27,67	10,22	5,02	2,97	3,32	1,67	5,15	6,52

*CV (%): coeficiente of variation
**Means followed by the same letter do not differ by Scott-Knott test at 5% probability
*** MT: Manual thinning treatment

Elevation of the ethephon dose resulted in increase of the fruit mass, length and diameter (Figure 2A). This is justified by the application of ethephon in the larger doses to cause a greater fruit thinning and,

consequently, a lower fruit load in the plant, predisposing to the formation of larger peaches. According to Rodrigues *et al.* (1999) and Greene and Costa (2013), the average fruit mass increases with the reduction of the fruit quantity in the plant, due to the greater availability of nutrients allocated to each organ of fruiting. For Anzanello and Tedesco (2017), with the reduction of the number of fruits, there is an improvement in the distribution of photoassimilates, resulting in fruits of larger size.

In the treatment of manual thinning the mean fruit mass was 113.1 g. Simonetto et al. (1995) show that cv. Chimarrita, using the manual thinning technique, produces fruits with a mean mass of 101g. Raseira *et al.* (2014) classify the fruit of cv. Chimarrita as being of large size, surpassing 100g. The concentrations of 80, 110 and 140 ml L^{-1} of ethephon did not differ statistically from the treatment of manual thinning, with means of 104.9g, 106.9g and 109g, respectively (Table 1).

In the analysis of soluble solids and titratable acidity (Figure 2B), it was found that the increase in the concentration of ethephon increased the SS content and decreased AT, with statistical differences between the dosages (Table 1). This was justified by the increase in the dose of ethephon to have caused a reduction of the fruit load in the plant and concentrated the sugars in the remaining fruits. No differences in pulp firmness were observed between the treatments tested (Figure 2B, Table 1). Lucchese *et al.* (1994) and Taheri *et al.* (2012) also reported no effect of ethephon on fruit pulp firmness when applied as a fruit thinner to the BR1 and Redhaven peach cultivars, respectively.

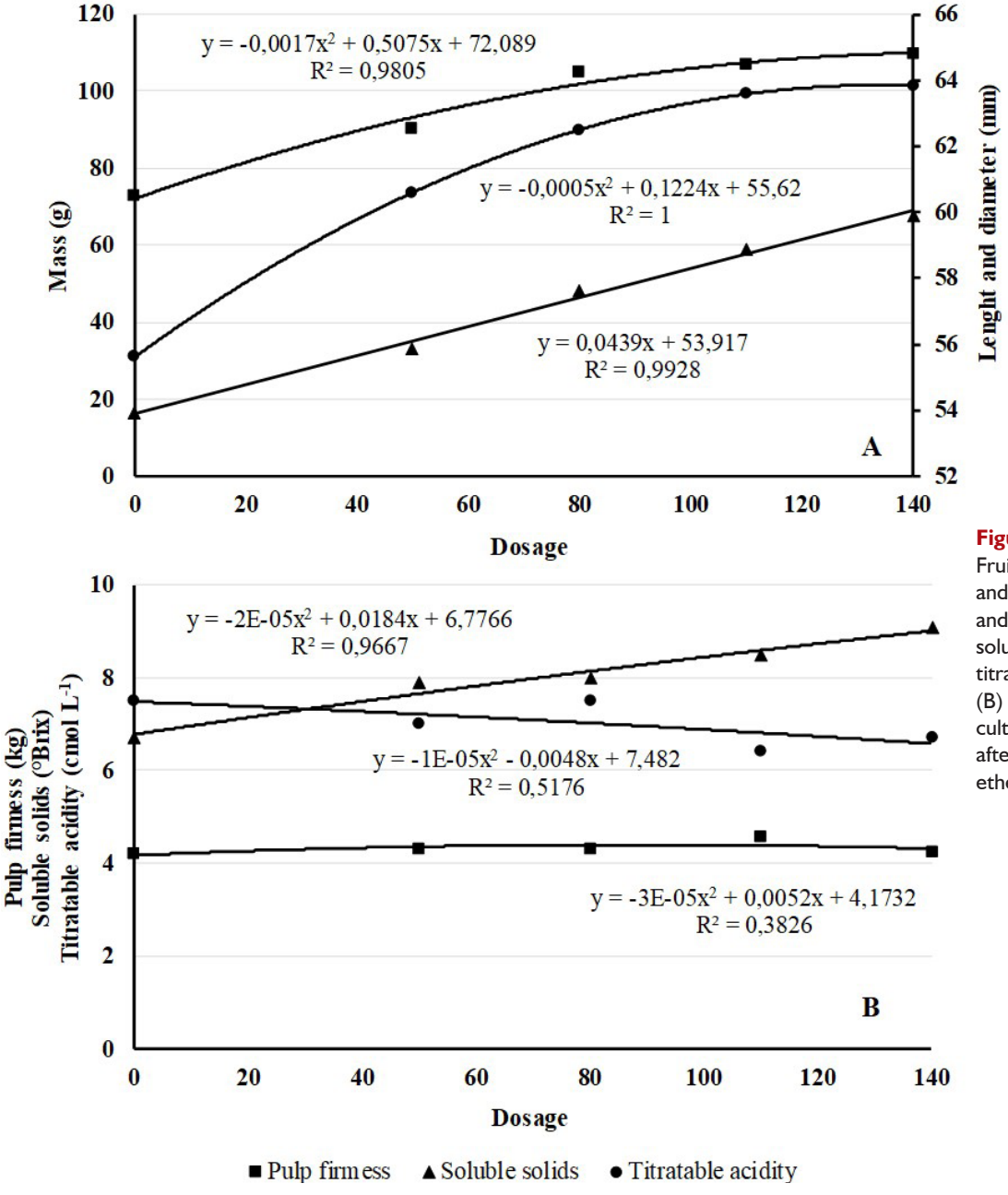

Figure 2
Fruit mass, lenght and diameter (A) and pulp firmness, soluble solids and titratable acidity (B) of the peach cultivar Chimarrita after application of ethephon.

Conclusion

Ethephon application is effective for chemical thinning of fruits of peach cultivar Chimarrita. Ethephon at 80 mg L^{-1} is the most efficient dose for chemical thinning of fruits in the cultivar Chimarrita. The fruit load (production) of the plant directly affects the physico-chemical characteristics of fruits

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