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Production of 'Ponkan' mandarin trees submitted to chemical thinning

ABSTRACT

Information about the productive behavior and development of the mandarin fruit by the application of phyto regulators that promote thinning are essential in order to obtain fruit within the standards required by the market. This study was designed to test different Ethephon concentrations in 'Ponkan' mandarin tree grafted on 'Rangpur' lime tree, to evaluate the percentage of thinning, growth and fruit production within and below commercial patterns. Five concentrations of Ethephon were tested: 0, 200, 400, 600 and 800 mg L⁻¹, applied when the fruits were at the development stage of 25 to 30 mm in transverse diameter. A percent of 28.5 thinning was obtained in the plants treated with the highest concentration of Ethephon. The chemical thinning with Ethephon application did not affect the 'Ponkan' mandarin production within commercial standards and it reduced the number of fruits below the commercial standards. Due to the intense leaf abscission observed in plants treated with 800 mg L⁻¹ Ethephon concentration, the concentration of 600 mg L⁻¹ of Ethephon was considered the most suitable to promote 'Ponkan' mandarin thinning.

Key words: *Citrus reticulata*, Ethephon, phyto regulators.

Produção de frutas de tangerineira 'Ponkan' submetidas ao raleio químico

RESUMO

Informações sobre o comportamento produtivo e o desenvolvimento das frutas da tangerineira mediante a aplicação de fitorreguladores capazes de promover o raleio são fundamentais no intuito de se obter frutas dentro dos padrões exigidos pelo mercado. Este trabalho foi realizado com o objetivo de testar diferentes concentrações de Ethephon em tangerineiras 'Ponkan' enxertadas sobre o limoeiro 'Cravo', visando avaliar o percentual de raleio, o crescimento e a produção de frutas dentro e abaixo dos padrões comerciais. Foram testadas cinco concentrações de Ethephon: 0; 200; 400; 600 e 800 mg L⁻¹, aplicadas quando as frutas estavam no estágio de desenvolvimento de 25 a 30 mm de diâmetro transversal. Obteve-se um percentual de 28,5 no raleio das plantas pulverizadas com a maior concentração de Ethephon. O raleio químico com a aplicação de Ethephon não alterou o rendimento da produção de tangerina 'Ponkan' dentro dos padrões comerciais e reduziu a quantidade de frutas classificadas abaixo dos padrões comerciais. Devido à intensa abscisão foliar observada nas plantas com a aplicação de 800 mg L⁻¹, a concentração de 600 mg L⁻¹ de Ethephon foi considerada a mais adequada para promover o raleio de tangerina 'Ponkan'.

Palavras-chave: *Citrus reticulata*, Ethephon, fitorreguladores.

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INTRODUCTION

The size and development of 'Ponkan' mandarin fruits are important to the production quality and yield, since they are supposed to be sold in the consumer market as fresh fruits.

Mandarin trees have the characteristic to produce excessive quantities of fruit, which leads to the production of small-sized fruits that are usually not sold.

The number of fruits per plant is one of the factors that influence 'Ponkan' mandarin fruit growth and yield, due to photoassimilate availability, which is reduced for fruits under development (García-Luis et al., 2002).

Management practices that provide the greatest fruit development are essential to ensure the high productivity of 'Ponkan' mandarin tree. Among the techniques that have been applied, chemical thinning, through the application of Ethephon, has provided fruits abscission, reducing the competition between sinks and improving fruit size (Cruz et al., 2009).

Among the phytohormones used to promote the thinning, Ethephon releases ethylene upon contact with the plant tissue, promoting abscission, and it has been considered more efficient in comparison to other phytohormones such as naphthalene acetic acid (Domingues et al., 2001), 3,5,6-TPA, 2,4-DP, Fenotiol and Etilclozate (Serciloto et al., 2003).

Studies that evaluated the Ethephon effect on chemical thinning of citrus species in concentrations from 150 to 600 mg L⁻¹ show different responses to thinning and fruit size, varying according to the time of application and the development stage of the fruit submitted to thinning (Domingues et al., 2001; Serciloto et al., 2003; Cruz et al., 2009; Ramos et al., 2009; Cruz et al., 2010). Furthermore, research results on growth regulators can vary due to differences between cultivars, concentrations and climate changes, making it difficult to extrapolate the results for specific situations.

For that reason, the use of Ethephon to promote chemical thinning in 'Ponkan' mandarin tree is an alternative to reduce the number of fruits on the plant and to increase its size and in the commercial production yield.

This study was designed in order to test different Ethephon concentrations in 'Ponkan' mandarin trees grafted on 'Rangpur' lime tree, to evaluate the percentage of thinning, growth and fruit production within and below the commercial standards.

MATERIAL AND METHODS

This work was carried out in a commercial orchard without irrigation in the city of Perdões, South of the state of Minas Gerais, Brazil, located at 21°05'27.3" (S) and 45°05'27.3" (W), with average altitude of 826 m. The soil was classified as typical Hapludalf and the climate type is Cwb, according to the Köppen classification, characterized with hot humid summers and dry and cold winters. Variations in temperature and precipitation were recorded during the experimental period (Figure 1).

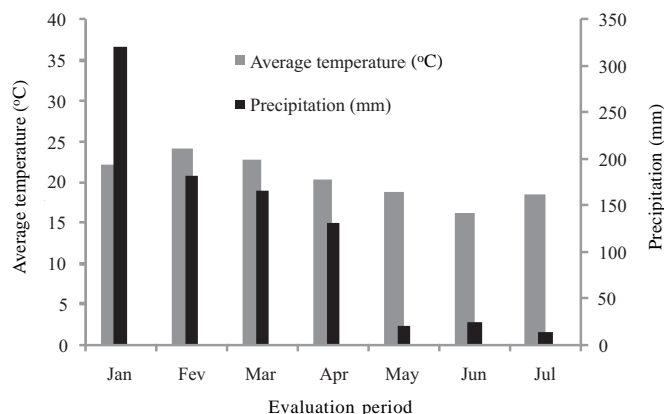


Figure 1 - Monthly averages of temperature and precipitation that occurred in the region of Perdões, South of Minas Gerais, Brazil, during the experimental period (2009)

Figura 1. Médias mensais de temperatura e precipitação ocorridas na região de Perdões, Sul de Minas Gerais, durante o período experimental (2009)

Twelve-year-old 'Ponkan' mandarin trees (*Citrus reticulata* Blanco cv. 'Ponkan'), grafted on 'Rangpur' lime tree (*Citrus limonia* Osbeck), cultivated in 6 m x 3 m spacing, were used. Before the treatments, in January 2009, the selection of the plants was made according to the reproductive potential. Thus, the thinning was made in plants with fruit number representative for all concentrations applied.

Five Ethephon concentrations were tested: 0; 200; 400; 600 and 800 mg L⁻¹, applied when the fruits were at the development stage of 25 to 30 mm in transverse diameter. The experimental design used was the randomized blocks one, with four replications. The experimental useful plot was constituted by four plants.

The plants were sprayed with the commercial product Ethrel®, a soluble concentrate with 240 g L⁻¹ phosphoric acid 2chloroetil. The applications were made after the period of physiological fruit drop in the month of January. The applications were made to the fullest extent of the crown (internal and external) to promote thinning throughout the plant.

About two liters of solution were spent per plant. This volume was previously determined by the blank test with water application.

A backpack sprayer with pressure of 6 kg cm⁻², with conical nozzle, particles deposition capacity around 70 - 100 drops cm⁻², with diameter of 100 to 200 microns, was used, resulting in homogeneous wetting of the entire leaf coverage, in order to keep the product runoff and drift as small as possible.

During the experimental period, the plants were conducted according to the culture recommendations regarding the cultural practices, fertilization and pest control.

In order to determine the thinning percentage, two branches per plant were marked in each plot, counting the fruits on the application day and on the remaining 15 days after the Ethephon application, when the fruit drop in the plants submitted to thinning had ceased.

Fruit growth evaluations were carried out in 40 fruits per plant, fortnightly, from the Ethephon application to harvest (January to July 2009).

During the harvest, in July 2009, the yield per plant was determined and classified in into or out of the commercial standards. The commercial production yield was obtained by considering the fruit size characteristics required by the destination market. These standards were considered in fruits above 58 and 60 mm in the longitudinal and transverse diameter, respectively.

Data were subjected to the analysis of variance and polynomial regression, using the Ethephon concentrations, and the characteristics, evaluated as dependent variables. The models were chosen based on the significance tests of the parameters and on the regression coefficient, using the 't' test, at 5% error probability.

RESULTS AND DISCUSSION

The different concentrations of Ethephon presented influence on abscission and on the production, which was below the commercial production standards of fruit per plant. No effects of the Ethephon application on fruit growth were observed in any of the periods.

For the thinning percentage, a linear increase was observed in function of the Ethephon concentrations, obtaining 28.5% of thinning in the plants sprayed with the 800 mg L⁻¹ concentration, while in the control treatment, the natural fruit drop percentage after this period was less than 1% (Figure 2). These observations were due to the ethylene action, which was identified as the component responsible for the abscission induction. The thinning percentage was considered low if compared to the percentage considered ideal for mandarin trees, which is 50% to 60%, according to Castro (2002).

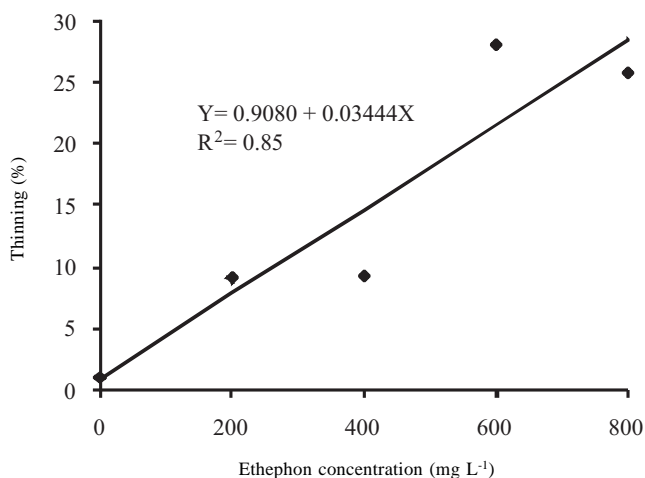


Figure 2. Thinning percentage in 'Ponkan' mandarin as a function of Ethephon application

Figura 2. Percentual de raleio em tangerina 'Ponkan' em função da aplicação de Ethephon

This difference regarding the plants response to thinning is possibly due to the initial fruit number on the plants, once the greater the amount of fruit per plant is, the greater the abscission will be. Moreover, the weather conditions may also have influenced, given that the Ethephon application was performed in a period prior to the occurrence of high precipitation (Figure 1), which may have attenuated the action of the ethylene released on the abscission, even in the concentration 800 mg L⁻¹.

Another significant aspect of the Ethephon action was the occurrence of leaf abscission in plants sprayed with concentrations from 600 mg L⁻¹ onwards, being more intense in plants treated with the 800 mg L⁻¹ concentration.

The visually observed result of leaves and fruit abscission in 'Ponkan' mandarin trees is attributed to the increased ethylene level that promotes the abscission of reproductive (Iglesias et al., 2006) and vegetative organs (Gómez-Cadenas et al., 1998), due to the increased cellulase activity in the abscission zone (Guan et al., 1995).

The leaf abscission is an important aspect that must be considered when the application is made with phytohormone to promote thinning, whereas the abscission occurs in mature leaves which are sources of photoassimilates for the fruit developing. Despite the high number of leaves on citrus trees, the falling of the leaves favors the emission of new ones, which initially act as sinks that compete with fruits for assimilates.

Siqueira et al. (2007) evaluated the relationship between the leaves number per fruit in 'Salustiana' orange. 30 leaves (total area of 290.21 cm²) were necessary to supply the demand for assimilates for the fruit growth. Therefore, it is necessary to evaluate the use of 'Ponkan' mandarin reserves caused by leaf abscission, since the fall of mature leaves, which are sources, and the emergence of new leaves, which are sinks, can disrupt the supply of photoassimilated fruit.

For the transversal diameter, the development as a function of the season was adjusted to the exponential model for all tested concentrations (Figure 3). The increase in transverse diameter over time is consistent with the characteristic behavior for the second growth phase of citrus fruits, which show an increase in cell volume and in locules filled by juice vesicles as they absorb water, which starts to occur slowly when the ripening stage begins. When the transverse diameters of fruits were compared in relation to Ethephon concentrations, no significant differences were observed.

For the yield of fruits harvested for selling, no significant differences between plants sprayed with different Ethephon concentrations were observed (Figures 4). This is probably due to the thinning percentage (28.5%), which was compensated by a higher number of fruits classified as commercial production, while in the control treatment plants, part of the production was classified as non-commercial production. Thus, the lowest number of fruits on plants sprayed with the highest Ethephon concentrations did not result in yield reduction per plant. These results are similar to Ramos et al. (2009) that observed no significant differences in production yields of 'Ponkan' mandarin with Ethephon application, and are contrasting with other authors, who

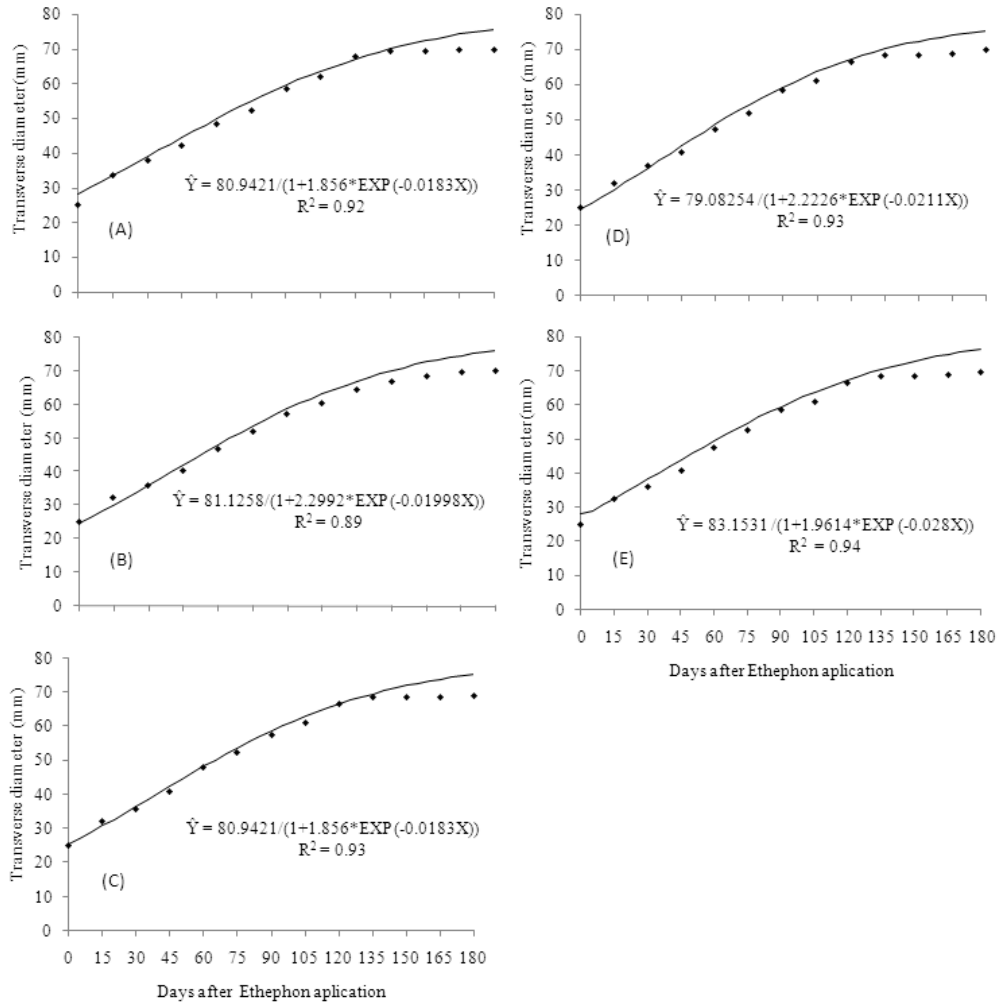


Figure 3. Transverse diameters of 'Ponkan' mandarin in the Ethephon concentrations sprayed with (A) 0 mg L⁻¹, (B) 200 mg L⁻¹, (C) 400 mg L⁻¹, (D) 600 mg L⁻¹ and (E) 800 mg L⁻¹ throughout the evaluation period

Figura 3. Diâmetros transversais de laranja 'Ponkan' nas concentrações de Ethephon pulverizadas com (A) 0 mg L⁻¹, (B) 200 mg L⁻¹, (C) 400 mg L⁻¹, (D) 600 mg L⁻¹ e (E) 800 mg L⁻¹ ao longo do período de avaliação

observed a decrease in the production per plant with Ethephon application (Serciloto et al., 2003).

In the yield evaluation of the production below the commercial standards, a significant reduction was observed in plants subjected to thinning. At the concentration of 675.8 mg L⁻¹ Ethephon the decrease was 99.3%, regarding the control treatment plants, which had about 11.95 kg of fruits per plant that were not commercialized (Figure 5). This result is important,

because these fruits, besides not being marketed, are responsible for the consumption of metabolites in mandarin trees and, for this reason, the production of the following year may be compromised.

This behavior may have occurred due to the lowest fruit number per plant caused by chemical thinning, because the number of fruits per plant is one of the factors that influence fruit and growth yields, depending on the assimilates availability (García-Luis et al., 2002).

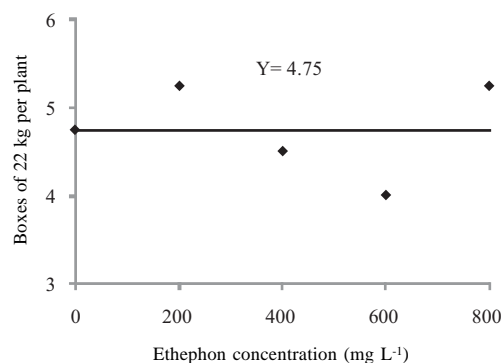


Figure 4. Productions of 22 kg boxes per 'Ponkan' mandarin plant in the commercial standards as a function of Ethephon application

Figura 4. Produção de caixas de 22 kg por planta de tangerina 'Ponkan' dentro dos padrões comerciais em função da aplicação de Ethephon

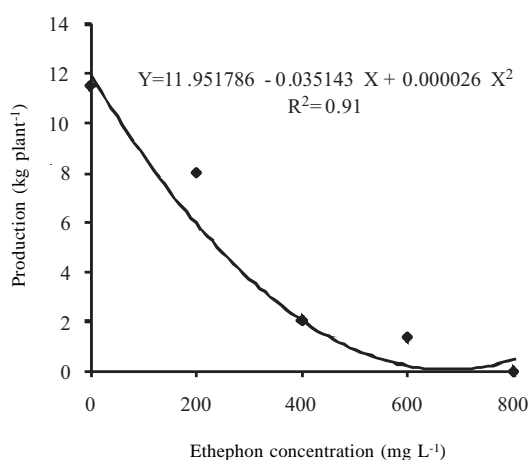


Figure 5. Production (kg plant⁻¹) of 'Ponkan' mandarin below the commercial standards as a function of Ethephon application

Figura 5. Produção (kg planta⁻¹) de tangerina 'Ponkan' abaixo dos padrões comerciais em função da aplicação de Ethephon

CONCLUSIONS

The chemical thinning with Ethephon application did not affect the 'Ponkan' mandarin production within commercial standards and it reduced the number of fruits below the commercial standards.

Due to the intense leaf abscission observed in plants treated with 800 mg L⁻¹ Ethephon concentration, the 600 mg L⁻¹ Ethephon concentration was considered the most suitable to promote 'Ponkan' mandarin thinning.

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