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Anticipation of 'ubá' mango ripening with preharvest ethephon application

Antecipação do amadurecimento de manga 'ubá' com a aplicação pré-colheita de ethephon

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ABSTRACT

Preharvest application of ethephon, a compound that releases ethylene when hydrolyzed, can anticipate and standardize mango harvesting. In this study, the effects of different doses of ethephon, applied at preharvest, on harvest anticipation of 'Ubá' mango were evaluated. On the 17th week after anthesis, 25 mango trees, five per treatment, were sprayed with ethephon at 0, 250, 500, 750 and 1000mg L^{-1}, plus 0.5% of mineral oil. Five fruits from each plant were harvested daily until full ripening, and evaluated. Except, for dose 0mg L^{-1}, in which six days after ethephon application (DAAE), harvest was carried out weekly up to 41DAAE The treated fruit presented a more intense flesh color than the non-treated, particularly at the doses of 500 and 750mg L^{-1}. Fruit treated with 500, 750 and 1000mg L^{-1}showed abrupt firmness reduction from the 1st DAAE and TSS higher than 18°Brix on the 6th DAAE. Non-treated fruit presented slower firmness reduction and reached 18°Brix on the 35th DAAE. The dose of 1000mg L^{-1} of ethephon resulted in premature fall and low fruit quality. Application of 500 or 750mg L^{-1} of ethephon allowed to anticipate and to standardize mango harvesting. These doses also allowed harvesting fruit with the best commercial quality and without the need of climatization after harvest.

Key words: ***Mangifera indica*** *L., Ethrel, postharvest.*

RESUMO

A aplicação pré-colheita de ethephon, composto que libera etileno quando hidrolisado, pode antecipar e uniformizar a colheita de manga. Neste trabalho foram avaliados os efeitos de diferentes doses de ethephon, aplicadas na pré-colheita, sobre a antecipação da colheita de manga 'Ubá'. Na 17ª semana após a antese, 25 mangueiras, sendo cinco por tratamento, foram pulverizadas com ethephon nas doses 0, 250, 500, 750 e 1000L^{-1}, acrescido de 0,5% de óleo mineral. Foram colhidos 10 frutos de cada planta, diariamente, até o completo amadurecimento, com exceção da dose 0L^{-1}, em que, a partir de 6 dias após aplicação do ethephon (DAAE), a colheita foi semanal até 42DAAE. Dos 10 frutos colhidos, cinco foram analisados no dia da colheita e cinco armazenados a 20±080°C e 90±5% UR e avaliados após o completo amadurecimento. Frutos tratados apresentaram coloração de polpa mais intensa que os não tratados, especialmente na dose 500L^{-1}. Frutos tratados com 500, 750 e 1000L^{-1} apresentaram brusca queda da firmeza a partir do 1ªDAAE, e SST superiores a 18°brix no 6ªDAAE, enquanto nos não tratados, a queda da firmeza foi mais lenta e atingiram 18°brix aos 35ªDAAE. A dose de 1000L^{-1}de ethephon resultou em queda prematura e má qualidade final dos frutos. Frutos colhidos no 3ªDAAE e armazenados atingiram o completo amadurecimento com 12, 7, 6, 4 e 6 dias para as doses 0, 250, 500, 750 e 1000L^{-1}, respectivamente. A aplicação de 500 ou 750L^{-1} de ethephon, seguida da colheita no 3ªDAAE, permitiu a obtenção de frutos com qualidade comercial, além de dispensar a climatização após a colheita.

Palavras-chave: ***Mangifera indica*** *L., ethrel, pós-colheita.*

INTRODUCTION

The 'Uba' mango grows naturally in almost all municipalities in the Zona da Mata of Minas Gerais and is well adapted to the ecological conditions of the region (ROCHA, 2009). Mango 'Uba' can be used fresh or as juice, in jelly and in other processed products

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(PINTO et al., 2004). The excellent quality of its juice makes it important for the agricultural industries of the region, concentrated in the municipalities of Viscount of Rio Branco, Uba and Astolfo Dutra, which are expanding and responsible for generating resources and jobs. This generates an increasing demand for fruits in quantity.

'Ubá' mango fruit generally ripe from November to January, and their non-uniform ripening in a same plant requires parceled harvest that can last for a month. Ethylene can also be directly related with the ripening process of the fruit. Thus, physiologically mature fruit of several species and cultivars have been submitted to treatments using ethylene or its analogues (experimentally and commercially) aiming to accelerate and make their ripening uniform and/or improving their quality standard.

Due to its high diffusion rate, it is very difficult to apply ethylene on the field in form of gas, but such limitation can be overcome using an ethylene-releasing compound (BRACKMANN et al., 2007).

The compound most widely used is 2-chloroethylphosphonic acid (Ethephon), a synthetic compound, which was discovered in the 1960s and is known by various commercial names such as Ethrel (CHITARRA & CHITARRA, 2005).

Ethephon, sprayed in aqueous solution, is rapidly absorbed and translocated into the plant. Under pH conditions equal to or higher than 5, ethephon hydrolysis and ethylene release occur (YANG, 1969). When ethephon is absorbed by the plant, decomposition occurs inside the cell, slowly releasing the product near its site of action, making possible a physiological response (TAIZ; ZEIGER, 2004). That is why its role in fruit ripening is attributed to the release of this gas inside the plant tissues (WARNER & LEOPOL, 1967).

Ethephon is efficient in anticipating color change and rendering it uniform when applied post-harvest on many fruits, such as tomato, plum, orange, banana, and apple (ANDREUCCETTI et al., 2007; FIORAVANÇO et al., 2007; NOGUEIRA et al., 2007; STEFFENS & BRACKMANN, 2006; STEFFENS et al., 2006; SALOMÃO & MAIA, 2004; ÁLVARES, 2003; DOMINGUES et al., 2001; MARTINS, 2003 e MEDINA et al., 1996).

'Keitt' mango treated with 1000mg L^{-1} of ethephon presented a lower content of organic acids and marked decrease in ascorbic acid content in relation to the non-treated fruit, showing the effect of this product in anticipating ripening with the reduction of acidity and vitamin C (CONEGLIAN & RODRIGUES, 1994; CONEGLIAN & RODRIGUES, 1993).

For ethephon application in the field, there are various commercial formulations, which are registered for use in various cultures and for various purposes. This compound is often found to be used to standardize and advance in the ripening of , cotton, coffee, fig and grape (AGROFIT, 2009). For the mango tree, ethephon has been found to induce flowering.

Studies were performed by BRACKMANN et al. (2007) to evaluate the effects of ethephon preharvest application (140g ha^{-1} for seven days before harvest) in 'Eldorado' peaches. Fruits treated with ethephon showed higher ethylene production and a drastic reduction in firmness and acidity, confirming the potential of this product in advancing fruit ripening.

There is a gap in the literature revised about mango behavior in relation to preharvest application of exogenous ethylene. No references were found in relation to preharvest application of ethephon on 'Ubá' mango tree. Such preharvest application may be especially important for the industry, due to the possibility of programming harvest time. Within this context, this research aimed to evaluate the effects of different doses of ethephon in anticipating and rendering it uniform ripening on the quality attributes of the 'Ubá' mango.

MATERIAL AND METHODS

The experiment was conducted in a 30-year-old orchard at the Universidade Federal de Viçosa, in Visconde do Rio Branco, MG, Brazil, which contained 60 plants. On December 2, 2007, which corresponds to the 17th week after anthesis, the plants were sprayed with 2-chloroethylphosphonic acid (commercial product Ethrel, 240g a.i. L^{-1}), at doses 0, 250, 500, 750 and 1000mg L^{-1}, added of 0.5% of mineral oil (commercial product ASSIST).

Five fruits of each plant were harvested daily until complete ripening and then analyzed. For dose 0mg L^{-1}, 6 days after ethephon application (DAAE), harvest was carried out weekly up to 41DAAE.

The experiment was arranged in a completely randomized design, in a split-plot scheme, with the plots being the 5 ethephon doses and the split-plots the evaluation days, with 5 repetitions of 5 fruit per

experimental unit. The data were analyzed by variance and regression. The models fit by means of regression were selected based on: the significance of the regression coefficients at 5% probability by the student "t" test; on the determination coefficient and on the potential to explain the biological phenomenon. Regardless of the dose and days interaction being significant or not, it was opted to dismember it, given the study's interest.

Pulp coloration was determined by reading the coordinates L, a and b in the central region of each fruit, next to the fruit pit with colorimeter (Color Reader CR-10 Minolta) and the results were expressed by h (0=red; 90=yellow; 180=green; 270°=blue) and by $\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$, with ΔE being the pulp color difference, which was calculated at the various time intervals, always in relation to the values obtained on day zero (before ethephon application), for each treatment. ΔE defines color saturation and intensity based on L, a and b readings (MINOLTA CORP, 1994).

Pulp firmness (N) was determined by digital penetrometer, soluble solid content (°brix) by refractometry, titratable total acidity (TTA) of the pulp by titration with NaOH 0,1M according to the analytical norms of the Adolfo Lutz Institute (2005) and expressed in percentage of citric acid.

RESULTS AND DISCUSSION

For fruit evaluated on the same day as harvest, the mean values of the difference in flesh color (ΔE) increased more slowly in fruits not treated with ethephon (Figure 1). ΔE values increased over time for all treatments, indicating the ripening of the fruits during the days after the ethephon application. According CHITARRA & CHITARRA (2005), changes in the fruits coloration with the advance of maturation are due to degradative or synthetic processes, and are used as key judging criteria for the fruit ripening. Fruits from plants treated with 500mg L^{-1}, 6thDAAE reached values of ΔE of 29.0, where as in control fruit plants, on the same day of evaluation, the value of ΔE was only 8.4. This occurred because the fruit not treated with ethephon did not undergo artificial induction and therefore the auto-catalytic synthesis of ethylene occurred naturally (KADER, 1999).

For the variable pulp color difference (ΔE), the fruit of the plants treated with 0mg L^{-1} of ethephon presented a hyperbolic behavior while for the remaining treatments, behavior was quadratic (Figure 1).

The ΔE values increased with time for all treatments, indicating ripening of the fruit along the

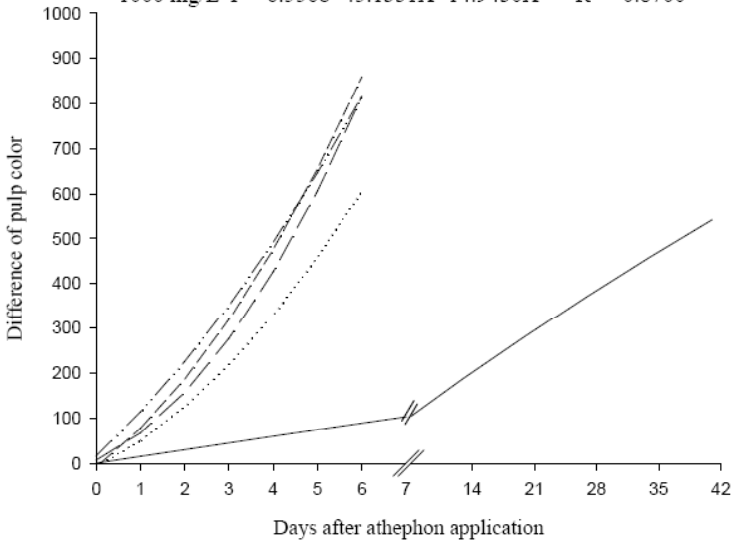

Figure 1 - Difference of pulp color (DE) of 'Ubá' mango on days after ethephon preharvest application.

days after ethephon application. According to CHITARRA & CHITARRA (2005), the changes in fruit coloration as ripening increases are due to degrading or synthetic processes, being one of the main criteria to judge fruit ripening. Fruit of the plants treated with 500mg L^{-1}, on the 6thDAAE reached ΔE values of 858.80, while for the control treatment fruit, on this same evaluation day, ΔE value was only 88.54.

The color of the flesh (h) in the central region of the fruit near the seed, appeared green on day zero (day of application of ethephon), and the pre-harvest application of ethephon resulted in fruit flesh with a more orange color (Figure 2). On the sixth DAAE, fruit showed values of h° angle of 93.9, 73.29 70.23, 69.07 and 71.81° for the doses 0, 250, 500, 750 and 1000mg L^{-1}, respectively. In non treated fruit (0mg L^{-1}), the pulp still appeared green in color on the 6th DAAE, whereas the other treatments on this evaluation day had pulp that was already yellow-orange, which confirms the effect of ethephon on anticipated changes and the standardization of color of mango pulp 'Uba'.

For the variable hue angle (h°) all the treatments presented hyperbolic behavior (Figure 2). Fruit pulp color in the central region near the fruit pit was greenish on day zero (the day ethephon was applied) and its preharvest application provided fruit with a more intense coloration. On the 6th DAAE, the fruit presented h angle values of 93.9; 73.29; 70.23; 69.07 and 71.81 for doses 0, 250, 500, 750 and 1000mg L^{-1} respectively; these results allow to state that fruit pulp at dose 0mg L^{-1} on the 6th DAAE, presented even more greenish coloration. For the remaining treatments on this same evaluation day, the pulp already presented orange-yellowish coloration, confirming the potential effect of ethephon in anticipating pulp coloration and reduction of firmness in the 'Ubá' mango fruit.

The variable pulp firmness presented hyperbolic behavior for all doses (Figure 3). The fruit of the treated plants had an abrupt reduction in pulp firmness from the first day after ethephon application, reaching on the 6thDAAE the values of 52.0; 23.7; 22.6 and 29.8 N for doses 250, 500, 750 and 1000mg L^{-1} respectively. For treatment 0mg L-1, firmness reached 46.18 N only at 41 DAAE. These results agree with those obtained by BRACKMANN et al. (2007), who observed that in fruit treated with ethephon during the preharvest of 'Eldorado' peach, pulp firmness was significant lower. FIORANÇO et al. (2007), ethephon application during post harvest reduced considerably pulp firmness of nectarines.

Soluble solids content had a quadratic effect for all evaluated doses, (Figure 4). Fruit of the plants

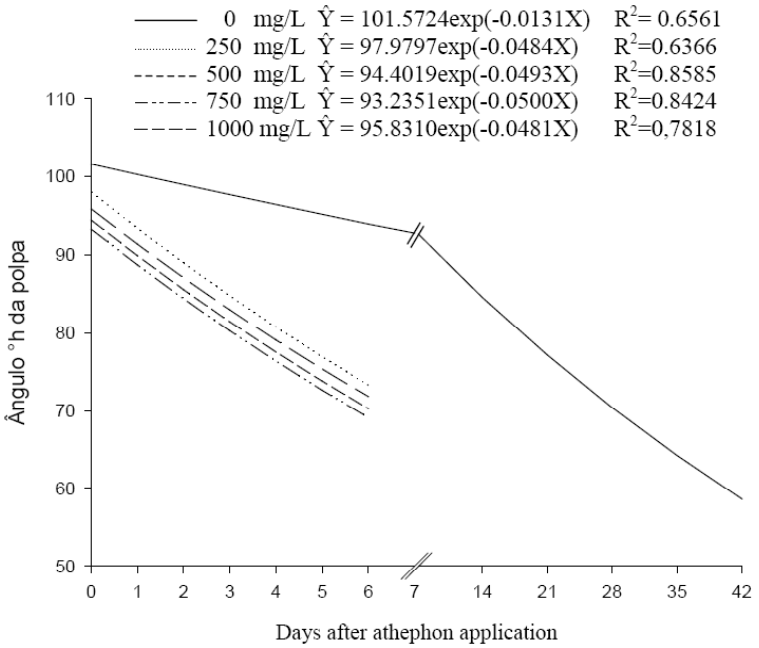

Figure 2 - Pulp hue angle (h°) of 'Ubá' mango, on the days after ethephon preharvest application .

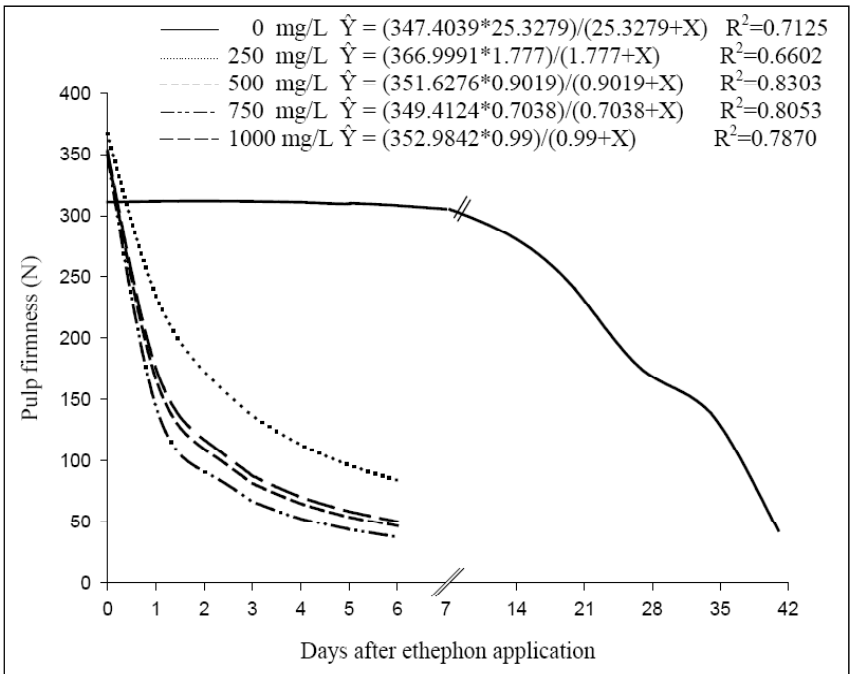

Figure 3 - Pulp firmness of 'Ubá' fruit on the days after ethephon preharvest application

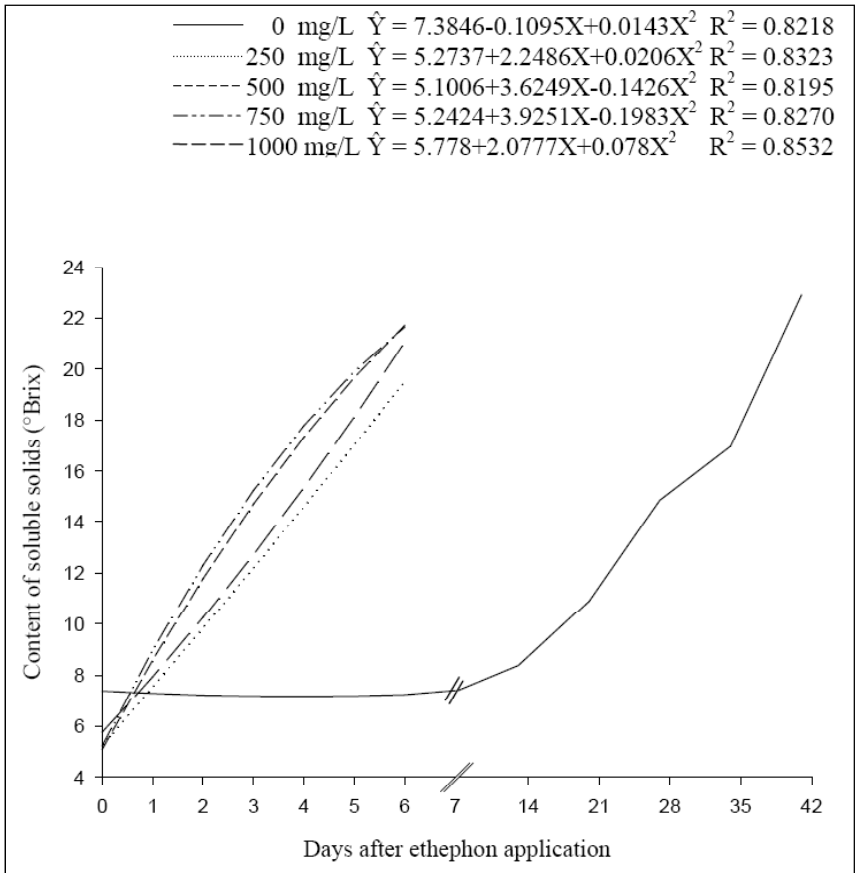

Figure 4 - Soluble solid contents in Ubá' mango pulp on the days after ethephon preharvest application.

sprayed with Ethephon obtained values above 18°Brix on the 6thDAAE, with high light for doses 500 and 750mg L^{-1} that reached approximately 22°Brix, evidencing the effect of ethephon in anticipating ripening of the 'Ubá' mango without hindering postharvest quality. The content of soluble solids in fruits treated with1000mg L^{-1} reached lower values than in that treated with 500 and 750mg L^{-1}. Fruit obtained from the control plants on the 6thDAAE presented soluble solids content of only 7.1°Brix, reaching values above 18°Brix only after the 31thDAAE. These meet the needs of the juice industry. Thus, ethephon use during preharvest becomes a rather interesting practice to anticipate Ubá' mango offer for industrial and *in natura* consumption, to render fruit ripening on the tree uniformly and to facilitate harvesting operation.

Similar results were found for the 'Keitt' mango whose fruit treated with 1.000mg L^{-1} of Ethrel at postharvest anticipated ripening when compared to the control fruit (CONEGLIAN & RODRIGUES, 1993).

Titratable total acidity presented a hyperbolic behavior for all the doses evaluated (Figure 5). Anticipation of organic acid content drop was observed in the fruit obtained from ethephon-sprayed plants. For doses of 1000mg L^{-1}, the tritatable total acidity contents were higher than the doses of 500 and 750mg L^{-1}. Positive ethephon effects in promoting complete fruit ripening could be observed through high ΔE values (Figure 1) and low tritatable total acidity indexes (Figure 5).

The soluble solids content for the dose of 1000mg L^{-1} was found to be lower (Figure 4) and titratable total acidity was higher (Figure 5) when compared with the doses 500 and 750mg L^{-1}. This can highlight non uniform and irregular ripening, indicating if this dose is excessive. Excessive abscission of the fruit for dose of 1000mg L^{-1} (data not shown) was also observed.

CONCLUSIONS

Preharvest application of 500 or 750mg L^{-1} ethephon allowed to anticipate and to standardize mango 'Ubá' harvesting. These doses also allowed harvesting fruit with the best commercial quality and without the need of climatization after harvest.

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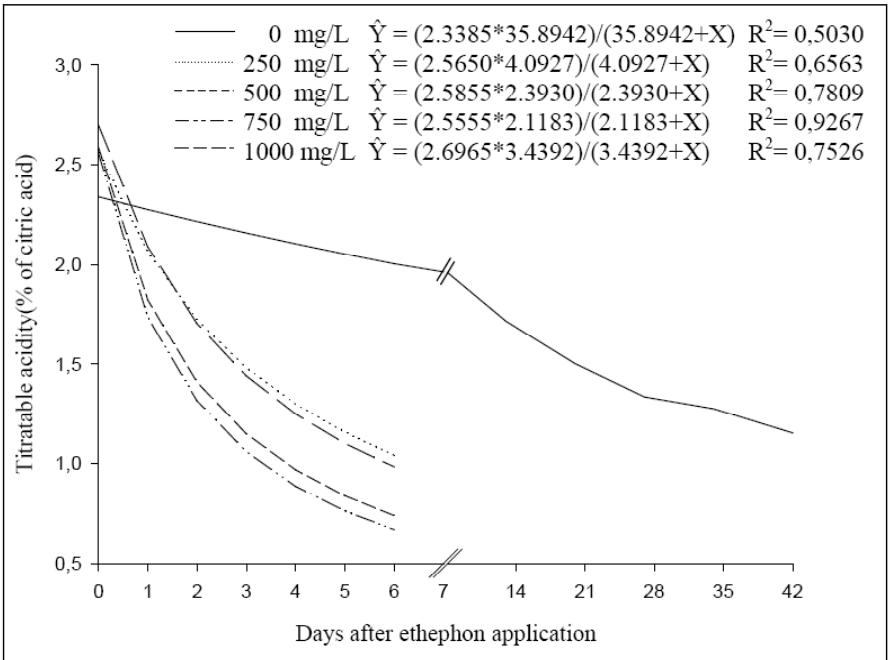

Figure 5 - Titratable total acidity of Ubá' mango pulp on the days after ethephon preharvest application of ethephon.

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