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REGULAR ARTICLE

Effects of coffee maturation regulators

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Abstract

The maturation of coffee fruits is a concern of coffee growers, as it directly influences the efficiency of the harvest and can interfere with the quality of the product. Therefore, the use of maturation regulators that act by controlling the speed of maturation are being increasingly used. As such, the objective of this work was to evaluate the effects of the regulators Ethrel® and Mathury™, in 4 treatments composed by the control, application of Ethrel®, application of Mathury™, application of the combination of Ethrel® followed by the application of Mathury™. Thus, the maturation stage of the fruits, the type, and the final grade regarding the quality of the drink were evaluated. After that, the data of the evaluated characteristics were submitted to statistical analysis by the Scott-Knott test at 5% probability. The maturation regulators used in this experiment did not interfere with the quality of the product and the classification of the coffee. However, treatments with application of Ethrel® alone or combined with Mathury™ provided anticipation and uniformity of coffee fruits.

Keywords

Coffee tree; Quality; Ethrel; Mathury; Ethylene

Introduction

Coffee is a noble product that stands out in Brazilian agribusiness. Currently, on the world stage, Brazil is widely known for being the largest producer and exporter of coffee. This is due to the great receptivity of this drink for presenting remarkable characteristics in flavour and aroma that confer great acceptance of it worldwide, spreading this drink more and more and, consequently, generating an increase in consumption and production.

Since it is a commodity both in Brazil and in the world, the coffee market has been expanding. As the product gains a special status in the international market, there are increasing demands on the quality of the beverage (Caldera; Caldarelli, 2020).

Brazil is characterized by a wide variety of microclimates, reliefs, altitudes, and soil conditions throughout its territorial extension. These conditions influence the achievement of various coffee quality standards (Goes; Chinelato, 2018). In addition to these, other factors can directly influence the quality of the drink, such as fruit maturation, which is guaranteed by the uniformity of flowering. In regions with adverse climates, it has become a challenge to achieve uniform flowering during coffee cultivation. Hence, it is increasingly sought to work with different strategies in the field in order to achieve good uniformity of flowering and its consequent more equal maturation of fruits, which in addition to favouring the harvest, contributes to the quality of the drink (Matiello et al., 2015).

Given this need, products that act as maturation regulators of coffee fruits can be used, which act on the speed of the ripening process, accelerating or delaying this process (Santinato et al., 2017).

Ethrel® (2-chloro-ethylphosphonic acid) is a ripening substance that contributes to the timing of the harvest, accelerating fruit maturation by releasing ethylene (Matiello et al., 2015). The synthesis of this product is characterized by a decrease in chlorophyll, an increase in carotenoids, as well as an increase in anthocyanins and anthocyanidins (Negreiros et al., 2019).

Just as Ethrel® accelerates maturation, there are maturation retarders that have the same objective of uniformity. The most used is Mathury™ (based on potassium acetate), which acts by delaying the ripening process of the fruits, by inhibiting the biosynthesis of ethylene in the plant, which in turn acts on the cherry fruits, delaying the speed of ripening as well as its passage to the dry stage, so that the cherry fruits remain in the same stage while the green fruits ripen (Matiello et al., 2015).

Given the above, the objective was to evaluate the effects of maturation regulators in coffee trees, and their influence on the uniformity of maturation and fruit quality.

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Materials and methods

The present research was carried out at Sítio Tajó, located in the municipality of Carvalhópolis, state of Minas Gerais, located at the geographical coordinates latitude: 21º 46' 44" S, longitude: 45º 52' 36" W, and altitude 885m.

The experiment was conducted in an Arabica coffee plantation installed in December 2018, of the Catuaí Vermelho IAC 144 variety, with a spacing of 3 x 0.8 m, a stand of 4166 plants/ha^{-1}, with 1400 plants comprising the experimental area.

A randomized complete block design (RCBD) was used, containing 4 treatments with 5 replications, totalling 20 experimental units. Each experimental unit consisted of 20 plants, where the 14 central plants were evaluated. The plots were installed 10 plants apart and a line of plants was maintained from one treatment to another.

The treatments were composed by the application of two different products that regulate the ripening of the coffee fruit. The 4 treatments are as follows:

T1- control without application of products that regulate the ripening of the fruits.

T2- with application of Ethrel® (Ethephon-concentration 720 g/L).

T3- with application of Mathury™ (Potassium Acetate).

T4- with application of the combination: Ethrel® (Ethephon-concentration 720g/L), followed by the application of Mathury™ two days after the application of Ethrel®.

The dosage for the application of Ethrel® was 0.650 L pc /ha^{-1} in 500 L of water. For Mathury™, the dosage was 5 L pc /ha^{-1} in 200 L of water. These dosages were used following the recommendation of each product manufacturer.

In all treatments, the application was carried out manually with a backpack sprayer, using a conical nozzle type Jacto JA-2 with a flow rate of 400 L / ha^{-1}. After the application of the products in each treatment, the harvest was carried out from the 14 plants of the central lines, manually, and the fruit stage was evaluated in each treatment from the percentage of green, green-yellow, cherry, and raisin fruits. Subsequently, the samples from each plot were sent to a concrete insolation area for drying the coffee equally. When reached 12% moisture, the representative lot of each plot was sent for evaluation of coffee classification by size and defects. Beverage quality was assessed by the Specialty Coffee Association of America (SCAA) method (SCAA**,** 2021).

Data from the evaluated characteristics were submitted to statistical analysis by SISVAR® as described by Ferreira (2014), and the averages were grouped by the Scott-Knott test at 5% probability.

Results and discussion

After the coffees reached the percentage of mature beans, the fruits were manually harvested from each plot. The treatments with the application of maturation regulators provided acceleration and uniformity in the maturation of the fruits, with an advance of 21 days of harvest in relation to the control treatment (Table 1 and Figure 1). This corroborates what was observed by Negreiros et al. (2019), who evaluated the effects of the application of a plant regulator on the maturation and final quality of the coffee fruit beverage. On that study, the application of regulators caused the acceleration and standardization in the maturation of the fruits, increasing the quality of the beverage in addition to proving the effectiveness of Ethephon for the high efficiency in the precocity and uniformity of the maturation of the coffee fruits.

The uniformity of fruit maturation promoted by the presence of ethylene in the plant through the application of Ethrel® also provides absorption, making the harvest process more efficient with more uniform fruits.

Figure 1. (a) Treatment without application of maturation regulators; (b) Maturation of coffee fruits under the effect of Ethrel regulator; (c) Maturation of coffee fruits under the effect of Mathury regulator; (d) Maturation of coffee fruits under the effect of both regulators (Ethrel+Mathury).

Table 1. Treatment collection date.

Treatment	Collection date
Control	31 of May
Ethrel®	10 of May
Mathury™	24 of May
Ethrel® + Mathury™	17 of May

For cherry and unripe fruits, the application of Ethrel® and the combination of Ethrel® + Mathury™ provided a higher percentage when compared to the application of Mathury™ alone, as well as to the control treatment (no application of maturation regulators), as it can be seen on Table 2. These results confirm the reports by Negreiros et al. (2019) and

Carvalho et al. (2013), who analysed the anticipation in the maturation of coffee fruits submitted to the application of the Ethrel® when compared to coffee trees where they were not applied.

The treatments without the application of products (control) and with the application of Mathury™ did not differ from each other, but they differentiated significantly from the treatments with the application of Ethrel®. They responded positively with the lowest percentages for this evaluation (Table 2). This fact proves the effectiveness of Ethrel® which, according to Matiello et al. (2015), is responsible for accelerating the maturation of green fruits, reducing their percentage, and increasing the percentage of cherry fruits.

The effect of this product is characterized by a reduction in chlorophyll, an increase in carotenoids, and an increase in anthocyanins and anthocyanins, which consequently generates the "greening" of the fruits. This results in the transformation of the green, rigid, and softer fruit that characterizes the fruit as ripe. This effect is caused by the action of ethylene and an increase in the concentration of enzymes that are responsible for softening the cell wall (Rodrigues; Ono 2014). As a result, there is an increase in the amount of cherry fruits. Besides, a harvest with a higher percentage of mature grains is essential to provide physical, physiological, and biochemical transformations, which reduces the possibility of staggered harvest and labour costs in addition to generating a batch of special coffee with greater added value to the product.

As for the characteristic percentage of green sugarcane fruits, there was a significant effect between treatments, with a positive highlight for the control treatments, with application of Ethrel® and with application of Ethrel® + Mathury™. However, the application of Mathury™ by itself provided a higher percentage of green-yellow fruits (Table 2), a fact that is justified by reason that Mathury™ is a maturation retarder, acting in this way on cherry fruits, reducing the speed of maturation, while the green fruits pass to the cherry stage, thus passing through the green-yellow stage. For the raisin fruit variable, there was no significant difference between treatments.

Table 2. Values of the percentages of coffee beans in the cherry, green-yellow, green, and raisin stages harvested on May 10, 2021.

Treatment	Cherry fruits	Green fruits	Green-Yellow fruits	Raisin
Control	58.52 B	17.11 B	16.12 A	8.24 A
Ethrel®	71.68 A	5.43 A	13.27 A	9.61 A
Mathury™	52.06 B	13.14 B	28.67 B	6.12 A
Ethrel® + Mathury™	83.28 A	5.07 A	3.36 A	8.27 A
CV%	14.07	9.99	6.42	5.42

*Means followed by the same letter in the column do not differ from each other by the Scott-Knott test ($p \leq 0.05$).

Coffee quality is closely related to the various physical-chemical and chemical constituents responsible for the characteristic flavour and aroma of beverages (Carvalho et al., 2013). In view of this, the analysis of coffee samples was carried out to study their constituents and assess whether the use of Ethephon adds to the final quality of the coffee, since this product accelerates the maturation of the grain.

The results of the sensorial analysis were submitted to analysis of variance, where the evaluated treatments had no statistical difference in relation to quality (score according to SCAA methodology) and type according to the Brazilian Official Classification (COB - *Classificação Oficial Brasileira* - BRASIL/MAPA, 2003), which can be seen on Table 3. All treatments received scores higher than 82 points, which characterizes them with a good quality beverage, without the influence of the application of maturation regulators, since even the treatment without the application of regulators also received a similar score.

Table 3. Classification of coffee by score according to SCAA and type according to BOC.

Treatment	Type	Score
Control	6.4 A	82.45 A
Ethrel®	6.6 A	82.35 A
Mathury™	6.6 A	82.90 A
Ethrel® + Mathury™	6.2 A	83.40 A
CV%	8.61	1.01

*Means followed by the same letter in the column do not differ from each other by the Scott-Knott test ($p \leq 0.05$).

Conclusions

The results obtained under the conditions of the present experiment show that the maturation regulators used in this experiment do not interfere in the quality of the beverage and coffee classification, when compared with the control treatment, which was done without the application of any ripening regulating products. Additionally, treatments with the application of Ethrel® alone or combined with Mathury™ provide anticipation and uniformity of coffee fruits.

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