Time of year and fungicides on anthracnose intensity in bananas from Northern Minas Gerais

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ABSTRACT

Banana cultivation is an important economic activity in the semi-arid region of Minas Gerais, however, diseases such as anthracnose are responsible for great losses that affect this fruit. The objective of this study was to evaluate the time of year and the effect of fungicides recorded on anthracnose intensity in the postharvest of 'Prata-Anã' banana produced in the North of Minas Gerais. The study was carried out from February 2017 to January 2018, with bunches of 'Prata-Anã' banana collected monthly. The central bunches were transported to the laboratory and subdivided into bouquets of three fruits. The fruits were treated with fungicides registered for the crop: imazalil and thiabendazole, immersed for two minutes at the recommended concentrations of 2 mL.L-1 and 0.92 mL.L-1, respectively, throughout the year. The fruits immersed for two minutes in water were the control treatment. Disease intensity was assessed by the severity of anthracnose in the fruits and the area under the disease severity progress curve (AACPS) in the fruits was calculated. The experimental design was completely randomized, consisting of three treatments, twelve evaluation periods, five replications and three fruits per replication. The data were submitted to analysis of variance and the means were compared using the Scott-Knott test ($p<0.05$). The fungicide thiabendazole was inefficient for the control of anthracnose in the postharvest of 'Prata-Anã' banana. The distribution of rainfall interfered significantly with the development of anthracnose. Treatment with the fungicide imazalil showed the lowest AACPS values throughout the year.

Keywords: *Musa sp.*, *Colletotrichum musae*, Post-harvest disease, Fruits, Chemical control, Environmental interference.

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INTRODUCTION

Bananas are one of the most consumed tropical fruits in the world. In Brazil, among the largest producing states are São Paulo, Bahia and Minas Gerais. In Minas Gerais, the North region stands out as the largest producer. Banana cultivation in the region covers about 30 municipalities, however, 80.7% of the production is concentrated in Jaíba, Janaúba, Matias Cardoso, Nova Porteirinha, Verdelândia and Pirapora (IBGE 2018). It is also an important economic activity and job creator in the semi-arid region of northern Minas Gerais, where the cultivation of the Prata-Anã variety irrigated under a conventional system predominates (Castricine et al. 2017).

The national average productivity is low (IBGE 2018) due, among other factors, to the incidence of diseases. Fungi are responsible for most of the diseases that affect bananas, especially anthracnose caused by *Colletotrichum musae* (Berk & Curt.) von Arx., which represents the most serious problem in the post-harvest of this fruit. The symptoms in ripe fruits are small brown lesions, which increase in size with the advance of maturation (Pessoa & Oliveira, 2006). Under favorable conditions, all the fruits of the flock can be affected (Ventura & Hinz, 2002), and under high humidity, the fruits are covered with pink to salmon fruiting and the acervula acquire a grayish color (Cordeiro et al. 2005).

The technologies that have been adopted in order to reduce postharvest rot are chemical treatment, physical treatment, resistance induction, proper handling practices and biological control (Barkai-Golan 2001). The development of appropriate methods for disease control requires knowledge related to nutritional aspects and environmental factors that influence the growth of the phytopathogen and the relationship between pathogen and host and environment (Agrios 2005). Environmental factors are directly involved in the intensity of the disease, since they influence the various phases of the pathogen's life cycle and also in the development of the host, being important for infection (Mafia et al. 2011, Oliveira et al. 2011).

There are no studies in the literature on the development of anthracnose in 'Prata-Anã' bananas treated with fungicides under climatic conditions in the semi-arid region of northern Minas Gerais. According to Panisson et al. (2002), the efficacy of control depends mainly on the fungicide and the time of application. Based on the above, the objective of this study was to evaluate the time of year and the effect of fungicides recorded on the intensity of anthracnose in the postharvest of 'Prata-Anã' banana produced in the North of Minas Gerais.

MATERIAL AND METHODS

The study was conducted from February 2017 to January 2018. Fruit samples were collected monthly on a commercial property in the municipality of Nova Porteirinha, North of Minas Gerais

(15º 49' 0" S, 43º 16' 0" W, 540 m altitude). The region's climate classification, according to Koppen, is Aw, characterized by rainfall concentrated in the summer, and dry in the winter months.

The bunches of banana cultivar Prata-Anã were harvested at preclimacteric stage or maturation stage 2 (green fruits with yellow traces) according to the Von Loesecke scale (PBMH & PIF, 2006). Then, the bunches were dropped, and the central bunches were selected, aiming at a greater uniformity of the fruits during post-harvest ripening. The bunches were packed in plastic boxes that had been previously washed and sanitized, covered with cardboard to prevent damage. They were then referred to the Post-Harvest Pathology Laboratory of Unimontes, Janaúba campus. The bunches were subdivided into bouquets of three fruits, which were washed with water and mild detergent and left to dry.

Part of the fruits were treated with fungicides recommended for the crop. The treatments consisted of fruits treated by immersion in syrup with the fungicide imazalil (Magnate®) and thiabendazole (Tecto®), for two minutes, at the concentrations recommended for each product of 2 mL.L-1 and 0.92 mL.L-1, respectively. Fruits immersed for two minutes in water were the control treatment. Subsequently, the treatments were placed in trays and stored in a refrigeration chamber at 25±1 °C and 80±5 % RH. The intensity of the disease was evaluated by the severity of anthracnose in the fruits with the aid of a diagrammatic scale, during a period of 12 days, and the area under the disease progress curve in the fruits was calculated. For the severity variable, the diagrammatic scale developed by Moraes et al. (2008) was adopted.

The statistical design was completely randomized with three treatments, twelve evaluation periods, five replications and three fruits per replication. The results were submitted to analysis of variance, and the means were compared using the Scott-Knott test ($p<0.05$) using the SISVAR software.

RESULTS AND DISCUSSION

In February 2017 and January 2018, the fungicide imazalil reduced the Area Under the Anthracnose Severity Progress Curve (AACPS) in relation to thiabendazole treatment and control (Table 1).

TABLE 1. Averages of the Area Under the Anthracnose Severity Progress Curve (AACPS) of 'Prata-Anã' banana produced from February 2017 to January 2018, submitted to chemical control.

Month	AACPS (*)		
	Imazalil	Tiabendazole	Control
February	3.50 Aa	68,50 Ab	71,25 Ab
March	1.00 Aa	11,50 Ba	44,50 Bb
April	0,00 Aa	0,25 Ca	0,75 Ca
May	0,00 Aa	0,00 Ca	0,00 Ca
June	0,00 Aa	0,00 Ca	0,00 Ca
July	0,00 Aa	0,00 Ca	0,00 Ca
August	0,00 Aa	0,00 Ca	1,00 Ca
September	0,00 Aa	0,00 Ca	1,25 Ca
October	0,00 Aa	1,25 Ca	4,50 Ca
November	0,00 Aa	3,25 Ca	6,50 Ca
December	0,00 Aa	3,00 Ca	9,25 Ca
January	1,00 Aa	22,25 Bb	20,25 Cb
CV (%)	35,23		

Means followed by the same lowercase letter in the row and uppercase letter in the column did not differ from each other according to the Scott-Knott test ($P<0.05$).

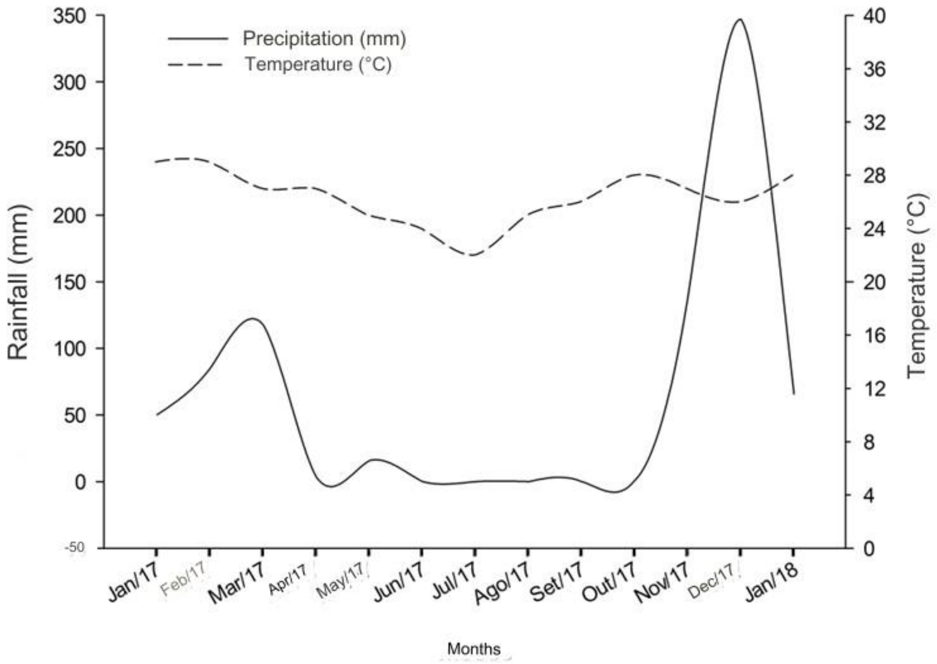
In March 2017, imazalil and thiabendazole reduced anthracnose AACPS relative to control. In the other months, there was no significant difference between the fungicides and the control treatment. The fruits treated with imazalil presented the lowest AACPS values when compared to the other treatments throughout the evaluation period, even though they did not fully control the disease in the months of February and March 2017 and January 2018. However, during the months evaluated, there was no significant difference in the AACPS in the fruits of this treatment. These results corroborate those reported by Silva et al. (2016) reporting that the application of the fungicide imazalil on 'Prata-Anã' banana provided a reduction in the intensity of the disease in all months of evaluation. According to the authors, the reduction caused by this treatment is related to the direct action on the pathogen. Coelho et al. (2010), studying the anthracnose of 'Prata-Anã' banana treated with the fungicide imazalil, also did not verify total control of the disease.

Thiabendazole at the recommended dose for bananas had little effect on disease control in fruits harvested in February 2017 and January 2018, with the highest mean AACPS during the entire period evaluated, with an increase of up to 68.5% in the intensity of the disease in the months of greatest severity. There was no difference in disease intensity between April and December 2017, with mean AACPS close to zero.

The control treatment behaved similarly to the fruits treated with the fungicide thiabendazole, with the highest mean AACPS in February and March 2017. In the other months, there was no significant difference in the AACPS of anthracnose in fruits without fungicide use. There was an increase of 95.09% and 97.75% in AACPS in February and March 2017, respectively, when compared to fruits treated with the fungicide imazalil in the same period.

The distribution of rainfall in the producing region in the months of January, February, March, November and December 2017 is among the climatic conditions that most interfered with the emergence of anthracnose, related to the availability of free water for the development of the disease. On the other hand, the months with no wetness period and milder temperatures (May, June and July) provided the best control in the development of anthracnose, which was observed in untreated fruits (control) and fruits treated with thiabendazole (Figure 1).

FIGURE 1. Rainfall and average temperature data observed at the EPAMIG Nova Porteirinha Meteorological Station, from January 2017 to January 2018.



For the development of the fungus *C. musae*, water becomes an essential element, since the conidia are released and distributed only when the acervuli are wet and germinate only in the presence of free water or when the relative humidity of the air is quite high. Generally, they are spread by winds, splashes and heavy rains (Menezes 2002, Agrios 2005).

In a study carried out by Pessoa et al. (2007), using different temperatures and wetness period of bananas inoculated with *C. musae*, they observed that low temperatures, around 15ºC, and the absence of the wetness period also provided the best control in the development of anthracnose. High temperatures also provide the greatest development of anthracnose. Chillet et al. (2006), evaluating the influence of oscillations in climatic conditions on the development of *C. musae*, concluded that temperature is an important factor for this pathosystem, as it influences the increase of infection, accelerating the maturation stage of the fruit, and the losses caused by the pathogen.

The treatment with the fungicide imazalil showed few variations in the AACPS in the months of evaluation of the collected fruits, with values close to zero throughout the study period. The fruits belonging to the thiabendazole fungicide treatment and control treatment showed AACPS decreasing from February to August 2017 with an increase from September 2017 to January 2018. However, thiabendazole treatment resulted in slightly lower AACPS when compared to the control treatment (Figure 1).

The results found in this study indicate that the fungicide thiabendazole, which is registered for the control of anthracnose in the postharvest of bananas, is not very efficient for this purpose. Negreiros et al. (2013), using the fungicide thiabendazole to control anthracnose in the postharvest of 'Prata' banana, found efficiency in reducing severity, but there was no reduction in the incidence of the disease.

The fungicides recommended for the postharvest of bananas may undergo changes in the response to treatment in fruits produced under favorable conditions for the pathogen.

Anthracnose can achieve rapid progress and is easily introduced and spread. Under environmental conditions favorable to the disease, the use of fungicides becomes the only viable alternative. However, the selection pressure promoted by the fungicide molecules frequent in the crop generates major problems such as sensitivity to the fungicide (Ghini & Kimati, 2000). Difference in sensitivity to pesticides may be due to their intensive use in orchards, resulting in selection pressure on the pathogen population (Ficher et al. 2017). The phenomenon of resistance began with the emergence of systemic fungicides, acting only on certain metabolic pathways of fungi (Rodrigues et al. 2007).

CONCLUSIONS

The rainy season significantly interferes with the development of anthracnose of the 'Prata-Anã' banana in the North of Minas Gerais.

Fruits treated with imazalil fungicide result in lower AACPS throughout the year.

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