PROGRESS OF RUST (*Hemileia vastatrix* Berk e Br.) ON COFFEE TREES IN ORGANIC AND CONVENTIONAL CROP SYSTEMS

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ABSTRACT: The progress of rust on coffee trees in organic and conventional crop systems was assessed in two neighboring coffee plantations, in Santo Antônio do Amparo, Minas Gerais state, between December/2004 and October/2006. The plantations were under similar climate, soil and relief conditions. The coffee plants (*Coffea arabica* L.) evaluated were of the cv. Acaiá MG-474-19, and were eight years old at the beginning of the trial. Comparatively, the progress of the rust in the organic system was not significantly different from the progress in the conventional system. A maximum rust incidence of 24.88% was observed in August/2005, and of 25.72% in August/2006 in the conventional system, and similar incidence values were observed also in the organic. The yield of the organic coffee, in comparison with the conventional, was lower in the two year period assessed. Comparing the data from 2005 and 2006, it was observed that production decreased by 19.88% in the conventional system and by 5.08% in the organic. This suggests a lower effect of the disease on the following crop of the trees cultivated in the organic system, in relation to those cultivated in the conventional.

Key words: Coffee, *Hemileia vastatrix*, organic system.

PROGRESSO DA FERRUGEM NA CAFEICULTURA ORGÂNICA E CONVENCIONAL

RESUMO: O progresso da ferrugem em cafeeiros sob sistema de produção orgânico e convencional foi avaliado em duas lavouras vizinhas, no município de Santo Antônio do Amparo, MG, entre dezembro/2004 e outubro/2006. As lavouras encontravam-se sob condições similares de clima, solo e relevo. Os cafeeiros avaliados (*Coffea arabica* L.) são da cultivar Acaiá MG-474-19, com oito anos no início do ensaio. Comparativamente, o progresso da ferrugem no sistema orgânico não se diferenciou do observado no sistema convencional. Observou-se incidência máxima de 24,88% em agosto/2005 e de 25,72% em agosto/2006, no sistema convencional, e valores muito próximos no sistema orgânico. A produção dos cafeeiros orgânicos foi menor nos dois anos de avaliações, em relação ao sistema convencional. A diferença na produção, de 2005 para 2006, no sistema convencional, foi de 19,88%, ao passo que no sistema orgânico, a redução foi de 5,08%. Infere-se, com isso, uma tendência de menor efeito da doença sobre a safra seguinte dos cafeeiros no sistema orgânico de produção, comparado ao convencional.

Palavras-chave: Café, *Hemileia vastatrix*, sistema orgânico.

1 INTRODUCTION

Due to the increasing global demand for healthier foods, the organic product market is the fastest expanding sector in the food segment, with a growth rate of 20% a year in both developed and developing countries (UNCTAD, 2003). The international organic coffee market is dominated by Mexico, which commercializes over 30 thousand tons/year of the product and, with an estimated production area of 70,3 thousand hectares, is also its largest producer (LERNOUD & PIOVANO, 2004; YUSSEF & WILLER, 2002), followed by Peru, Bolivia, Nicaragua, Guatemala and Costa Rica.

In Brazil, organic coffee production has maintained growth rates close to 100% a year (CAIXETA & PEDINI, 2002) and occupies an area of 13.000 ha, represented by 419 producers

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(ORMOND et al., 2002). However, investments combining social and environmental sustainability are still necessary to guarantee its competitiveness in the international market (MOREIRA et al., 2002).

As in conventional production systems, the diseases with the greatest impact on organic coffee are rust (*Hemileia vastatrix* Berkeley & Broome) and brown-eye spot disease (*Cercospora coffeicola* Berkeley & Cooke). Rust can lead to production losses between 35% and 40% (ZAMBOLIM & VALE, 2000) and the losses caused by the brown-eye spot may reach 30% (SANTOS, 2006).

There are few studies on organic coffee diseases. Samayoa & Sanchez (2000), comparing conventional and organic production systems in Costa Rica, observed a higher brown-eye spot incidence in the conventional crops but no difference regarding rust. In Poço Fundo, Minas Gerais state, Brazil, rust and brown-eye spot incidence above 10% and 59%, respectively (MARTINS et al., 2004), has been found. Teixeira et al. (2005) observed, in organic crops, a higher rust incidence, in comparison to the conventional system (38% and 17%, respectively), while brown-eye spot disease presented the opposite behavior (3% and 15%, respectively). More recently, Santos (2006) found a higher rust progress in an organic system, in comparison to the conventional, for two consecutive years, with peaks of 47% and 0,5% in 2004, and 35% and 21% in 2005.

In organic systems, in order to reach a high intensity and maintain a good yield, it is still not clear which cultivation practices provide the best balance between plant physiology, disease cycle and pathogenic antagonism. However, through comparative studies of organic and conventional coffee production systems, it is possible to determine relevant differences in the progress of the diseases in function of plant nutritional levels and yield, and also to compare behavior trends (BERGAMIN FILHO & AMORIN, 1996; CAMPBELL & MADDEN, 1990; SANTOS, 2006; VANDERPLANK, 1982). This is a pre-requisite for establishing the most efficient phytosanitary management possible.

Thus, rust was assessed in coffee cultivated in the conventional and organic systems and its progress was related to the crop's vegetative standard and yield in both systems.

2 MATERIAL E METHODS

Two assays with coffee in production (*Coffea arabica* L.) were conducted for two years (2004/2005 and 2005/2006 harvests) in neighboring fields, one managed in the organic system and the other in the conventional (without application of fungicides), in the municipality of Santo Antônio do Amparo, Minas Gerais state, Brazil.

The experimental area is located in the geographic coordinates $20^{0}53'026"$ latitude South and $44^{0}57'026"$ latitude West, at 1.021 m altitude. The organic system assay was set up at Cachoeira farm, of which 70 ha have been converted since 1995 and certified since 1999. The property is managed in compliance with the norms of the Instituto Biodinâmico (IBD), according to Brasil (1999), which forbid the use of chemical fertilizers or of any other product inadequate to this production system, such as fungicides, insecticides and herbicides, applied in conventional coffee production. Pests and diseases were controlled with mixtures of organic compounds produced on the property, such as bovine manure, milk and grass (*Urochloa decumbens* (Stapf) R.D.Webster), enriched with minerals and composted for 30 days. Nutrition of the coffee trees was done with manure (ruminants, non-ruminants and birds), compounds, biofertilizers and vegetation biomass residues, including green fertilizers.

The other assay was conducted at Taquaril farm in a conventional system, the most widely used in traditional coffee production, on a planted area of 35 ha. Chemical control of pests and diseases was used (25 kg/ha tiametoxan + cyproconazol, applied in October 2004 and 2005, and 500 ml/ha cyproconazol + azoxystrobin, applied in March 2005 and 2006), as well as chemical fertilizers, based on soil analysis results interpreted according to Ribeiro et al. (1999). However, after the assays were set up, no fungicides were used and both systems were sprayed only with Viça-Café Plus® leaf fertilizer (K_2O, 10,0 %; Mg, 1,0%; S, 13,5 %; B, 3,0 %; Cu, 10,0%; Zn, 8,2%). In both systems an eight year old Acaiá MG/474-19 cultivar was planted on a dark red dystrophic Latossol with clayey texture (68% clay), in a 2,8 x 0,8 m spacing.

Each experiment was set up in a random block design with 4 replications. The experimental unit was constituted by 3 planting rows, each with 16 trees.

The useful plot was represented by 12 trees, selected with the greatest possible leaf retention levels, fruit load and height uniformity.

Soil fertilization in these identical plots was done according to each production system. Fertilization was based on soil analysis, carried out after harvesting and interpreted according to the fertility levels proposed by the 5ª Aproximação das Recomendações para Uso de Corretivos e Fertilizantes em Minas Gerais (RIBEIRO et al., 1999).

Leaf fertilization was done with three sprayings of Viça-Café Plus®. The treatment was applied in the same way and on the same date in both systems. To avoid interference in the results, neither system was treated with triazol and strobilurin fungicides.

In both assays, rust and brown-eye spot incidence and severity were assessed every 15 days. Samples were taken randomly, in a non-destructive way, from 12 leaves of each plots' useful trees, between the 3rd and 4th leaf pair, in plagiotropic branches chosen randomly, totalizing 96 leaves per plot.

Disease incidence was determined according to the number of damaged leaves in each useful plot. To assess rust and brown-eye spot severity, the Kushalappa & Chaves (1980) and Oliveira et al. (2001) diagrammatic scales were used, respectively.

The means of the 4 incidence and severity replications were transformed into area below the disease progress curve (AACPD), determined by the Shaner & Finney (1977) equation.

Coffee leaf development was also monitored during the period of assessment of the diseases by a leaf area index analyzer (Lai-2000 Plant Canopy Analyser) (WELLES & NORMAN, 1991). Thus, it was possible to take leaf area index measurements in a non-destructive way (Leaf Area Index - LAI). Sampling was done in 4 different points of the experimental unit.

The defoliation percentage and IAF estimates were compared and related to the disease indexes in the experimental plots.

The crops' production in 2004/2005 and 2005/2006 was also determined. Harvesting was done in each unit when the mean percentage of green beans reached 10% to 15%. Production was determined from the weight and volume of the beans picked. The production data were used estimate yield, in sacks per hectare (sacks/ha), with a mean performance of 20% in weight in the whole experiment. Yield was compared between the treatments and related to the progress of the diseases.

During the experiment, a micro climatological station (Campbel Scientific®) was set up in the experimental area, composed of a thermo-hygrograph, leaf wetness sensors and pluviometer, solar radiation, wind speed and direction. Connected to a data logger, it provided climate information every 15 minutes. This equipment registered maximum and minimum temperatures, relative humidity, wind speed, insolation, precipitation and leaf wetness in the assays.

The data were related to the disease progress curves in each production system and the variables that influenced most the onset of the disease and of epidemic peaks were identified.

In the variation analysis, the percentages were transformed into areas below the incidence (AACPI) and severity (AACPS) progress curves.

The data on the AACPI and AACPS variables of rust and brown-eye spot, AACPIAF, and the data of the 2004/2005 and 2005/2006 harvests were subjected to the F test, for variation analysis between the conventional and organic system samples (Statistical Analysis System ver. 8.0; SAS Institute Inc. Cary, NC USA). Based on these results, the observations were compared by the "t" test, at 5% probability, presuming equivalent or different variations between the two samples (SISVAR ©, Federal University of Lavras (UFLA), Lavras, Minas Gerais state).

The effects of the treatments were also compared through the progress curves and maximum disease intensity. The trees' nutritional level, measured through leaf nutrient contents during fruit maturation, was also considered.

3 RESULTS AND DISCUSSION

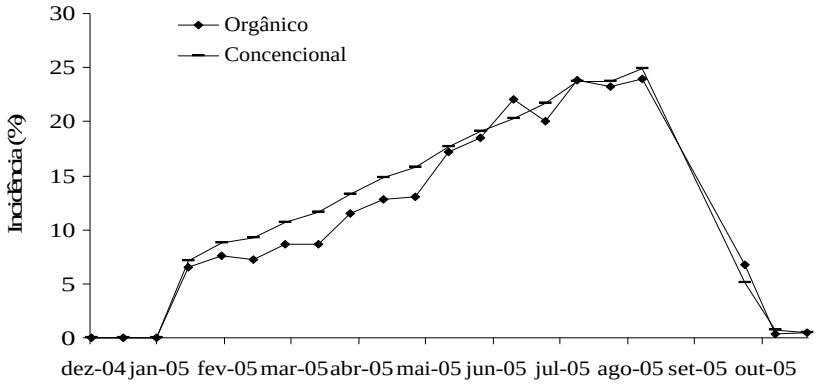
Rust progress in the conventional system began in January. Its incidence peaked in August 2005, at 24,88%, and in 2006, at 25,72% (Figure 1).

Rust progress in the organic and conventional systems was very similar, with very close initial values and peaks.

In the two year period assessed, no significant differences were found between the areas below the rust incidence and severity progress curves (Figure 2).

This result was also verified by Samayoa & Sanchez (2000), who also did not find differences regarding the incidence of the disease in organic and conventional systems in Costa Rica.

A



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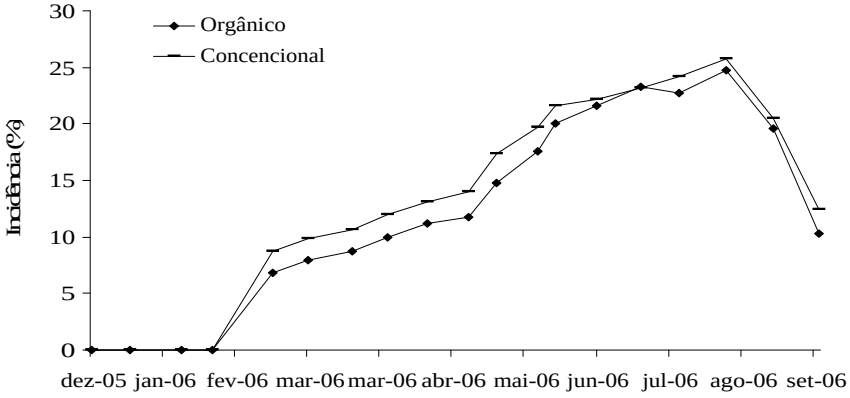
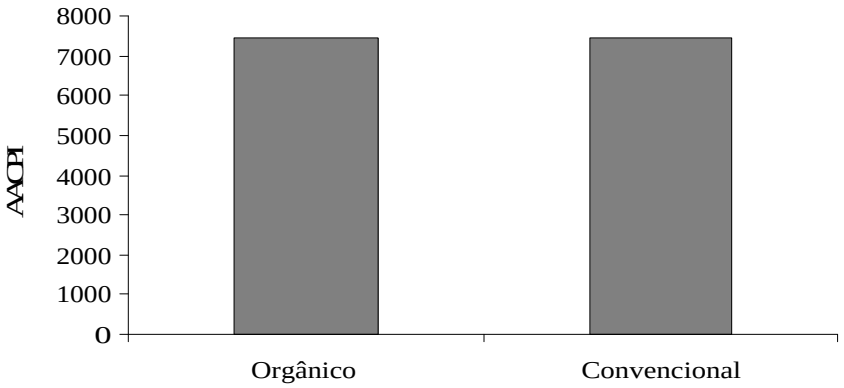


Figure 1 - Rust incidence progress curves of coffee cultivated in conventional and organic systems, in two production cycles: (A) 2004/2005 harvest and (B) 2005/2006 harvest. UFLA, Lavras, MG, 2007.



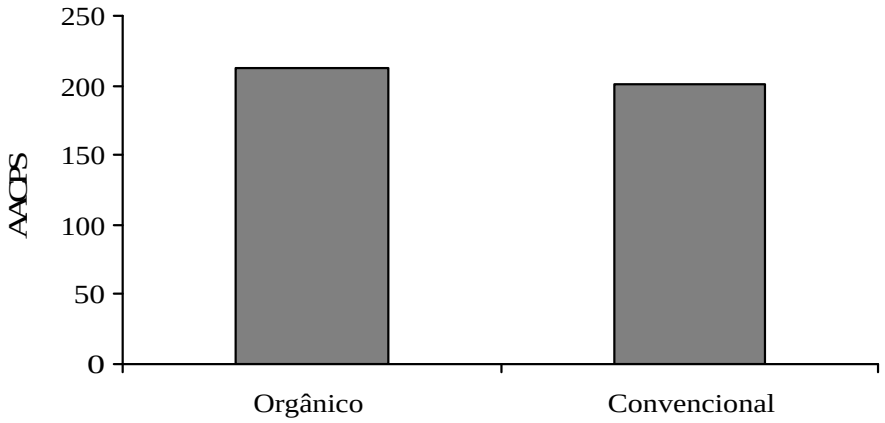


Figure 2 - Area below the rust incidence (AACPI) and severity (AACPS) curves of coffee in the conventional and organic systems, in two production cycles: 2004/2005 harvest and 2005/2006 harvest. Means followed by the same letter did not differ statistically in the *t* test (student) at a 5% probability level. UFLA, Lavras, MG. 2007.

Teixeira et al. (2005), however, observed a higher rust intensity in an organic crop, in comparison to the conventional, respectively 38% and 17%. Santos (2006) also observed a significant difference between the systems, with an incidence of 47% in the organic and of 21% in the conventional systems.

The high incidence observed in the conventional production system is due to the management of the assay. The data used to generate the figures were obtained from plots sprayed only three times with Viça-Café Plus®. Therefore, so that the same treatment could be applied to both systems, and as defensives cannot be used in organic crops, no fungicides were used in the conventional system.

Rust progress was similar in both production cycles assessed, probably due to the influence of environmental variables (Figure 3). In 2005 and 2006, there was little climate variation, according to information provided by the micro-climatological station.

Disease behavior is directly related to climate variables. Temperature has a fundamental role infection of coffee trees by the fungus *Hemileia vastatrix*, the ideal epidemic temperature remaining between 22º and 24ºC (KUSHALAPPA & MARTINS, 1980; VALE et al., 2000). In the period assessed, mean temperatures of approximately 24ºC were registered during the rainy season. Therefore, temperature does not seem to be the limiting factor behind the low disease intensity (Figure 3).

As highlighted by Kushalappa & Chaves (1980), leaf wetness may also cause higher rust germination. In this assay, a higher leaf wetness was registered in the second year (2006); however, there was no difference in the spread of the disease in the systems. Therefore, considering that climate conditions did not limit the rust occurrence and spread, the relatively low levels of the disease are attributed to low fruit load and, consequently, the low susceptibility to diseases.

Although rust severely impairs leaf development in coffee trees (CHALFOUN & ZAMBOLIM, 1985), a significant difference in leaf development was observed between the systems ($P \leq 0,05$), and a higher leaf area index was registered in the organic crop (Figure 4).

The lower disease intensity, associated to a better nutritional balance, led to a higher leaf development rate in the organic coffee, in relation to the conventional (Figure 5). According to Santos (2006), after a high rust incidence, retention or leaf replacement is better in the organic coffee.

The yield of the coffee assessed in this work corroborates the high disease intensity results found in the conventional system during the period assessed. According to Santos (2006), in the 2003/2004 harvest yield was approximately 81,8 sacks/ha for the same area; however, this was considered a year of high fruit load. In the following harvest (2004/2005), when the assays had already been installed, productivity underwent a severe reduction (32,03 sacks/ha).

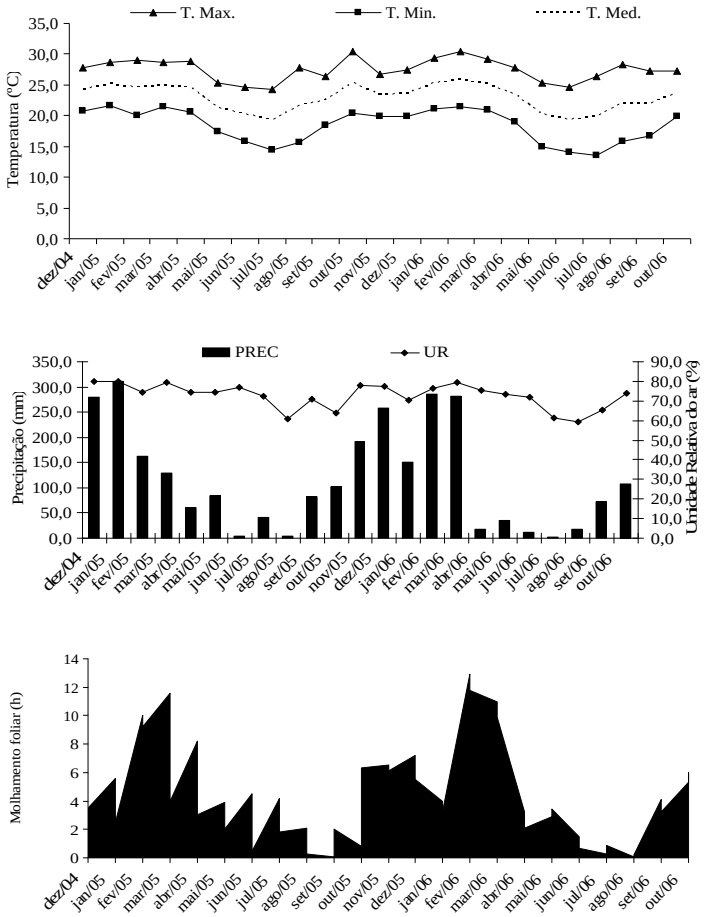


Figure 3 - Maximum (T Ma.), medium (T Me.) and minimum (T Mi.) temperature, precipitation, mean relative humidity and duration of leaf wetness, between December 2004 and October 2006. UFLA, Lavras, MG, 2007.

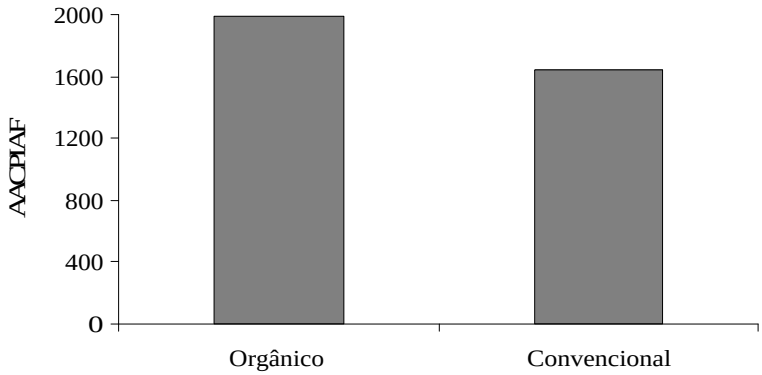


Figure 4 - Area below the leaf area index progress curve (AACPIAF) of organic and conventional production systems in two production cycles: 2004/2005 and 2005/2006 harvests. Means followed by the same letter did not differ statistically in the t test (student) at 5% probability. UFLA, Lavras, MG, 2007.

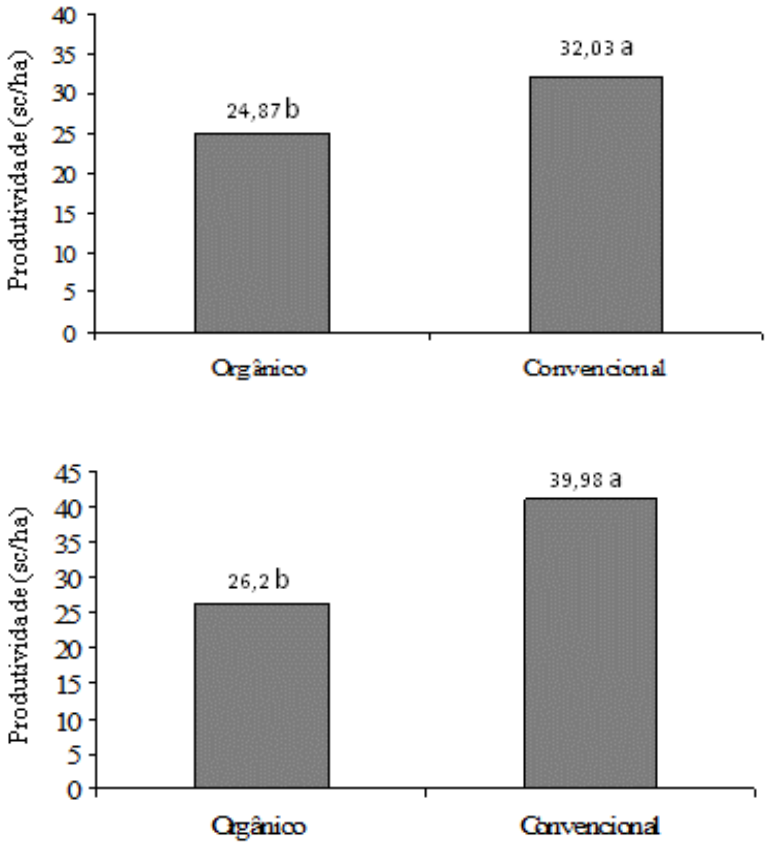


Figure 5 - Production of coffee cultivated in the organic and conventional systems, in the 2004/2005 (A) and 2005/2006 (B) harvests. Means followed by the same letter did not differ statistically in the t test (student), at a 5% probability level. UFLA, Lavras, MG, 2007.

In function of rust intensity, a similar result was found in the following harvest (2005/2006), when a higher production was expected due to the strong characteristic effect of coffee's biennual production pattern. As organic coffee production remained stable throughout the harvests, rust did not affect its results.

Regarding production, there was a significant difference between the systems. The highest productivity levels were registered for the conventional system in both harvests assessed.

It is important to highlight that defensives were not used in this work, which explains the low yield of the conventional coffee. The lack of a specific disease control may have greatly contributed to the lower productivity of the conventional system, in comparison to the previous years.

4 CONCLUSIONS

Rust progress was similar in the organic and conventional (without fungicide) systems in two consecutive production cycles.

In both systems, rust incidence peaked in August.

Coffee leaf development was influenced by fruit load and was lower in the conventional system, precisely the system with the highest load, in relation to the organic.

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