

Effect of sheep manure on coffee leaf rust

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RESUMO

Bettiol, W.; Franco, D.A. de S. Efeito do esterco de ovino na ferrugem do cafeeiro. *Summa Phytopathologica*, v.31, p.100-103, 2005.

O objetivo do trabalho foi avaliar o efeito do esterco de ovino na interação cafeeiro x Ferrugem em mudas desenvolvidas em casa-de-vegetação. As mudas de café cv. Mundo Novo foram transplantadas no estádio de orelha de onça para substratos contidos em vasos plásticos de cinco litros. O substrato foi produzido utilizando-se um Latossolo Vermelho distroférrico misturado ao esterco de ovino compostado nas concentrações de 0; 2,5; 5; 7,5; 10; 15; 20; 30; 40 e 50% (v/v). As plantas foram inoculadas três vezes, com intervalo de 90 dias, com uma suspensão (2 mg mL⁻¹) de urediniosporos de *H. vastatrix* raça II. As avaliações foram realizadas determinando-se o número de lesões por folha lesionada (NL/FL), a % de folhas lesionadas (%FL), a altura das plantas, o teor total de nitrogênio foliar, o pH, a condutividade elétrica (CE), a atividade microbiana total do substrato (FDA) e a esporulação das lesões. Tanto para o NL/FL, quanto para a %FL a resposta das mudas de cafeeiro à incorporação do esterco de

ovino no substrato foi quadrática, com o ponto de máximo em 30%, para as três inoculações. Os coeficientes de determinação das curvas quadráticas para o NL/FL foram de 0,86; 0,88 e 0,94 para a primeira, a segunda e a terceira inoculação, respectivamente; enquanto que para a %FL foram de 0,70; 0,26 e 0,86, respectivamente. Os aumentos máximos no NL/FL em relação à testemunha foram de 263,2; 400 e 157,3%, respectivamente, para a primeira, a segunda e a terceira inoculações. Também para a altura das plantas a curva de resposta quadrática foi a mais adequada, com ponto de máximo em 10%. Com o aumento na concentração do esterco de ovino ocorreu um aumento significativo e linear no teor total de nitrogênio foliar, no pH e na CE do substrato, com R²=0,87; 0,92 e 0,76, respectivamente. O esterco de ovino nas concentrações estudadas não induziu resistência à Ferrugem do cafeeiro.

Palavras-chave adicionais: Matéria orgânica, indução de resistência sistêmica, *Coffea arabica*, *Hemileia vastatrix*.

ABSTRACT

Bettiol, W.; Franco, D.A. de S. Effect of sheep manure on coffee leaf rust. *Summa Phytopathologica*, v.31, p.100-103, 2005.

The objective of the present work was to evaluate the effect of sheep manure on the development of coffee leaf rust under greenhouse conditions. The seedlings of coffee cv. Mundo Novo were obtained from a nursery planted in washed sand and transplanted at the stage of "orelha de onça" to 5-liter plastic containers containing different substrates. The substrate was obtained by mixing a Dark Red Dystroferic Latosol with 2 kg of calcareous, 5 kg of simple superphosphate and 0.5 kg of potassium chloride per m³. Composted sheep manure was added to the mixture in the concentrations of 0; 2.5; 5; 7.5; 10; 15; 20; 30; 40; and 50% (v/v). The plants were inoculated three times, with a suspension (2 mg mL⁻¹) of urediniospores of *Hemileia vastatrix* race II, in 90 days intervals. The parameters evaluated were the number of lesions per injured leaf (NL/IL), % of infected leaves (%IL), height of the plants, total foliar nitrogen, pH, electric conductivity (EC), total microbial activity in the substrate by hydrolyses of fluorescein diacetate and lesions

sporulation (LS). For the NL/IL and %IL, the response to the incorporation of sheep manure in the substrate was quadratic, reaching its maximum at 30%, for the three inoculations of urediniospores of *H. vastatrix*. The coefficients of determination of the quadratic curves for the NL/IL were 0.86; 0.88 and 0.94 for the first one, the second and third inoculation, respectively; while that for the %FL were 0.70; 0.26 and 0.86, respectively. The maximum increases in the NL/IL in relation to the control were 263.2; 400 and 157.3%, respectively, for the first, the second and third inoculations. Also for the height of the plants the curve of quadratic response was adjusted, with a maximum peak up at 10%. The increase in the concentration of sheep manure resulted in a significant and linear increase in the total foliar nitrogen, in pH and the EC of the substrate, with R²=0.87; 0.92 and 0.76, respectively. Sheep manure in the studied concentrations did not induce resistance to the coffee leaf rust.

Additional keywords: systemic induced resistance, organic matter, *Coffea arabica*, *Hemileia vastatrix*.

Among the challenges that must be overcome by organic coffee producers is the control of the crop's main disease, coffee leaf rust, caused by *Hemileia vastatrix* Berk. & Br. With the objective of improving the physical, chemical and biological soil characteristics and therefore interfering in phytosanitary problems, different sources of organic matter are being tested. The use of organic residues in agriculture dates from 50 BC; however, only starting in the 1960's there was an awakening concerning the use of organic matter aimed at inducing suppressivity to soilborne plant pathogens, and/or to plant diseases (3). Hoitink & Boehm (4) verified that this phenomenon depends on the pathosystem and on the quality of the organic material incorporated into the soil. Zhang et al. (11, 12) studied the effect of both composted organic matter incorporated into the substrate, and its water extract, on the induction of acquired systemic resistance on cucumber and *Arabidopsis thaliana*. The potential for inducing resistance to pathogens shown by organic matter could be relevant for integrated disease management. The mechanisms involved in the induction of resistance through the use of organic matter are not completely understood, but Zhang et al. (12) verified an increase in the activities of protein β -1.3 glucanase and peroxidase on cucumber and *Arabidopsis*. This demonstrates that organic matter induces plants to defend against certain pathogens, by activating biochemical pathways of defense metabolism. The action of rhizosphere microorganisms should also be considered, as demonstrated by Silva et al. (9) and Liu et al. (5). The minerals resulting from organic matter decomposition can play important roles on plant metabolism, influencing, in addition to plant development, responses to certain plant pathogens.

The use of organic matter incorporated into the soil in order to control foliar diseases could potentially become an agricultural practice. However, the phenomenon by which the host is modified must be known. Thus, we aimed to obtain information about the effect of sheep manure on the interaction coffee plant \times coffee leaf rust, in seedlings grown in the greenhouse, since the induction of resistance to foliar diseases conferred by organic matter sources could result both from alterations in the composition and activity of the microbiota, and from physical and chemical soil characteristics, as well as from balanced plant nutrition (2, 3).

The study was conducted with cv. Mundo Novo coffee seedlings, IAC line 388-17, physiological group E. The seedlings were transplanted to substrates kept in five-liter plastic pots at the cotyledon stage (known as the "orelha-de-onça" stage). The substrate was prepared with a Dark Red dystroferic Latosol (sifted through a 1 cm² mesh sieve and mixed with 2 kg lime, 5 kg single superphosphate and 0.5 kg KCl per m³ soil), mixed to composted sheep manure (OM=661, C=384, N=27.5, P=6.3, K=16.9, Ca=12.1, Mg=7.3, and S=4.0 g kg⁻¹; B=43.1, Cu=36.8, Fe=3,352, Mn=486 and Zn=114 mg kg⁻¹; Moisture=24.7%; Density=0.357 g cm⁻³; C:N=14:1; and pH=8.5), at the concentrations of 0; 2.5; 5; 7.5; 10; 15; 20; 30; 40; and 50% (v/v). The experimental design consisted of random blocks, with ten replicates and one plant per replicate. The plants developed on the substrates for eight months, and showed six to eight pairs of leaves when the first inoculation with *H. vastatrix* urediniospores was performed. Plant inoculation (suspension containing 2 mg *H. vastatrix*

urediniospores, strain II, per mL) was performed using a sprayer attached to a compressor at a 20 cm distance from the adaxial surface of the leaves. After inoculation, the plants were incubated in a humid and dark chamber at 25°C and 90-95% RH for 24 hours and then returned to greenhouse conditions. To evaluate the effect of time, three inoculations spaced 90 days apart were performed on the same plants; all inoculations were performed on young leaves. Disease evaluation was performed about 25 days after inoculation; determinations included: number of lesions per injured leaf (NL/IL), percentage of infected leaves (%IL), and percentage of sporulated lesions per injured leaves (LS). On the same day of disease evaluation, the height of each plant (cm) was determined, from the soil surface in the pot to the apical bud in the central stem. The following rating scale was adopted to evaluate the percentage of sporulated lesions per injured leaves: (0) no sporulation, (1) >0 to 25%, (2) >25 to 50%, (3) >50 to 75% and (4) >75% sporulated lesions. This evaluation was performed only for the first inoculation, one, seven, and 16 days after the appearance of lesions. Soon after evaluating disease symptoms in the first inoculation, the pH, electrical conductivity, moisture content and microbial activity were determined in the substrates by means of fluorescein diacetate hydrolysis (FDA) (1). The total nitrogen leaf content was also determined.

The response of the coffee seedlings to sheep manure incorporation in the substrate was quadratic, both for number of lesions per injured leaf and for percentage of injured leaves, with maximum response at 30%, for the three *H. vastatrix* inoculations. The coefficients of determination of the quadratic curves for NL/IL were 0.94; 0.88 and 0.86 for the first, second and third inoculations, respectively, while for %IL they were 0.70; 0.26 and 0.86, respectively (Figure 1). With regard to the control treatment, it was observed that the sheep manure incorporated into the soil and tested with respect to its ability to promote coffee leaf rust control only caused a reduction in the number of lesions per injured leaf (19.5 and 35.7%, respectively) and in % of injured leaves (20.5 and 35.6%, respectively) at the concentrations of 40 and 50% in the third inoculation (Figure 1). The maximum increases in NL/IL in relation to the control were 263.2; 400 and 157.3%, respectively, for the first, second and third inoculations. Possibly, the sheep manure in the substrate did not develop microbial activity that would stimulate modifications in the plant's defense mechanisms, inducing systemic resistance against the disease, as in results obtained by Zhang et al. (11, 12). The microbial activity determined by fluorescein diacetate hydrolysis did not show correlation with the increase in manure concentration in the substrate (Figure 1).

The percentage of sporulated lesions was negatively correlated with manure concentration in the substrate, with $r=0.72$; 0.88; and 0.94, for evaluations performed one, seven, and 16 days after the appearance of lesions, respectively. The ratings for percentage of sporulated lesions from plants grown on substrates with manure concentrations of 40 and 50% in evaluations performed seven and 16 days after the appearance of lesions were lower than 1 and 2, respectively, statistically differing from the other concentrations which, in general, were higher than 1.7 and 3, respectively. These data demonstrate that, despite the fact that no reduction in NL/IL and %IL occurred after the first inoculation of urediniospores, there was

a reduction in sporulation at high concentrations of sheep manure in the substrates. This information is interesting from an epidemiological perspective, since a delay in the sporulation of lesions was obtained, thus decreasing the production of inoculum and secondary coffee leaf rust cycles. However, this information must be confirmed under ecological growing conditions.

The quadratic response curve was the most suitable for plant height, with maximum response at 10% (Figure 1). Phytotoxicity occurred beyond that concentration, and at 50%

sheep manure in the substrate death occurred for 20% of the seedlings. Significant and linear increases in total leaf nitrogen content, pH, and substrate electric conductivity occurred as manure concentration increased, with $R^2=0.87$; 0.92 and 0.76, respectively (Figure 1). The N contents in the control and in the 2.5% concentration treatment were considered adequate (26 to 30 g kg⁻¹), while the other contents were deemed as pertaining to the excess class (>30 g kg⁻¹) (6). According to Sander & Heitefuss (8), under excess of nitrogen, competition between the primary and secondary metabolic pathways will occur, favoring quick plant development, and phenylalanine will be preferentially directed toward protein synthesis rather than to the synthesis of phenylalanine-ammonia-lyase, which is related to plant resistance to diseases. In the case of foliar diseases, other factors influence the disease process. Unbalanced nutrition, as was the case with the excess nitrogen, may stimulate or harm development of the plants, as well as development of the pathogens (2). According to Zambolim & Ventura (10), with regard to rusts, nitrogen nutrition tends to increase the severity of attack, while the contrary occurs with

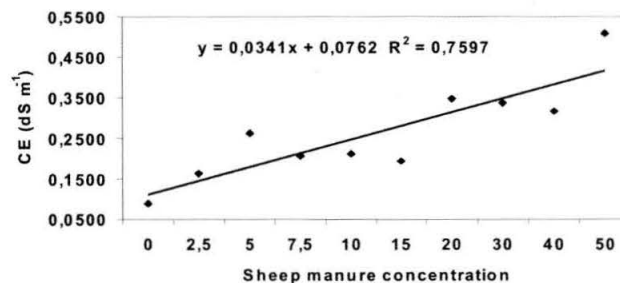
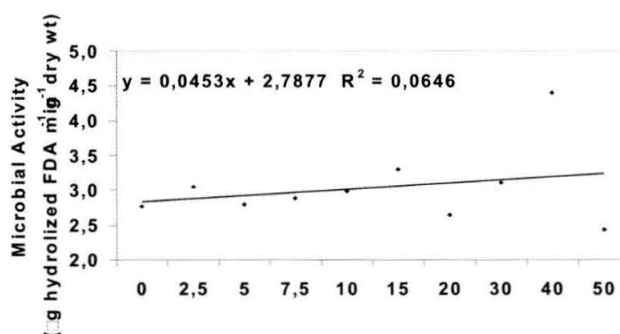
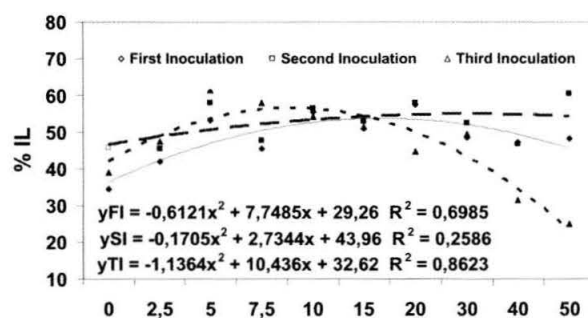
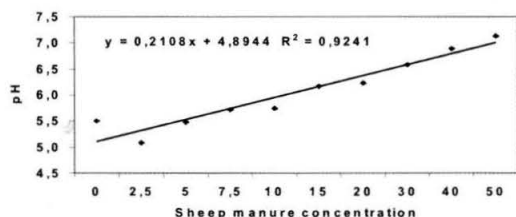
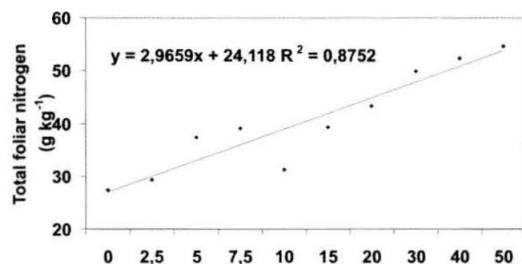
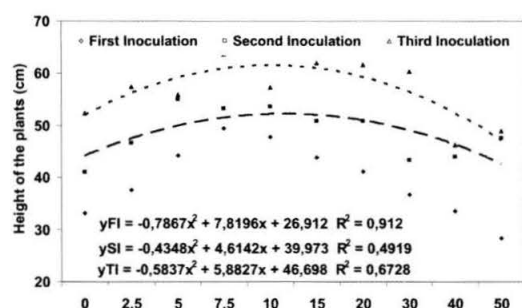
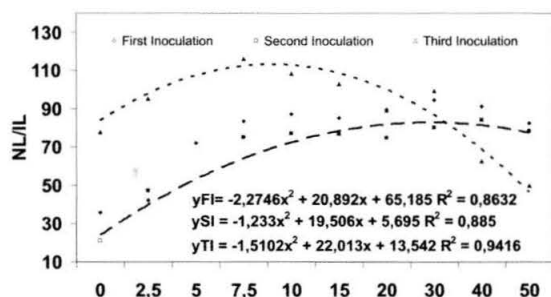


Figure 1. Effect of sheep manure on the number of lesions per injured leaf (NL/IL), percentage of injured leaves (%IL), and coffee seedling height in three *Hemileia vastatrix* inoculations; and on seedling total nitrogen leaf content, pH, electric conductivity, and total microbial activity (FDA) in the substrate where the coffee seedlings developed after the first inoculation.

potassium. With respect to brown eye spot caused by *Cercospora* in coffee seedlings, Pozza et al. (7) have reported a smaller intensity of the disease when the seedlings were grown on a substrate containing 80% cattle manure and 20% subsoil dirt fertilized with a slow-release fertilizer.

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