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Manure effect on the incidence of rose diseases in the Integrated Production System

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ABSTRACT

Deficiency, excess or imbalance in the combinations of nutritional elements can influence the response of plants to pathogen infection by either increasing the level of defense or favoring the occurrence of diseases. The rose is susceptible to several pathogens and the consumer market requires flower stalks with no level of damage. Therefore, in the production of roses the application of pesticides is performed in a preventive and intensive way, which causes environmental contamination. This study evaluated the effects of chemical fertilization management and intercropping with green manure on the incidence and severity of downy mildew and powdery mildew in rosebushes grown in an Integrated Production System. The experiment was conducted in a greenhouse with 'Carolla' rosebushes. The experimental design was a randomized block with split plot in space, with eight treatments and four replications. The treatments consisted of four percentages of chemical fertilizer (25%, 50%, 75% and 100%), based on fertilization recommended for culture of rosebushes in the state of Minas Gerais, versus the presence or absence of green manure (*Calopogonium mucunoides*). Treatments that did not receive 100% of the chemical fertilizer had been incremented with two types of bio-fertilizers applied monthly, Bokashi (16 g/plant, applied to soil) and Supermagro (5% applied to leaves). Assessments of disease were carried out weekly on the central leaves of the productive flower stalks. In the integrated management of disease, preventive applications were made with alternative products and biological pesticides, such as neem oil (*Azadirachta indica*), sodium bicarbonate, bordeaux mixture, infusion of *Equisetum* sp., raw milk, silicon and bio-fertilizers. The alternative pesticides were efficient; however, despite reducing the frequency of application, spraying with chemical pesticides was necessary. None of the treatments related to chemical fertilization and intercropping with green manure influenced the incidence and severity of downy mildew and powdery mildew in 'Carolla' rosebushes.

Keywords: *Rosa* sp., sustainability, certification, downy mildew, powdery mildew.

RESUMO

Efeito da adubação na incidência de doenças em roseiras cultivadas no Sistema de Produção Integrado

A deficiência, excesso ou desequilíbrio nas combinações de elementos nutricionais pode influenciar a reação das plantas à infecção por patógeno de forma a aumentar o nível de defesa ou favorecer a ocorrência de doenças. A roseira é suscetível a diversos patógenos e o mercado consumidor requer hastes florais sem nenhum nível de dano. Por isso, na produção de rosas, a aplicação de defensivos químicos é realizada de forma preventiva e intensiva, o que causa contaminações ambientais. Este trabalho teve como objetivo avaliar o manejo da adubação química e orgânica na incidência e severidade de oídio e míldio em roseiras cultivadas em sistema de produção integrada. O experimento foi realizado em casa de vegetação com o cultivo de roseiras 'Carolla'. O delineamento experimental utilizado foi o de blocos casualizados, com parcelas subdivididas no espaço, com oito tratamentos e quatro repetições. Os tratamentos foram constituídos de quatro porcentagens de adubação química recomendada para a cultura em Minas Gerais, Brasil (25%, 50%, 75% e 100%) versus presença ou ausência de adubo verde (*Calopogonium mucunoides*) plantado em consórcio com a roseira. Os tratamentos que não receberam 100% de adubação química foram incrementados com 2 tipos de biofertilizantes aplicados mensalmente: Bokashi (16 g/planta, via solo) e Supermagro (5% aplicado via foliar). As amostragens para a avaliação de míldio e de oídio foram feitas semanalmente nos folíolos das folhas centrais do ramo produtivo da planta. No manejo integrado de doenças, foram realizadas aplicações preventivas com produtos alternativos e defensivos biológicos: óleo de nim (*Azadirachta indica*), bicarbonato de sódio, calda bordalesa, infusão de cavalinha (*Equisetum* sp.), leite cru, silício e biofertilizantes. Os defensivos alternativos foram eficientes, entretanto, apesar da redução da frequência de aplicações, as pulverizações com defensivos químicos foram necessárias. Nenhum dos tratamentos relacionados às adubações química e orgânica influenciou na incidência e severidade de míldio e oídio.

Palavras-chave: *Rosa* sp., sustentabilidade, certificação, míldio, oídio.

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Brazil has emerged as a major rose producing country, which exports to Netherlands, United State of America and Portugal. The rosebush has a high nutritional requirement, because the harvest of flower stalks is continuous, requiring frequent replacement of nutrients (Almeida *et al*., 2013). As a result, many farmers overestimate fertilizer amounts to the point as to cause soil salinity in the areas of production. Associated with this, to avoid loss of quality flowers, it is common to see exaggerated preventive spraying of pesticides, exposing field workers, consumers and the environment to the problems that these products can cause, such as allergies, intoxication and contamination of soil and groundwater. In addition to the environmental consequences, the flowers contaminated with pesticides, even if not ingested, are harmful to health, because skin contact is also a way of contamination for field workers, the floral artist who prepares the bouquets and arrangements, and the final consumer (Almeida *et al*., 2014).

The growing concern for the preservation and conservation of the environment has influenced the search for technologies for deploying production systems with an ecological approach, profitable and socially just (Fontanétti & Santos, 2010). An Integrated Production System is an alternative that includes the requirements for sustainable agriculture. To have sustainability of agricultural activities, the rules to be followed must ensure the careful use of natural resources, minimizing the use of pesticides and other inputs. The requirement for the seal of Integrated Production and demand for certification of products related to the floriculture sector are increasing. Certification of rose production in Brazil facilitates the export of flowers, adding commercial value to this product (Brasil, 2009).

The integrated management of diseases within integrated production has been treated as the use of control methods in an organized way, with a cumulative effect and economic viability, aiming to reduce the use of pesticides, while ensuring production, where the ecological and waste aspects of these products are in first place (Vida *et al.*, 2004).

The management of chemical and organic manure can influence the incidence and severity of disease. Green manure changes the biological activity of soil as it provides nutrients for plants and regulates the metabolic activity associated with plant resistance to attack by pathogens. Most green manure is used to increase the availability of nitrogen and other nutrients such as phosphorus and potassium. Nitrogen fixation through N-fixing bacteria greatly increases the levels of N in the soil. Green manure can have a significant effect on the development of the disease; in addition, can affect the availability of other nutrients such as phosphorus, manganese and zinc, which can affect the tolerance of plant disease (Cherr *et al.*, 2006).

Mineral nutrients can increase or decrease the resistance of plants to diseases due to its effect on growth, morphology, anatomy and chemistry of the plant (Marschner, 1995). Among the nutrients, nitrogen and potassium play an important role. Excess of nitrogen can increase and potassium can reduce the susceptibility of plants to diseases (Huber & Thompson, 2007).

In commercial production of ornamental plants quality and health of the final product are of great importance for the success of the activity. The rosebush is characterized by being affected by many diseases that reduce or lose its commercial value. The main diseases affecting this crop are anthracnose (*Sphaceloma rosarum*), cercosporiose (*Cercospora* sp.), rose rust (*Phragmidium rosae*), downy mildew (*Peronospora sparsa*), powdery mildew (*Sphaerotheca pannosa*), gray mold (*Botrytis cinerea*) and black spot (*Diplocarpon rosae*) (Imenes & Alexandre, 2003).

Downy mildew is one of the most important and common diseases of rosebushes. It has a high destructive potential and can cause serious damage for the growers. Powdery mildew is also a disease of great economic importance, because of its rapid spread through the culture. It may cause severe defoliation affecting production and flower stalks quality (Imenes & Alexandre, 2003).

The aim of this study was to evaluate the management of chemical fertilization and intercropping with green manure (*C. mucunoides*) on the incidence and severity of diseases in rosebushes grown in an Integrated Production System.

MATERIAL AND METHODS

The experiment was conducted at the Experimental Farm Risoleta Neves, the Agricultural Research Enterprise of Minas Gerais State, located in São João Del Rei, Minas Gerais State, Brazil, using the rules of the Integrated Production System (Fráguas *et al.*, 2001). 'Carolla' rose graftings were planted in a greenhouse, in beds at 15 cm in height, in single rows spaced 1.20 m between rows and 0.20 m between plants.

The experimental design was randomized complete blocks, in split plot arrangement in space, with eight treatments and four replications, in factorial scheme 4x2 [4 percentages of chemical fertilizer x 2 (presence and absence) of green manure]. Four percentages of chemical fertilizer (NPK 13-40-13), calcium nitrate, potassium nitrate, magnesium sulfate, urea and a formulated of micronutrients) (25%, 50%, 75% and 100%), based on fertilization recommended for culture of rosebush in the state of Minas Gerais versus presence and absence of a intercropping with green manure (*C. mucunoides*) were used. Plants submitted to 100% of chemical fertilizer (recommendation for the culture of rosebushes in the state of Minas Gerais) received, per hectare, 80 kg N, 300 kg P_2O_5 and 240 kg K_2O and monthly applying 60 kg N, 35 kg P_2O_5 and 60 kg K_2O (Comissão, 1999). All treatments received 10 kg/linear meter of cattle manure, both at planting and every three months. Treatments that did not receive 100% of chemical fertilizer were augmented with two types of biofertilizers applied monthly, Bokashi (16 g/plant, applied to the soil) and Supermagro (5% applied to leaves). Plots of 3 m² were composed of three rows with six plants each, totaling 18 plants per plot and the six central plants

were deemed as useful plot.

For disease evaluations, samples were taken weekly, during six months, from the central leaves of the productive branches. The incidence was determined by the presence and absence of leaves with injury in the experimental unit. For the assessment of disease severity were used diagrammatic scales proposed by Pasini *et al.* (1997). The average rates of incidence and severity were observed in the transformed area under the curve of progress and severity (AUCPSD) and incidence (AUCPID) of diseases to the rosebush, determined by the equation proposed by Shaner & Finney (1977).

RESULTS AND DISCUSSION

In the integrated management of diseases, preventive applications were made with alternative products and biological pesticides such as neem oil (*A. indica*), sodium bicarbonate, bordeaux mixture, infusion of *Equisetum* sp., raw milk, silicon and bio-fertilizers. The alternative pesticides were moderately efficient; however, despite reducing the frequency of application, spraying with chemical pesticides was necessary.

The control of plant diseases in a greenhouse is a complex task, measures should be integrated into a flexible system that is compatible with the production systems used, as well as economically viable. These measures use methods already available; many are routinely used by farmers with the philosophy that the health of crops should not rely on a single strategy (Bergamin Filho & Amorim, 1996).

Zambolim & Ventura (1993) suggested that the grouping of those integrated management strategies aimed at reducing initial inoculums and the rate of disease progression according to the pathosystem. Bioactive natural products are already part of the portfolio of conventional management of diseases. Products that are usually employed in organic agriculture are gaining ground, and are used alone or in combination with pesticides (Dayan *et al.*, 2009).

In this study the diseases that have emerged in the cultivation of rosebushes were downy mildew, powdery mildew, mosaic and black spot, but those with the greatest intensity were downy and powdery mildew. The different levels of fertilization and the presence or absence of green manure did not interfere in the incidence and severity of powdery mildew and downy mildew (Table 1).

Nutrients affect disease tolerance and resistance of plants to pathogens (Dordas, 2008). However, there are many factors that favor disease severity, such as crop rotation, green manure, bio-fertilizers and manure, mineral fertilization, liming, tillage, irrigation, mulching and so on. Many of these practices interfere in the level of nutrients available to the plant and the pathogen, which may influence disease severity.

Green manure interferes with infection incidence, as observed by Cherr *et al.* (2006), but was not observed in this study because there were no differences between presence and absence of green manure.

Generally, adequate levels of nutrients are required to maintain high resistance to diseases (Huber & Haneklaus, 2007). An example is the leaf application of phosphorus which induces local and systemic protection against downy mildew on rosebushes. In grapevines, reducing the severity of powdery mildew occurred with high levels of nitrogen, phosphorus and potassium fertigation. This effect was attributed mainly to phosphorus, which increased the level of resistance to the pathogen.

Table 1. Effect of various chemical fertilization levels, presence and absence of green manure (*Calopogonium mucunoides*), in the area under the curve of progress and severity (AUCPSD) and incidence (AUCPID) of downy mildew (*Peronospora sparsa*) and powdery mildew (*Sphaerotheca pannosa*) in rosebushes {efeito de diferentes níveis de fertilização química, presença e ausência de adubação verde (*Calopogonium mucunoides*), na área abaixo da curva do progresso da severidade (AUCPSD) e da incidência (AUCPID) do míldio (*Peronospora sparsa*) e oídio (*Sphaerotheca pannosa*) em roseiras}. São João Del Rei, EPAMIG, 2011.

Chemical fertilization (%)	AUCPID					
	Green manure		Average	Green manure		Average
	Presence	Absence		Presence	Absence	
100	0.5348[1] a	0.4996 a	0.5172 A	2126.3 a	2429.6 a	2277.9 A
75	0.4083 a	0.4052 a	0.4067 A	2289.6 a	2245.8 a	2267.7 A
50	0.3794 a	0.4346 a	0.4070 A	2359.6 a	2210.8 a	2285.2 A
25	0.4406 a	0.5028 a	0.4717 A	2323.1 a	2450.0 a	2386.5 A
Average	0.4407a	0.4605 a		2274.6 a	2334.0 a	
	AUCPSD					
100	0.4469[1] a	0.4132 a	0.4300 A	1655.2 a	2043.1 a	1849.1 A
75	0.2792 a	0.3477 a	0.3134 A	1808.3 a	1996.5 a	1902.4 A
50	0.3125 a	0.3244 a	0.3184 A	1677.1 a	1876.9 a	1777.0 A
25	0.3188 a	0.3535 a	0.3361 A	1706.2 a	2041.7 a	1873.9 A
Average	0.3393 a	0.3597 a		1711.7 a	1989.5 a	

[1]Means with same lowercase letter (in the row) and capital letter (in the column) do not differ at 5% by Tukey test. (médias com letras minúsculas na coluna e letras maiúsculas na linha não diferem, Tukey, 5%)'

Develash & Sugha (1997) observed that increasing amounts of potassium delayed the development of powdery mildew on onions. They also verified that increasing amounts of nitrogen was correlated with the variation in severity of powdery mildew on onions. Pozza & Pozza (2003) stated that the reduction of the inoculum and the rate of disease progress can be achieved through the availability of nutrients or by direct supply of nutrients, or by cultural practices that enhance absorption or interaction with the environment.

The predisposition to disease occurs with plants grown in greenhouses because of the techniques used in order to provide them with nutritional conditions to express its maximum productive potential, however, this factor provided more favorable conditions for many pathogens.

The adoption of Integrated Production System of rosebushes brought back the use of traditional and important control methods adapted to local conditions. Alternative and natural pesticides applied at the right time control plant diseases and at the same time contribute to the sustainability of production, reducing dependency on foreign agrochemicals.

Neither percentages of mineral fertilization either intercropping with green manure (*C. mucunoides*) affect the incidence and severity of powdery mildew and downy mildew in 'Carolla' rosebushes.

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