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Soil amendment with chopped or ground dry leaves of six species of plants for the control of *Meloidogyne javanica* in tomato under greenhouse conditions

Incorporação ao solo de folhas secas picadas ou moídas de seis espécies de plantas para o controle de *Meloidogyne javanica* em tomateiro em casa de vegetação

Everaldo Antônio Lopes[I] Silamar Ferraz[II] Paulo Afonso Ferreira[II] Leandro Grassi de Freitas[II] Rosangela Dallemole-Giaretta[III]

ABSTRACT

Greenhouse experiments were conducted to evaluate the effect of soil amendment with chopped (1cm²) or ground (1mm sieve) dry leaves of assa-peixe *(**Vernonia polyanthes**), lemon-grass (**Cymbopogon citratus**), eucalyptus (**Eucalyptus citriodora**), castor (**Ricinus communis**), mango (**Mangifera indica**) or neem (**Azadirachta indica**) for the control **Meloidogyne javanica**. Into the soil (Yellow red oxisol) of each pot were added leaves (5g kg⁻¹ of soil) and 5,000 eggs of the nematode. After seven days, one tomato seedling "Santa Cruz Kada" was transplanted to each pot. The tomato root weight, galls and eggs/root system were determined 60 days after transplant. None of the soil amendments reduced gall or eggs, when applied as leaf pieces. However, all tested plant species reduced the gall number, when they were incorporated into the soil as powder, and maximum nematode suppression occurred in soil amended with neem leaves (61%). The amendment with ground leaves of castor, neem, eucalyptus and lemon-grass reduced the number of eggs, with maximum reduction occurring in soil amended with ground castor leaves (69%), evidencing that these organic amendments can be an alternative for **M. javanica** control in tomato. Further studies are required under field conditions to confirm the potential of these organic amendments on the control of **M. javanica**.*

Key words: *root-knot nematodes, organic amendment, castor, neem, eucalyptus, lemon-grass, mango and* assa-peixe.

RESUMO

*Experimentos em casa de vegetação foram conduzidos com o objetivo de avaliar o efeito da adição ao solo de folhas secas picadas (1cm²) ou trituradas (peneira de 1mm) de assa-peixe (**Vernonia polyanthes**), capim-limão (**Cymbopogon citratus**), eucalipto (**Eucalyptus citriodora**), mamona (**Ricinus communis**), manga (**Mangifera indica**) ou nim (**Azadirachta indica**) para o controle de **Meloidogyne javanica**. Ao solo de cada vaso (latossolo vermelho-amarelo), foram adicionadas folhas (5g kg⁻¹ de solo) e 5.000 ovos do nematoide. Após sete dias, uma muda de tomateiro "Santa Cruz Kada" foi transplantada em cada vaso. O peso das raízes e os números de galhas e de ovos foram avaliados 60 dias após o transplantio. As folhas picadas de nenhuma planta reduziram o número de galhas e de ovos. Entretanto, as folhas de todas as plantas estudadas reduziram o número de galhas quando foram incorporadas ao solo na forma de pó e a máxima supressão foi obtida com as folhas de nim (61%). A adição ao solo de folhas trituradas de mamona, nim, eucalipto e capim-cidreira reduziu o número de ovos, com redução máxima após aplicação de folhas de mamona (69%), indicando que esses materiais orgânicos podem ser uma alternativa de controle de **M. javanica** em tomateiro. Novos estudos devem ser realizados em condições de campo para confirmar o potencial desses materiais orgânicos no controle de **M. javanica**.*

Palavras-chave: *nematoide-das-galhas, material orgânico, mamona, nim, eucalipto, capim-cidreira, manga e assa-peixe.*

INTRODUCTION

The plant nematodes are among major groups of plant pathogens, and their effective control is essential for profitable production of certain crops

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(HALBRENDT & LAMONDIA, 2004). Nematicides provide efficient control measure, but their use is very restricted and has been declining drastically during last few years, especially due to high toxicity to mammalians, long persistence in the ecosystem, and high costs (AKHTAR & MALIK, 2000; FERRAZ & FREITAS, 2004). Because several major nematicides have been withdrawn from the market, there is an intensive search for alternative and sustainable control measures, especially those based on the use of biocontrol agents and soil amendments with organic matter (AKHTAR & MALIK, 2000; NICO et al., 2004).

The practice of adding organic matter to soil to increase yield is as old as the agriculture itself (AKHTAR & ALAM, 1993) and has been successfully explored to control some plant parasitic nematodes (FERRAZ & FREITAS, 2004). The mechanisms of nematode population reduction by soil amendments with organic matter involve stimulation of antagonistic microorganisms, liberation of secondary volatile or not-volatile phytochemicals with nematicidal properties. Besides, the amendments improve the growth of the plants and hence increase the tolerance and plant resistance to nematodes (CHAVARRÍA-CARVAJAL & RODRÍGUEZ-KÁBANA, 1998). Soil amendment with the aerial portion of certain plant species has been reported. LINFORD et al. (1938) were the first to report such a phenomenon by amending soil with chopped pineapple leaves (***Ananas comosus*** L.) to control ***Meloidogyne*** spp. in cowpea (***Vigna unguiculata*** L.) Walp.).

The nematicidal effect of plants, such as neem (***Azadirachta indica*** A. Juss.) and castor (***Ricinus communis*** L.), is well known (AKHTAR & MALIK, 2000), but many other plant species need to be studied and investigated. The objective of the following study was to assess the potential of amending the soil with the leaves of castor, neem, *assa-peixe* (***Vernonia polyanthes*** Less), mango (***Mangifera indica*** L.), eucalyptus (***Eucalyptus citriodora*** Hook) and lemon-grass (***Cymbopogon citratus*** (DC.) Stapf) on the control of ***Meloidogyne javanica*** (Treub) Chitwood in tomato (***Solanum lycopersicum*** L.) plants.

MATERIAL AND METHODS

The inoculum of ***M. javanica*** consisted of eggs extracted from a pure population of the nematode raised and maintained on the tomato in a greenhouse. The eggs were extracted from the infected roots according to the modified technique of HUSSEY & BARKER (1973) and BONETI & FERRAZ (1981).

The leaves of plants commonly found in the rural areas around the city of Viçosa, Minas Gerais, were harvested and allowed to dry on greenhouse benches. The plants used were castor, neem, *assa-peixe*, mango, eucalyptus and lemon-grass. The study was conducted in two bioassays (independent experiments conducted on different dates). In the first bioassay, the dried leaves were manually cut to about $1cm^2$ pieces, while in the second bioassay the leaves were mechanically ground to pass 1mm sieve.

For both bioassays, methyl bromide ($80cm^3$ m^{-3}) treated 1:1 mixture of soil (Yellow red oxisol) and sand was used as substrate for plant growth. The plant materials were mixed with dry soil at the rate of $5g\ kg^{-1}$ of soil, equivalent to $10ton\ ha^{-1}$. For mixing, two kilogram of soil and the leaves were placed in a 5L capacity plastic bag, and after tying, the bag was vigorously shaken manually. Similarly treated soil without amendments served as control. The soil then was placed into 2L capacity pots, where it was infested by mixing 5mL of a suspension containing 5,000 eggs of the nematode. The soil was watered and maintained at field capacity for seven days, before transplanting one tomato seedling of cv. "Santa Cruz Kada" (one-week old) to each pot. The pots were arranged on a greenhouse bench according to a completely randomized design with seven replicates. The plants were fertilized and irrigated as required. Fresh root weight and number of galls and eggs/root systems were evaluated 60 days after transplant.

During the first bioassay (from March 23 to May 23, 2007), the mean maximum, and the mean minimum temperatures were 30°C and 14°C, respectively, and 27°C, 9°C, respectively, during the second bioassay (from April 30 to June 30, 2007).

The data of fresh root weight and number of galls and eggs/root systems from the two bioassays were subjected to a one-way analysis of variance (ANOVA), and when required were compared using the Fisher's LSD test. All analyses were performed using STATISTICA statistical package (STATSOFT, 2004).

RESULTS AND DISCUSSION

In the first bioassay, the soil amendments with any of the plants (pieces) leaves did not affect the root weight of tomato plants, neither the gall or egg number/ tomato root system (Table 1). On the other hand, when the soil was amended with ground leaves, the number of galls per root system was significantly ($P<0.05$) less than in the control plants (Table 2). Although ground leaves of all the plants reduced the gall number, maximum suppression occurred in soil amended with neem leaves (61%). The amendment with ground leaves of castor, neem, eucalyptus and lemon-grass also significantly reduced the number of eggs/ root system, with maximum reduction occurring in soil amended with ground castor leaves (69%). None of

Table 1 - Effect of the incorporation into the soil of pieces of dried leaves of six plant species on the tomato root weight, number of galls and eggs of ***Meloidogyne javanica***, 60 days after transplanting tomato seedlings.

Plant species	Root weight (g)	Galls/root system	Eggs/root system
Ricinus communis	15.7 ^{ns}	1,498 ^{ns}	677,333 ^{ns}
Azadirachta indica	16.9	1,371	1,248,504
Vernonia polyanthes	17.6	1,378	1,245,429
Mangifera indica	17.9	1,800	1,300,095
Eucalyptus citriodora	19.3	1,399	1,205,712
Cymbopogon citratus	20.1	1,626	962,857
Control	19.2	1,857	1,349,667

Each value is mean of seven replicates; ^{ns}: not significant at P=0.05

the soil amendments affected the root weight of tomato plants.

The use of soil amendments with organic matter to control nematode populations has been reported by several researchers (FERRAZ & FREITAS, 2004; HALBRENDT & LAMONDIA, 2004). Similarly, the results of soil amendment with neem and castor leaves achieved in this study also corroborate with those of others (AKHTAR & ALAM, 1990; AKHTAR et al., 1990). Neem has been controlled several species of plant nematodes, and the effect has been attributed mainly to azadirachtin, nimbin, salannin, nimbidin, thionemone, and meliantrol (AKHTAR & MALIK, 2000; FERRAZ & FREITAS, 2004). Ritzinger & McSorley (1998) amended the soil with different quantities of dry castor leaves and concluded that application at the rate 0.5% was sufficient to significantly reduce the population of ***M. arenaria*** Neal (Chitwood). The mode of action of the castor leaves is not clear yet. The nematicidal properties of castor plant have been attributed to ricin (RICH et al., 1989), a substance found only in the seeds (MOSHKIN, 1986). Further investigations are needed to evaluate the nematicidal potential of substances found in the castor leaves, such as the alkaloid ricinine (MOSHKIN, 1986).

Soil amendment with the leaves of lemon-grass, a medicinal plant, for nematode management has not been reported before. However, *in vitro* studies have shown that its extracts are nematicidal (SIDDIQUI & HUSSAIN, 1990; SWEELAN, 1989). SWEELAN (1989) showed that application of lemon-grass extract into the soil reduced the soil population and number of egg masses of the ***M. javanica*** in tomato roots by more than 50%. ***Cymbopogon*** spp. are rich in citral, geraniol, and citronelol, which have good nematicidal activity (SANGWAN et al., 1985, 1990).

This study also showed that the efficacy of soil amendments with certain plant species can be considerably influenced by the granulometry of the residues, such as observed in the bioassays. The use of leaf pieces did not show any nematode control, while control was significant when the same materials were applied as powder. The mode of action of soil amendment with plant materials is complex and dependent upon type and quantity (McSORLEY & GALLAHER, 1995; RITZINGER & McSORLEY, 1998; LOPES et al., 2005). Further studies are required under field conditions to confirm the potential of ground leaves of castor, neem, eucalyptus and lemon-grass on the control of ***M. javanica***.

Table 2 - Effect of the incorporation into the soil of powder of dried leaves of six plant species on the tomato root weight, number of galls and eggs of ***Meloidogyne javanica***, 60 days after transplanting tomato seedlings.

Plant species	Root weight (g)	Galls/root system*	Eggs/root system*
Ricinus communis	16.7 ^{ns}	363 cd	118,067 d
Azadirachta indica	15.0	278 d	118,800 cd
Vernonia polyanthes	18.3	534 b	316,617 ab
Mangifera indica	15.3	427 bc	243,833 ab
Eucalyptus citriodora	16.2	421 bc	207,533 b
Cymbopogon citratus	16.5	447 bc	181,317 bc
Control	18.2	710 a	384,450 a

Each value is mean of seven replicates; ^{ns}: not significant at P=0.05. *Means followed by the same letter in the column do not differ at 5% level by Fisher's LSD test.

CONCLUSION

Soil amendment with dry powdered leaves of castor, neem, eucalyptus and lemon-grass reduced the number of galls and eggs of ***M. javanica*** in tomato plants and worth of more investigations to obtain insights on rates and timing of application under field conditions.

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