# EFFECT OF SEWAGE SLUDGE COMPOST ON *MELOIDOGYNE JAVANICA* ON TOMATO

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## ABSTRACT

Barbosa, G. M. de C., M. L. Mendes, J. Tavares-Filho, P. B. N. Rodriguez and E. Vizoni. Effect of sewage sludge compost on *Meloidogyne javanica* on tomato. Nematropica 34:13-21.

A preliminary study to determine the influence of sewage sludge compost on *Meloidogyne javanica* on tomato was carried out under greenhouse conditions. Organic soil amendments were prepared from sewage sludge from the Paraná water treatment and green plant residues from urban waste. The experiment was performed in a complete randomized design with five treatments and six replications. The treatments were made up of different organic soil amendment rates (0, 25, 50, 75, and 100% compost) applied to the soil. Sixty days after the plant inoculations, the numbers of galls, egg masses, and eggs per root systems were obtained. The dry matter weight of the canopy was greatest with 75%; however, it was not different from 50% and 100% compost. The results indicated that the treatments with 75 and 100% organic compost gave the best results in terms of reduced numbers of galls, egg masses, and eggs per root systems, suggesting its potential benefit for *M. javanica* population control.

*Key words:* control, cultural management, *M. javanica*, nematode, organic matter, root-knot nematode, sewage sludge.

## RESUMO

Barbosa, G. M. de C., M. L. Mendes, J. Tavares-Filho, P. B. N. Rodriguez and E. Vizoni. Efeito de composto de lodo de esgoto sobre *Meloidogyne javanica* em tomateiro. Nematropica 34:13-21.

Um estudo preliminar para avaliar a influência de composto de lodo de esgoto sobre *Meloidogyne javanica* em tomateiro foi realizado em condições de casa-de-vegetação. O composto foi preparado a partir de lodo de esgoto da estação de tratamento de água do Paraná, e resíduos vegetais verdes, resultante do lixo urbano. O experimento foi conduzido no delineamento inteiramente casualizado com cinco tratamentos e seis repetições. Os tratamentos foram constituídos por diferentes taxas do composto (0, 25, 50, 75 e 100%) misturados ao solo. Sessenta dias após a inoculação as plantas foram removidas dos vasos, os sistemas radiculares coletados e os números de galhas, de massas de ovos e de ovos por sistema radicular determinados. O maior peso da matéria seca da parte aérea foi observada com 75% do composto; entretanto, não foi estatisticamete diferente daqueles obtidos com 50% e 100% do composto. Os resultados indicaram que os tratamentos utilizando 75% e 100% de composto proporcionaram maiores reduções nos números de galhas, de massa de ovos e de ovos por sistema radicular, mostrando potencial para controle de *M. javanica*.

*Palavras-chave:* controle, prática cultural, lodo de esgoto, matéria orgânica, *M. javanica*, nematóide de galha.

## INTRODUCTION

Addition of organic materials to soils have been known to improve crop productivity. The organic matter contributes to cation exchange capacity, water holding capacity, aggregate stability, and nutrient availability (McConnell *et al.*, 1993). The increases in crop yield have been attributed to improvement of soil structure or nutrients (Bryan and Lance, 1991; Harrison *et al.*, 1985; Muller and Gooch, 1982), as well as to a decrease in the soil pathogen populations (Hoitink *et al.*, 1991).

Many types of soil amendments have been tested as a means of managing nematode populations (Muller and Gooch, 1982). Some of the less common organic amendments used include urban compost and sewage sludge (Mannion *et al.*, 1994). The use of sewage sludge compost produced by sewage treatment has been studied by several researchers. Composted solid waste and sewage sludge contain considerable amounts of plant nutrients and have successfully been used as agricultural soil amendments (Bettiol *et al.*, 1983; McSorley and Gallaher, 1996; Mannion *et al.*, 1994). However, the bacteria and parasite concentrations in sewage sludge compost indicate that a cleaning treatment is needed for risk-free agricultural recycling (Fernandes *et al.*, 1996).

Bettiol and Carvalho (1982) found that biosolids are rich in organic matter and nutrients. Organic matter not only influences plant growth, but also stimulates the development of microorganism which can produce toxic metabolites that are released in the environment. These substances can be toxic to eggs and juveniles of root-knot nematodes (Habicht, 1975; Johnson and Shamiyeh, 1975; Mian and Rodriguez-Kábana, 1982). Nematode population reduction also can be attributed to the production of nematicidal compounds during the degradation of organic matter, to the multiplication of natural enemies that attack nematodes, and to an increase in host-plant resistance (Wallace, 1973).

This study was carried out to assess the effect of sewage sludge compost on *M. javanica* in tomato.

## MATERIALS AND METHODS

The experiments were conducted under greenhouse conditions at Londrina State University, in Londrina, PR, Brazil. The sewage sludge compost was obtained from the Sewage Treatment Station—South (Londrina-PR)/(Companhia de Saneamento do Paraná—SANEPAR) and mixed with plant residues (from gardens, tree prunings, and weeds) collected by the Londrina Town Council. The final compost was prepared by the Technology and Urbanized Center, Londrina State University, by mixing 5% fresh sewage sludge, 47% sewage sludge paste, and 48% green plant residues. The preparation was done at the Refúgio Farm, Londrina county, using the 'windrow' technique with manual mixing. This technique involves preparing the compost in elongated piles (Casey and Davis, 1991). The piles or 'windrows' are turned periodically to aerate and mix the material, speeding up the decomposition process and reducing odors. The physical (moisture and temperature), chemical (pH, total solid content, macro and micro nutrients and heavy metals), and biological (helminthe eggs and juveniles counted followed by an egg viability test) variables were obtained over a period of 6 months (Table 1).

The compost amendment was applied at different rates (0, 25, 50, 75, and 100% compost), and incorporated into a sandy soil that was previously treated with methyl bromide (80 $cm^3/m^3$ of soil). The mixtures were placed in 6 liter clay pots. One-week-old tomato seedlings (*Lycopersicum esculentum* L. cv. Rutgers), were transplanted to each pot 3 days later and transferred to a greenhouse. Plants were grown under natural light conditions with relative humidity and temperature within greenhouse ranging from 55-68% and 26-31°C, respectively. A week later, the plants were inoculated

Table 1. Chemical, physical, and biological analysis of the sewage sludge compost.

| Macro-nutrients | Concentration ($g.Kg^{-1}$) | Micro-nutrients | Concentration ($g.Kg^{-1}$) | Heavy metals | Concentration ($mg.Kg^{-1}$) |
|---|---|---|---|---|---|
| Ca | 18.4 | Al | 12.3 | Cr | 48.2 |
| K | 3.3 | B | 0.02 | Co | 9.3 |
| Mg | 2.1 | Cu | 0.3 | Ni | 29.6 |
| N | 20.8 | Fe | 19.0 | Pb | 102.9 |
| $P_2O_5$ | 5.3 | Mn | 0.3 | Cd | 0.0 |
| S | 13.7 | Zn | 1.0 | | |
| Ashes 23.9% | C/N ratio 20.6 | pH 5.8 | | | |
| Physical | Moisture | 82% | | | |
| | Temperature | 78°C | | | |
| Biological | Helminthes eggs/g d.w.[a] | 0.42 | | | |
| | Juvenile (%)[b] | 9.8 | | | |

[a]d.w. = dried weight.
[b]The number of juveniles per g. d.w. were counted and their viability (%) estimated.

with a suspension containing 8,000 *M. javanica* eggs. The inoculum was obtained from a pure population of *M. javanica* kept on tomato plants cv. Rutgers in a greenhouse using the technique previously described by Bonetti and Ferraz (1981).

The number of galls, egg masses, and eggs per root system were obtained according to the methodology described by Taylor and Sasser (1978) 60 days after inoculation. The shoot weight (fresh and dry) was also determined at the end of the experiment. After determining the fresh weight of each plant per replication and treatment, plant material was transferred to an oven at 60°C until reach constant weight. To determine the number of egg masses, the roots were carefully collected, washed in running water and immersed for 20 minutes in a Phloxine B solution (0.15 g/liter tap water) (Taylor and Sasser, 1978). The eggs were extracted using the blend technique as described by Bonetti and Ferraz (1981).

The experiment was arranged in a complete randomized design with five treatments and six replications. The data were subjected to analysis of variance ($P \leq 0.05$) and mean differences for each variable were compared by Tukey's multiple-range test ($P \leq 0.05$). Values for number of galls, eggs masses, and eggs in the root system were $\sqrt{(X+1)}$ transformed before statistical analysis. Polynomial regression were analyzed using SAS (SAS Institute, Inc., 1989, Cary, NC) to show the relationship among the compost rates and numbers of galls, egg masses, and eggs per root system. The experiment was repeated twice and data for each variable studied were pooled because homogeneity of variance was confirmed by Bartlett's test (Gomez and Gomez, 1994).

## RESULTS AND DISCUSSION

The sewage sludge compost affected the canopy green and dry matter weights, and the number of galls, egg masses and eggs per root system of tomato plants infected by *M. javanica* (Table 2) ($P \leq 0.05$).

The greatest canopy green matter weight was found with plants grown in pots with 50% compost, but was only significantly different from the other treatments, except from the control (Table 2) ($P > 0.05$). The dry matter weight of the canopy was greatest with 75%; however, it was not different from 50% and 100% compost.

The effect of sewage sludge compost on the number of galls of *M. javanica* per root system shows an inversely proportional relationship among the compost rates and the number of galls. The regression analysis ($Y = 808.46 - 10.01x + 0.04x^2$) shows this relationship (Fig. 1). Greatest number of galls per root system was observed when plants were grown in soil with 0% and 25% compost (Table 2). Increases in the rate of sewage sludge compost over 50% resulted in an inverse proportional decrease in the number of galls. The 50, 75, and 100% compost treatments, which did not differ among each other, had fewer galls/root system than the 0 and 25% compost treatments turned out with a reduced in the number of galls/root system (Table 2).

The linear regression analysis ($Y = 38.23 - 0.33x$) of the number of egg masses per root system shows that the increase of compost rate corresponded to a decrease in the number of egg masses (Fig. 2). However, there were no differences between 0% and 25% compost rates (Table 2). The reduction was greatest in soils with 75% and 100% compost, without difference between them ($P > 0.05$).

The number of eggs per root system was the parameter with the greatest difference among the treatments. The linear regression analysis ($Y = 761.32 - 6.24x$) of these data indicates that for each increase of the compost rate there occurred a correspondent decrease in the number of eggs (Fig. 3). The greatest reduction was detected when the compost was used at rates of 75% and 100%.

The use of organic soil amendments has provided significant control of plant diseases, especially those caused by soilborne fungi, such as root rot and seedling wilt (Millner *et al.*, 1982), and root-knot

Table 2. Effect of sewage sludge compost: soil mixtures on growth of tomato and population development of *Meloidogyne javanica*.

| Treatments (% compost) | Shoot weight (g/plant) | | Number of galls/root system | Number of egg masses/root system | Number of eggs/root system |
|---|---|---|---|---|---|
| | Fresh matter | Dry matter | | | |
| 0 | 11.1 c | 4.3 b | 38.8 a | 36.8 a | 803.0 a |
| 25 | 13.5 abc | 5.1 b | 35.6 a | 35.7 a | 579.6 b |
| 50 | 15.3 a | 5.7 ab | 24.7 b | 18.1 b | 441.8 c |
| 75 | 15.1 a | 6.9 a | 19.1 b | 9.3 c | 219.6 d |
| 100 | 14.1 ab | 5.7 ab | 23.8 b | 8.6 c | 203.5 d |

Data are means of six replication. Means followed by the same letter in the same column do not differ among them $P \leq 0.05$ based on Tukey's test. Values for number of galls, eggs masses, and eggs in the root system were $\sqrt{(X+1)}$ transformed before analysis.

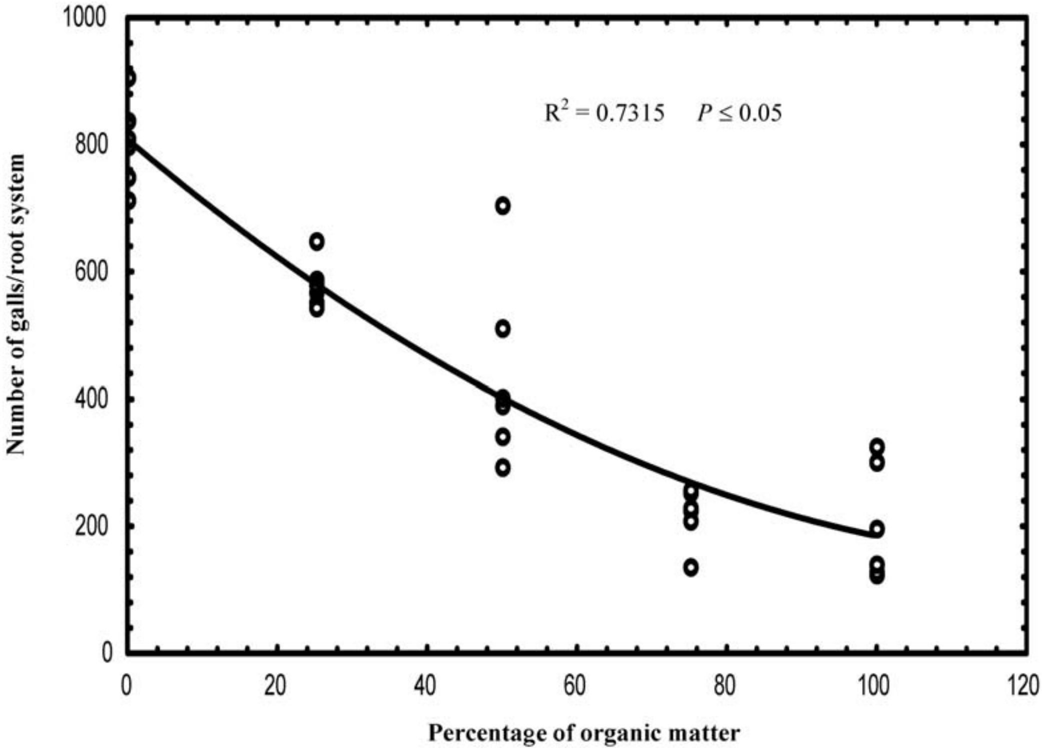


Fig. 1. Effect of different sewage sludge amendment rates on the number of galls of *Meloidogyne javanica* per root system. Values were $\sqrt{(X+1)}$ transformed before analysis.

nematodes (Castagnone-Sereno and Kermarrec, 1991; Habicht, 1975; Mannion *et al.*, 1994). Yard waste compost and biosolids can be used as a suitable carbon source to soils (Schroeder, 1997), and may improve plant growth. According to McSorley and Gallaher (1996), yard waste composts have a high C:N ratio and the effect on nematodes requires a prolonged period. The effect may not appear up to the third season of the crop. Stolt *et al.* (1995) reported that yard waste compost also increases the cation exchange capacity, base saturation, porosity, water holding capacity, and saturated hydraulic conductivity. These changes in soil chemical and physical properties may induce plant responses that have increased their tolerance to nematodes, as suggested by McSorley and Gallaher (1995).

Nematode population reductions as a result of compost addition to soil are often inconsistent (McSorley and Gallaher, 1996; McSorley and Gallaher, 1995; Stirling, 1991). The efficacy of organic amendment against plant-parasitic nematodes depends on many different factors, including the nematode species (McSorley and Gallaher, 1996), the chemical composition of the amendment and the ratio of C:N (Mojtahedi *et al.*, 1993; Stirling, 1991); and the interval between the application of the organic matter and the evaluation of the nematode population (McSorley and Gallaher, 1996). However, many other benefits to the crop can be attributed to addition of compost, and the plant responses may be due to improve tolerance rather than reductions in nematode density (McSorley and Gallaher, 1995).

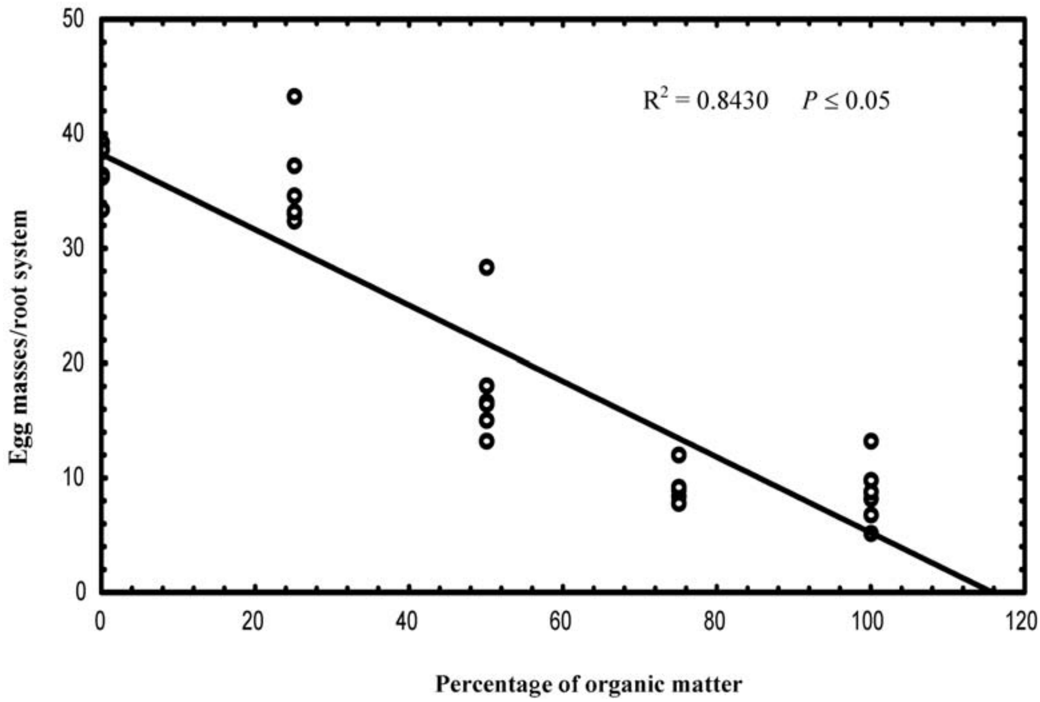


Fig. 2. Effect of different sewage sludge amendment rates on the number of egg masses of *Meloidogyne javanica* per root system. Values were $\sqrt{(X+1)}$ transformed before analysis.

Increase in green and dry matter in tomato, related to organic amendment, as found in this study, was also reported by Sterrett *et al.* (1982) when the plants were cultivated with organic composts. The increase in corn (*Zea mays*) and bush bean (*Phaseolus vulgaris*) yields, with addition of sewage sludge compost (Hornick, 1988), was attributed to increase of soil organic matter and its effect on pH stability, soil physical and chemical properties, such as moderation of soil temperature, and the supply of micro- and macro-nutrients (Gallaher and McSorley, 1994; Hornick, 1988; McSorley and Gallaher, 1995).

Reduction in the number of egg masses and eggs of *M. javanica* per root system were similar to those presented by Castagnone-Sereno and Kermarrec (1991). They reported a decrease in the number of egg masses per plant and the number of eggs by females of *M. incognita*, and suppression of root invasion by the juveniles with 33% sewage sludge compost. Mannion *et al.* (1994) also observed a negative effect of soil mixed with sewage sludge compost on the *M. javanica* population growth in tomato and squash plants under field conditions.

The greatest reduction in the number of galls, egg masses, and eggs per root system in this study were observed with 50%, 75%, and 100% composted, suggesting high quantities of this kind of organic compost are required to control the root-knot nematode, as also reported by Habicht (1975). According to our results, the increase in the compost rate from 75 to 100% did not give an additional decrease the number of eggs per root system.

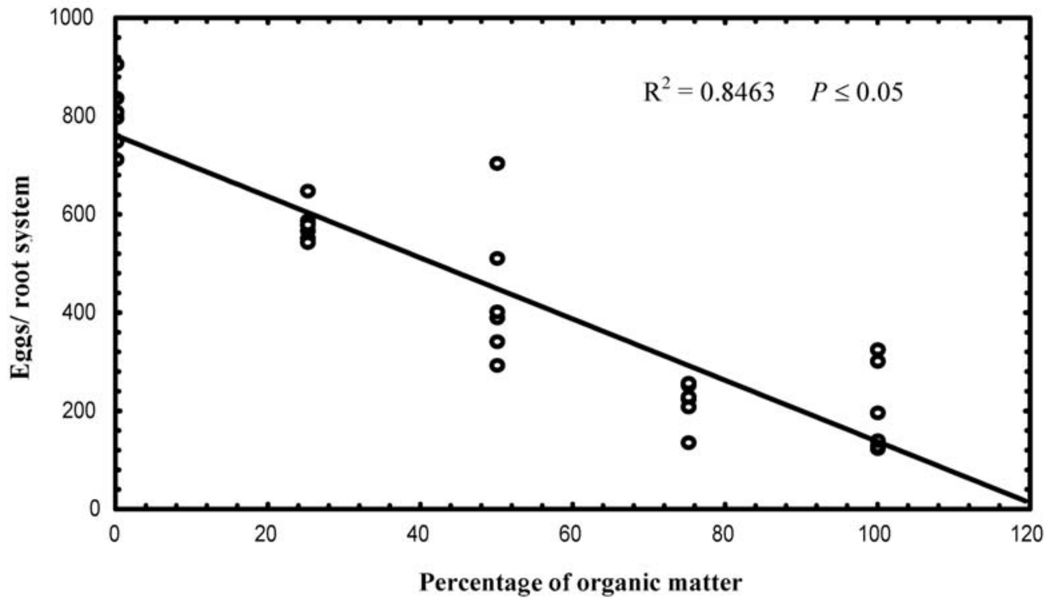


Fig. 3. Effect of different sewage sludge amendment rates on the number of eggs of *Meloidogyne javanica* per root system. Values were √(X+1) transformed before analysis.

Although the use of sewage sludge compost against *M. javanica* was encouraging in this study, as well as the positive result reported by Castagnone-Sereno and Kermarrec (1991), in others cases, no effect on population density of *M. incognita* have been observed (McSorley & Gallaher, 1996; McSorley *et al.*, 1997). This suggests that further research is needed to determine the viability of sewage sludge and yard waste composts under tropical conditions, such as those that occur in Brazil.

Urban centers produce huge amounts of organic waste, resulting in many problems, such as environmental pollution. The utilization of sewage sludge and yard waste compost as organic amendments may represent an alternative that will help alleviate this problem of disposal. Bettiol *et al.* (1983) forecast that the Sewage Treatment Station of São Paulo City (SABESP) would produce 8,000 MT of sewage sludge per day. This amount of sewage sludge obviously represents a serious problem. In a preliminary study, they concluded the use of this amount of sewage sludge would recycle 20 MT of nitrogen and 40 MT of phosphorus ($P_2O_5$) per day. Although only 25% of this would recycle as nitrogen available to plants (OMAF/OME/OMH, 1976), there would still be a benefit under field conditions, once the nutrients were slowly released (Bettiol *et al.*, 1983).

Sewage sludge compost can be used in nurseries, as media for plant propagation, or under field conditions. Yard waste and sewage sludge compost have been reported to improve yields of rice, corn, bean, soybean, sorghum, tall fescue, and bermudagrass (Bettiol *et al.*, 1983; Hornick, 1988; Hortenstine and Rothwell, 1972; Mays *et al.*, 1973; Schroeder, 1997; Terman *et al.*, 1973). The use of these organic amendments with an agricultural purpose would provide a good manner for the large urban centers to disposal of their trash, while providing farmers, especially those located near large municipalities with cheap and useful organic compost. This kind of compost is not well accepted for vegetable growing, but can be very useful for crops like corn, coffee, fruit trees, and others.

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