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Suppression of the Root-knot Nematode *Meloidogyne incognita* on Tomato by Composted Animal Manures

Amel Kerkeni[1*] • Najet Raouani[2] • Mohamed Ben Khedher[3]

[1] Higher Agronomic School of Mograne 1121, Zaghouan, Tunisia
[2] Higher Agronomic Institute of Chott Mariem 4042, Sousse, Tunisia
[3] Technical Centre of Organic Agriculture of Chott Mariem 4042, Sousse, Tunisia

Corresponding author: * **amel.chakroun@hotmail.fr**

ABSTRACT

The efficacy of five animal manure composts (C1, C2, C3, C4 and C5) as substrate amendments for control of root-knot nematode *Meloidogyne incognita* on tomato was studied. Results showed that plants in substrates amended with 25% of the different composts had lower number of *M. incognita* in the roots than those grown in unamended control substrate (perlite). Compared to untreated control, all treatments decreased significantly ($P < 0.05$) the galling index with the effect being more pronounced with 25% of compost C4 (40% cattle manure (CM) + 40% sheep manure (SM) + 20% crop residues) and compost C1 (50% CM + 25% SM +25% poultry manure). Moreover, improvement of plant growth parameters as a consequence of suppression of *M. incognita* was observed in the inoculated plants.

Keywords: compost, galling index, growth, *Meloidogyne incognita*, pf/pi, tomato

INTRODUCTION

Soil-borne pests, especially root knot nematodes (*Meloidogyne incognita*), are widespread tomato (*Lycopersicon esculentum*) pests that can lead to poor economic return by reducing fruit yield (Hashem and Abo-Elyousr 2010). Control strategies for nematodes rely to a large extent on the use of chemical nematicides that can lead to environmental damage and are often toxic to human as well as other non-target organisms (Oka and Yermiyahu 2002; Simon *et al.* 2003).

This has occasioned a growing effort in the search of new bioactive and ecofriendly products (Amaral *et al.* 2003). Currently, biological control is becoming an increasingly effective alternative control measure to replace synthetic nematicides application or to be implemented as part of integrated control programs (Trudgill *et al.* 2000). Biocontrol applications are now directed more towards the use of composted organic matter (compost) that is biodegradeble, that does not leave toxic residues in the soil and on plants and displays effective disease control as a conventional nematicide (Hoitink and Grebus 1994; Zhang *et al.* 1998; Fuchs 2003).

Previous field experiments have demonstrated that composts can be effective in controlling some pathogenic fungi such as *Pythium* and *Phytophthora* (Hoitink and Grebus 1994; Zhang *et al.* 1998; Fuchs 2003; Kerkeni *et al.* 2007a). The use of composts prepared from various wastes (chitin, animal manures, etc.) as biocontrol agents against nematodes have already been reported (Akhtar 1999; Oka and Yermiyahu 2002; Siddiqui 2004; Rivera and Aballay 2007). However, there is dearth of information about the potential toxicity of composts against *M. incognita* and their effects on tomato growth (Jin *et al.* 2005; Siddiqui and Futai 2009).

With regard to this topic, this study was extended to evaluate the nematicidal activity of five different composts prepared from various animal manures mixture against *M. incognita* multiplication and to assess their impact on tomato growth.

MATERIALS AND METHODS

Composts

Different composts (C1, C2, C3, C4 and C5) prepared from poultry, sheep, cattle and horse manures were prepared at different proportions in the unit of composting of the Technical Centre of Organic Agriculture of Chott Mariem (Tunisia). The composition of each compost is given in **Table 1**.

Obtaining the eggs

The egg-masses of *M. incognita* used in this study were manually picked with forceps from infected tomato roots and then stored in Dropkin (1958) solution (NaCl 0.3 M) until use.

Experiment

Tomato seeds from the cultivar 'Rio Grande' were sterilized with sodium hypochlorite (1%), thoroughly rinsed with sterile water and then sown in alveolar flats (104 cells per flat 13 × 8 unit) filled with disinfected peat. One-month-old seedlings were transplanted into plastic pots (15 cm diameter) containing a mixture of compost/sterilized perlite (25/75) and then inoculated by *M. incognita* egg (five egg masses per pot). To assess the effect of compost on *M. incognita* reproduction, perlite alone was used as negative control.

Tomato plants were placed in a growth chamber with a photoperiod of 16 h light (150 µmol.m^{-2}.s^{-1}) and 8 h dark (Djebali

Table 1 Composition of the different composts used in this study.

Composts	Composition
C1	50% CM + 25% SM + 25% PM
C2	60% CM + 30% SM + 10% crushed straw
C3	50% CM + 25% SM + 25%HM
C4	40% CM + 40% SM + 20% crop residus
C5	25% CM +25% SM + 25% PM + 23.5% HM + 1.5% natural phosphate

CM: cattle manure; SM: sheep manure; PM: poultry manure; HM: horse manure

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Short Communication

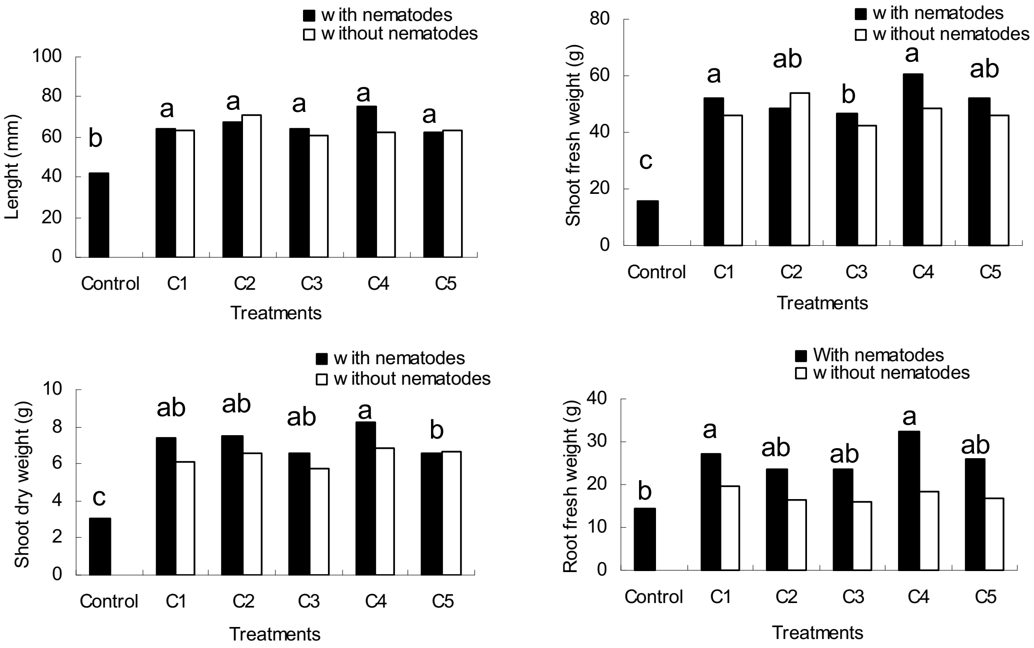

Fig. 1 Effect of different treatments on tomato growth parameters (length, shoot fresh and dry weight and root fresh weight). Values with different superscript are significantly different at $P < 0.05$.

et al. 2002) and allowed to hatch at 27°C for 18 weeks. Ten replicates were used for each treatment.

Data analysis

Plant height, fresh and dry weight of roots and shoots were measured. The galling index (GI), which represents the degree of galling of the sampled roots was determined as 0 = no gall; 1 = from 1 to 20 galls; 3 = appearance of big galls; 4 = dominance of big galls and 5 = all roots were transformed to galls. Pf/Pi is the ratio final population/initial population of *M. incognita*.

The data of different parameters were submitted to one-way analysis of variance (ANOVA) followed by Duncan's multiple range test using SPSS v.11 statistical program and the differences between means were deemed to be significant at $P < 0.05$.

RESULTS

Plant growth

The height of plants, fresh and dry weights of the roots and shoots are displayed in **Fig. 1**. As can be seen, compost application resulted in a significant ($P < 0.05$) increase of plant growth parameters which appears to be more pronounced in inoculated plants. Among the compost used, C4 (40% CM + 40% SM + 20% crop residues) was the most efficient in the improvement of plant growth while those amended with C3 (50% CM+ 25% SM + 25% HM) showed very weak effects.

Nematode effect

1. Pf/pi ratio

The population of *M. incognita* was higher in substrates without compost (Pf/pi = 2.98). Addition of 25% of each of the five composts to perlite was significantly effective at reducing *M. incognita* population (**Fig. 2**).

2. Galling index (GI)

Compared with the control, amended substrates and inoculated with nematodes showed significant ($P < 0.05$) reduction in GI (**Fig. 3**). The lowest values (1 and 1.3) were observed with C1 and C4 treatments while they values were relatively higher but not significant with the remaining composts (C2, C3 and C5).

DISCUSSION

Application of different composts caused a significant decline in the population of *M. incognita* and in galling index on tomato roots. These results were similar to those previously reported by Akhtar and Mahmood (1996) and Akhtar (1999). These authors showed that the application of organic compost reduced the number of plant-parasitic nema-

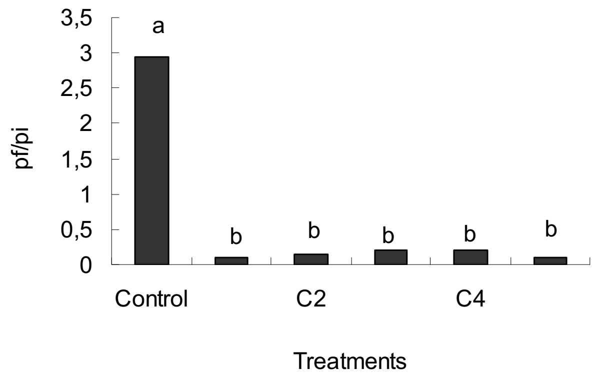

Fig. 2 Effect of different treatments on pf/pi ratio of *M. incognita*. Values with different superscript are significantly different at $P < 0.05$.

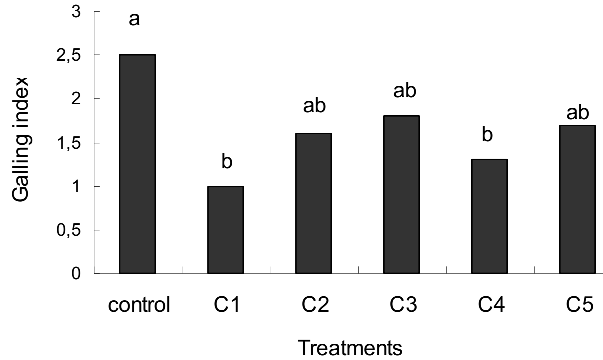

Fig. 3 Effect of different treatments on galling index. Values with different superscript are significantly different at $P < 0.05$.

todes. Reduction of nematode population in response to compost application was presumably due to the presence of predatory nematodes (unpublished data). Support to this assumption is given by Akhtar and Mahmood (1993) and Akhtar (1995) who reported suppression of symptoms caused by the root-knot nematode *M. incognita* by predatory nematodes founded on organic amendments like compost. In the same way, Siddiqui (2004) showed that the decrease on *M. incognita* population may be attributed to the presence of other antagonistic micro-organisms such as bacteria and fungi. In this context, we previously reported the occurrence of many antagonistic bacteria of the genus *Aeromonas*, *Serratia* and *Pseudomonas* that inhibit the development of many pathogenic fungi and bacteria (Kerkeni *et al.* 2007b, 2008).

De Jin *et al.* (2005) and Byrne *et al.* (2001) showed that compost contains chitinolytic bacteria producing enzymes, like chitinase suppress plant parasitic-nematodes in tomato plants and reduce their population. Additionally, the over production of chitinase might be responsible of the significant reduction on galling index by dissolution of nematode eggs (De Jin *et al.* 2005).

Compared with uninoculated plants, the presence of *M. incognita* in substrates amended with compost had no effects on plant growth parameters with the exception of roots fresh weight which increased significantly. However, in the inoculated substrates, a significant improvement in tomato plant growth parameters was observed in treatment C4 as compared with the other composts. This is presumably due to the decrease in nematode population and galling index noted in this treatment, while treatment C3 was found to be the less effective.

To summarize, the present study showed that composts prepared from various animal manures had negative effects on *M. incognita*. They could constitute a promising alternative for a biological control of some plant diseases and reduce the abusive use of synthetic nematicides. However, a more field comprehensive studies are needed to confirm our findings.

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