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Suppression of root-knot nematodes in potting mixes amended with different composted biowastes

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Summary

Suppressiveness of soil amendments with different rates of composted biowaste materials, olive pomace, municipal green wastes, sewage sludge and spent mushroom substrate, was evaluated against the root-knot nematode *Meloidogyne incognita* on tomato in potting mixtures. Soil amendments were applied at 0, 10, 25, 50 and 100 g kg^{-1} soil, according to a randomized block design with five replications for each treatment. Sixty days after tomato transplanting, nematode population density on plant roots and in soil and root gall infestation were assessed on each root system, and plant top and root weight were also recorded. Soil pH, dry and organic matter content, total and ammoniacal nitrogen were analyzed at the same time. Olive pomace-based composts resulted in the highest nematode suppression (73 – 97 %, according to the rate) and significantly reduced gall formation on tomato roots. Olive-waste compost affected positively tomato growth only in combination with sheep wool wastes, but it caused phytotoxicity when mixed with chicken manure and urea. Soil amendments with composted mushroom substrate also provided a consistent nematode suppression and a significant increase of plant growth, whereas composted municipal green wastes were more suppressive and positively affected tomato growth when combined with sewage sludge. Soil chemical parameters were scarcely affected by compost amendments, as organic matter was significantly increased only by the olive pomace-derived composts and nitrogen content only at the highest rate of the five composts. Data from the experiment confirmed the potential of compost amendments for sustainable management of root-knot nematodes both in field and greenhouse container media, though their technical effectiveness and economic convenience are strictly dependent on a correct proportion and local availability of raw materials used in the composting process.

Keywords: root-knot nematodes; control; biowastes; compost

Introduction

A wrong disposal of large amounts of wastes generated by urban settlements and agro-industrial processes, such as sewage sludge, pomaces, manures and green wastes, may cause serious environment pollution (Williams, 2005). The composting process may represent a valuable alternative for the management of these wastes, as converting them into a stabilized form, destroying human and animal pathogens, recycling valuable plant nutrients and improving soil biological, chemical, and physical properties (De Bertoldi, 2008). In addition, composted raw materials from different origin were also found suppressive on several soil-borne fungal pathogens and on phytoparasitic nematodes (Bailey & Lazarovits, 2003; Hu & Qi, 2010; Renčo *et al*. 2011).
Root-knot nematodes (RKN), *Meloidogyne* species, are among the most damaging pests in agriculture, as spread worldwide and causing heavy yield losses on several economically relevant crops. Control of these pests is primarily based on chemical treatments, but the withdrawal of most nematicides available on the market has been leading to the investigation of more sustainable alternative control strategies (Greco & Esmenjaud, 2004).
Soil amendments with a wide range of composted organic wastes were frequently documented for a suppressive effect on RKN, though their failure in nematode control was also reported (Akhtar & Malik, 2000). Nematode suppression in a compost-amended soil may involve different mechanisms, such as direct toxicity of degradation products, an increase of natural nematode-antagonist microorganisms on the compost substrate or even the induction of a systemic aquired resistance in plants (Stirling, 1991; Zhang *et al*., 1996).
The suppressive effect of compost amendments on soil phytonematode populations is largely variable and scarcely predictable, as depending on the starting raw materials, the type of composting process and the maturity of the final

Table 1. Raw material composition (%) of composts used in the experiment

Raw material	Percentage amounts				
	C_1	C_2	C_3	C_4	C_5
Chicken manure	-	-	-	-	8.0
Fresh olive pomace	72	-	-	-	87.4
Sewage sludge	-	-	-	30	-
Sheep wool	11	-	-	-	-
Soil	-	10	-	-	-
Spent mushroom substrate	-	-	100	-	-
Straw	17	-	-	-	4.0
Urban green wastes	-	90	-	70	
Urea	-	-	-	-	0.6

product incorporated into the soil, and, therefore, should be specifically assessed for each compost. The study presented in this paper was aimed to a comparative evaluation of the nematicidal potential of five new composts, based on different municipal and agro-industrial raw wastes largely available in southern Italy, against the root-knot nematode *Meloidogyne incognita* (Kofoid *et* White) Chitw. on tomato (*Solanum lycopersicum* L.) in potting mixtures.

Materials and methods

Raw materials used for the formulation of the five composts are reported in Table 1. Composts C_1 and C_5, were prevalently based on fresh olive pomace (FOP), combined with sheep wool wastes or chicken manure and urea, respectively. Composts C_2 and C_4 were mainly derived from municipal green wastes, integrated with soil or sewage sludge, respectively, whereas spent mushroom substrate was the starting material of compost C_3. All composts were still at an experimental phase but C_1, as also commercially available.

Chemical analyses were preliminarily performed on a 100-g composite sample of each compost and on a similar amount of soil from each treatment replicate at the end of the experiment. A pH electrode was used to measure the pH values of a 1:10 w/v water extract of the composts and the soil samples, obtained after a 1-hour mechanical shake of samples in double distilled water. Total dry matter (DM) and inorganic matter percentage contents were obtained by drying sample portions for 4 h at 105 °C or 550 °C, respectively, up to a constant weight. Percent organic matter (OM) was calculated as the difference between 100 and percent inorganic matter value. Total nitrogen content (N_t) was evaluated through a previous digestion of sample portions by a Didesdahl apparatus (HACH Company, Loveland, Colorado, USA), followed by distillation with 40 % NaOH (Bremner, 1996), whereas the water-soluble ammoniacal N (NH_4^+) fraction was determined by titration (Mulvaney, 1996).

Tomato plants were artificially infested with an Italian population of *M. incognita* and grown in a greenhouse for two months. The roots of these plants were finely chopped to quantify the number of eggs and juveniles by processing 6 root samples of 10 g each with a 1 % aqueous solution of sodium hypoclorite (Hussey & Barker, 1973). The chopped infested roots were then thoroughly mixed with 2 kg of steam sterilised sandy soil (8 h at 100°C) and used as inoculum. Appropriate amounts of this inoculum were then added and mixed with a steam sterilised sandy soil (64.4 % sand, 18.7 % silt, 16.9 % clay, 0.8 % organic matter and 7.5 pH) to provide an initial population density of 15 eggs and juveniles ml^{-1} soil (*Pi*).

The infested soil was then added with 25, 50 and 100 $g.kg^{-1}$ soil rates of the five composts and mixtures were poured into 14 cm diam clay pots with five replicates of each compost x dose combination. Pots were arranged in a completely randomized block design, providing non-amended and infested or non-infested soil, as controls, in a glasshouse at 25 ± 2 °C.

A 1 month-old tomato cv. Roma seedling was transplanted in each pot four weeks after the compost incorporation.

During the experiment tomato plants were maintained in the glasshouse randomizing the position of the blocks and at the same time repositioning each plant within a block every five days, to avoid a block position effect and at the same time the factor position of the plant within the block. Plants received all the necessary maintenance, watered as required and maintained free of weeds. Two months after the transplant plants were uprooted and their height and fresh top and root weight were recorded. Gall formation caused by *M. incognita* was evaluated on each tomato root according to a 0 – 5 scale in which 0 = no galls, 1 = 1 – 2 galls, 2 = 3 – 10 galls, 3 = 11 – 30 galls, 4 = 31 – 100 galls and 5 > 100 galls (Taylor & Sasser, 1978). Final population density of *M. incognita* on tomato roots was determined processing each root system by sodium hypochlorite method (Hussey & Barker, 1973), and then microscopically counting eggs and juveniles.

Table 2. Comparison of pH, dry matter (DM), ammoniacal (NH_4^+) and total (N_t) nitrogen contents of the tested composts

Compost	Chemical parameters							
	pH		DM (%)		NH_4^+ (mg kg^{-1} DM)		N_t (g kg^{-1} DM)	
C_1	9.0	c	93.9	e	49.1	c	22.0	d
C_2	8.5	b	65.8	c	69.7	d	18.1	c
C_3	7.9	a	47.6	a	50.0	c	23.8	d
C_4	7.9	a	56.2	b	0.1	a	7.7	a
C_5	10.0	d	79.5	d	38.6	b	14.3	b

Data followed by the same letters on the same column are not significantly different according to Least Significant Difference's Test ($P \leq 0.05$)

Moreover, a 100 g soil sample was taken from each pot to measure the chemical parameters as described above.
All data were subjected to a one-way or factorial analysis of variance and treatment means were compared using Fisher's Least Significant Difference pairwise procedure at $P \leq 0.05$. Nematode data were Ln (x + 1) transformed before statistical analysis, due to homogenisation of error variances. All statistical analyses were performed using the PlotIT program.

Results

Analysis of composts

Values of pH were slightly above neutrality in composts C_3 and C_4, and clearly alkalyne in C_1, C_5 and, at a less extent, in C_2 (Table 2). Dry matter content varied largely among materials, as ranging from 47.6 to a 94 % of C_3 and C_1, respectively. N_t amounts ranged from the 22 – 24 g kg^{-1} soil of C_1 and C_3, respectively, to the 7.7 g kg^{-1} in C_4,

Table 3. Effect of soil treatments with different composts on soil chemical parameters at the end of the experiment

Treatment		Chemical parameters									
Compost	Rate (g kg^{-1} soil)	pH		Dry matter (%)		Organic matter (%)		Ammoniacal nitrogen (mg kg^{-1} soil)		Total nitrogen (g kg^{-1} soil)	
C_1	10	8.8[(1)]	bcde[(2)]	91.4	cdef	2.1	abcd	7.5	ab	2.96	abc
	25	8.8	bcde	92.4	ef	2.7	bcdef	10.9	bc	3.02	abc
	50	8.7	bcde	88.0	bcde	3.4	fg	17.1	e	3.49	abc
	100	8.7	bcd	90.9	cdef	5.6	h	29.2	f	9.34	e
C_2	10	9.0	defgh	88.4	bcde	2.1	abcd	17.8	e	3.05	abc
	25	9.0	defgh	91.0	cdef	2.0	abcd	18.4	e	2.94	abc
	50	9.1	efgh	90.6	cdef	2.2	abcde	16.2	de	3.81	abc
	100	9.1	efgh	91.9	def	2.8	cdefg	17.2	e	6.57	d
C_3	10	9.1	efgh	88.1	bcde	1.8	ab	15.5	cde	2.09	a
	25	8.9	cdefgh	90.6	cdef	2.3	abcde	15.9	cde	4.27	bc
	50	8.6	abc	92.5	ef	2.2	abcde	18.6	e	2.37	a
	100	8.4	a	93.2	f	3.1	efg	17.9	e	4.59	c
C_4	10	8.7	bcde	93.6	f	1.8	abc	8.8	ab	2.01	a
	25	8.6	ab	90.9	cdef	2.3	abcde	8.6	ab	2.00	a
	50	8.9	bcdefg	90.4	cdef	2.5	abcdef	11.2	bcd	4.26	bc
	100	8.8	bcdef	91.1	cdef	3.0	defg	17.5	e	7.22	d
C_5	10	9.1	fghi	87.1	bc	2.2	abcde	4.1	a	2.13	a
	25	9.2	hij	87.2	bc	2.6	bcdef	4.2	a	3.27	abc
	50	9.4	ij	87.2	bc	3.8	g	11.5	bcd	3.53	abc
	100	9.5	j	84.1	ab	6.3	h	24.6	f	8. 38	de
Non-amended soil (Untreated control)		8.8	bcde	92.5	ef	1.5	a	5.1	a	2.54	ab
ANOVA F values											
Compost		**[(3)]		**		**		**		*	
Rate		-		*		**		**		**	
Compost x rate		**		**		**		**		**	

[(1)]Each value is an average of five replicates
[(2)]Data followed by the same letters on the same column are not significantly different according to Least Significant Difference's Test ($P \leq 0.05$)
[(3)]Significant at $P \leq 0.01$(**), $P \leq 0.05$ (*) or not significant (-) according to factorial analysis of variance

Table 4. Global comparison of effects of the tested composts and amendment rates on soil chemical parameters at the end of the experiment

Factors	Chemical parameters									
	pH		Dry matter (%)		Organic matter (%)		Ammoniacal nitrogen (mg kg^{-1} soil)		Total nitrogen (g kg^{-1} soil)	
Comparison of composts										
C_1	8.8	ab	88.2	ab	3.6	b	16.2	bc	4.2	a
C_2	9.0	bc	90.1	bc	2.2	a	17.2	c	3.7	a
C_3	8.7	a	91.1	c	2.4	a	17.1	c	3.1	a
C_4	8.7	a	91.4	c	2.3	a	11.6	ab	3.6	a
C_5	9.3	c	86.6	a	3.7	b	11.2	a	3.9	a
Comparison of amendment rates										
0	9.1	a	91.7	a	1.6	a	6.9	a	2.4	a
10	8.9	a	89.7	a	2.0	a	10.7	b	2.4	a
25	8.9	a	90.4	a	2.4	ab	11.6	b	3.1	ab
50	9.0	a	89.7	a	2.8	b	14.9	c	3.5	b
100	8.9	a	89.2	a	4.2	c	21.3	d	7.2	c

Data followed by the same letters on the same column, within each factor, are not significantly different according to Least Significant Difference's Test ($P \leq 0.05$)

whereas intermediate values were found in C_2 and C_5. The highest NH_4^+ content, independently from the doses, was detected in C_2, followed by C_1 and C_3, though with significantly lower values, whereas the ammoniacal N fraction was almost nil in C_4.

Effects on soil chemical parameters

At the end of the experiment, pH and DM content of soil amended with all composts were not significantly different from control but in the soil added with C_5, presenting a significantly higher pH and a lower DM content in comparison to non-amended soil (Table 3). Percentage OM content was significantly increased by almost all C_1 and C_5 rates and only by the highest dosage of C_2, C_3 and C_4. N content significantly exceeded the values of the control only at the highest rate of all composts, whereas NH_4^+ was significantly increased by all rates of C_2 and C_3 and by the 50 and 100 g kg^{-1} soil rates of the other composts. Factorial analysis of variance showed that chemical parameters of the amended soil were always significantly affected by the type of compost. A statistically significant effect of amendment rate was found only on soil OM, N_t and NH_4^+ (Table 4).

Effects on the nematode infestation

The number of eggs and juveniles of *M. incognita* on the tomato roots was always significantly lower in all the compost-amended pots than in non-amended soil (Table 5). Among the compost treatments, the lowest nematode

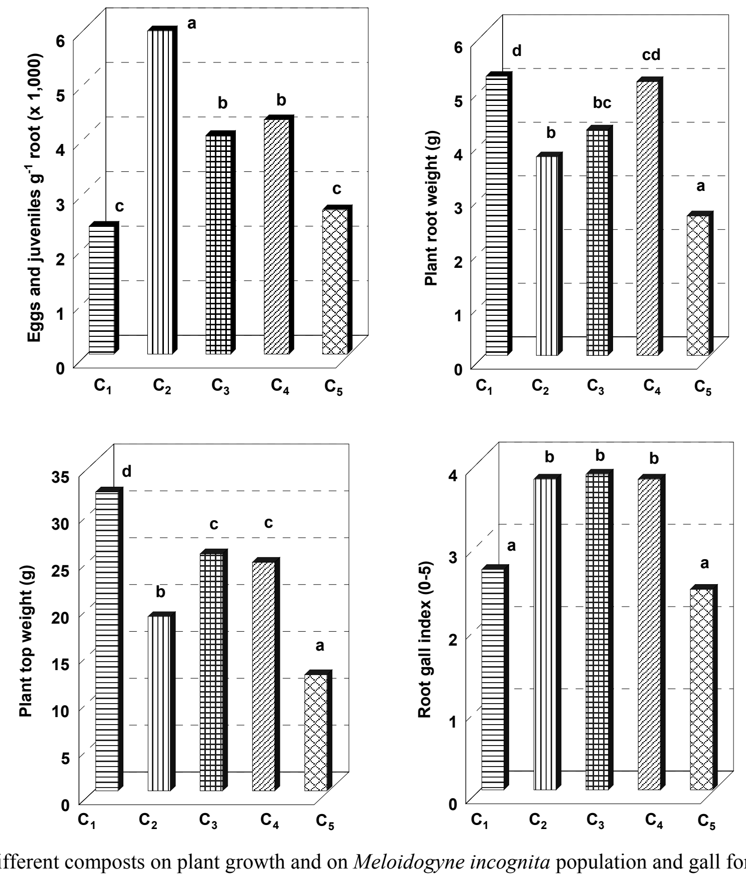

Fig. 1. Main effect of different composts on plant growth and on *Meloidogyne incognita* population and gall formation on tomato roots at the end of the experiment

Table 5. Effect of the different compost treatments on the population density of *M. incognita* and on gall formation on tomato roots

Compost	Rate (g kg^{-1} soil)	*M. incognita* population (Eggs and juveniles)			Root gall index (0 – 5)	
		Number g^{-1} roots		% suppression		
C_1	10	1,925[1]	g[2]	76.7	3.5	abc
	25	956	i	88.4	2.5	bcdef
	50	354	k	95.7	1.7	def
	100	226	k	97.3	1.2	f
C_2	10	4,698	b	43.1	4.0	ab
	25	4,031	c	51.1	3.7	abc
	50	3,910	c	52.6	3.5	abc
	100	2,802	ef	66.0	3.2	abcd
C_3	10	3,395	d	58.9	4.0	ab
	25	3,296	d	60.1	3.7	abc
	50	3,111	de	62.3	3.5	abc
	100	1,982	g	76.0	3.5	abc
C_4	10	3,846	c	53.4	4.2	a
	25	3,435	d	58.4	3.7	abc
	50	3,323	d	59.7	3.5	abcd
	100	2,624	f	68.2	3.0	abcde
C_5	10	2,183	g	73,5	2.5	bcdef
	25	1,347	h	83.7	2.2	cdef
	50	907	ij	89.0	1.5	ef
	100	532	jk	93.6	1.5	ef
Non-amended soil (Untreated control)		8,251	a		4.5	a
ANOVA F values						
Compost		369.5	**[3]		10.3	**
Rate		114.2	**		4.8	**
Compost x rate		3.5	**		0.3	-

[1]Each value is an average of five replicates
[2]Data followed by the same letters on the same column are not significantly different according to Least Significant Difference's Test ($P \leq 0.05$)
[3]Significant at $P \leq 0.01$(**), $P \leq 0.05$ (*) or not significant (-) according to factorial analysis of variance

population densities were provided by the 50 and 100 g.kg^{-1} soil rates of C_1 and by the 100 g.kg^{-1} soil rate of C_5, whereas the 10 – 50 g.kg^{-1} soil dosages of C_2 resulted in the largest number of eggs and juveniles. Soil amended with the intermediate rates of C_2, C_3 and C_4 resulted in root nematode populations statistically similar among them, but significantly different from those of the extreme dosages.

Formation of galls on the roots from soil amended with all rates of C_2, C_3 and C_4 did not significantly differ from the control, whereas it was statistically reduced by almost all C_1 and C_5 treatments without differences among the rates (Table 5).

Factorial analysis of variance evidenced a highly significant effect of both compost type and rate on the root nematode population and on the root gall formation. In particular, the number of nematodes expressed as eggs and juveniles was significantly lower on the tomato roots from soil amended with the composts C_1 and C_5 than with the other composts (Fig. 1). Adversely, C_2 amendments resulted in a nematode density statistically higher than those provided by the other composts. The root nematode density decreased by increasing the amendment rates, though differences were statistically significant only among the extreme dosages (Fig. 2). Moreover, C_1 and C_5 resulted sig-

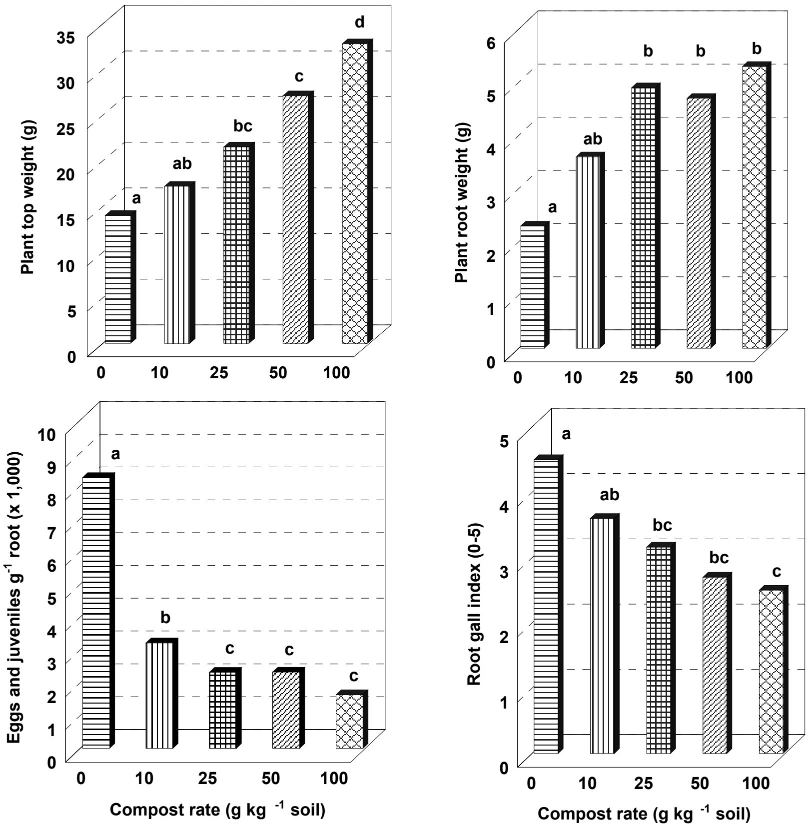

Fig. 2. Main effects of different amendment rates on plant growth and on *Meloidogyne incognita* population and gall formation on tomato roots at the end of the experiment

nificantly more effective than the other materials also for reducing root gall formation (Fig. 1).

An analytical relationship between amendment rate and nematode population density g^{-1} tomato root was also fitted to the experimental data (Fig. 3). The best fit was provided by power equation $y = a + bx^c$, in which: y = nematode population density g^{-1} tomato root expressed in eggs and juveniles; x = amendment rate; a, b, c = coefficients. The high values of the coefficients of correlation indicate that almost all the total variation in nematode population at the end of the experiment can be explained by the above relationship (Fig. 3).

Effects on plant growth

Presence of the root-knot nematode caused a strong reduction of tomato growth, as demonstrated by the largely higher plant top and root weight (+81 and +122 %, respectively) in the non-infested than in infested soil (Table 6). Soil amendments with C_1, C_3 and C_4 significantly increased plant biomass in comparison to the infested control. However, the highest dosages of these composts provided a plant growth also better than the non-infested control. Adversely, growth of plants from soil amended with C_5 was inconsistently or negatively affected by compost treatments, as biomass weight was not different or even significantly lower than control at all the tested rates. Treatments with C_2 always resulted in a slight and not significant growth increase, but at the highest incorporation rate. A high significance of the effect of compost type was found also for the plant growth parameters, as green biomass of plants grown in soil amended with C_1 was significantly heavier compared to that of other composts, whereas C_5 resulted always in the lowest plant growth (Fig. 1).

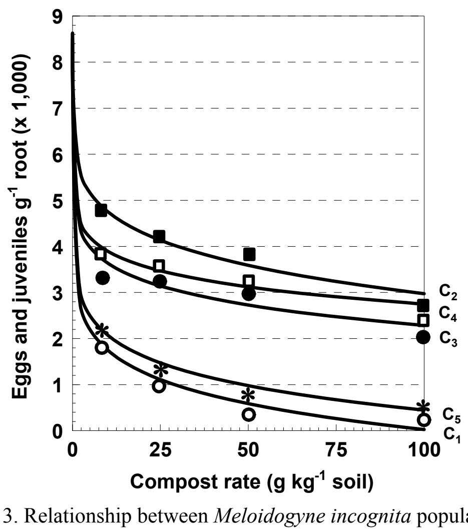

Fig. 3. Relationship between *Meloidogyne incognita* population density per g tomato root (*y*) and incorporation rate (*x*), according to best fitted equation $y=a+bx^c$ and to the following equation parameters: C1 (○): a= 8,627; b = -5,495; c = 0.0973; R^2 = 0.996; C2 (■): a= 8,263; b = -2,323; c = 0.1787; R^2 = 0.991; C3 (●): a = 8,434; b = -3,738; c = 0.1081; R^2 = 0.986; C4 (□): a = 8,503; b = -3,685; c = 0.0968; R^2 = 0.997; C5 (*): a= 8,613; b = -5,231; c = 0.0967; R^2 = 0.999.

Table 6. Effect of soil treatments with the different composts on tomato plant growth

Treatment Compost	Rate (g kg^{-1} soil)	Plant weight (g) Top		% increase	Root		% increase
C_1	10	21.5[1]	ef[2]	54	3.7	bcd	61
	25	33.5	ij	139	6.4	efg	178
	50	44.0	kl	214	6.5	fg	183
	100	46.6	l	233	7.0	g	204
C_2	10	17.4	bcd	24	2.9	abc	26
	25	16.8	bcd	20	4.6	d	100
	50	17.8	bcde	27	4.0	bcd	74
	100	26.8	gh	91	4.8	de	109
C_3	10	20.6	de	47	4.0	bcd	74
	25	27.4	gh	96	5.0	def	117
	50	30.2	hi	116	4.7	de	104
	100	34.4	j	146	4.9	def	113
C_4	10	18.6	cde	33	3.9	bcd	70
	25	20.5	de	46	4.5	cd	96
	50	28.6	gh	104	6.8	g	196
	100	40.4	k	189	7.9	g	243
C_5	10	7.7	a	-45	3.7	bcd	61
	25	9.5	a	-32	4.0	cd	74
	50	15.0	bc	7	1.3	a	-43
	100	15.9	bc	14	1.8	a	-22
Non-amended soil		14.0	b	-	2.3	ab	-
Non-infested soil		25.4	fg	81	5.1	def	122
ANOVA F values							
Compost		193.3	**[3]		17.6	**	
Rate		128.1	**		5.8	**	
Compost x rate		9.8	**		3.8	**	

[1]Each value is an average of five replicates
[2]Data followed by the same letters on the same column are not significantly different according to Least Significant Difference's Test ($P \leq 0.05$)
[3]Significant at $P \leq 0.01$(**), $P \leq 0.05$ (*) or not significant (-) according to factorial analysis of variance

Conclusions and discussion

All compost treatments demonstrated to be suppressive on *M. incognita*, though at different extent and more weakly on root gall formation than on nematode population. Moreover, most composts tested in this experiment were recently found also suppressive on the cyst nematode *Globodera rostochiensis* Woll. on potato and on seven different plant-parasitic nematode genera in natural grassland soil (Renčo *et al*., 2007, 2009). Previous findings on RKN suppression by compost amendments were quite contrasting, as several authors documented a satisfactory nematode control but inconsistent results were also reported (Akhtar & Malik, 2000).

The suppressiveness of composted organic matrices on phytoparasitic nematodes is generally considered as the resultant of different contributory mechanisms (Stirling, 1991). The release of nematotoxic nitrogenous compounds or high-molecular-weight substances, such as tannins or phenols, during the OM decomposition, can be hypothesized as primarily involved in nematode suppression in amended or treated soil (Mian & Rodríguez-Kábana, 1982; Rodríguez-Kábana, 1986; Maistrello *et al*., 2010), mainly in the presence of a strictly dose-dependent suppressive effect of a compost. In our experiment, nematode suppression resulted more strictly related to compost pH and DM, whereas no correlation was found with N_t or NH_4^+. Moreover, an enhanced development of nematode competitors, antagonists and parasites on the feeding substrate provided by the compost was also suggested as a further mechanism of the RKN population decrease (Rodríguez-Kábana & Morgan-Jones, 1987).

The FOP-based composts C_1 and C_5 resulted to be the most suppressive materials, as reducing nematode eggs and juveniles by 77 – 97 and 73 – 94 %, as confirming the high root-nematode suppressiveness previously documented for raw and composted FOP (D'Addabbo & Sasanelli, 1997; Marull *et al*., 1997; D'Addabbo *et al*., 2003). The phytotoxicity of the highest rates of C_5 may be probably related to the high pH of this material (Arvanitoyannis & Kassaveti, 2007).

In both C_1 and C_5, FOP was combined with a nitrogenous waste material as sheep wool wastes and chicken manure, respectively. Nitrogen content of the waste materials added to FOP in composting mixture can consistently affect the nematode suppressiveness of compost, as improved or limited by the combination with high or low-nitrogen wastes, respectively (Oka & Yermiyahu, 2002; Nico *et al*., 2004). This synergism of nitrogenous materials with FOP wastes could be attributed to the enhancement of both nematicidal mechanisms above described for compost soil amendments (Raviv *et al*., 2005).

Our experiment is the first report of the suppressive activity of a mushroom substrate-based compost, as C_3, on RKN, as it was previously stated against *Pratylenchus penetrans* on potato and various trichodorid nematode species on ornamental bulb crops (LaMondia *et al*., 1999; Zoon *et al*., 2002).

The lowest suppressive effect on the population of *M. incognita* was exhibited by the composts derived from municipal green wastes, C_4 and C_2, as confirming the poor effect of composted yard-wastes (leaves, branches, grass clippings) on root-knot nematodes stated also by other authors (McSorley & Gallaher, 1995; Kimpinski *et al*., 2003). Also the combination of green wastes with sewage sludge, as provided by C_4, was always found to result in inconsistent or even negative effects on the nematode activity of the derived compost (Mannion *et al.*, 1994; McSorley *et al.*, 1997).

Tomato plant growth was positively affected by all treatments with C_1, C_3 and C_4 and only by the highest rates of C_2, whereas C_5 was not plant beneficial or even phytotoxic. Beneficial plant growth effects of compost amendments are mainly related to the release of nutrients as well as to an improved drainage and water retention in the amended soils, though stimulation of growth–promoting microorganisms and biocontrol agents in the plant rhizosphere may also be a contributory mechanism (Chen & Inbar, 1993; Alvarez *et al*., 1995;). However, the comparison among data from compost treatments and those of the infested and noninfested controls may suggest that the growth effect of the tested materials may be concurrently due to an increased plant nutrition, as exerted mainly by C_1 and C_3, as well as to the nematode suppression, prevailing in the soil amended with C_4. Composts from many raw materials, among which manures and FOP, were reported for a general improvement of physical soil properties and availability of nutrients (Sasanelli *et al*., 2002; Al-Widyan *et al*., 2005), though in our experiment N_t content was consistently enriched only at the highest rates of the five materials and OM content was improved mainly by FOP composts. Finally, the soil pH was not affected by compost amendments and, therefore, could not be related to their nematicidal effect. Adversely, a significant correlation between soil pH increase and disease suppressiveness of composts was previously documented (Termorshuizen *et al*., 2005).

All the tested compost could play a relevant role for a sustainable management of RKN, though the highest applicative potential was surely shown by C_1, as joining a high nematode suppressiveness to a remarkable plant growth effect. In addition, the local availability of the raw components of this compost, i.e. FOP, sheep wool wastes and wheat straw, allows to reduce the costs of the composting process and offers, at the same time, a safe alternative for the disposal of large amounts of these biowastes. The other composts, though possessing a suppressive potential, still need a standardization of the source raw materials and of the composting process, as to ensure constant and predictable effects on nematode and crop and to avoid phytotoxicity phenomena.

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