Nematol. medit. (1997), 25: 195-198

Istituto di Nematologia Agraria, C.N.R., Bari, Italy
Istituto di Ricerche sulla Olivicoltura, C.N.R., Perugia, Italy

THE SUPPRESSIVE EFFECT OF SOIL AMENDMENTS WITH OLIVE RESIDUES ON *MELOIDOGYNE INCOGNITA*

by

T. D'Addabbo, G. Fontanazza, F. Lamberti, N. Sasanelli and M. Patumi

Summary. Ground olive leaves, fresh and exhausted pomace, raw sewage and a commercial olive based product (Eufert) were incorporated at the rate of 1, 2, 4 and 8% w/w into a sandy soil naturally infested by *Meloidogyne incognita* (32 eggs and juveniles/g soil) in clay pots and planted with six week old seedlings of tomato cv. Rutgers. Ground olive leaves and fresh and exhausted olive pomace reduced significantly gall indices and nematode reproduction, but were highly phytotoxic. Raw sewage enhanced plant growth and Eufert produced moderate effect on the root gall index but significantly less than 300 kg c.p./ha of fenamiphos.

Root galling induced by *Meloidogyne arenaria* on tomato was suppressed when fresh olive pomace was incorporated into the soil (Rodríguez-Kábana *et al.*, 1992). However, the product caused some phytotoxicity but this was overcome by the addition of urea or other sources of organic nitrogen (Rodríguez-Kábana *et al.*, 1995).

Exhausted pomace, the waste product resulting from the chemical extraction of residual oil from fresh pomace, was effective in controlling root-knot (D'Addabbo and Sasanelli, 1996a) and cyst (D'Addabbo and Sasanelli, 1996b) nematodes and its efficacy was enhanced by the addition of wheat straw or urea (D'Addabbo and Sasanelli, 1997).

Green olive leaves, added to the soil, also reduced root galling of *Meloidogyne* spp. on tomato (Vouyoukalou, 1994).

Crop residues and side and waste products from olive oil extraction are widely available and at low cost in the Mediterranean region. Therefore, a pot experiment was undertaken to assess the nematicidal effect of various olive side products on root-knot nematodes attacking tomato.

Materials and methods

A sandy soil naturally heavily infested (32 eggs and juveniles/g soil) by an Italian population of *Meloidogyne incognita* (Kofoid *et* White) Chitw., race 1 (Taylor and Sasser, 1978) was thoroughly mixed with appropriate quantities of ground green olive (cv. Coratina) leaves, fresh or exhausted olive pomace, olive raw sewage or a commercial olive pomace-based amender (Eufert) (ground exhausted olive pomace mixed with grape peelings and grape-stone meal), to give a concentration of 1, 2, 4 and 8% w/w. These mixtures were then potted in 12 cm diam clay pots (500 ml mixture) with six replicates for each treatment. A group of six pots filled with

untreated soil served as the control. Six pots were filled with soil to which an appropriate quantity of 5% fenamiphos had been incorporated to simulate a field rate of 30 g c.p./m^2. The pots were arranged on benches in a glasshouse at 25±2 °C in a randomized block design.

After four weeks a six week old tomato (*Lycopersicon esculentum* Mill.) seedling, cv. Rutgers, was transplanted into each pot. Two months later the plants were uprooted and fresh and dry top and fresh root weights were recorded. The root gall index was assessed according to a 0 to 5 scale, where 0 = no galls, 1 = 1 to 2 galls, 2 = 3 to 10, 3 = 11-30, 4 = 31 to 100 and 5 more than 100 galls per root system (Taylor and Sasser, 1978). Roots were then processed by the Hussey and Barker (1973) method and the soil by the modified Coolen's method (Coolen, 1979; Di Vito *et al.*, 1985) and eggs and juveniles were counted to determine the nematode reproduction rate ($r = Pf/Pi$).

Data were statistically analyzed and mean values compared by the Duncan's multiple range test.

Results and discussion

Data on the growth of the plants (Table I) indicate that olive leaves and exhausted pomace was slightly phytotoxic and fresh pomace highly phytotoxic. Conversely the commercial amender

TABLE I - *Growth of tomato in soil infested by* Meloidogyne incognita *and amended with olive side products.*

Treatment	Fresh top weight (g)	*	*	Dry top weight (g)	*	*	Fresh root weight (g)	*	*
Control	**51.6**	**def**	**BCDEF**	**cd**	**BC**	**4.4**	**efgh**	**CDEF**	**10.8**	**d**	**F**	**c**	**C**
Olive leaves													
1%	43.6	bcdef	ABCDEF			3.0	abcdef	ABCDEF	8.4	cd	EF		
2%	57.0	ef	CDEF			4.6	efgh	DEF	10.4	d	F		
4%	35.0	abcde	ABCDE			2.6	abcde	ABCDE	7.2	bcd	ABCDEF		
8%	20.4	ab	AB			1.6	abc	ABC	3.2	a	ABC		
Average	**39.0**			**b**	**B**	**3.0**			**7.3**			**b**	**B**
Fresh pomace													
1%	25.8	abc	ABC			1.6	abc	ABC	4.8	abc	ABCDE		
2%	21.0	ab	AB			1.4	ab	AB	3.6	ab	ABCD		
4%	16.6	a	A			1.2	a	A	2.4	a	A		
8%	21.8	ab	AB			1.4	ab	AB	2.8	a	AB		
Average	**21.3**			**a**	**A**	**1.4**			**3.4**			**a**	**A**
Exhausted pomace													
1%	44.2	bcde	ABCDEF			3.2	abcdef	ABCDEF	9.6	d	EF		
2%	44.8	bcdef	ABCDEF			3.4	bcdef	ABCDEF	7.2	bcd	ABCDEF		
4%	51.1	cdef	BCDEF			3.1	efgh	DEF	7.6	cd	CDEF		
8%	27.2	abcd	ABCD			2.0	abcd	ABCD	4.0	ab	ABCD		
Average	**41.8**			**bc**	**B**	**2.9**			**7.1**			**b**	**B**
Raw sewage													
1%	51.4	cdef	BCDEF			4.0	defgh	ABCDEF	7.2	bcd	ABCDEF		
2%	59.4	ef	DEF			4.6	efgh	DEF	8.4	cd	DEF		
4%	67.2	f	EF			5.6	gh	F	8.4	cd	DEF		
8%	68.4	f	F			5.8	h	F	10.0	d	F		
Average	**61.6**			**d**	**C**	**5.0**			**8.5**			**bc**	**BC**
Commercial amender													
1%	56.2	ef	CDEF			4.6	efgh	DEF	10.4	d	F		
2%	57.0	ef	CDEF			5.0	fgh	EF	10.4	d	F		
4%	46.2	bcdef	ABCDEF			4.0	defgh	ABCDEF	9.6	d	EF		
8%	55.4	abcdef	CDEF			4.2	defgh	BCDEF	9.2	d	EF		
Average	**53.7**			**cd**	**BC**	**4.5**			**9.9**			**c**	**BC**
Fenamiphos	**48.0**	**cdef**	**ABCDEF**	**bc**	**BC**	**3.8**	**cdefgh**	**ABCDEF**	**8.4**	**cd**	**DEF**	**bc**	**BC**

Data flanked by the same letters in the same column are not significantly different according to Duncan's multiple range test (small letters for P = 0.05, capital letters for P = 0.01). (*) = significance of mean values.

TABLE II - *Reproduction of* M. incognita *on tomato in soil amended with olive side products.*

Treatment	Root gall index				Eggs and juveniles/g root (x 1000)				Reproduction factor (r = Pf/pi)			
			*	*			*	*			*	*
Control	**4.5**	**a A**	**a**	**A**	**95.7**	**a A**	**a**	**A**	**60.8**	**a A**	**a**	**A**
Olive leaves		BCDE										
1%	2.7	cdef BC			54.7	cdefg BCDEF			27.2	efg CDEFG		
2%	3.0	bcde BCDE			34.8	fgh EFGHI			22.8	fghi DEFGH		
4%	2.7	cdef E			27.5	ghi EFGHI			13.2	ghij FGHI		
8%	1.7	g			13.3	hi GHI			4.0	j HI		
Average	**2.5**		**cd**	**BC**	**32.6**		**c**	**C**	**16.8**		**d**	**D**
Fresh pomace												
1%	2.3	defg CDE			41.5	fgh DEFGH			15.2	ghij EFGHI		
2%	2.8	cde BCD			41.4	fgh DEFGH			9.2	ij GHI		
4%	1.8	fg DE			4.0	i I			1.6	j I		
8%	1.7	g E			5.5	i HI			2.0	j I		
Average	**2.1**		**d**	**C**	**23.1**		**c**	**C**	**7.0**		**d**	**D**
Exhausted pomace												
1%	3.8	ab AB			89.9	ab AB			52.8	abc AB		
2%	3.0	bcde BC			77.5	abcde ABCD			36.0	def BCD		
4%	3.0	bcde BC			53.5	defgh CDEF			26.4	efgh CDEFG		
8%	2.3	defg CDE			48.9	efg CDEF			11.6	hij FGHI		
Average	**3.0**		**bc**	**B**	**67.4**		**b**	**B**	**31.7**		**c**	**C**
Raw sewage												
1%	3.2	bcd BC			91.5	ab AB			54.0	bcd		
2%	2.7	cdef BCDE			85.1	abc ABC			54.0	bcd ABC		
4%	3.2	bcd BC			64.7	bcde ABCDE			37.2	cdef ABC		
8%	2.8	cde BCD			62.8	bcdef ABCDEF			38.0	bcdef BCD		
Average	**3.0**		**bc**	**B**	**76.0**		**b**	**B**	**45.8**		**b**	**B**
Commercial amender												
1%	3.3	bc ABC			82.8	abcd ABC			54.4	ab AB		
2%	3.2	bcd BC			60.8	bcdef ABCDEF			42.0	bcde ABCD		
4%	3.2	bcd BC			54.1	defg CDEF			34.0	def BCDE		
8%	3.2	bcd BC			52.5	defg BCDEF			31.2	def CDEF		
Average	3.2		**b**	**B**	62.5		**b**	**B**	40.4	**FGHI**	**bc**	**BC**
Fenamiphos	**2.2**	**efg CDE**	**d**	**C**	**25.4**	**ghi FGHI**	**c**	**C**	**14.8**	**ghij**	**d**	**D**

Data flanked by the same letters in the same column are not significantly different to Duncan's multiple range test (small letters for P = 0.05, capital letters for P 0.01). (*) = significance of mean values.

(Eufert) or the raw sewage did not exert any statistically significant effect on plant growth.

Ground leaves and fresh pomace suppressed the reproduction of *M. incognita* (Table II) at low dosages and at higher rates they were effective as fenamiphos and always significantly more suppressive than the corresponding dosages of the other materials tested. This result, however, must be considered to be a side effect due mainly to the poor development of the root system (Table I). Exhausted pomace and raw sewage caused significant nematode suppression only when added at rates ≥ 4%, whereas Eufert was suppressive just at the 2% dosage.

In conclusion, ground leaves and fresh and exhausted pomace cannot be used as soil amenders to control plant parasitic nematodes unless they are used at very low dosages, unless the phytotoxic components they carry, such as fatty acids, organic acids and phenols (Estaún *et al.*, 1985), are either removed or inhibited. Mixtures of olive pomace with urea or other nitrogen sources have a lower C:N ratio that stimulates the microbial degradation of the phytotoxic components (Rodríguez-Kábana *et al.*, 1992; 1995) and olive leaves suppress *Meloidogyne* spp. even at dosages ≤ 1%, with no toxic effect on tomato plants (Vouyoukalou, 1994).

Raw sewage and Eufert seem to be effective in controlling root-knot nematodes without harming plant growth. However, they control *M. incognita* significantly less efficiently than a

dose of 300 kg c.p./ha of fenamiphos. Cost/benefit on yield must then be analyzed before growers can be advised to use such products.

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Accepted for publication on 16 July 1997.