JOURNAL OF PLANT PROTECTION RESEARCH
Vol. 48, No. 3 (2008)

DOI: 10.2478/v10045-008-0046-1

EFFECT OF CHITIN AND ABAMECTIN ON *MELOIDOGYNE INCOGNITA* INFESTING RAPESEED

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Received: April 25, 2008
Accepted: July 20, 2008

Abstract: The tested rates of chitin (2, 4 and 8 g/m^2) significantly ($p \leq 0.05$ and 0.01) reduced the number of galls, egg masses, females and the second stage juveniles (J_2) in oilseed rape cvAD201 under field conditions. The plant growth parameters as length and weight of shoots increased at all rates of chitin compared to the untreated check. When using abamectin at the concentrations of 500, 1000 and 1500 ppm, it significantly ($p \leq 0.05$) reduced the above listed nematode criteria and enhanced the plant growth criteria.

Key words: chitin, abamectin, *Meloidogyne incognita*, rapeseed

INTRODUCTION

Scattered notes appear in the literature on the effect of chitin amendment on plant growth, microbial populations and certain parasitic nematodes in the soil. Brown et al. (1995**)** determined the effects of soil amendment with three rates of chitin (0, 0.5 and 1.0% by weight) and pre-incubation of soil with chitin for 0, 3, 6, and 9 weeks on the growth of white clover (*Trifolium repens* L.) and perennial ryegrass (*Lolium perenne* L.) and on populations of soil bacteria, fungi and plant-parasitic nematodes. Ryegrass yield increased in 0.5 and 1% chitin amended pots compared to the control. White clover yield decreased with increasing of chitin content, probably due to phytotoxic effects of chitin. Pre-incubation with chitin increased ryegrass yield but had no effect on white clover. Populations of micro-organisms but the fungal counts were unaffected by pre-incubation. The numbers of plant-parasitic nematodes, *Meloidogyne* spp. *and Heterodera trifolii* were reduced by chitin. Pre-incubation had no effect on nematode numbers. Hallmann et al. (1999) showed that addition of chitin to the

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soil at 1% (w/w) eliminated plant-parasitic nematodes in a first planting of cotton cv. 'Rowden' and significantly reduced *Meloidogyne incognita* infestation in a second planting, confirming long-term nematode suppressiveness induced by this organic amendment. The chitin amendment was associated with an increase in fungal and bacterial population, especially those with chitinolytic activity. Ehteshamul-Haque et al. (1997) showed that the soil amendment with shrimp, prawn, and crab chitin at 0.1% w/w or crab powder at 0.5g/ 100g soil significantly ($p \leq 0.05$) reduced infection of *Meloidogyne javanica* on chickpea.

Avermactins (from which abamectin) are a new class of macrocyclic lactones isolated from the organism, *Strptomyces avermitilis* (Burg et al. 1979). Cayrol *et al. (*1993**)** showed that 1 mg/1 AVM B_1 solution inhibited the hatching *of M. arenaria* after 12 days incubation and that juveniles were paralyzed after 24 h exposure when dipped in a low concentration (0.3 mg/1). Experiments on tomato seedlings, in greenhouse, to control nematode penetration in tomato roots by application of AVM B_1 on foliage were not effective. In contrast, direct application of AVM B_1 to the soil induced a significant reduction in nematode penetration. Jansson and Rabatin *(*1998*)* indicated that experiments were conducted against *M. incognita* on tomato, *M. javanica* on banana, and *Radopholus similar* on banana. Foliar applications of avermectins to banana and tomato were not effective for controlling any of the nematodes evaluated. Root dips of banana and tomato were moderately effective for controlling *M. incognita* on tomato and *R. similis* on banana. Injections (1 ml) of avermectins into banana pseudostems were effective for controlling *M. javanica and R. similis* Ao-lilin et al. (2000) found that the spraying a solution of 1.85 abamectin (10.2 kg) + water (1000 l)/ha and using this to wet the soil down to a depth of 15–20 cm helped to control *Meloidogyne* spp. on kiwifruits in China. El-Nagdi (2001) found that the application of abamectin when injected in plant pesudostem or poured on plant top of banana cv. Williams at three doses significantly decreased population densities of *M. incognita* and increased plant growth compared to untreated plants.

The aim of this work is to compare the effects of chitin and abamectin on *M. incognita* infesting rapeseed under field conditions.

MATERIALS AND METHODS

Effect of chitin

This test was conducted in a clay loam soil naturally infested with *M. incognita* located in Kafer-Kandeel, Attfeih, Giza Governorate. One week before rapeseed (*Brassica napus* L.) cv. AD201 seed sowing, chitin powder (poly-B(1-4)-N-acetyl-D-glucosamine ($C_8H_{13}NO_5$) was separately applied to the soil at the rates of 0, 2,4 and 8 g/m^2 (equivalent to 0, 8.4, 16.8 and 33.6 kg/Feddan (Fed. = 4 200 m^2). Rapeseed seeds were sown in rows, 10m long, 50cm apart and the distance between ridges was 40 cm. Each treatment was replicated five times and all treatments were distributed in a completely randomized block design. Hundred days after application, plants were harvested. Nematodes were extracted from soil samples by sieving and decanting methods. Number of galls, females and egg masses on roots were counted. The length and weight of shoots were measured.

Effect of abamectin

This test was conducted in a clay loam soil area naturally infested with *M. incognita* root knot nematode located in Kafer-Kandeel, Attfeih, El-Giza Governorate. Seeds of rapeseed cv. AD201 were sown in rows, 10 m long, 50cm apart and the distance between ridges was 40cm. Two weeks after germination, plants were thinned and then, abamectin 1.8% was added separately as soil drench at concentrations of 0, 500, 1 000 and 1 500 ppm. All treatments were distributed in a completely randomized block design. After 90 days from application plants were harvested. Nematodes in soil were extracted by sieving and decanting methods. Number of galls, females and egg masses on roots were counted. The length and weight of shoot were measured.

RESULTS

The effect of chitin on root knot nematode, *M. incognita* infesting rapeseed cv. AD201

Data in Table 1 showed that the tested rates of chitin significantly ($p \leq 0.01$and 0.05) reduced the number of galls, egg masses, females, and J_2 in the soil of *M. incognita* infesting rapeseed cv. AD201. The highest, rate of chitin reduced number of the galls, females, egg masses, and J_2 in the soil by 75.4, 84.8, 95.0 and 94.7%, respectively compared to the untreated check.. As for the medium rate, the reduction was 73.1, 86.7, 90.0 and 93.8%, for the respective nematode criteria. As for the lowest rate, the reduction was 69.2, 82.9, 85.0 and 94.3% for the galls, females, egg masses and J_2 in the soil, respectively. It was observed that plant growth parameters increased at all rates of chitin compared with the untreated check. In other words, the highest rate of chitin increased shoot length and weight by 10.3 and 26%, respectively. While the medium rate of application increased shoot length and weight by 17.6 and 52.0%, respectively. The lowest rate increased shoot length and weight by 10.3 and 9.3% only, respectively.

Table 1. The effect of chitin on root-knot nematode *M. incognita* – infested rapeseed (*Brassica napus* L.) cv. AD201 under field conditions

Rate of application [g/m²]	Plant growth				No. of nematodes/200 g soil and 10/g roots							
	Length [cm]	Inc. %	Fresh weight [g]	Inc. %	Galls	Red. %	Females	Red. %	Egg-Masses	Red. %	J_2 in soil	Red. %
0	204	–	1080	–	130	–	210	–	40	–	2600	–
2	225	10.3	1180	9.3	40	69.2	36	82.9	6	85	149	94.3
4	240	17.6	1640	52.0	35	73.1	28	86.7	4	90	160	93.8
8	225	10.3	1360	26.0	32	75.4	32	84.8	2	95	138	94.7
LSD.0.05	8.2	–	10.1	–	5.1	–	4.6	–	4.2	–	5.1	–
0.01	11.2	–	13.9	–	7.1	–	6.4	–	5.8	–	7.0	–

Values are averages of 5 replicates. Inc. = Increase over control, Red. = Reduction over control

The effect of abamectin on *M. incognita* infesting rapeseed cv. AD201

Data in Table 2 indicated that all tested abamectin concentrations significantly ($p \leq 0.05$) reduced nematode development on rapeseed AD201. The reduction in nematode development increased by increasing abamectin concentration. As for the reduction in root galls, females, egg masses and J_2 in soil it was 61.5, 95.2, 92.5and 94.2% at the highest concentration (1500 ppm), at medium concentrations the reduction was 52.8, 85.7, 90.0 and 94.6%, and it was 30.8, 81.0, 87.5 and 93.8% at the lowest concentration, respectively. As for the plant growth, it was noticed that plant length and weight were significantly increased at the treated abamectin concentrations. The highest increase in plant length (19.1%) was obtained at the highest concentration, while the highest increase in plant weight (52.8%) occurred at the medium concentration (1000 ppm).

Table 2. The effect of abamectin (1.8%) on root-knot nematode *M. incognita* – infested rapeseed (*Brassica napus* L.) cv. AD201 under field conditions

Rate of application	Plant growth				No. of nematodes/200 g soil and 10/g roots							
	Length [cm]	Inc. %	Fresh weight [g]	Inc. %	Galls	Red. %	Females	Red. %	Egg-masses	Red. %	J_2 in soil	Red. %
0	204	–	1080	–	130	–	210	–	40	–	2600	–
500 ppm	222	8.8	1390	28.7	90	30.8	40	81.0.	5	87.5	160	93.8
1000 ppm	236	15.7	1650	52.8	60	53.8	30	85.7	4	90.0	140	94.6
1500ppm	243	19.1	1540	42.6	50	61.5	10	95.2	3	92.5	150	94.2
LSD 0.05	13.2	–	14.9	–	9.7	–	8.3	–	7.8	–	7.2	–

Values are averages of 5 replicates. Inc. = Increase over control. Red. = Reduction over control

DISCUSSION

In the present study, effect of chitin in the soil varied with its different tested rates. All rates significantly ($p < 0.05$ and 0.01) reduced gall formation, egg masses, females and J_2 in soil and improved rapeseed plant growth compared to untreated check. The results are in agreement with those obtained by other author (Godoy *et al.* 1983 and Brown *et al.* 1995). Although the mode of action of chitin in controlling plant parasitic nematodes is not well understood, the suggested mechanisms include increased microbial chitinase activity which may damage chitin-containing egg shell and the nematicidal activity of increased ammonia levels released by chitin hydrolysis (Mian *et al.* 1982). Free ammonia permeates cellular membranes much more readily than ionized ammonia. Since toxicity is dependent on the amount of ammonia entering cells, the ammonia in the free state is much more toxic (Warren 1962). While ammonia is an important source of nitrogen for living plants, high concentrations of ammonia in the soil have been shown to be phytotoxic, inhibiting both seed germination (Hunter and Rosenau 1965) and growth (Warren 1962; Cooke 1962). Some substances such as those containing chitin are thought to stimulate the growth of nematophagous fungi which utilize chitin for food (Godoy *et al.* 1983; Muzzarelli 1977; Spiegel *et al.* 1987).

During the microbial breakdown of chitin, several substances are liberated. Addition of chitin to the soil stimulates the populations of bacteria, actinomycetes and a limited number of fungal species with chitinolytic properties (Muzzarelli 1977) which possibly due to increased C and N supply from chitin. These results are consistent with previous findings (Mian *et.al.* 1982; Godoy *et al*. 1983; Brown *et al.* 1995; Culbreath *et al.* 1985; Hallmann *et al*. 1999; Spiegel *et al.* 1986, 1987; Westerdahl *et al.* 1992).

Results obtained in the present study indicate that abamectin at the tested concentrations significantly ($p \leq 0.05$) reduced most nematode parameters and enhanced plant growth parameters. These results agree with those obtained by Garabedian and Van Gundy (1983); Blackburn *et al. (*1996); Auarles (1991); El-Nagdi and Youssef (2004) and Lashein (2002). The reduction in *M. incognita* parameters may be referred to gross effect of abamectin on the movement and infective behavior of the parasites. Mellin *et al*. (1983) suggested that the initial loss of movement of *M. incognita* larvae may reflect avermentins activity. Wright *et al.* (1984) stated that when *M. incognita* was exposed to 120-nM aqueous solution of avermentins B_2-23-ketone, it initially lost movement within 10 minutes and irreversibly lost movement after 120 minutes. Nordmeyer and Dickson (1989) reported that a little is known about the physiological effect of the avermactins on plant parasitic nematodes, as oxygen uptake by freshly hatched juveniles of three *Meloidogyne* species exposed to a 0.05 ppm solution of avermectin B_2a was reduced by 61.7%, while the reasons for the lessened oxygen uptake are not known.

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POLISH SUMMARY

DZIAŁANIE CHITYNY I ABAMETRYNY NA NICIENIA *MELOIDOGYNE INCOGNITA* PORAŻAJĄCEGO RZEPAK

Testowane dawki chityny (2, 4 i 8 g/m^2) istotnie ($p \leq 0,05$ i 0,01) zmniejszały liczbę narośli, złóż jaj, osobników żeńskich i osobników drugiego stadium młodocianego (J2) *Meloidogyne incognitana* rzepaku odmiany AD 201 rosnącym w ziemi zakażonej tym nicieniem. Parametry wzrostu roślin wzrastały w przypadku zastosowania wszystkich dawek w porównaniu do nie traktowanej kombinacji kontrolnej. Stosowanie abamektyny w stężeniach 500, 1 000 i 1 500 ppm również wywoływało podobny efekt ($p \leq 0,05$) redukujac populację nicieni oraz stymulując wzrost roślin.