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Research Note

Compatibility of entomopathogenic nematodes *Heterorhabditis indica* (Poinar, Karunakar and David) and *Steinernema glaseri* (Stainer) with insecticides

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ABSTRACT: Compatibility of six insecticides, *viz.*, dimethoate, carbosulfan, imidacloprid, endosulfan, carbofuran and phorate, at different concentrations (500, 1000 and 2000ppm) with *Steinernema glaseri* and *Heterorhabditis indica* was studied. The survival of IJs (infective juveniles), infectivity on *Corcyra cephalonica* (Stainton) and reproductive capacity of IJs were observed after 72h of exposure. *S. glaseri* was compatible with carbofuran, carbosulfan, imidacloprid, phorate and dimethoate, but not compatible with endosulfan at higher concentration (2000 ppm). *H. indica* was compatible with carbofuran, carbosulfan and imidacloprid, but not compatible with phorate, dimethoate (at all concentrations) and endosulfan at higher concentration (2000ppm).

KEY WORDS: *Corcyra cephalonica*, entomopathogenic nematodes, *Heterorhabditis indica*, insecticides, *Steinernema glaseri*

The entomopathogenic nematodes (EPN), *Steinernema glaseri* and *Heterorhabditis indica*, are most promising biological control agents and their role in the natural regulation of insect populations is well documented. EPN were successfully utilized to control the economically important lepidopteran pests within 24-48 hours (Kaya, 1990) with no detrimental effects on non-target species (Poinar, 1989). To reduce the adverse effects of chemical insecticides such as pollution hazards, resurgence and resistance in insects, the current thrust in plant protection is rightly on promoting integrated pest management, which is ecologically sound, economically viable and socially acceptable. Hence, compatibility of insecticides with EPN was studied in the laboratory.

A lab experiment was conducted to find out the compatibility of insecticides with entomopathogenic nematodes at Tamil Nadu Agricultural University, Coimbatore, during the year 2004-05. The effects of six chemical insecticides, *viz.*, dimethoate, carbosulfan, imidacloprid, endosulfan, carbofuran and phorate, were tested on *S. glaseri* and *H. indica*. All the chemicals were diluted in distilled water and tested at 500, 1000 and 2000ppm concentrations. Nematode suspension

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(0.5, 1.0 and 2.0ml) containing about 1000IJs was placed in each petridish, which contained 9.5, 9.0 and 8.0ml of the insecticide solutions respectively for 500, 1000 and 2000ppm concentration, respectively. Five replications were maintained. Observations on the mortality of IJ were made after 72h of exposure by counting dead and surviving juveniles using counting dish. The ability of chemical insecticide-treated IJs (after 72h of exposure) to cause infection was tested against last instar *C. cephalonica* larvae. After 72h of exposure, chemical treated nematodes were washed thoroughly and transferred (1 ml containing 100 IJs) to Petri dishes containing whatman No.1 filter paper. Five larvae were placed in each dish and the dishes were sealed with klin film. Larval mortality was determined after 72h of exposure. Five replications were maintained. The dead *C. cepholonica* larvae obtained from experiments conducted for infectivity were transferred to plaster of Paris trap (Woodring and Kaya, 1988). Nematodes were recovered from the traps until exit of IJs ceased and nematodes from each treatment were counted. Statistical analysis with suitable transformations of data was carried out.

Effect of chemical insecticides on the survival of EPN

In the present study, among all the chemicals and all the concentrations (500, 1000 and 2000 ppm), phorate caused 100 per cent mortality of IJs of *H. indica* (Table 1). Similar results were obtained by Rovesti *et al.* (1988). Highest mortality (96, 99.4 and 100%) of IJs of *H. indica* was observed at 500, 1000 and 2000 ppm concentrations of dimethoate after 72 h of exposure. Jaworska (1990) reported that dimethoate (37%) at 0.0001–0.2 per cent concentrations caused 16.7 per cent mortality of *H. bacteriophora* after 24h exposure. Endosulfan at 2000 ppm caused 71.76 per cent mortality of *H. indica* after 72 h of exposure (Table 1). Carbosulfan, carbofuran and imidacloprid caused 2-7 per cent mortality of IJ of *H. indica* which were not significantly different from control (Table 1). This was supported by Rovesti *et al.* (1988) and Heungens and Buysse (1987). Endosulfan caused highest mortality (56-71%) of IJs of *S. glaseri* at all concentrations (500, 1000 and 2000 ppm) after 72h of exposure (Table 1). This was supported by Gupta and Siddiqui (1999) who reported that endosulfan (0.05 %) caused 42-49 per cent mortality of *S. glaseri*. In the present study, imidacloprid, carbofuran, phorate, carbosulfan and dimethoate caused 0.6–13.6 per cent mortality of IJs of *S. glaseri*, which was not significantly different from control. Similar results were obtained by Zang *et al.* (1994) and Bednarek *et al.* (2000).

Infectivity to *Corcyra cephalonica*

In the present study the highest infectivity of IJs of *H. indica* to *C. cephalonica* was observed in all concentrations of imidacloprid (52-72%), followed by carbofuran and carbosulfan (62-64%) after 72h of exposure (Table 2). Bednarek *et al.* (2000) also reported that the pathogenicity of carbosulfan (3mg kg^{-1} soil) treated *H. megidis* was not negatively affected. The highest mortality (56-76%) of *C. cephalonica* due to *S. glaseri* was recorded at all the concentrations of imidacloprid and carbofuran. Lowest mortality (24, 32 and 48%) was recorded at 2000ppm concentration of endosulfan, dimethoate and phorate (Table 2).

Reproduction of EPN

The highest reproduction of *H. indica* was observed at 500ppm of imidacloprid, carbosulfan and endosulfan (13886, 12536.6 and 12053.2Ijs / insect, respectively). This was followed by 1000 ppm (12583.4, 11880.2 and 11185Ijs / insect, respectively) and 2000ppm concentrations (11005.4, 10662 and 8702IJs / insect, respectively). In carbofuran treated IJs reproduction were 11058.8, 10169 and 9411.6IJs / insect recorded at 500, 1000 and 2000ppm concentrations, respectively (Table 3). In case of *S. glaseri*, the highest reproduction was recorded at all concentrations of imidacloprid (5692, 4840, 4141.2IJs / insect, respectively), followed by dimethoate, carbosulfan and carbofuran. The lowest reproduction was recorded at all concentrations of phorate and endosulfan (Table 3). Similar results were observed by Zhang *et al.* (1994).

Table 1. Effect of insecticides on infective juveniles of EPN

Treatment	Per cent mortality after 72h of exposure	
	H. indica	*S. glaseri*
Dimethoate 500 ppm	96.00 (78.90)	4.00 (11.52)
Dimethoate 1000 ppm	99.40 (87.02)	6.42 (14.66)
Dimethoate 2000 ppm	100.00 (89.65)	9.76 (18.20)
Carbosulfan 500 ppm	4.30 (12.02)	4.80 (12.61)
Carbosulfan 1000 ppm	5.50 (13.611)	8.80 (17.27)
Carbosulfan 2000 ppm	7.86 (16.29)	13.60 (21.59)
Imidacloprid 500 ppm	0.00 (0.36)	0.60 (3.12)
Imidacloprid 1000 ppm	1.40 (6.15)	2.30 (8.64)
Imidacloprid 2000 ppm	2.90 (9.64)	5.32 (13.33)
Endosulfan 500 ppm	30.00 (33.22)	56.60 (48.80)
Endosulfan 1000 ppm	54.50 (47.39)	61.70 (51.76)
Endosulfan 2000 ppm	71.76 (57.90)	71.40 (57.68)
Carbofuran 500 ppm	1.80 (6.94)	1.18 (5.64)
Carbofuran 1000 ppm	3.70 (11.02)	2.24 (8.60)
Carbofuran 2000 ppm	5.10 (2.98)	3.80 (11.26)
Phorate 500 ppm	100.00 (89.52)	2.55 (8.13)
Phorate 1000 ppm	100.00 (89.52)	3.96 (11.46)
Phorate 2000 ppm	100.00 (89.52)	4.92 (63.98)
Control (Sterile distilled water)	0.00 (0.36)	0.00 (0.36)
CD (P = 0.01)	(2.87)	(2.15)

Figures in parentheses are arc sine transformed values.

Table 2. Effect of insecticides on infectivity of EPN

Treatment	Per cent infectivity	
	H. indica	*S. glaseri*
Dimethoate 500 ppm	0.0 (0.36)	68.0 (56.06)
Dimethoate 1000 ppm	0.0 (0.36)	48.0 (43.85)
Dimethoate 2000 ppm	0.0 (0.355)	32.0 (34.17)
Carbosulfan 500 ppm	60.0 (51.00)	52.0 (46.16)
Carbosulfan 1000 ppm	56.0 (48.69)	48.0 (43.85)
Carbosulfan 2000 ppm	52.0 (46.16)	28.0 (31.63)
Imidacloprid 500 ppm	72.0 (58.37)	76.0 (60.90)
Imidacloprid 1000 ppm	60.0 (51.00)	72.0 (58.37)
Imidacloprid 2000 ppm	52.0 (46.16)	64.0 (53.53)
Endosulfan 500 ppm	56.0 (48.46)	52.0 (46.16)
Endosulfan 1000 ppm	40.0 (39.01)	32.0 (34.17)
Endosulfan 2000 ppm	28.0 (31.63)	24.0 (29.10)
Carbofuran 500 ppm	64.0 (53.53)	72.0 (58.37)
Carbofuran 1000 ppm	56.0 (48.46)	60.0 (51.00)
Carbofuran 2000 ppm	52.0 (46.16)	56.0 (48.46)
Phorate 500 ppm	0.0 (0.48)	60.0 (51.00)
Phorate 1000 ppm	0.0 (0.48)	52.0 (46.16)
Phorate 2000 ppm	0.0 (0.48)	48.0 (43.85)
Control (Sterile distilled water)	100.0 (89.52)	100.0 (89.52)
CD (P = 0.01)	(11.16)	(14.65)

Figures in parentheses are arc sine transformed values.

Table 3. Effect of insecticides on reproduction of EPN

Treatment	Reproduction (IJ / insect)	
	H. indica	*S. glaseri*
Dimethoate 500 ppm	0.00 (0.00)	5449.20
Dimethoate 1000 ppm	0.00 (0.00)	4833.60
Dimethoate 2000 ppm	0.00 (0.00)	3977.40
Carbosulfan 500 ppm	12536.60 (4.10)	4069.6
Carbosulfan 1000 ppm	11880.20 (4.08)	3706.6
Carbosulfan 2000 ppm	10662.00 (4.03)	2874.80
Imidacloprid 500 ppm	13886.00 (4.14)	5692.00
Imidacloprid 1000 ppm	12583.40 (4.10)	4840.0
Imidacloprid 2000 ppm	11005.40 (4.04)	4141.20
Endosulfan 500 ppm	12053.20 (4.08)	2893.00
Endosulfan 1000 ppm	11185.0 (4.41)	2407.40
Endosulfan 2000 ppm	8702.00 (3.94)	1738.00
Carbofuran 500 ppm	11058.80 (4.04)	4314.00
Carbofuran 1000 ppm	10169.00 (4.01)	3939.80
Carbofuran 2000 ppm	9411.60 (3.97)	3320.80
Phorate 500 ppm	0.00 (0.00)	3977.00
Phorate 1000 ppm	0.00 (0.00)	2913.80
Phorate 2000 ppm	0.00 (0.00)	2096.00
Control (Sterile distilled water)	16177.00 (4.209)	9443.00
CD (p=0.01)	(0.01)	(189.45)

Figures in parentheses are arc sine transformed values.

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