J. Biol. Control, 21(1): 31-36, 2007

Toxicity of biopesticides and synthetic insecticides to egg parasitoid, *Trichogramma chilonis* Ishii and coccinellid predator, *Cheilomenes sexmaculata* (Fabricius)

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ABSTRACT: Toxicity of biopesticides and synthetic insecticides was assayed for egg parasitoid, *Trichogramma chilonis* Ishii and coccinellid predator, *Cheilomenes sexmaculata* (Fabricius) under laboratory conditions. Neem seed kernel extract (NSKE 5%), custard apple seed extract (CASE 5%), pongamia seed extract (PSE 5%), neem oil (2%) and pongamia oil (2%) were compared with commercial neem formulation (0.2%) for their toxic effect. Synthetic insecticides like imidacloprid (0.01%), acetamiprid (0.002%), thiomethoxam (0.02%), profenophos (0.05%), and carbosulfan (0.14%) were compared with monocrotophos (0.05%) for their toxicity to *T. chilonis* and *C. sexmaculata*. Most of the botanicals were found safe to *T. chilonis* and *C. sexmaculata*. Among six insecticides tested, carbosulfan was found to be highly toxic to *T. chilonis* and *C. sexmaculata*, followed by acetamiprid. Imidacloprid was relatively less toxic to both species. Microbial biopesticide, *Bacillus thuringiensis* (Bt) was also found safe to both species.

KEY WORDS: Biopesticides, *Cheilomenes sexmaculata*, safety, synthetic insecticides, toxicity, *Trichogramma chilonis*

INTRODUCTION

Biopesticides of plant and microbial origin, biocontrol agents and insecticides are important components of integrated pest management (IPM). *Trichogramma chilonis* Ishii was found to parasitise up to 53.5 per cent of eggs of *Helicoverpa armigera* on different genotypes of sunflower (Tandon and Bakthavatsalam, 2004). Coccinellids are one of the most popular and widely recognized groups of predatory insects. Coccinellid predator, *Cheilomenes sexmaculata* (Fabricius) is most beneficial as one of the promising predators of sucking pests like leafhoppers, thrips and whiteflies as well as eggs and early instar larvae of lepidopteran insect pests in the sunflower ecosystem (Basappa and Santha Lakshmi Prasad, 2005).

Several biopesticides of botanical origin like neem seed kernel extract (NSKE 5%), custard apple seed extract (CASE 5%), pongamia seed extract (PSE 5%), neem oil (2%), pongamia oil (2%) and *Spodoptera litura* NPV (*Sl*NPV), *Helicoverpa armigera* NPV (*Ha*NPV), *Bacillus thuringiensis* (Bt) of microbial origin (Basappa, 2005) as well as insecticides like imidacloprid (0.01%), acetamiprid (0.002%), thiomethoxam (0.02%), profenophos

(0.05%), corbosulfan (0.14%), monocrotophos (0.05%) (Satish *et al.*, 2004; Singh and Nagaraj, 2004) were found to be effective against major insect pests of sunflower. All the biopesticides and insecticides involved in the investigation were evaluated against different insect pests of sunflower under field conditions at the Directorate of Oilseeds Research. However, information on the toxicity of these biopesticides and insecticides to promising biocontrol agents prevailing in the sunflower ecosystem is lacking. Thus the present investigations were initiated to study the toxicity of various botanical formulations, *Bt* and newer insecticides to potential natural enemies like *T. chilonis* and *C. sexmaculata*.

MATERIALS AND METHODS

Studies were conducted during 2002 and 2003 on the toxic effect of different botanicals (Table 1), *Bt* and insecticides (Table 2) to *T. chilonis* and *C. sexmaculata* in the Entomology laboratory, Directorate of Oilseeds Research, Rajendranagar, Hyderabad.

Preparation of botanicals : Fifty grams of smashed neem, custard apple and pongamia seed kernels were soaked overnight in one liter of water, filtered through muslin and diluted with water to get desired concentration.

Mass production of *T. chilonis*: Egg parasitoid, *T. chilonis* was reared on fresh *Corcyra cephalonica* (Stainton) eggs in the laboratory by pasting eggs on paper cards of 21x30 cm size having thirty 7x2 cm rectangles. These egg cards were placed in a polythene cover along with nucleus culture of *T. chilonis* parasitised eggs of *Corcyra* (6:1). The eggs were treated with UV radiation to kill the embryo of un parasitized host eggs. The parasitized egg cards were cut into pieces of 2x2 cm by retaining fifty parasitized eggs on each piece and kept in test tubes of 20x1.5 cm size for toxicity studies.

Toxicity to *T. chilonis*: Toxicity of biopesticides (Table 1), *Bt* and insecticides (Table 2) on developmental stages of *T. chilonis* was determined by treating 1, 3 and 7-day-old *C. cephalonica* eggs parasitised by *T. chilonis*. Fifty eggs parasitized by *T. chilonis* were sprayed with one ml of spray fluid using Potters Tower sprayer with three replications. The treated eggs were shade dried for 10 minutes and kept inside the test tube for adult emergence. In control only distilled water was sprayed. Number of adults emerged from eggs treated with different botanicals, *Bt* and insecticides was recorded.

Mass production of predatory beetle, *C. sexmaculata*: Adults of *C. sexmaculata* collected the cowpea (*Vigna unguiculata* L.) were reared on aphid (*Aphis craccivora*) multiplied on sprouted cowpea in the laboratory. Cowpea seeds were cleaned and washed in distilled water before soaking. After 24 hours of soaking seeds sprouted and were gently placed over blotting paper on soaked cotton placed inside glass jars (20x15 cm). Full-grown adults of *A. craccivora* were inoculated on the sprouts kept inside the jar. The jars were covered with moist muslin cloth in order to avoid escape of aphids. *C. sexmaculata* was reared on aphids and adults were used for experimentation.

Toxicity to *C. sexmaculata*: Fifteen adults of *C. sexmaculata* were used per treatment and replicated 3 times. *C. sexmaculata* beetles were exposed to biopesticide and insecticide treated surface, *i.e.* glass tube of 20 x 1.5cm and aphids were released along with cowpea sprouts into the tube for 3 days as food for beetles. In the control, glass tube surface was treated with distilled water. Mortality of *C. sexmaculata* was recorded on 1, 2 and 3 days after exposure to treated surface. The cultures of *T. chilonis*, *C. cephalonica*, *C. sexmaculata* and *A. craccivora* were maintained at 27±1°C temperature and 60±5 per cent RH in the laboratory. The data were subjected to angular transformation and statistically analysed.

RESULTS AND DISCUSSION

Toxicity to *T. chilonis*

Biopesticides: The adult emergence from one-day-old sprayed eggs ranged from 52.66 to 78.00 per cent with highest emergence in NSKE (78.00%), followed by neem oil (77.33%) compared to 96.66 per cent in control. The lowest emergence was recorded in the commercial neem product (52.66%). Similar trend was observed on adult emergence from 3- day-old sprayed eggs, which ranged from 58.66 to 82.66 per cent compared to 95.33 per cent in control. Adult emergence from 7-day-old sprayed eggs ranged from 78.66 to 92.66 per cent compared to 92.66 per cent in control. All the botanicals were found to be safe to different developmental stages of *T. chilonis*. As the developmental period extended from day-old to 7-day- old, the per cent emergence also increased gradually (Table 1).

Insecticides: The adult emergence from one-day-old sprayed eggs ranged from 5.33 to 34.66 per cent with maximum emergence in imidacloprid (34.66%), followed by profenophos (30.00%) compared to 98.00 per cent in control. The lowest emergence was recorded in the carbosulfan (5.33%). Similar trend was observed on adult emergence from 3-day-old sprayed eggs, which ranged from 8.66 to 44.00 compared to 96.66 per cent in control. Adult emergence from 7-day-old sprayed eggs ranged from 11.33 to 60.66 compared to 97.33 per cent in control. Carbosulfan was found to be highly toxic to *T. chilonis* followed by acetamiprid. Among all the newer insecticides imidacloprid was found to be relatively less toxic to different developmental stages of *T. chilonis* (Table 2). As the developmental period extended from day old to 7-day-old, the per cent emergence of *T. chilonis* adults also increased gradually. *Bt* was also found safe to *T. chilonis* with 96.66, 98.00 and 97.33 per cent emergence from 1, 3 and 7-day-old treated eggs, respectively.

Toxicity to *C. sexmaculata*

Biopesticides: There was increase in mortality of *C. sexmaculata* adults with increase in time (Table 3). The adult mortality on one DAT ranged from 8.88 (NSKE) to 22.21 per cent (commercial neem products). The mortality was 11.11, 13.33, 15.55 and 19.99 per cent in PSE, CASE, neem oil and

Table 1. Toxicity of biopesticides of botanical origin on *T. chilonis*

Treatment	Emergence of *T. chilonis* adults (%)		
	1-day-old parasitised eggs	3-day-old parasitized eggs	7-day-old parasitized eggs
NSKE (5%)	82.66 (65.46)	78.00 (62.14)	92.66 (74.67)
CASE (5%)	70.00 (56.63)	68.00 (55.71)	82.60 (65.70)
PSE (5%)	74.00 (59.63)	64.66 (53.59)	78.66 (62.63
Neem oil (2%)	79.33 (63.07)	77.33 (61.66)	86.66 (69.05)
Pongamia oil (2%)	70.66 (57.24)	66.6 (54.61)	80.66 (64.17)
Neem Product (0.2%)	58.66 (50.02)	52.66 (46.54)	82.66 (65.68)
Control	95.33 (77.97)	96.66 (81.81)	92.66 (78.44)
C V (%) CD (P=0.05%)	5.07 5.54	9.23 9.76	10.40 NS

Figures in parentheses are angular transformed values.

Table 2. Toxicity of insecticides on *T. chilonis*

Treatment	Emergence of *T. chilonis* adults (%)		
	1-day-old parasitised eggs	3-day-old parasitized eggs	7-day-old parasitized eggs
Monocrotophos (0.05%)	44.00 (41.52)	34.66 (36.03)	60.66 (51.42)
Imidacloprid (0.01%)	42.66 (40.78)	30.00 (35.19)	60.00 (50.78)
Acetamiprid (0.002%)	16.00 (23.47)	11.33 (20.09)	18.66 (25.50)
Thiomethoxam (0.02%)	25.33 (30.14)	17.33 (26.25)	39.33 (51.02)
Carbosulfan (0.14%)	8.66 (17.02)	5.33 (15.47)	11.33 (19.34)
Profenophos (0.05%)	40.00 (39.22)	32.66 (35.19)	39.23 (50.42)
Bt (2g/L)	95.33 (77.84)	98.00 (83.44)	98.66 (84.58)
Control	96.66 (81.81)	98.00 (83.44)	97.33 (82.31)
C V (%) CD (P=0.05%)	9.88 7.61	9.82 7.20	9.30 8.46

Figures in parentheses are angular transformed values.

Table 3. Toxicity of biopesticides of botanical origin to *C. sexmaculata*

Treatment	*C. sexmaculata* adult mortality (%)		
	1 DAT	2 DAT	3 DAT
NSKE (5%)	8.88 (17.13)	17.77 (24.88)	17.77 (24.88)
CASE (5%)	13.33 (20.98)	15.55 (23.13)	22.22 (28.06)
PSE (5%)	11.11 (16.17)	17.77 (24.88)	19.99 (26.33)
Neem oil (2%)	15.55 (23.13)	22.22 (28.11)	24.44 (29.55)
Pongamia oil (2%)	19.99 (26.33)	24.44 (29.55)	28.88 (32.35)
Neem Product (0.2%)	22.21 (28.11)	24.44 (29.55)	24.44 (29.55)
Control	0.00 (0.57)	0.00 (0.57)	2.22 (5.38)
C V (%) CD (P=0.05%)	12.47 4.31	12.27 4.99	19.07 11.97

DAT - Days after treatment

Figures in parentheses are angular transformed values.

pongamia oil, respectively. Similar trend was observed on 2 DAT and 3 DAT with mortality ranging from 15.55 (CASE) to 24.44 per cent (pongamia oil and commercial neem product). All the biopesticides were found safer to *C. sexmaculata*.

Table 4. Toxicity of insecticides on *C. sexmaculata*

Treatment	*C. sexmaculata* adult mortality (%)		
	1 DAT	2 DAT	3 DAT
Monocrotophos (0.05%)	55.55 (48.21)	93.33 (77.84)	100.00 (90.00)
Imidacloprid (0.01%)	42.22 (40.45)	88.88 (71.15)	100.00 (90.00)
Acetamiprid (0.002%)	75.55 (60.53)	100.00 (90.00)	100.00 (90.00)
Thiomethoxam (0.02%)	55.55 (48.23)	93.33 (77.84)	100.00 (90.00)
Carbosulfan (0.14%)	84.44 (67.47)	100.00 (90.00)	100.00 (90.00)
Profenophos (0.05%)	71.11 (57.70)	95.55 (82.84)	100.00 (90.00)
Bt (2g/L)	0.00 (0.57)	0.00 (0.57)	8.88 (17.13)
Control	0.00 (0.57)	0.00 (0.57)	4.44 (10.19)
C V (%)	15.16	11.83	4.42
CD (P=0.05%)	10.75	12.71	5.49

DAT - Days after treatment

Figures in parentheses are angular transformed values.

Insecticides: The mortality of adult beetles increased with increase in time (Table 4). On one DAT mortality of adult beetles was 42.22, 55.55, 71.11, 75.55 and 84.44 per cent in imidacloprid, thiomethoxam, monocrotophos, profenophos, acetamiprid and carbosulfan, respectively. On 2 DAT all the insecticides caused 90 to 100 per cent mortality except imidacloprid (88.88%). On 3 DAT all the insecticides caused 100 per cent mortality compared to 8.88 and 4.44 per cent in *Bt* and control, respectively.

Biopesticides have not been found to be toxic to both the natural enemies. The findings of Singh and Jalali (1994) agreed with the present findings in the case of *T. chilonis* in respect of biopesticides of botanical origin. Some of the insecticides like profenophos, acetamiprid and carbosulfan affected various growth stages of *T. chilonis* with 11.33 to 39.23 per cent adult emergence but imidacloprid and monocrotophos had 60 per cent adult emergence from 7-day-old parasitised eggs indicating their relative safety. Generally synthetic insecticides are toxic to egg parasitoids than plant products and biopesticides (Jhansi Lakshmi *et al.*, 1997). Except imidacloprid most of the insecticides caused more than 50 per cent mortality of *C. sexmaculata* adults at one DAT and all the insecticides caused cent per cent mortality at 3 DAT. Commercial neem product, *Bt* and imidacloprid could reduce 17.14, 18.19 and 34.83 per cent of *C. sexmaculata* population in Okra crop (Sunitha *et al.*, 2004) which is in agreement with the present findings. As per the classification by Hassan (1986) the tested biopesticides fall in the harmless group contrary to insecticides tested.

At the global level there is increasing demand for reducing toxic effect in the environment and supplying pesticide residue free food. Thus for profitable pest management in sunflower ecosystem the concept of limited usage of insecticides coupled with augmenting natural enemies needs serious consideration for sustainable production.

ACKNOWLEDGEMENT

The author is grateful to the Project Director, Directorate of Oilseeds Research, Rajendranagar, Hyderabad for the facility provided.

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(Received: 27.05.2006; Revised: 25.01.2007; Accepted: 05.02.2007)