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Susceptibility of three biocontrol agents of brinjal insect pests to seven selected insecticides

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Abstract
Susceptibility of three biological control agents of Brinjal insect pests to seven selected insecticides were evaluated. Lowest mortality (6.67 %) of *Camponotus compressus* was found in Bactoil and Nimbicidene 0.03 EC treated brinjal and the highest mortality (100%) was recorded from Necstar-50 EC and Booster-10 EC treatments. The lowest mortality of *Micraspis crocera* Muls was recorded from Bactoil (3.67%) treatment while the highest mortality of *Micraspis crocera* Muls was found in Necstar-50 EC (100.00%) and Booster-10 EC (100.00%) treated brinjal. In case of *Trathala* emergence from infested shoot, the highest percentage (22.22%) was observed in the untreated control plots and lowest emergence was in Necstar-50 EC (2.22%) and Proclaim-5 SG (3.33%) treated brinjal shoots. In case of the infested fruit specimen, the highest (22.22%). *Trathala* emergence was found in the untreated control plots followed by the plots treated with Bactoil (18.89 %) and Nimbicidene 0.03 EC (17.78 %) while the lowest was in Necstar-50 EC (1.11%) and Booster-10 EC (2.22 %) treated brinjal fruits. Compatibility factor was highest for Bactoil (13.94, 25.33 and 27.92 with *C. compressus*, *M. crocera* and *Trathala*, respectively) and was lowest for Booster-10 EC (0.86, 0.86 and 4.30 with *C. compressus*, *M. crocera* and *Trathala*, respectively). Therefore Bactoil, Nimbicidene 0.03 EC and Tracer-45 SC were found to be the most compatible insecticides for controlling the Brinjal shoot and fruit boruss.

Key words: Brinjal, biological control agents, insecticides, compatibility, insect pest

INTRODUCTION

Predators of five different orders such as Coleoptera, Neuroptera, Diptera, Hymenoptera and Mantoidea were reported to be found in brinjal ecosystem (El-shafie 2001). Eight different taxonomic groups of soil dwelling natural enemies were also recorded, among them Formicidae, Forficulidae, Araneae, Gryllidae, Carabidae and Staphylinidae were common. Major parasitoids recorded in the brinjal field were *Trathala* sp., *Trichogramma* sp., *Erioborus* sp., *Ceranisus* sp. (FAO, 2003).

In brinjal cultivating field different kinds of natural enemies viz., ladybird beetles, carabid beetles (ground beetle), lacewings, preying mantids, spiders, earwigs, predatory bugs, syrphid flies, *Trathala*, true bugs, predatory flies, predatory mites etc. are frequently active and play important role against insect pests of brinjal. Among them spiders, ladybird beetles, black ants are the most frequently occurring predators (FAO, 2003).

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For controlling insect pests of brinjal, farmers usually spray different kinds of chemical insecticides during the crop season, which kill natural enemies and lead to the resurgence of target pest and outbreak of secondary pests, resistance biotype development, environmental pollution and health hazards (Pedigo, 2002). It also leads to the development of the pesticides resistance of the target pests. However some pesticides are less toxic, more selective and less harmful to natural enemies (Schuster & Stansly, 2000). The botanical and microbial insecticides are more selective and less harmful for natural enemies as well as to the environment. Considering the above facts, the present study was undertaken to know the mortality rates of biological control agents of brinjal insect pest by exposing them to insecticides under laboratory condition and to identify the safer ecofriendly or more compatible insecticide (s) with the biological control agents.

MATERIALS AND METHODS

Experiment was conducted at Insecticide Toxicology Laboratory of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during June to September 2009. Seven insecticides used for the experiment were Bactoil @ 2 ml/l of water, Nimbicidene 0.03 EC @ 4 ml/l of water, Tracer-45 SC @ 0.4 ml/l of water, Helicide @ 0.50 ml/l of water, Proclaim-5 SG @ 1 g/l of water, Necstar-50 EC @ 1 ml/l of water and Booster-10 EC @ 1 ml/l of water. The tested biocontrol agents were two predators viz., black ant (*Camponotus compressus*) and lady bird beetle (*Micraspis crocera* Muls) and one parasitoid *Trathala* sp. Test dose were prepared by diluting a definite amount of each of the insecticides separately in water in a 200 ml volumetric flask. The predators were exposed to the insecticide doses mentioned above by spraying in a 12 cm Petri desh and were covered with a netted cloth. They were supplied with water soaked cotton ball and necessary number of aphids as food. Three replicates and a control were maintained at 30 ± 1^{0}C and 70±3% R.H. Mortality counts were made after 24 and 48 hours of exposure. Insects showed abnormal body symptoms such as body contraction, cessation of feeding and paralysis were counted as dead. Abbott’s corrections were done wherever necessary (Abbott, 1925). In case of the parasitoid (*Trathala sp.*) percentage parasitism was assessed by collecting data from infested shoots and fruits of treated and untreated brinjal plants and simulating the difference in emergence of the parasitoids.

The percent mortality of black ant or ladybird bettle was calculated according to the following formula:

% Mortality = (Number of dead/Total number) × 100

Mortality data were corrected by Abbott's (1925) formula as follows:

% Corrected mortality= {(Treatment mortality - Control)/ (100-control mortality)} × 100

The percent parasitism was calculated according to Mills' (1997) formula:

Percent parasitism = Number of adult parasitoid emerged/ (Number of host adult insects + Number of adult parasitoid) × 100

Compatibility factor = Percent mortality of brinjal shoot and fruit borer/ Percent mortality of *C. compressus* and *M. crocera* and *Trathala*.

RESULTS AND DISCUSSION

Effect of insecticides on the mortality of Biocontrol agents, Black ant, *C. compressus* and Lady bird beetle, *M. crocera*: Mortality data obtained after exposing *C. compressus* and *M. crocera* to seven insecticides doses for 24 and 48 hours are presented in Table 1. It is evident from the data that the mortality of *C. compressus* were 90%, 80%, 23.33%, 6.67%, 6.67%, 0%, 0% for 24 hours and 100%, 100%, 92.59%, 20.74%, 13.70%, 6.67%, 6.67% for 48 hours of exposure to Necstar-50 EC, Booster-10 EC, Proclaim-5 SG, Helicide, Tracer-45 SC, Bactoil, Nimbicidene 0.03 EC, respectively.

The percentage of mortality of *M. crocera* were 59.26%, 51.48%, 48.15%, 6.67%, 3.33% 3.33%, 0% for 24 hours of exposure to Proclaim-5 SG, Booster 10 EC, Necstar-50 EC, Helicide, Tracer-45 SC, Nimbicidene 0.03 EC and Bactoil, respectively while 100%, 100%, 96.30%, 7.04%, 6.67%, 6.33%, 3.67% for 48 hours of exposure to Necstar-50 EC, Booster-10 EC, Proclaim-5 SG, Helicide, Nimbicidene 0.03 EC, Tracer-45 SC and Bactoil, respectively (Table 1).

From Table 1 it is clear that Bactoil, Nimbicidene and Spinosad (Tracer 45 SC) appear to be less toxic and the rest test insecticides were more toxic to the *C. compressus* and *M. crocera* in terms of mortality.

Table 1. Effect of insecticides on black ant, *C. compressus* and lady bird beetle *M. crocera*

Insecticides	Concentration	Percent mortalities of the biocontrol agents			
		C. compressus		*M. crocera*	
		After 24 hr	After 48 hr	After 24 hr	After 48 hr
Bactoil (Bt)	2 ml/liter	0.00 e	6.67 c	0.00 c	3.67 b
Helicide (HNPV)	0.50 ml/liter	6.67 d	20.74 b	6.67 c	7.04b
Nimbicidine 0.03 EC	4 ml/liter	0.00 e	6.67c	3.33 c	6.67 b
Tracer-45 SC (Spinosad)	0.40 ml/liter	6.67 d	13.70 bc	3.33 c	6.33 b
Proclaim-5 SG (Emamectin benzoate)	1 g/liter	23.33 c	92.59 a	59.26 a	96.30 a
Necstar-50 EC (Chlorpyriphos)	1 ml/liter	90.00 a	100.00 a	48.15 b	100.00 a
Booster-10 EC (Cypermethrin)	1 ml/liter	80.00 b	100.00 a	51.48 b	100.00 a
Control		0.00 e	3.33 c	0.00 c	0.00 b
LSD		4.89	10.94	6.25	7.31
%CV		7.81	10.68	12.16	7.66

Figures followed by the same letter in a column are not significantly different (at 1 % level by DMRT)

Effect of insecticide on parastism of *Trathala*: The percentage of *Trathala* emergence for the treatments of seven insecticides is presented in Table 2. From infested shoot samples, the order of percent emergence of *Trathala* were control (22.22%)>Bactoil

(15.55%)>Nimbicidene 0.03EC (14.44%)>Tracer-45SC (13.33%)>Helicide (11.00%)>Booster-10EC (6.66%)>Proclaim-5SG (3.33%)>Necstar-50EC (2.22%). In terms of percent *Trathala* emergence reduction over control from shoot specimen all insecticides showed negative effect on emergence.

From the infested fruit samples, the percentage of *Trathala* emergence were (22.22%) order control> (18.89%) Bactoil> (17.78%) Nimbicidene 0.03EC> (12.22%) Helicide≥ (12.22%) Tracer-45 SC> SG (5.56%) Proclaim-5> EC (2.22 %) Boster-10> EC (1.11%) Necstar-50. In terms of percentage of *Trathala* emergence reduction over control from infested brinjal fruit specimen, all insecticides showed negative effect on emergence of *Trathala* from infected larvae of BSFB.

Table 2. Effect of insecticides on *Trathala flavoorbitalis* emergence from infested shoot and fruit samples

Treatments	Concentration	% parasitism of BSFB larvae by parasitoid *Trathala*		% parasitization reduction over control	
		From infested shoot	From infested fruit	From infested shoot	From infested fruit
Bactoil (Bt)	2 ml/liter	15.55 b	18.89 b	29.97 e	14.99 f
Helicide (HNPV)	0.50 ml/liter	11.00 e	12.22 d	50.54 c	44.97 d
Nimbicidene 0.03 EC	4 ml/liter	14.44 c	17.78 c	34.95 de	20.00 e
Tracer-45 SC (Spinosad)	0.4 ml/liter	13.33 d	12.22 d	39.93 d	44.99 d
Proclaim-5 SG (Emamectin benzoate)	1 g/liter	3.33 g	5.56 e	84.99 a	74.99 c
Necstar-50 EC (Chlorpyriphos)	1 ml/liter	2.22 h	1.11 g	90.01 a	95.00 a
Booster-10 EC (Cypermethrin)	1 ml/liter	6.66 f	2.22 f	69.98 b	90.02 b
Control		22.22 a	22.22 a		
LSD		1.01	0.927	5.197	4.542
%CV		5.24	4.65	5.19	4.72

Figures followed by the same letter (s) in a column are not significantly different at 1 % level by DMRT

From Table 2, it is clear that treatments Bactoil, Nimbicidene 0.03EC and Tracer-45 SC are less toxic to *Thrathala flavoorbitalis* ensuring more percent emergence from both infested shoot and fruit.

Table 3 shows the compatibility factors determined by the ratio of percent mortality of the BSFB and that of either black ant or ladybird beetle or *Trathala*. The compatibility factor was the highest (13.94, 25.33 and 27.92 with *C. compressus, M. crocera* and *Trathala,* respectively) for Bactoil followed by Nimbicidene 0.03 EC (Providing compatibility factor 11.22, 11.22 and 16.85 with *C. compressus, M. crocera* and *Trathala,* respectively), Tracer-45 SC-45 SC (Providing compatibility factor 7.30, 15.80 and 10.00 with *C. compressus, M. crocera* and *Trathala*, respectively), Helicide (Providing compatibility factor 2.14, 6.31 and 4.44 with *C. compressus, M. crocera* and *Trathala,* respectively), Proclaim-5 SG (Providing compatibility factor 1.00, 0.97 and 5.58 with black ant, ladybird beetle and *Trathala*, respectively), Necstar-50 EC (Providing compatibility factor 0.86, 0.86 and 4.30 with *C. compressus*, *M. crocera* and *Trathala*, respectively) and Booster-10 EC (Providing compatibility factor 0.86, 0.86 and 5.58 with *C. compressus*, *M. crocera* and *Trathala*, respectively) (Table 3).

Table 3. Compatibility factor of seven insecticides with biological control agents

Treatment	Ratio of percent mortality of BSFB and percent mortality of		
	C. compressus	*M. crocera*	*Trathala*
Bactoil (Bt)	13.94	25.33	27.92
Helicide (HNPV)	2.14	6.31	4.44
Nimbicidene 0.03 EC	11.22	11.22	16.85
Tracer-45 SC (Spinosad)	7.30	15.80	10.00
Proclaim-5 SG (Emamectin benzoate)	1.00	0.97	5.58
Necstar-50 EC (Chlorpyriphos)	0.86	0.86	4.07
Booster-10 EC (Cypermethrin)	0.86	0.86	4.30
Control	2.00	6.67	-

Figures followed by the same letter (s) in a column are not significantly different at 1% level by DMRT

The findings of present study are more or less in conformity with several studies. Filho *et al.* (2004) reported that spraying of chlorpyriphos decreased the activity of *Solenopsis saevissima* up to 2 weeks after spraying but recovered afterwards. Frampton (1999) observed that collembolan abundance decreased after chloropyriphos application but increased after cypermethrin application. Effects of chlorpyriphos varied spatially as a result of faunal heterogeneity among the fields. Latif (2007) found that Nimbicidene 0.03 EC and Flubebdiamite were comparatively safer for natural enemies and would be fit well to the integrated pest management (IPM) programs for brinjal. Azadirachtin had little or no negative effect on beneficial insects and found to be relatively harmless to bees, spiders, ladybeetles, parasitoid wasps and adult butterflies. Neem products are generally thought to be suitable for inclusion into integrated pest management programs (Banken & Stark, 1997).

The specific activity of Bt is considered highly beneficial. Unlike most insecticides, Bt insecticides do not have a broad spectrum of activity, so they do not kill beneficial insects like predators, parasites as well as beneficial pollinators such as honeybees. Therefore, Bt integrates well with other natural controls (Dutton *et al*., 2003). Nuclear Polyhedrosis Virus (NPV) a viral pesticide is slow acting and very species specific, making it effective under certain circumstances and safer to nontarget insects (Anon, 2011).

Several field studies have confirmed the low activity of Spinosad for many beneficial insect species. Against the sensitive indicator species, *Typhlodromus pyri*, Spinosad was harmful in the laboratory but safe under field conditions at rate up to 48 g ai/ha approximately one week after application. Against another sensitive indicator species, *Aphidius rhopalosiphi*, Spinosad was toxic to the adult wasps, but a level of safety was confirmed to wasps developing within mummified aphids. Spinosad was harmless to *Poecilus cupreus* (ground dwelling predator) and had limited adverse effects on *Episyrphus balteatus* and *Coccinella septempunctata* (foliage dwelling predators). Against another foliage dwelling predator, *Chrysoperla carnea*, Spinosad was harmless at 36 g ai/hL in an extended laboratory study involving realistic application methods (Anon, 2012). Field studies with Spinosad in which bees have been introduced the day following applications to orchards have also demonstrated the lack of Spinosad impacts. Applications of Spinosad to alfalfa fields, in which honeybee hives were covered for the first 3 hours of post-application, also demonstrated no adverse effects to honeybees or leafcutter bees **(**Saunders & Bret, 2012**)**.

It was reported that *T. flavo-orbitalis* was the only parasitoid species recorded from Gannoruwa area of Sri Lanka with the parasitism ranging from 15.9 to 48.9 % in an organically managed brinjal crop (AVRDC, 2003; Wahundeniya, 2003). This result supports the findings of present study. *T. flavoorbitalis* is larval–pupal parasitoid of brinjal shoot and fruit borer (BSFB), *L. orbonalis* Guenee, parasitizes many Lepidopterous species throughout the world. It is widely distributed in the orient and has been released in Hawaii (Swezey, 1926) and into several other states of USA. In Sri Lanka *T. flavoorbitalis* has been recorded from 17 different hosts (Beesan & Chatterjee, 1935). One of which is *L. orbonalis* (Guen.), the brinjal shoot and fruit borer. *T. flavoorbitalis* can attack all larval stages of *L. orbonalis*, but successful development of parasitoid was observed when later instar *L. orbonalis* larva was parasitized (Sandanayake & Edirisinghe, 1992).

From this experiment it can be concluded that Bactoil, Nimbicidene 0.03 EC and Tracer-45 SC (Spinosad) are less toxic to biological control agents such as, *C. compressus, M. crocera* and *Trathala*. Thus on overall basis Bactoil, Nimbicidene 0.03 EC and Tracer-45 SC could be used as the most compatible pesticides for controlling BSFB.

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