IMPACT: Journal of Research in Applied,
Natural and Social Sciences (IMPACT: JRANSS)
ISSN(E): Applied; ISSN(P): Applied
Vol. 1, Issue 1, Jun 2015, 61-72

IMPACT OF INSECTICIDES ON THE DIVERSITY AND EQUITABILITY OF ARTHROPODS IN BRINJAL AGRO-ECOSYSTEM

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ABSTRACT

Experiment was conducted during summer season to study the impact of seven insecticides on arthropod diversity and equitability in brinjal agro-ecosystem. Results revealed that among insecticide treated plots, the highest number of arthropods families was recorded in` Tracer-45 SC, Bactoil (Bt), Nimbicidene 0.03 EC treated plots and lowest was in Necstar-50 EC and Proclaim-5 SG. The highest total abundance of arthropod individuals was recorded in the plots treated with Helicide (HNPV) and Nimbicidene 0.03 EC and lowest total abundance of arthropod individuals was recorded from the plots treated with Proclaim-5 SG, Necstar-50 EC and Booster-10 EC. The diversity index and equitability of arthropod species were highest in the plots treated with Helicide and Bactoil in visual search and sweep net methods but also in the plots treated with Nimbicidene 0.03 EC and Proclaim-5 SG in pitfall trap method. However, lowest diversity index and equitability were obtained from the plots treated with Necstar-50 EC, Tracer-45 SC and Booster 10 EC in visual search and sweep net methods but also in plots treated with Helicide and Bactoil in pitfall trap method. In case of natural enemies, the highest number of families was recorded in Nimbicidine 0.03 EC and Tracer-45 SC treated plots while lowest was in Necstar-50 EC, proclaim-5 SG, Booster 10 EC and Helicide treated plots. The highest total abundance of natural enemy was recorded in the plot treated with Helicide and Nimbicidine 0.03 EC while lowest abundance was in the plot treated with Boster-10 EC. The diversity index and equitability of natural enemies were the highest in the plots treated with Helicide and Nimbicidene 0.03 EC in visual search method, Helicide and Booster 10 EC in sweep net method, Nimbicidene 0.03 EC and Proclaim-5 SG in pitfall trap method while lowest was in Proclaim-5 SG and Necstar-50 EC treated plots in visual search method, Nimbicidene 0.03 EC treated plots in sweep net method, Helicide and Tracer-45 SC treated plots in pitfall trap method. Nimbicidene 0.03 EC, Bactoil, Helicide and Tracer-45 SC were relatively safe for natural enemies and therefore would be fit well into integrated pest management (IPM) against BSFB of brinjal crop.

KEYWORDS: Arthropod Species, Natural Enemies, Sweep Net Method, Pitfall Trap Method

INTRODUCTION

In brinjal field in addition to brinjal shoot and fruit borer (BSFB) (*Leucinodes orbonalis* Guenee) as the major pest, various arthropod species both pests and natural enemies prevail from seedling to harvesting stage. EL-Shafie (2001) observed 28 species of insect pests of 7 different insect orders from the brinjal ecosystem, while Nayer *et al.* (1995) reported 53 species of insect pests of brinjal. Many arthropod natural enemies of those obnoxious pests also exist in the same ecosystem (FAO 2003). In general commonly used insecticides are not specific and they frequently kill natural enemy populations and may cause upset and resurgence of other pest populations (Pedigo 2002, Debach and Rosen 1991). Many researchers reported that insecticides killed other non-target arthropods, which caused serious ecological imbalance and affected arthropods biodiversity (Alam *et al.* 2006, Navntoft *et al*. 2006, Filho *et al.* 2004, Prijno *et al*. 2004, Rodriguez *et al*. 2003, Maleque *et al.*1998). Tohnishi *et al*. (2005) reported that flubendiamide was highly toxic to Lepidopteran insect pests but it was very safe for different natural enemies like ladybird beetles, spiders, parasitic wasp, lacewings, predatory bug and predatory mite and might fit well into the integrated pest management (IPM). Several researchers reported that neem products are less harmfull to natural enemies (Schuster and Stansly 2000, Smith and Krischik 2000).

Bacillus thuringiensis used against BSFB, *Beauvaria bassiana*, against Lepidopteran caterpillar, regarded as environmentally friendly, with little or no effect on human, wildlife, pollinators and most other beneficial insects (Anon. 2011a). Nimbicidene and Flubebdiamite were comparatively safe for natural enemies and would be fitted well into the integrated pest management (IPM) programs for brinjal (Latif, 2007). Spinosad (*Saccharopolyspora spinosa*), relatively a new insecticide, which is toxic to a wide variety of insects and relatively non-toxic to mammals and beneficial insects (Anon. 2011b). Reports on the effects of other insecticides under study on natural enemies are not available, although studies on the effects of different insectisides on biodiversity have been carried-out at abroad. Therefore, it is important to know the effect of different selected insecticides on arthropod diversity including natural enemies for judging their suitability as eco-friendly component in the IPM package of BSFB. So the present experiment was undertaken to know the impact of insecticides on arthropod diversity and equitability in the brinjal agro-ecosystem and to identify the insecticide (s) which have least harmful effects on arthropods.

MATERIALS AND METHODS

The experiment was laid out in randomized complete block design (RCBD) with three replications in the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during summer season (April to September 2009).

The whole field was divided into 3 blocks of equal size having space of 2 meters between blocks and 1.5 meters between plots. Each block was subdivided into 7 equal plots. The unit plot size was 3m x 3m accommodating 15 pits per plot. The distance between rows was 1m and that of plants was 60 cm. The application of manures and chemical fertilizers was followed by the method described by Rashid (1993). Seeds of brinjal variety BARI brinjal-8 were collected from the Horticultural Research Center (HRC) of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. A small seed bed measuring 5 m x 1 m was prepared and seeds were sown in the nursery bed at Experimental field of the Department of Entomology, BSMRAU, on 6 March 2009. A total of 360 seedlings having 35 days old were planted in 21 plots @ 15 seedlings per plot with spacing row to row 1.00 m and seedling to seedling 60 cm. Weeding in the plots was done as and when necessary.

Treatments

T_1 = Bactoil (*Bacillus thuringiensis*, Bt) @ 2 ml/liter, T_2 = Helicide (Heliothis Nuclear Polyhedrosis Virus, HNPV) @ 0.5 ml/liter, T_3 = Nimbicidene 0.03 EC (Azadirachtin) @ 4 ml/liter, T_4 = Tracer-45 SC (Spinosad) @ 0.4

ml/liter, T_5 = Proclaim-5 SG (Emamectin benzoate) @ 1 gm/liter, T_6 = Necstar-50 EC (Chlorpyriphos) @1 ml/liter and T_7 = Boster-10 EC (Cypermethrin) @1 ml/liter.

The insecticides were applied with the help of Knapsack sprayer. The first application of insecticides was started after 4^{th} week of transplanting and subsequent applications were made at 7 days intervals. Precautions were taken to avoid drift to the adjacent plots.

Data Collection

The number of species was the simplest measure of diversity. However, for limitation in species identification, concept was restricted to order and family level. The counting of individuals was performed by using visual search, sweep net and pitfall trap method. The normal seasonal fluctuations and the population dynamics of arthropods were collected and recorded from the insecticides treated plots.

Visual Search Method

Arthropods species comprising sessile, agile, adult, nymphs and larvae of flying insects on brinjal plants were counted from a random sample of 5 plants taken from each plot. For this ten leaves were chosen randomly on each plant, four from the bottom (older leaves), two from the middle and four from the top (younger leaves). The lower surface of the leaf was thoroughly examined for the presence of insects. Counting was done before 08:30 hr (Bangladesh local time) to avoid the excessive mobility of the adult insects after this time, but nevertheless, the migration of the fast moving and mobile adults from one plot to the other could not be totally avoided. The data pooled over the season's average was combined to provide an overall average density per plot. The population density of each insect was expressed as number of individuals per 10 leaves of the plant. Individuals were counted from five branches selected randomly from 5 plants of each plot at weekly interval.

Sweep Net Method

This method was used for counting insects on brinjal plants to know the abundance pattern of plant dwelling insects in the present study. Five times return sweeping were done in each plot to make a composite sample by a sweep net at 15 days intervals. Each sample was examined separately without killing the insects and released them in the same plot immediately after counting. The individuals of each sample were counted by family.

Pitfall Trap Method

The pitfall trap method was used for the species that roam in the soil surface such as ground beetle, spiders, ants, earwig, crickets, centipedes, collembola etc. Small plastic pots having 10 cm diameter and 18 cm deep were used as pitfall traps. Three traps were placed in soil in each of the plots and the mouth of the pot was kept at ground level, so as not to obstruct insect movement. Each pot was then half filled with water and detergent as trapping fluid. After 24 hours of setting traps, the trapped arthropods were emptied with a seive and funnel into small plastic bottles filled to the half with 70 % alcohol. The samples were labeled and stored until sorting, counting and finally were identified. Traps were set at 15 days intervals throughout the cropping season and insects were collected and counted separately from each plot.

Measurement of Diversity Index and Equitability

To assess the abundance pattern and the species richness in different insecticides treated plots, Simpson's diversity index was used (Simpson 1949).

$$\text{Simpson's Index (D)} = \frac{1}{\sum_{i=1}^{S} Pi^2}$$

Where, Pi is the proportion of individual for the ith insect family and S is the total number of insect family in the community (i.e., the richness).

The value of index depends on both the richness and the evenness (equitability) with which individuals distributed among the families. Equitability was quantified by expressing Simpson's index, 'D' as a proportion of the maximum possible value of D.

$$\text{Equitability, } E = \frac{D}{D_{max}} = \frac{1}{\sum_{i=1}^{S} Pi^2} \times \frac{1}{S} \qquad [D_{max} = S]$$

RESULTS AND DISCUSSIONS

Arthropod Species Observed Through Visual Search Method

Effects of seven insecticides on plant dwelling arthropods observed during summer through visual search method is presented in Table 1. The highest number of arthropods families were recorded in`Tracer-45 SC (20) followed by Helicide (19), Nimbicidine 0.03 EC (18) and Bactoil (17), Proclaim-5 SG (16) and Boster-10 EC (15) treated plots while it was the lowest in Necstar-50 EC (14). The highest total number of arthropod individuals (685.67) were recorded in the plots treated with Helicide followed by 594.00, 551.33, 440.33 403.67, 384.67 and 367.33 in the plots treated with Nimbicidene 0.03 EC, Boster-10 EC, Tracer-45 SC, Bactoil and Necstar-50 EC, respectively. The lowest number of arthropod individuals (211.67) was recorded from the plots treated with Proclaim-5 SG (Table 1).

The diversity index was the highest (4.66) in the plots treated with Helicide followed by Bactoil (3.61) and Nimbicidene 0.03 EC (3.60). Though the total abundance of Bactoil treated plots is less than the Nimbicidene 0.03 EC but it showed higher diversity index than the Nimbicidene 0.03 EC treated plots, which indicates more abundance of some families than the Nimbicidene 0.03 EC. The lowest diversity index was obtained from the plots treated with Necstar-50 EC (2.07) followed by Boster-10 EC (2.72), Tracer-45 SC (3.17) and Proclaim-5 SG (3.38). The highest equitability 0.25 was recorded from the plots treated with Helicide followed by 0.21 in both the treatments Bactoil and proclaim-5 SG, 0.20 in Nimbicidene 0.03 EC treated plots and Tracer-45 SC (0.16) while it was the lowest from Necstar-50 EC (0.15) which indicate species richness of these treatments (Table 1).

Table 1: Diversity and Equitability of Arthropods Species in Seven selected Insecticides Treated Plots of Brinjal Agro-Ecosystem through Visual Searching Method

Treatments	No. of Families	Total Abundance	Diversity Index	Equitability
Bactoil (Bt)	17.00	384.67	3.61	0.21
Helicide (HNPV)	19.00	685.67	4.66	0.25
Nimbicidene 0.03 EC	18.00	594.00	3.60	0.20
Tracer-45 SC	20.00	403.67	3.17	0.16
Proclaim-5 SG	16.00	211.67	3.38	0.21
Necstar-50 EC	14.00	367.33	2.07	0.15
Boster-10 EC	15.00	440.33	2.72	0.18

Natural Enemies Observed Through Visual Searching Method

The highest number of natural enemy families (10) were recorded in Nimbicidine 0.03 EC treated plots followed by Tracer-45 SC (9), Bactoil & Helicide (7), Proclaim-5 SG (6), Boster-10 EC (5) while it was the lowest (4) in Necstar-50 EC treated plots. The highest number of natural enemy abundance (209.33) was recorded in the plot treated with Helicide followed by Nimbicidene 0.03 EC (166.00), Tracer-45 SC (118.00), Bactoil (104), Proclaim-5 SG (63.00) and Necstar-50 EC (46.33) while it was the lowest (38.67) in the plot treated with Boster-10 EC (Table 2). The diversity index was the highest (2.36) in the plots treated with Proclaim-5 SG followed by Boster-10 EC (2.26), Necstar-50 EC (2.17), Bactoil (1.72), Nimbicidine 0.03 EC (1.65) and Tracer-45 SC (1.58), which indicates more abundance of some families of these treatments while it was the lowest (1.53) from the plot treated by Helicide and their diversity index increased with the increase of total abundance except Bactoil and Tracer-45 SC. Diversity index of Bactoil and Tracer-45 SC were higher than the Helicide though their total abundances were less than the treatment Helicide.

Table 2: Diversity and Equitability of natural Enemies in Seven Selected Insecticides Treated Plots of Brinjal Agro-Ecosystem through Visual Searching Method

Treatments	No. of Families	Total Abundance	Diversity Index	Equitability
Bactoil (Bt)	7.00	104.00	1.72	0.25
Helicide (HNPV)	7.00	209.33	1.53	0.22
Nimbicidene 0.03 EC	10.00	166.00	1.65	0.16
Tracer-45 SC	9.00	118.00	1.58	0.18
Proclaim-5 SG	6.00	63.00	2.36	0.39
Necstar-50 EC	4.00	46.33	2.17	0.54
Boster-10 EC	5.00	38.67	2.26	0.45

The highest equitability 0.54 was recorded from the plots treated with Necstar-50 EC followed by Boster-10 EC (0.45), Proclaim-5 SG (0.39), Bactoil (0.25), Helicide (0.22) and Tracer-45 SC (0.18), while it was the lowest in Nimbicidene 0.03 EC (0.16) treated plots which indicates species richness of natural enemiy of these treatments (Table 2).

Arthropod Species Observed Through Sweep Net Method

The highest number of arthropods families were recorded in plots treated with Bactoil (23.00), followed by Nimbicidene 0.03 EC (22.00), Tracer-45 SC (22.00), Helicide (20.00), Necstar-50 EC (20.00), Boster-10 EC (17.00) while it was the lowest (12.00) in Proclaim-5 SG. The highest numbers of arthropod individuals (252.67) were recorded in the plots treated with Nimbicidene 0.03 EC followed by Bactoil (193.67), Tracer-45 SC (177.00), Helicide (168.33), Boster-10 EC (165.33) and Proclaim-5 SG (142.00) while it was the lowest (126.33) in the plots treated with Necstar-50 EC (Table 3). The diversity index was the highest (6.32) in the plots treated with Bactoil followed by Helicide (4.82), Necstar-50 EC (4.20), Nimbicidene 0.03 EC (4.00), Proclaim-5 SG (3.06) and Tracer-45 SC (2.17) while it was the lowest in the plots treated with Boster-10 EC (2.08). The highest equitability 0.27 was recorded in the plots treated with Bactoil followed by Proclaim-5 SG (0.26), Helicide & control (0.24), Necstar-50 EC (0.21) and Boster-10 EC (0.12) while it was the lowest in Tracer-45 SC (0.10), lower equitability indicates higher species richness of the treatments (Table 3).

Table 3: Diversity and Equitability of Arthropod Species in Seven Selected Insecticides Treated Plots of Brinjal Agro-Ecosystem through Sweep net Method

Treatments	No. of Families	Total Abundance	Diversity Index	Equitability
Bactoil (Bt)	23.00	193.67	6.32	0.27
Helicide (HNPV)	20.00	168.33	4.82	0.24
Nimbicidene 0.03 EC	22.00	252.67	4.00	0.18
Tracer-45 SC	22.00	177.00	2.15	0.10
Proclaim-5 SG	12.00	142.00	3.06	0.26
Necstar-50 EC	20.00	126.33	4.20	0.21
Boster-10 EC	17.00	165.33	2.08	0.12

Natural Enemies Observed Through Sweep Net Method

The highest number of natural enemy families (11) was recorded in Nimbicidene 0.03 EC treated plots followed by 10 in the plots treated with Bactoil, Helicide, Tracer-45 SC (9) and Necstar-50 EC (8) while it was the lowest (5) in Boster-10 EC and Proclaim-5 SG. The highest number of natural enemy abundance (130.00) was recorded in the plots treated with Nimbicidene 0.03 EC followed by Bactoil (78.00), Tracer-45 SC (67.67), Proclaim-5 SG (49.00), Necstar-50 EC (46.33) and Helicide (25.00) while it was the lowest (22.33) in the plots treated with Boster-10 EC (Table 4).

The diversity index was the highest (4.10) in the plots treated with Helicide followed by Bactoil (3.84) and Tracer-45 SC (3.39) though the total abundance of Helicide was less than the total abundance of most of the treatments where it indicates more abundance of some families. The lowest diversity index (2.13) was obtained in the plots treated with Nimbicidene 0.03 EC followed by Proclaim-5 SG (2.21) and Boster-10 EC (2.84), though having the highest total abundance in Nimbicidene 0.03 EC treated plots it showed the lowest diversity index, which indicates improper distribution of species of some families. The highest equitability 0.57 was recorded in the plots treated with Boster-10 EC followed by 0.44, 0.44, 0.41, 0.38 0.38 and 0.32 in the plots treated with Necstar-50 EC, Proclaim-5 SG, Helicide, Bactoil and Tracer-45 SC while it was the lowest in Nimbicidene 0.03 EC (0.19), which indicates species richness of natural enemy (Table 4).

Table 4: Diversity and Equitability of Natural Enemies in Seven Selected Insecticides Treated Plots of Brinjal Agro-Ecosystem through Sweeping Net Method

Treatments	No. of Families	Total Abundance	Diversity Index	Equitability
Bactoil (Bt)	10.00	78.00	3.84	0.38
Helicide (HNPV)	10.00	25.00	4.10	0.41
Nimbicidene 0.03 EC	11.00	130.00	2.13	0.19

Tracer-45 SC	9.00	67.67	3.39	0.38
Table 4: Contd.,				
Proclaim-5 SG	5.00	49.00	2.21	0.44
Necstar-50 EC	8.00	46.33	3.50	0.44
Boster-10 EC	5.00	22.33	2.84	0.57

From the Table 3 & 4, it was revealed that treatments with Bactoil, Nimbicidene 0.03 EC and Tracer-45 SC showed lower equitability i.e; higher species richness in case of natural enemy biodiversity and may be fitted well into the IPM package.

Arthropod Species Observed Through Pitfall Trap Method

The highest number of arthropods families (16) were recorded in plots treated with Bactoil & Nimbicidene 0.03 EC (16) followed by Tracer-45 SC (15), Boster-10 EC and Necstar-50 EC (11) and Helicide (9) while it was the lowest (8) in the plots treated with Proclaim-5 SG. The highest number of arthropods (171.33) was recorded in the plots treated with Helicide followed by Nimbicidene 0.03 EC (132.00), Proclaim-5 SG (101.00), Bactoil (92.33), Tracer-45 SC (91.33) and Necstar-50 EC (52.33) while it was the lowest (45.67) in the plots treated with Boster-10 EC (Table 5).

The diversity index was the highest (3.96) in the plots treated with Nimbicidene 0.03 EC followed by Proclaim-5 SG (3.77), Necstar-50 EC (3.71), Bactoil (3.26), Tracer-45 SC (3.18), Boster-10 EC (3.09) and Helicide (2.47). Though the total abundance of treatment Helicide was the highest than all other treatments but its diversity index was the lowest, which indicates less abudance of some families compared to others. The highest equitability (0.47) was recorded from the plots treated with Proclaim-5 SG followed by Necstar-50 EC-50 (0.34), Boster-10 EC (0.28), Helicide (0.27), Nimbicidene 0.03 EC (0.25) and Tracer-45 S (0.21) while it was the lowest in Bactoil (0.20) treated plots. Lower the equitability indicates higher arthropods species richness of these treatments (Table 5).

Table 5: Diversity and Equitability of Arthropod Species in Seven Selected Insecticides Treated Plots of Brinjal Agro-Ecosystem through Pitfall Trap Method

Treatments	No. of Families	Total Abundance	Diversity Index	Equitability
Bactoil (Bt)	16.00	92.33	3.26	0.20
Helicide (HNPV)	9.00	171.33	2.47	0.27
Nimbicidene 0.03 EC	16.00	132.00	3.96	0.25
Tracer-45 SC	15.00	91.33	3.18	0.21
Proclaim-5 SG	8.00	101.00	3.77	0.47
Necstar-50 EC	11.00	52.33	3.71	0.34
Boster-10 EC	11.00	45.67	3.09	0.28

Natural Enemies Observed through Pitfall Trap Method

The highest number of natural enemy families (12) was recorded in Tracer-45 SC plots followed by the plots treated with Nimbicidene 0.03 EC (10.00) and Bactoil (9.00), Boster-10 EC (8) and Necstar-50 EC (7) while it was the lowest (6) in the plots treated with Proclaim-5 SG and Helicide. The highest number of natural enemy abundance (166.67) was recorded in the plots treated with Helicide followed by Nimbicidene 0.03 EC (122.33), Proclaim-5 SG (95.67), Bactoil (83.00), Tracer-45 SC (81.33), Necstar-50 EC (45.00) while it was the the lowest (43.33) in the plots treated with Boster-10 EC. The diversity index was the highest (3.42) in the plots treated with Nimbicidene 0.03 EC followed by Proclaim-5

SG (3.39), Necstar-50 EC (2.81), Boster-10 EC (2.76), Bactoil (2.66) and Tracer-45 SC (2.56) while it was the lowest diversity index (2.33) in the plots treated with Helicide (Table 6).

The total abundance of Nimbicidene 0.03 EC and Proclaim-5 SG were less than the total abundance of Helicide, their diversity indices were more than that of Helicide, which indicates more abundance of some families of these two treatments. The highest equitability (0.57) was recorded in the plots treated with Proclaim-5 SG followed by treatments Helicide (0.39), Nimbicidene 0.03 EC and Boster- 10 EC (0.34) while it was the lowest (0.21) in the plots the treated with Tracer-45 SC. Lower equitability indicates higher species richness of natural enemies of these treatments (Table 6).

Table 6: Diversity and Equitability of Natural Enemies in Seven Selected Insecticides Treated Plots of Brinjal Agro-Ecosystem through Pitfall Trap Method

Treatments	No. of Families	Total Abundance	Diversity Index	Equitability
Bactoil (Bt)	9.00	83.00	2.66	0.30
Helicide (HNPV)	6.00	166.67	2.33	0.39
Nimbicidene 0.03 EC	10.00	122.33	3.42	0.34
Tracer-45 SC	12.00	81.33	2.56	0.21
Proclaim-5 SG	6.00	95.67	3.39	0.57
Necstar-50 EC	7.00	45.00	2.81	0.40
Boster-10 EC	8.00	43.33	2.76	0.34

From the Table 5 and 6, it was revealed that treatments with Bactoil, Nimbicidene 0.03 EC, Tracer-45 SC and Helicide showed lower equitability i.e; higher species richness specially in case of natural enemy biodiversity through pitfall trap method and may be fitted well into the IPM package.

The above findings are in conformity with several workers. Sauphanor *et al.*1995, reported that Azadirachtin is relatively harmless to spiders, butterflies and insects such as bees that pollinate crops and trees, ladybirds that consume aphids and wasps that act as parasitoid on various crop pests. In a few trials, negative effects have been noted on immature stages of beneficial species exposed to neem products. However, neem products are generally thought to be suitable for inclusion into integrated pest management programs (Banken and Stark 1997). A field study has confirmed the general 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 rates 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). Spinosad (*Saccharopolyspora spinosa*) relatively a new insecticide that is toxic to a wide variety of insects and relatively non toxic to mammals and beneficial insects (Anon. 2011b). 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 post-application, also demonstrated no adverse effects to honeybees or leafcutter bees (Saunders and Bret 2012). Regende *et al.* (2005) recommended that flubendiamite (0.48 g a.i./l) was not harmful to *Trichramma atopovirilia* an egg parasitoid of maize pest. Giolo *et al.* (2005) reported that Vermitec 18 EC (0.001%) (Abamectin) were harmful to *Trichramma atopovirilia*. Prijno *et al*. (2004) also observed the toxic effect of Emamectin benzoate against parasitoids of *Liriomyza huidobrensis*. Carvalho *et al*. (2005) studied the side effect of some insecticides including flubendiamide on larval, pupal and adult stages of *Trichogramma pretiosum* Riley, a parasitoid of tomato pests, *Tuta absulata* (Lepidoptera: Gelechidae) under laboratory condition. They observed that the chemical was harmless (< 30% mortality) to the adult *Tuta absulata* and did not show significant difference in the parasitism capacity when compared with control. No harmful effect was detected on larvae and pupae of this species inside the host egg. Low toxicity of newer insecticides (Imidacloprid, Spinosad and Thiodicarb) was observed by Boyd and Boethel (1998) against predacious Hemipteran species of soybean lopper. They found greater toxicity of Cypermethrin and Methyl parathion against those predators and demonstrated that most of the newer insecticides were more selective than the older insecticides. Alam *et al*. (2003) observed very low or non-existence of *Trathala flavo-orbitalis*, a larval-pupal parasitoid of BSFB in pesticides sprayed field. Dutton *et al*. (2003) performed tritrophic experiments with *S. littoralis* and the spider mite *Tetranychus urticae* (Koch) (Acari: Tetranychidae), which is not susceptible to Bt toxins. Although adverse effects were found in lacewing larvae fed *S. littoralis*, there was no effect on larvae fed the tolerant prey, suggesting that the detrimental effects observed when lacewing larvae were fed *B. thuringiensis*-treated *S. littoralis* larvae were due to the quality of the prey and not to a direct toxic effect of the Bt toxin. The specific activity of Bt generally is considered highly beneficial. Unlike most insecticides, Bt insecticides do not have a broad spectrum of activity, so they do not kill beneficial insects. Therefore, BT integrates well with other natural controls. Nimbicidene and flubendiamide were less harmful to arthropods species and natural enemies, while Abamectin was moderately harmful insecticide to the arthropods diversity in the brinjal ecosystem (Latif 2007).

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