Impact of Some Insecticides on the Coccinellid Predator, *Coccinella undecimpunctata* L. and its Aphid Prey, *Brevicoryne brassicae* L.

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ABSTRACT

Sensitivity of the coccinelled predator, *Coccinella undecimpunctata* L. and its prey *Brevicoryne brassicae* L. towards four insecticides [Thiomethoxam (Actara 25% WG), Imidacloprid (Confidor 35% SC), Natural oil of Jojoba plant (Nat-1), formulated as 96% FC and Pirimicarb (Aphox 50% DG)] were investigated. All of the tested insecticides were found much more toxic to the prey than to the predator. When both insects were subjected to the aforementioned insecticides at the highest tested concentration (0.125%) for 24 hours, mortality percentages of the prey were about 90, 99, 69 and 90%, which represent 3.23, 2.74, 5.32 and 2.35 times higher than those evaluated among predator adults, respectively. While at the lowest tested concentration (0.031%), aphid mortality percentages were about 69, 58, 38 and 69%, which represent 16.69, 8.08, 36.41 and 5.13 times higher than those evaluated among predator adults, respectively. Calculated LC_{50} of Actara, Confidor and Aphox for the predator were about 19.2, 7.0 and 16.6 times higher than those for the prey, respectively. At 0.031% concentration, predator mortality ranged between (2.15 and 24.73%) and (8.60 and 35.48%) at 48 and 72 hours post treatments, respectively, while the corresponding mortality among aphids ranged between (58.33 and 89.58%) and (62.77 and 98.96%) at the same periods, respectively. In case of aphid, the same concentration caused about 100% mortality after 72 hours when Aphox and Actara were applied and after 5 and 7 days when Confidor and Nat-1 formulations were used, respectively. Actara, Confidor and Nat-1 formulations at the same concentration (0.031%) form slight reduction in hatching percentages of the predator eggs ranged between 0.50 and 7.00%, 7 days post treatment.

Key Words: *Coccinella undecimpunctata*, *Brevicoryne brassicae*, Actara, Confidor, Aphox, Jojoba oil, toxicity

INTRODUCTION

The cabbage aphid, *Brevicoryne brassicae* L. feeds on all cultivated and wild cruciferous plants. Major economic hosts include broccoli, Brussels sprouts, cauliflower, head cabbage and most members of the genus *Brassica*. Colonies of this aphid are found on both lower and upper leaf surfaces, leaf stalks and on leaf axles and in leaf folds of developing heads. Infested seedlings may become stunted and distorted. Continuous feeding on mature plants causes wilting, yellowing and general stunting of the plants (Berry, 1998). The cabbage aphid is a vector of 23 virus diseases of Cruciferous and many diseases of Citrus (Toba, 1962). Naturally occurring parasitoids and predators are important factors for regulating population densities. The ladybird beetles are among the most efficient predators of aphids.

There are many insecticides that are effective against this aphid. Because of the waxy nature of the pest and crop, care must be taken and sprays must provide good wetting of the crop. The broad-spectrum organophosphate (OP) insecticides have been successfully used in controlling insect pests for many years and many growers used to rely solely on these products one season after another (Berry, 1998). Such systematic usage in many cultivated areas formed an adverse effect on many beneficial insect populations and consequently caused outbreaks of secondary pests such as mites. Besides, developing of insecticide resistance and the increasing compliance requirements of the market are clearly signals for the need of growers to continually review their pest management practices. Now, through the introduction of the new era of chloronicotinyl (CNI) insecticides, by Bayer Crop Science, growers have two selective, effective and highly complimentary tools providing another opportunity to further reduction in the reliance on OP and carbamate insecticides (Babu and Sharma, 2003 b).

The objective of these experiments aimed to evaluate the efficacy of the tested insecticides against the aphid pest (*B. brassicae*), to study their side effect on one of the most efficient natural enemies, the predator (*Coccinella undecimpunctata* L.) and to choose the proper efficient concentration,

MATERIALS AND METHODS

Rearing of *Brevicoryne brassicae* L.

B. brassicae was collected from different cabbage fields and allowed to reproduce in the laboratory on cabbage leaves confined in glass jars. Cabbage leaves were renewed every other day with fresh ones. Rearing of aphid culture was carried out at 25±2°C and 70±5% R.H. (Dimetry and Marei, 1992).

Rearing of *Coccinella undecimpunctata* L.

C. undecimpunctata larvae and adults were collected from clover fields at Giza Governorate. Stock culture of the predator was maintained under the laboratory conditions of 25±2°C and 70±5% R.H. Five pairs of the predator's adult were kept in 2-Liter glass jar. The jars were supplied with sufficient number of Duranta leaves, infested with aphid for feeding and covered with muslin cloth held in position by rubber bands. Food was renewed every 48 hours (Farag, 1995).

Tested Insecticides

1- Thiamethoxam (Actara): 25% WG. "Syngenta, UK".
2- Imidacloprid (Confidor): 35% SC. "Bayer CropScience, Germany".
3- Pirimicarb (Aphox): 50% DG. "Syngenta, UK".
4- Nat 1: Natural oil of Jojoba plant, formulated as 96% FC. "Egyptian Natural Oils Company-Cairo, Egypt".

Three concentrations, i.e., 0.125, 0.062 and 0.031% were selected according to their efficient effects on the pest in preliminary experiments. These concentrations were prepared using tap water according to the producing company's recommendations for each of the aforementioned insecticides.

Predator's treatments

1. Effect of insecticides on *C. undecimpunctata* adults

Groups of jars (five jars per each) were made. One group was used per concentration per insecticide. Each jar, comprising 10 pairs of ladybird adults (males + females) was supplied with enough number of the prey (aphid), and sprayed with the corresponding concentration of the tested insecticide. Another group of jars was sprayed with water only and used as a check. All jars were covered with muslin cloth fitted with rubber bands and incubated under the previously mentioned laboratory conditions for 24 hours. Jars were examined and fresh plant leaves infested with the aphid were renewed daily until the end of the experiment. The whole experiment was replicated five times.

2. Effect of the tested insecticides on *C. undecimpunctata* eggs

Five glass jars (500ml volume) comprise clusters of ladybird eggs (40 eggs/each) were treated as the abovementioned procedure. Jars were examined daily until hatching. The percentages of hatchability were calculated in each case.

Aphid treatment

Five plastic cups (120ml volume) covered with muslin cloth were used for each tested concentration per insecticide. Each cup comprised a piece of moisten cotton wool for providing moisture and a plant leaf, infested with 20 individuals of aphid, and sprayed with 1ml of the proposed concentration of the tested insecticide, then incubated under the previously mentioned conditions. The check cups were sprayed with water only. Percentage of mortality and the LC_{50} values were calculated. The whole experiment was replicated five times.

Statistical analysis:

All data were subjected to analysis of variance (ANOVA) through SPSS computer program. Means were compared using Duncan's Multiple Range test. The percent mortality was corrected using Abbott's formula (Abbott, 1925); the LC_{50} and LC_{90} values were calculated by using Finney's equation (Finney, 1952).

RESULTS AND DISCUSSION

Effect on *C. undecimpunctata* adults

Data in table (1) indicated that the percent mortality among treated predator adults, in general, did not exceed 46.24% for all the tested insecticides at the highest concentration (0.125%). In case of Actara, Confidor or Aphox, no further mortality occurred after 48 hours of treatment, while in case of Jojoba oil, it appeared till 72 hours post treatment.

At all tested concentrations, Aphox and Confidor scored the highest mortality percentages at all post treatment periods, followed by Actara. Nat-1 oil almost possessed the lowest mortality percentages (Table 1).

Using the insecticides at (0.062%) concentration, Aphox possessed the highest mortality (27.84 and 38.71%), after 24 and 48 hours, respectively, while the rest of the tested insecticides induced (16.49, 12.37 and 7.22%) and (24.73, 18.28 and 13.98%) mortality for Confidor, Actara and Nat-1 after the same periods, respectively.

Predator mortality percentages, 24 hours post treatment, with Aphox and Nat-1 oil at low concentration (0.031%) were 13.40 and 1.03%, respectively, while after 72 hours, they reached higher mortality percentages, ranged between

Table (1): Mortality percentages of *Coccinella undecimpunctata* L. treated with different insecticides

(%) Concentration	Insecticide	% Corrected mortality at the indicated post treatment periods		
		Adult treatment		
		24h	48h	72h
0.125	Actara	27.84±2.12 b	35.48±1.70 b	35.48±1.70 b
	Confidor	36.08±1.76 a	43.01±1.14 a	43.01±1.14 ab
	Nat-1	12.90±0.84 c	13.40±1.92 c	19.35±1.00 c
	Aphox	38.14±1.84 a	46.24±4.09 a	46.24±4.09 a
F- value		64.834**	36.630**	23.478**
0.062	Actara	12.37±1.22 b	18.28±1.41 c	23.66±1.41 b
	Confidor	16.49±1.41 b	24.73±2.28 b	24.73±2.28 b
	Nat-1	7.22±1.14 c	13.98±1.14 c	26.88±2.28 b
	Aphox	27.84±1.84 a	38.71±1.58 a	38.71±1.58 a
F- value		19.001**	42.426**	14.272**
0.031	Actara	4.12±1.14 bc	7.53±1.30 c	17.58±3.77 c
	Confidor	7.22±1.00 b	13.98±2.72 b	24.73±1.41 b
	Nat-1	1.03±0.45 c	2.15±0.71 d	8.60±1.41 d
	Aphox	13.40±1.84 a	24.73±1.41 a	35.48±0.71 a
F-value		18.915**	32.522**	27.549**

** = Highly significant NS= not significant

Means in a column followed with the same letter(s) are not significantly different at 5% level of probability

Table (2): Effect of the different insecticides on *Brevicoryne brassicae* L.

(%) Concentration	Insecticide	Corrected percent mortality after the indicated hours		
		24h	48h	72h
0.125	Actara	89.85±1.51 b	98.96±0.58 a	98.96±0.58 a
	Confidor	98.96±0.48 a	98.96±0.55 a	98.96±0.55 a
	Nat 1	68.75±1.99 c	79.17±2.28 b	79.17±2.28 b
	Aphox	89.58±1.88 b	98.96±0.80 a	98.96±0.80 a
F- value		65.113**	60.404**	60.404**
0.062	Actara	84.38±1.22 a	89.58±2.21 a	96.81±1.43 a
	Confidor	79.17±2.95 a	79.17±1.76 b	94.68±2.00 a
	Nat 1	68.75±2.42 b	68.75±1.22 c	75.53±1.70 b
	Aphox	79.17±2.77 a	89.58±2.66 a	97.87±1.02 a
F- value		7.240**	23.958**	44.536**
0.031	Actara	68.75±1.64 a	89.58±1.58 a	98.96±0.48 a
	Confidor	58.33±1.92 b	79.17±2.35 b	89.36±2.90 b
	Nat 1	37.50±1.96 c	58.33±2.17 c	62.77±1.41 c
	Aphox	68.75±2.12 a	89.58±6.04 a	96.81±1.54 a
F- value		58.943**	43.403**	85.225**

** = Highly significant.

Means in a column followed with the same letter(s) are not significantly different at 5% level of probability.

Table (3): LC_{50} and slope values of the tested insecticides 24 hours post treatment

Insecticide	*C. undecimpunctata* 24h			*B. brassicae* 24h		
	LC_{50}	LC_{90}	Slope	LC_{50}	LC_{90}	Slope
Actara	0.250	1.158	1.929	0.013	0.118	1.309
Confidor	0.196	0.960	1.861	0.028	0.077	2.881
Aphox	0.199	0.846	1.319	0.012	0.137	1.252

35.48 and 8.60%, respectively (Table 1).

Statistical analysis showed that Ahpox caused significant higher mortality than the other tested insecticides when used at 0.062 and 0.031% concentrations, while Nat-1 almost caused significantly lower mortality percentages than the other insecticides.

The LC_{50} values of the tested insecticides, 24 hours post treatment, could be arranged in an ascending order as follows, Confidor (0.196%) Aphox (0.199%) and Actara (0.250%), while Nat-1 showed very low or negligible mortality percentages (Table 3).

Effect on *C. undecimpunctata* eggs

Evaluation of egg hatching percentages was performed after 7 days of treatment, when no more hatching in the check group occurred. The highest concentration (0.125%), reduced the hatching of eggs by 42.71% for Aphox, 22.28% for Confidor, 10.00% for Actara and 8.08% for Nat-1. All the tested concentrations possessed significant differences among each other (Fig. 1).

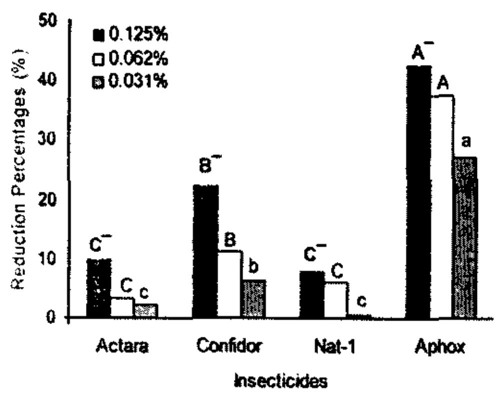

Fig. (1): Reduction percentages in *Coccinella undecimpunctata* egg hatching, 7 days post treatment.

F-value for 0.125% concentration = 80.055, P=0.000
F-value for 0.062% concentration = 135.114, P=0.000
F-value for 0.031% concentration = 119.720, P=0.000

Using 0.062% concentration, Aphox, also revealed the highest reduction in hatchability (37.50%), followed by Confidor (11.13%) and Nat-1 (6.60%), while Actara induced the lowest one (3.23%). Statistically, the tested concentrations showed significant differences among them (Fig. 1) Insecticides used at the lowest concentration (0.031%) induced low or negligible effect upon the hatchability of eggs, the highest recorded percentage was for Aphox (27.08%), being significantly different with the other tested insecticides that induced 6.50, 2.23 and 0.50% for Confidor, Actara and Nat-1, respectively (Fig. 1).

Aphid treatment

Generally, the tested insecticides possessed high effectiveness upon the treated aphid, *B. brassicae*. Higher concentration (0.125%) gave a complete reduction within 48 hours, while the other two concentrations (0.062 and 0.031%) gave complete reduction after 72 hours, except for Nat-1 insecticide that gave a complete reduction after 5 and 7 days at 0.062 and 0.031% concentrations (Table 2). The LC_{50} values for the tested insecticides were estimated 24 hours post treatment. They arranged as: Aphox (0.012%), Actara (0.013%) then Confidor (0.028%) (Table 3).

Effect on the predator

Obtained results clarify that the tested insecticides were relatively harmful to *C. undecimpunctata* when used at relatively higher concentrations, especially Aphox and Confidor, followed by Actara then Jojoba oil (Nat-1). These are in accordance with those obtained by Sterk *et al.* (2001) who evaluated the effects of some pesticides against non-target beneficial arthropods. They reported that, neonicotinoids, imidacloprid and thimethoxam, were toxic to the prevailing natural enemies. Also, Pons and Albajes (2001), reported that Imidacloprid significantly reduced the densities of natural enemies when applied to control maize aphids. Nevertheless, the obtained results were matched with those of Babu and Sharma, (2003 a&b), who reported that Confidor caused significant reduction in *Rhopalosiphium maidis* aphid population at all tested concentrations, but it was comparatively safer than the conventional insecticide monocrotophos to the coccinellid predators. Similar conclusion was reported in laboratory and semi-field studies carried by Shaheen *et al.* (2005) which revealed that Actara and Confidor gave effective control against cotton aphids, and preserved associated predators.

When insecticides were used at low concentrations, obtained results matched with those of Starb and Jentsch (2005) reported that low rate of (Confidor) applications provided adequate suppression of apple aphid, while preserving the predators.

In case of aphids, obtained results are in accordance with many authors who reported that Confidor and Actara are very toxic to aphids (Nucifora, 1998 on *Aphis gossypii* Glov. and *Myzus persicae* Sulz.; Kharboutli and Allen, 2000 on *A. gossypii*; Aslam and Ahmad, 2001 on *Lipuphis erysimi* (Kalt.); Laskowski, 2001 on pea aphid; Babu and Santharam (2001 a & b) and Babu and Sharma, (2003 a & b) on *Rhopalosiphium maidis*; Conway *et al.*, 2003 on *A. gosspii* Glover; Workman *et al.*, 2004 on lettuce aphid and Royer *et al.*, 2005 on cereal aphids. Therefore, Actara and Confidor could be advocated for use at the lowest concentration level (0.031%) and recommended in an integrated management program for aphids in cotton field.

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