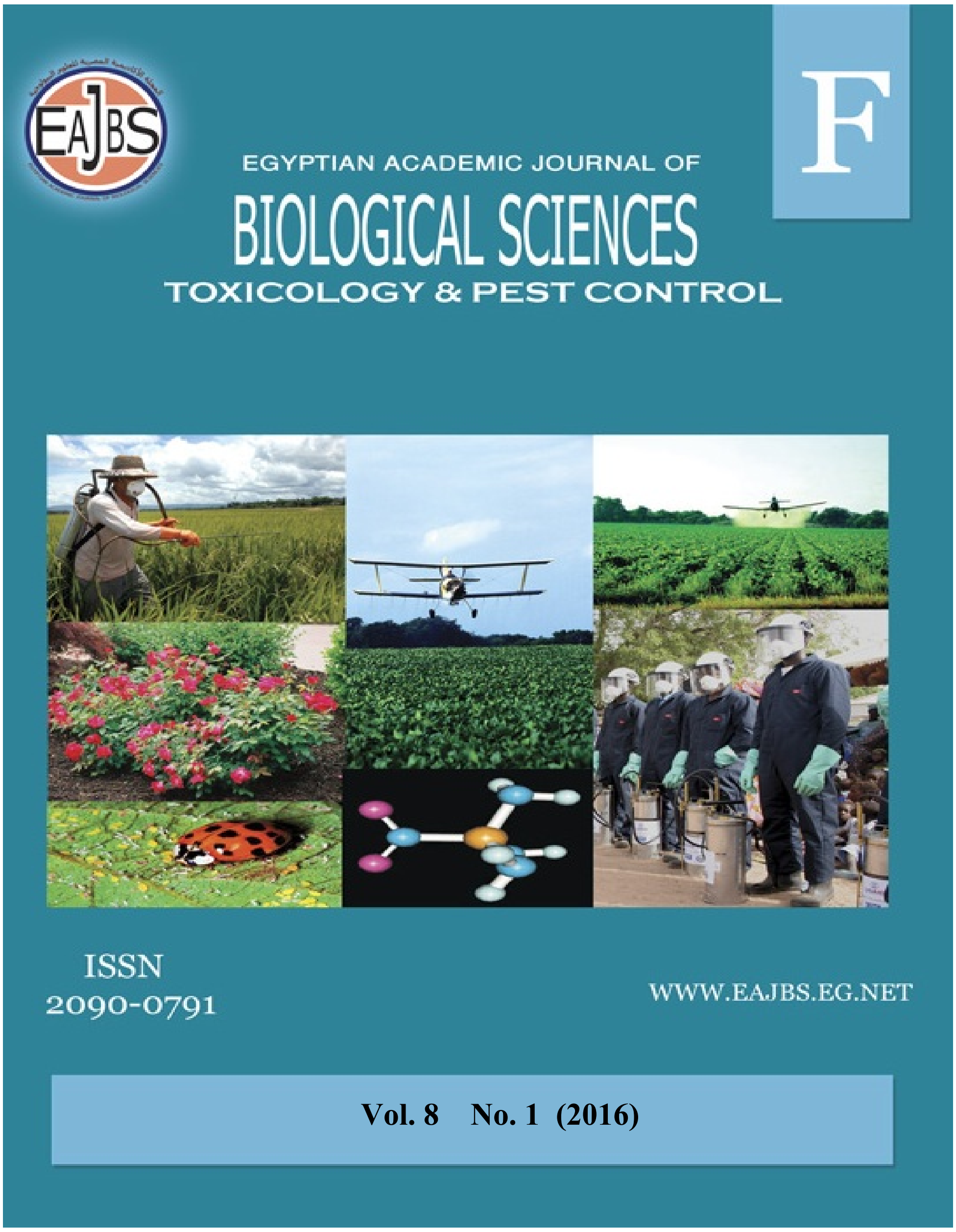

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Resistance to Confidor (imidacloprid) in Two Sap-Sucking Insects and Cross-Resistance to Several Insecticides

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ABSTRACT

Laboratory selection pressure was implemented to the adults of cowpea *Aphis craccivora* (Koche) as well as adults of whitefly *Bemisia tabaci* (Gennadius) collected from Behira field-strain to build up resistance toward confidor (imidacloprid) insecticide. The level of selection pressure was carried out using LC_{25} and LC_{50} values of tested compound . After 15 generations, the level of resistance to confidor (imidacloprid) was 73.78 folds for *B. tabaci* and 78.40 fold for *A. craccivora*. The two strains showed cross-resistance to primiphos-methyl (actilic) (9.64 and 7.04 fold) for *B-tabaci* and *A. craccivora* respectively, while these strains showed high resistance to lambda-cyhalothrin (karate) and diafenthiuron (polo) with 73.90 and 33.73 fold for *A. craccivora* respectively and it was 50.41 and 19.07 fold for *B. tabaci* respectively.

INTRODUCTION

The whitefly, *Bemisa tabaci* (Gennadins) and aphids *Aphis craccivora* (Koche) are of the most common insect pests attacking a wide spectrum of economic plants, causing great losses in their yield. The problems of these pests are not only due to their direct damage but also their capability to transmit viruses. Insecticides have been extensively used for the control of these pests and resistance to various insecticides have been reported in different countries and Egypt. Confidor (imidacloprid), was introduced in 1990 and having high activity and long-lasting effect, it has become the primary insecticide for controlling pests. Similar Compounds belonging to the same class of insecticide and introduced after wards, which exhibit to a great or less extent the same efficacy characteristics and were shown to have an identical mode of action by binding to the same site action nicotinic acetylcholine receptor (nAChR) (Nauen *et al*., 2000). Resistance to imidacloprid has been reported in a range of species including silver leaf whitefly (*Bemisia* argentifollii), Western Flower thrips (*Frankliniella occidentalis*), Colorado potato beetle (*Leptintotarsa decemlineata*). German cochroach (*Blattela germanica*) and housefly (*Musca domestica)* (Wen and Scott, 1997). The objective of this work is to study development of resistance to confidor (imidacloprid) for *B.. tabaci* and *A. Craccivora*, as well as cross resistance spectum of confidor (imidacloprid) -resistant strains of *B. tabaci* and *A. craccivora* has been carried out.

MATERIALS AND METHODS

Insects:

Laboratory strains of *Bemisia tabaci* and *Aphis craccivora* were obtained from department of stander rearing in the Central Laboratory of Pesticides, Agricutlural Research Center, Giza, Egypt.

Resistant-strains of *B. tabaci* and *Aphis Cruccivora* were derived from the Behira field strains which selected with confidor (imidacloprid) for 15 generations.

The strain of *B. tabaci* was reared on cotton plants in the laboratory as described by Coudriet, *et al*. (1985), but strains of *A. craccivora* were reared on faba bean seedlings according to Norman and Sutton (1967).

Bioassay:

The bioassay method for *B. tabaci* was done according to Prabhaker *et al.* (1985), but for *A. craccivcora* was reared as described by Moores *et al.* (1996).

In case of *B. tabaci*, cotton leaves were dipped for 10 seconds in 100 ml. of the desired concentration of each insecticide and allowed to dry. Treated leaves were laid on a thin layer of 2% agar in small cage and twenty adults were transferred into the cage by an aspirator.

For *A. craccivora*, faba bean leaves were dipped in the tested insecticide for about 10 seconds, and allowed to dry, then placed upside down on an agar bed in small petri dish. Ten apterous adults of *A. craccivora* were placed on the treated leaf surface.

Mortality of adults was recorded at 24 and 48 hr after treatment. At least six concentrations were tested for each insecticide, and five replicates were done for each test. LC_{50} values were determined on the computer by probit according to Finney (1971).

Selection procedures:

The resistant-strain was selected with confidor (imidacloprid), at a level producing 25% mortality to the adult stage. Resistance ratio (RR) was detemined by dividing the LC_{50} of the R-strain by the LC_{50} of lab-strain.

Insecticides used:

- **Neonicotinoids:**
  Imidacloprid (confidor, 20% SL)
- **Pyethroids:**
  Lambda-Cyhalothrin (Karate, 20% EC).
- **Organophosphorus:**
  Primiphos methyl (Actilic 50% EC).
- **Miscellaneous insecticides:**
  Diafenthiurone (Polo 50% SC).

RESULTS AND DISCUSSION

Development of resistance:

Resistance ratio in *A. craccivora* confidor (imidacloprid)-resistant strain as set up in Table (1) was 8.48 folds compared with the parents after selection for 15 generations and estimated 78.4 folds compared with laboratory strain, moreover, changes in the response of the adult of pest due to the selection pressure of the used insecticide . However, in case of *B. tabaci* confidor (imidacloprid)-resistant strain, resistant ratio was 21 folds after selection for 15 generations compared with the parents; whereas the resistance ratio reached 73.78 folds compared with the laboratory strain (Table 2) . This reflects the acceleration of building up resistance in *B. tabaci* faster than in case of *A. craccivora*, this may be due to the immature stages of *B. tabaci* were resident (static) but the adult was very active, and confidor (imidacloprid) is recently introduced to be one the non-conventional pest control agent against these pests.

Table 1: LC_{50}'s of confidor (imidacloprid) resistant strain in *Aphis craccivora* and Resistance ratio selected for 15 generatins.

Generation	LC_{50}	Slope	RR**	RR*
Laboratory strain	0.37	0.870 ± 0.24		
1st generation (Parent)	3.42	1.12 ± 0.45	9.24	
2nd generation	4.01	1.84 ± 0.22	10.83	1.17
5th generation	9.23	1.51 ± 0.24	24.94	2.69
7th generation	18.56	1.52 ± 0.32	50.16	5.42
10th generation	18.93	1.61 ± 0.10	51.16	5.53
12th generation	23.52	2.11 ± 0.23	63.56	6.87
15th generation	29.01	0.81 ± 0.23	78.40	8.48

$RR^{**} = \frac{LC_{50} \text{ of every generation}}{LC_{50} \text{ of susceptibile strain}}$ $RR^{*} = \frac{LC_{50} \text{ of every generation}}{LC_{50} \text{ of } 1^{st} \text{ generation}}$

Table 2: LC_{50}'s of confidor (imidacloprid) resistant strain in whitefly *Bemisia tabaci* and Resistance ratio selected for 15 generations.

Strain and tested generations	LC_{50}	Slope ± S. E.	RR**	RR*
Laboratory strain	6.14	0.74 ± 0.21		
Parent	21.57	0.36 ±0.053	3.51	
2nd generation	65.89	0.76 ± 0.061	10.73	3.05
5th generation	91.35	0.84 ± 0.063	14.88	4.24
7th generation	124.014	0.40 ± 0.097	20.20	5.75
10th generation	136.18	1.15 ± 0.161	22.18	6.31
15th generation	452.98	0.46 ± 0.1	73.78	21

$RR^{**} = \frac{LC_{50}\text{'s of every generation}}{LC_{50} \text{ of S. strain}}$

$RR^{*} = \frac{LC_{50}\text{'s of every generation}}{LC_{50} \text{ of parent}}$

The results are in agreement with Wang *et al.* (2002), they selected for a low level of resistance to confidor (imidacloprid) (approximately 8 fold after 13 generations of selection) in a line of the cotton aphid. Also, Chen Xiaokun *et al*., (2013) revealed that the resistant strain of *A. craccivora* was continuously selected with imidacloprid for 75 generatins and the resistance ratio reached to 72.6 fold as high as that of the susceptible strain.

Similarly, testing field collected strains of the tobacco whitefly *B. tabaci* showed a slow but steady increase in resistance to imidacloprid (Elbert and Nauen, 2000).

Basit *et al* (2011) stated that after selecting a field population of *B. tabaci* Genn for eight generations with acetamiprid, resistance to acetamiprid increased to 118 fold compared with the laboratory susceptible population.

Cross resistance:

The toxicity of the insecticides against the adult stage of *A. craccivora* and *B. tabaci* to confidor (imidacloprid)-resistant strain was presented in Tables 3 and 4, respectively.

Summarized results showed that the organophorus insecticide, actilic and the pyrethroid insecticide, karat were the most potent compounds against the adults of *A. craccivora* laboratory and resistant strains, whereas, polo was the least effective one against the same laboratory and resistant strains Table (3). Thus, it is suggested that, pyrethroid insecticides should be applied in alternative with organophosphorus insecticides for control aphids. On the other hand karate and polo exhibited high efficiency against both laboratory and resistant strains of *B. tabaci* adults, therefore polo could be applied as alternative to pyrethroid insecticides for controlling *B. tabaci*.

Table 3: Cross-resistance confidor (Imidacloprid)-resistant strain in cowpea aphid *A. craccivora* to some conventional insecticides.

Insecticides	Strain	LC50ppm	Slope ± S. E.	Resistant ratio RR1
Actilic (Pirimiphos-methyl)	S	0.61	1.25 ± 0.33	7.04
	R	4.30	1.76 ± 0.22	
Karate (Lambda-cyhalothrin)	S	0.30	2.08 ± 0.25	73.90
	R	22.17	1.95 ± 0.11	
Polo (Thioria Diafenthiuron)	S	5.39	0.93 ± 0.43	33.73
	R	181.82	1.06 ± 0.37	

S: Susceptible strain R: Resistant strain

$$RR1 = \frac{LC_{50}\text{ of R strain}}{LC_{50}\text{ of S strain}}$$

Table 4: Cross-resistance confidor (imidacloprid) resistant strain in whitely *Bemisia tabaci* to some conventional insecticides.

Insecticides	Strain	LC_{50} ppm	Slope ± S. E.	RR
Actilic (Pirimiphosmethyl)	S	20.61	0.57 ± 0.062	9.64
	R	198.65	0.52 ±0.06	
Karate (Lambda-cyhalothein)	S	1.47	0.49 ± 0.18	50.41
	R	74.11	0.58 ± 0.06	
Polo (Diafenthiuron)	S	8.94	0.57 ± 0.10	19.07
	R	170.46	0.85 ± 0.22	

S = laboratory strain R = Resistant stain

$$RR = \frac{LC_{50}\text{ of R strain}}{LC_{50}\text{ of S strain}}$$

It could be concluded that actilic and karate showed slower developed resistance in *A. craccivora* than polo, while karate and polo inducer slower developed resistance in *B. tabaci* than actilic. Accordingly, it is suggested that using actilic for control of *A. craccivora* and polo for control of *B. tabaci* in cotton field. Wang *et al.* (2002) found that resistant strain of imidacloprid exhibited cross-resistance to fenvalerate, with a resistance ratio of 108.9 fold on cotton and 33.5 fold on cucumber. Also Farghaly (2005) who found that the resistance strain of thiamethoxam showed cross-resistance only with imidacloprid, diafenthiuron and lambda-cyhalothrin with 22.41, 17.28 and 1540.8 fold, respectively and she suggested that treatment of whitefly *B. tabaci* with neonicotinoid followed by pyrethroids or reverse caused resistance to thiamethoxam and lambda-cyhalothrin.

Georghiou *et al* (1983) pointed out the number of generations or length or time between uses of any one material is sufficient to allow resistance to decline, below a critical frequency. Also, factors determining the selection of resistance to insecticides can be classified genetically or ecological once relating to the intrinsic properties of pests and resistance mechanisms and operational one relating to the chemical itself in how applied.

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ARABIC SUMMERY

المقاومة لمبيد الايميداكلوبريد في اثنين من الحشرات الثاقبة الماصة والمقاومة العبورية للعديد من المبيدات

عزة داوود وسيدة فرغلى

المعمل المركزي للمبيدات – مركز البحوث الزراعية- دقي- جيزة- مصر

تم انتخاب الحشرة الكاملة لمن الفول وحشرة الذبابة معلميا باستخدام مبيد الكونفيدور حتي خمسة عشر جيلا من الآفة ، وقد أظهرت النتائج أن :

المقاومة للمبيد باستخدام LC_{25} و LC_{50} كانت 73.74 ضعف لحشرة الذبابة البيضاء ، أما بالنسبة الي حشرة من الفول وصلت المقاومة للمبيد إلي 74.40 ضعف.

كما أظهرت كل من الآفتين مقاومة عبورية لمبيد الأكتيليك فكانت كالآتي :

9.64 ، 7.04 ضعف لآفة الذبابة البيضاء ومن الفول علي التوالي ، وأيضا أظهرت كل من حشرة الذبابة البيضاء ومن الفول مقاومة عالية لمبيدي كارات وبولو فكانت 73.90 – 33.73 ضعف علي التوالي لآفة من الفول ، وكانت المقاومة للمبيدين 50، 41 – 19.07 ضعف علي التوالي لآفة الذبابة البيضاء.