Field Efficiency of Some Insecticide Treatments against Whitefly, *Bemisia tabaci*, Cotton Aphid, *Aphis gossypii* and Their Associated Predator, *Chrysopa vulgaris*, in Cotton Plants

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Received on: 11/5/2014 *Accepted: 3/8/2014*

ABSTRACT

The efficiency of two chitin synthesis inhibitors (pyriproxyfen and novaluron), compared with three neonicotinoid insecticides (thiamethoxam, imidacloprid and acetamiprid) and chlorantraniliprole against *Bemisia tabaci*, *Aphis gossypii* and their associated predators were determined in cotton fields. The experiments were carried out during 2012 and 2013 cotton seasons at Lakana village, Shobrakeate, El-Beheira Governorate. Results showed that, statistically, all tested insecticides were comparable against *B. tabaci* adults except chlorantraniliprole which recorded the least reduction percentages at 2012 and 2013 cotton seasons. The same results also were recorded with *B. tabaci* immature stages at 2012 and 2013 cotton seasons. Concerning *A. gossypii*, the neonicotinoid insecticides (thiamethoxam, imidacloprid and acetamiprid) recorded the highest mean reduction (89.99, 88.79 and 76.86%) at 2012 and (95.05, 94.61 and 94.90) at 2013. On the other hand, the chitin synthesis inhibitors (pyriproxyfen and novaluron) achieved the least reduction percentages against *A. gossypii* in both seasons. The neonicotinoids revealed a residual toxicity higher than, the chitin synthesis inhibitors on *B. tabaci* and *A. gossypii*, while chitin synthesis inhibitors revealed a residual toxicity higher than chlorantraniliprole against *B. tabaci*. Under the same conditions, all treatments have moderate toxic effects on the natural enemy *Chrysopa vulgaris* except chlorantraniliprole which recorded low toxic effects in both seasons.

Key words: Cotton, Sucking and peiring insects, Neonicotinoids, Aphid lion.

INTRODUCTION

Whitefly, *Bemisia tabaci* (Gennadius) and cotton aphid, *Aphis gossypii* (Glover) remain key pests of many fields, horticultural and protected agricultural crops with significant problems (Brown *et al*., 1995; Said *et al*., 2005). They feed on the phloem sap of more than 500 host plant species (Hunter and Polston, 2001), causing damage by the excretion of large amounts of honeydew which serves as a medium for black sooty mold fungi. The mold reduces photosynthesis and lessens the market value of the plant or yields it unmarketable (Berlinger, 1986). In addition, *B. tabaci* biotypes can transmit more than 90 types of plant virus (Jorge and Mendoza, 1995; Hunter and Polston, 2001) including the tomato yellow leaf curl virus (Ghanim and Czosnek, 2000), the sweet potato leaf curl virus (Lotrakul *et al.*, 1998) and the tomato mottle virus (Hunter *et al.*, 1998). In many agricultural systems worldwide, it is well known that *B. tabaci* populations are resistant to organophosphate and pyrethroid insecticides (Horowitz *et al.*, 1998). Hence, it is urgent to develop new or non-conventional groups of insecticides to combat highly resistant insect pest like *B. tabaci* biotypes, and to conserve their efficacy by applying insecticide resistance management strategies (Horowitz *et al.*, 1998). Current management systems for many crops are dominated by the use of insecticides that typically rely on sampling, threshold and resistance information to optimize timing of applications and make best use of existing chemistry (Palumbo *et al.*, 2001).

Novaluron and pyriproxyfen are chitin synthesis inhibitors (CSI) that belongs to the benzoyl phenyl urea's (BPUs) group; it is known as an active larvicidal with a broad spectrum activity on various insects, including Lepidoptera, Coleoptera, Homoptera, Hymenoptera and Diptera (Malinowski and Pawinska, 1992; Pluciennik *et al.*, 1999; Barazani, 2001; Ishaaya and Horowitz, 2002). Several studies reported about the direct effects of CSIs on insect pest organisms, such as mortality or adult emergence inhibition (Soltani and Rehini, 1999; Su *et al.*, 2003; Batra *et al.*, 2005). Novaluron offers the additional advantage of freedom from cross-resistance effects with other insecticides, such as pyriproxyfen is commonly used for pest (whitefly) control (Ishaaya and Horowitz, 2002). Thiamethoxam, imidacloprid and acetamiprid are belonging to the neonicotinoid insecticides. Neonicotinoids interfere with the nicotinic acetylcholine receptor and therefore have specific activity against the insect nervous system (Maienfisch *et al.*, 2001).

The purpose of this study was to determine, the efficiency of two chitin synthesis inhibitors (pyriproxyfen and novaluron), compared with three neonicotinoid insecticides (thiamethoxam, imidacloprid and acetamiprid) and chlorantraniliprole against the whiteflies, *B. tabaci*, *A. gossypii* and their associated predator *Chrysopa vulgaris* in cotton fields. Two field experiments were *carried* out during 2012 and 2013 cotton seasons at Lakana village, Shobrakeate, El-Beheira Governorate.

MATERIALS AND METHODS

Test pest: Tested insecticids:

Pyriproxyfen (Admiral 10% EW) provided by Sumitomo Company. Novaluron (Roxy 10% EC) provided by United Phosphorus Ltd. Thiamethoxam (Actara 25% WG) provided by Syngenta Company. Imidacloprid (Ecomida 30.5% SC) provided by Bharat Insecticides Ltd. Acetamiprid (Gentraceta 10% EC) provided by Qingdao KYX Chemicals Co. Ltd. Chlorantraniliprole (Coragen 20% SC) provided by DuPont Du Nemours Company.

The field trials:

The field trials were carried out in cotton fields at Lakana village, Shobrakeate, El-Beheira Governorate during the summer seasons of 2012 and 2013. All cultural practices were carried out as recommended for optimal cotton (Giza 88), production. Treatments were arranged in a randomized complete blocks design with four replicates (42m² each) in addition to the control plots. Insecticides were tested at rates of 120ml, 200ml, 60gm, 80ml 100ml and 60ml/fed. for pyriproxyfen, novaluron, thiamethoxam, imidacloprid, acetamiprid and chlorantraniliprole, respectively, according to Ministry of Agriculture recommendations. The insecticides were sprayed by Knapsack sprayer equipment (CP3) at the rate of 200 liter per feddan. For counting the numbers of whiteflies (adults and immature stages) and cotton aphid, samples of 25 leaves (from three different levels of the plants) were collected at random in the morning for both diagonals of the inner square area of each experimental plot. At the same time, samples of 25 cotton plants were examined and the number of larvae & adults of the aphid lion, *Chrysopa vulgaris* were counted.

Statistical analysis:

Percentages of each insect reduction were calculated according to Handerson and Tilton equation (1955) and subjected to analysis of variance (ANOVA). Means were determined for significance at 0.05 using LSD test (SAS Statistical software, 1999).

RESULTS AND DISCUSSION

Reduction percentages of *B. tabaci* (adults & nymphs) caused by pyriproxyfen, novaluron, thiamethoxam, imidacloprid, acetamiprid and chlorantraniliprole were investigated (Tables 1, 2, 3 and 4). Mean of the reduction percentages of *B. tabaci* adults caused by pyriproxyfen, novaluron, thiamethoxam, imidacloprid, acetamiprid and chlorantraniliprole were 68.98, 66.19, 79.71, 73.39, 74.82 & 55.54%, respectively, at 2012 and 70.46, 68.71, 78.10, 75.43, 83.22 & 51.75%, respectively, at 2013 cotton season.

Table 1: Reduction percentages of *B. tabaci* adults after application of different insecticides during 2012 cotton season:

Tested compounds	Rate/fed.	%Reduction after				
		1-day	4-days	7-days	10-days	Mean
Pyriproxyfen	120ml	48.78	86.22	75.27	65.65	68.98 ab
Novaluron	200ml	53.13	82.86	69.23	59.52	66.19 ab
Thiamethoxam	60g	71.86	84.57	83.85	78.57	79.71 a
Imidacloprid	80ml	69.06	82.00	74.62	67.86	73.39 a
Acetamiprid	100ml	70.91	87.72	76.13	64.53	74.82 a
Chlorantraniliprole	60ml	32.50	66.61	66.77	56.29	55.54 b

*Means within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table 2: Reduction percentages of *B. tabaci* adults after application of different insecticides during 2013 cotton season.

Tested compounds	Rate/fed.	%Reduction after				
		1-day	4-days	7-days	10-days	Mean
Pyriproxyfen	120ml	56.00	69.54	84.29	72.00	70.46 a
Novaluron	200ml	59.53	70.57	79.50	65.22	68.71 a
Thiamethoxam	60g	78.06	84.33	79.63	70.37	78.10 a
Imidacloprid	80ml	78.85	82.37	73.81	66.67	75.43 a
Acetamiprid	100ml	80.47	83.73	87.91	80.77	83.22 a
Chlorantraniliprole	60ml	26.42	66.89	65.84	47.83	51.75 b

*Means within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table 3: Reduction percentages of *B. tabaci* immature stages after application of different insecticides during 2012 cotton season.

Tested compounds	Rate/fed.	%Reduction after				
		1-day	4-days	7-days	10-days	Mean
Pyriproxyfen	120ml	48.20	81.65	73.40	72.67	68.98 ab
Novaluron	200ml	52.78	83.05	74.50	68.52	69.71 ab
Thiamethoxam	60g	81.16	90.82	87.90	77.63	84.38 a
Imidacloprid	80ml	78.24	78.80	70.20	61.71	72.24 a
Acetamiprid	100ml	80.12	73.36	69.37	65.90	72.19 ab
Chlorantraniliprole	60ml	25.44	65.13	69.37	55.93	53.97 b

*Means within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table 4: Reduction percentages of *B. tabaci* immature stages after application of different insecticides during 2013 cotton season.

Tested compounds	Rate/fed.	%Reduction after				
		1-day	4-days	7-days	10-days	Mean
Pyriproxyfen	120ml	46.55	79.48	84.44	83.20	73.42 ab
Novaluron	200ml	60.95	80.91	85.86	90.45	79.54 a
Thiamethoxam	60g	73.27	86.56	84.44	74.80	79.77 a
Imidacloprid	80ml	77.97	93.54	91.03	83.85	86.60 a
Acetamiprid	100ml	78.79	90.67	94.24	80.56	86.07 a
Chlorantraniliprole	60ml	12.85	63.48	69.57	63.48	52.35 b

*Means within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Concerning *B. tabaci* immature stages (Tables 3 and 4), mean of reduction percentages caused by pyriproxyfen, novaluron, thiamethoxam, imidacloprid, acetamiprid and chlorantraniliprole were 68.98, 69.71, 84.38, 72.24, 72.19 and 53.97%, respectively at 2012 cotton season and 73.42, 79.54, 79.77, 86.60, 86.07 and 52.35%, respectively at 2013 cotton season. Results also showed that, neonicotinoids (thiamethoxam, imidacloprid and acetamiprid) revealed a residual toxicity higher than chitin synthesis inhibitors (pyriproxyfen and novaluron) on *B. tabaci* which revealed a residual toxicity higher than chlorantraniliprole in both seasons.

Under the same conditions, reduction percentages of *A. gossypii* caused by the tested insecticides were presented in Tables (5 and 6). Mean of reduction percentages of *A. gossypii* caused by pyriproxyfen, novaluron, thiamethoxam, imidacloprid, acetamiprid and chlorantraniliprole were 49.11, 46.54, 89.99, 88.79, 76.86 and 67.28%, respectively at 2012 cotton season and 57.08, 48.95, 95.05, 94.61, 94.90 and 86.26%, respectively at 2013 cotton season.

Table 5: Reduction percentages of *A. gossypii* after application of different insecticides during 2012 cotton season.

Tested compounds	Rate/fed.	%Reduction after				
		1-day	4-days	7-days	10-days	Mean
Pyriproxyfen	120ml	63.51	57.34	47.36	28.22	49.11 c
Novaluron	200ml	72.90	54.02	42.08	17.15	46.54 c
Thiamethoxam	60g	85.36	89.83	91.67	93.11	89.99 a
Imidacloprid	80ml	84.39	87.80	90.40	92.56	88.79 a
Acetamiprid	100ml	81.75	79.34	71.55	74.78	76.86 ab
Chlorantraniliprole	60ml	47.13	73.73	75.83	72.43	67.28 b

*Means within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

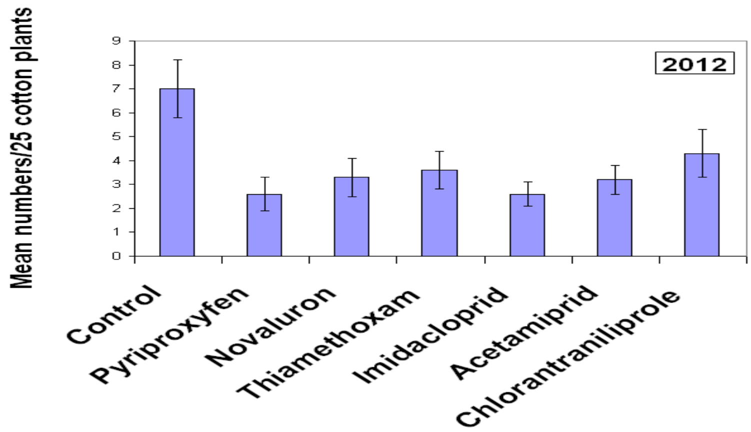
Table 6: Reduction percentages of *A. gossypii* after application of different insecticides during 2013 cotton season.

Tested compounds	Rate /feddan	%Reduction after				
		1-day	4-days	7-days	10-days	Mean
Pyriproxyfen	120ml	70.27	61.60	51.77	44.69	57.08 c
Novaluron	200ml	60.68	51.52	48.50	35.10	48.95 c
Thiamethoxam	60g	89.87	90.33	100.0	100.0	95.05 a
Imidacloprid	80ml	88.53	89.89	100.0	100.0	94.61 a
Acetamiprid	100ml	87.87	91.73	100.0	100.0	94.90 a
Chlorantraniliprole	60ml	65.95	87.15	92.00	100.0	86.26 ab

*Means within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Data from Figure (1) indicated that, mean numbers of natural enemy *C. vulgaris*/25 cotton plants at four investigation times were 7, 2.6, 3.3, 3.6, 2.6, 3.2 and 4.3 insect for control, pyriproxyfen, novaluron, thiamethoxam, imidacloprid, acetamiprid and chlorantraniliprole plots, respectively during 2012 and 6.5, 2.3, 2.8, 2.9, 3.2, 2.4 and 3.8 insect, respectively during 2013season. Data clarified that, all treatments have moderate toxic effects on *C. vulgaris* except chlorantraniliprole which has a low toxic effect.

The present results were in agreement with those obtained by Horowitz *et al*., (1999); Lee *et al*., (2002) and Cutler *et al*., (2005). They found that, chitin synthesis inhibitors (pyriproxyfen and novaluron) were very effective against immature stages of *B. tabaci* and were relatively low effective against the adults of *B. tabaci* and *A. gossypii*. These results indicate that pyriproxyfen and novaluron exhibits juvenoidal activity against *B. tabaci*. Consequently, intensive use of these products in some production systems has resulted in reduced susceptibility of *B. tabaci* (Palumbo *et al*., 2001). Neonicotinoids (thiamethoxam, imidacloprid and acetamiprid) treatments can cause mortality to *B. tabaci* (Kuhar *et al*., 2002). Daniels *et al*. (2009) reported that aphids feeding on wheat treated with thiamethoxam were reduced weight, body plan area and food consumption than aphids feeding on wheat treated with distilled water and negatively impact coccinellids through several routes of entry, including: topical contact, residual contact, inhalation of volatiles, ingestion of toxified plant products and ingestion of toxified prey tissues (Ruberson *et al*., 1998; Johnson and Tabashnik, 1999 & Moser and Obrycki 2009). Muhammad *et al*. (2011& 2013**)** reported that, *B. tabaci* has developed resistance to some of neonicotinoids so mixtures of neonicotinoids with pyriproxyfen could be used to restore the efficacy of these neonicotinoids. Jia *et al*. (2011) found that chlorantraniliprole, has a potent insecticidal activity against several important insect pests, and very low toxicity to nontarget organisms. Chlorantraniliprole causes feeding cessation, lethargy, muscle paralysis and ultimately death by activating the ryanodine receptor (Cao *et al*., 2010; Cordova *et al*. 2006; Lahm *et al*., 2005 and Cui *et al*. 2014).



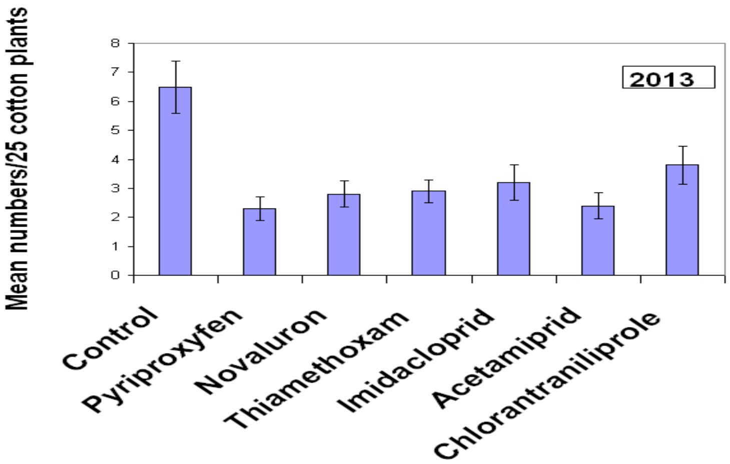


Fig. 1: Mean numbers of *C. vulgaris*/25 cotton plants at 2012 and 2013 cotton seasons. Symbols and bars represent means ± SD of four replications.

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الملخص العربى

الكفاءة الحقلية لبعض المبيدات ضد الذبابة البيضاء والمن و مفتريسهما فى حقول القطن

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[1]معهد بحوث وقاية النباتات- محطة البحوث الزراعية بايتاى البارود- مركز البحوث الزراعية

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تم إجراء هذا البحث بقرية لقانة مركزشبراخيت محافظة البحيرة لدراسة الكفاءه الإبادية لمركبين من مثبطـات تخليق الكيتين(بيريبروكسيفين، نوفاليورون) بالمقارنة مع ثلاثة مركبات مـن مشـابهات النيكـوتين (ثياميثوكسـام، إيميداكلوبريد، أسيتميبرايد) مع الكلورانترانيليبرول ضد الذبابة البيضاء ومن القطن ومفترس أسد المن فـى حقـول القطن خلال موسمى ٢٠١٢ و٢٠١٣. أوضحت النتائج أن كل المبيدات المختبره كانت متساويه إحصائيا فى خفـض تعداد الحشرات الكامله للذبابه البيضاء ما عدا مبيد الكلورانترانيليبرول والذى سجل أقل قيمة خفض فـى موسـمى التجربه ٢٠١٢ ، ٢٠١٣. نفس النتائج تقريبا تم تسجيلها ضد الأطوار الغير كامله للذبابه البيضـاء خـلال ٢٠١٢، ٢٠١٣. أما بالنسبه لمن القطن: مشابهات النيكوتين(ثياميثوكسام، إيميداكلوبريد، أسيتميبرايد) سجلت أعلى خفض فى تعدادها(٨٩.٩٩، ٨٨.٧٩، ٧٦.٨٦) فى ٢٠١٢ و(٩٥.٠٥، ٩٤.٦١ ، ٩٤.٩٠) فى ٢٠١٣. من ناحيه أخرى فـإن مركبي مثبطات تخليق الكيتين (بيريبروكسيفين، نوفاليورون) سجلت أدنى نسبة خفـض لحشـرة المـن فـى كـلا الموسمين. كما أوضحت النتائج أن مركبات مشابهات النيكوتين (ثياميثوكسام، إيميداكلوبريد، أسيتميبرايد) كان تأثيرها المتبقى أكثر فاعلية بالمقارنة بمثبطات تخليق الكيتين (بيريبروكسيفين، نوفاليورون) ضد المـن والذبابـة البيضـاء والمركب الاخير (أسيتميبريد) كان أكثر فاعلية من الكلورانترانيليبرول ضد الذبابة البيضاء. وتحت نفس الظـروف كل المعاملات كان لها تأثيرات سمية متوسطة ضد أسد المن ما عدا مبيد كلورانترانيليبرول الذى كان له تأثير سمية منخفض.