Field Efficiency of some New Insecticides Against some Sucking Insects at Cucumber Plants

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ABSTRACT

The efficiency of some new insecticides, (sulfoxaflor and flupyradifurone) were compared with three neonicotinoid insecticides (clothianidin, thiamethoxam and acetamiprid), at recommended rates, against *Bemisia tabaci, Aphis gossypii* and their parasitoid on cucumber plants, during 2017and 2018 summer seasons at Nubarya district, El-Beheira Governorate. Results showed that, sulfoxaflor and flupyradifurone exhibited excellent and fast action activity against *B. tabaci* and *A. gossypii*, and the least reduction percentages were recorded by acetamiprid at both seasons. Under the same conditions, three neonicotinoid insecticides had moderate toxic effect against natural enemies; *Chrysoperla carnea* and *Coccinella spp*, while, sulfoxaflor and flupyradifurone had slightly toxic effect. The present study suggests the use of sulfoxaflor and flupyradifurone are preferred insecticides, with less harmful effects on the fitness components of *natural enemies*, for integrated pest management of sucking insects at cucumber plants.

Keywords: Cucumber, *Aphis gossypii, Bemisia tabaci*, sulfoximines, flupyradifurone, neonicotinoid

INTRODUCTION

Cucurbits represent an important part of vegetable production and are considered very important in agricultural crops in Egypt. They are cultivated in wide areas either old lands or newly reclaimed lands. Cucumber, *Cucumis sativus* L. is one of the most important cucurbitaceous vegetable crops in Egypt, as it is cultivated under different environmental conditions, open fields and greenhouses for local consumption and exportation (Mohamed, 2012).

The cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae), is hazardous to many agricultural crops worldwide. It is a highly polyphagous pest, feeding on> 320 plant species of 46 families, including Cucurbitaceae, Malvaceae, Solanaceae, and Rutaceae (Blackman and Eastop, 2000; Aheer *et al*. 2008; Mesbah et al. 20016**;**and Almasi *et al*., 2018). Cotton aphids physically damage the plants by directly sucking their phloem sap, which can result in premature leaf drop، wilting, and desiccation of the host plants (Attia and El-Hamaky, 1987). Indirect damages by aphids include the honeydew extractions that substantially impact the photosynthesis rate and plant growth (Kersting *et al*., 1999), and cause transition of over 76 plant pathogenic viruses (Kim، 2007; Kersting *et al*., 1999), resulting in significant crop loss (Nazeri *et al*.2018).

The whitefly, *Bemisia tabaci* (Genn.) considered one of the most important pests infesting cucumber plants during its three growth stages, seedling, flowering and fruiting. The behavior of this insect makes chemical control difficult، i.e. adult feeding; mating and oviposition and larval development occur on the lower surface of the leaves (Coudriet *et al*., 1985; Mohamed, 2012). The nymphal and adult stages of this pest feed on phloem sap and excrete honeydew that hamper photosynthesis and render fruits unmarketable (Lenteren Van and Noldus, 1984). In addition, *B. tabaci* 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 ptato leaf curl virus (Lotrakul *et al*., 1998) and the tomato mottle virus (Brown 1994; Heinz 1996; Hunter *et al*., 1998 and Jones, 2003).

Sulfoximines are a new class of insecticides targeting sap-feeding insects (Babcock *et al*.,2011and Sparks *et al*., 2012) including the aphids, whiteflies, hoppers, and lygus (Nawaz *et al*., 2018; Babcock *et al*., 2011 and Zhu *et al*., 2011). Sulfoxaflor is the initial compound in this new sulfoximine insecticide class to be selected for commercial development. Sulfoxaflor is an agonist at insect nicotinic acetylcholine receptors (nAChRs) and functions in a manner distinct from other insecticides acting at nAChRs (Liao *et al*.,2017; Watson *et al*., 2017; Sparks *et al*., 2013). The sulfoximines are also effective against a wide range of sap-feeding insect pests that are resistant to other classes of insecticides, such as neonicotinoids (Zhu *et al*., 2011; Sparks *et al*., 2013. Also, sulfoxaflor is reported as being slightly harmful to biological control agents, including *Nesidiocoris tenuis* (Reuter) (Hemiptera: Miridae), *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), and *Adalia bipunctata* (L.) (Coleoptera: Coccinellidae) (Sparks *et al*., 2013; Wanumen *et al*., 2016 and Nawaz *et al*., 2018,).

Flupyradifurone, is a member of the new class of butenolide insecticides, contains a novel bioactive

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scaffold as pharmacophore. It is very versatile in terms of application methods to variety of crops, exhibits excellent and fast action against a broad spectrum of sucking pest insects including selected neonicotinoid resistant pest populations such as whiteflies and aphids expressing metabolic resistance mechanisms (Jeschke *et al.* 2015). The butenolide insecticide flupyradifurone acts selectively on the insect central nervous system (CNS) as a partial agonist of post synaptic *n*AChRs and binds to the acetylcholine (Ach) binding site (Nauen *et al.* 2014). Flupyradifurone provides excellent control of many sucking pests resistant to other chemical classes including neonicotinoids, and is thus a new resistance management tool for sustainable pest control. As a modern insecticide and based on the results at manufacturer recommended field-rates, it has an excellent profile concerning human- and environmental safety, safety to bees as well as bumble bees (Smith and Giurcanu 2013; Haas *et al.* 2014).

The purpose of this study was to determine the efficiency of a new or non-conventional groups of insecticides against the whiteflies, *B. tabaci*, cotton aphid, *Aphis gossypii* and their associated predators on cucumber plants at recommended rates, during 2017 and 2018 summer seasons at Nubarya district, El-Beheira Governorate.

MATERIALS AND METHODS

Insects

Tested compounds:

Sulfoxaflor (Closer 24%, SC) was provided by DowAgro Sciences Co., Ltd. Flupyradifurone (Sivanto-prime 20%, SL) was provided by Bayer Crop Science. Clothianidin (Supertox-1® 48%, SC) was provided by Jiangs Jiag chemical industry Co. Ltd China. Thiamethoxam (Actara 25%, WG) provided by Syngenta Company. Acetamiprid (Mospilan 20%, SP) provided by Nippon Soda Chemical Industry Co. Ltd.

The field trials:

Field experiments were carried out throughout two successive seasons (2017 and 2018) during summer plantation in Nubarya district, El-Beheira Governorate. These experiments were cultivated with cucumber varieties, *Cucumis sativus* L. (Prince). The experimental site was divided into 24 plots, each plot 1/100 feddan (42m²). Randomized complete blocks design was used with four replicates for each treatment with the control plots. Field concentrations were 40 ml, 240 ml,1000 ml, 60 gm and 50 gm/200 liters per feddan for sulfoxaflor, flupyradifurone, clothianidin, thiamethoxam, and acetamiprid, respectively. The insecticides were sprayed by Knapsack sprayer equipment (CP3). For counting the numbers of whiteflies, *B. tabaci* (immature stages) and cotton aphid, *A. gossypii*, 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. Pre-treatment counts were done in the early morning just before application while post-treatment counts were done on 1, 4, 7and 10 days after treatment. In the same time, sample of 25 cucumber plants were examined and the number of the aphid lion, *Chrysoperla carnea*, and the lady birds, *Coccinella spp*. were counted. Counts were done by the lenses in the early morning when flight activity is minimal according to Bulter *et al*. (1988). Percentages of pest reduction numbers were calculated according to Henderson and Tilton equation (1955) and subjected to analysis of variance (ANOVA) (CoStat Statistical software,1998).

RESULTS AND DISCUSSION

Gradual reduction percentages of whitefly numbers as a result of insecticide treatments were recorded in both seasons 2017and 2018 (Tables 1and 2). The highest reduction percentages of whitefly were recorded for flupyradifurone and sulfoxaflor where the mean reduction percentages were 97.73% and 92.43% at 2017 and 96.75% and 94.48% at 2018, respectively. The least reduction percentages were recorded by acetamiprid where the mean reduction percentages were 69.50 and 79.08% at 2017 and 2018, respectively.

Table 1. Efficacy of certain treatments against *Bemisia tabaci* immature stages on cucumber plants at 2017 season

Tested compounds	Rate / feddan	%Reduction After				
		1-day	4-days	7-days	10-days	Mean
Sulfoxaflor	40 ml	79.8	92.5	98.2	99.2	92.43b
Flupyradifurone	240 ml	92.8	98.4	100.0	99.7	97.73a
Clothianidin	1000ml	80.2	91.8	90.8	89.3	88.03c
Thiamethoxam	60 g	78.8	84.1	91.1	86.8	85.20c
Acetamiprid	50 g	65.1	69.3	74.2	69.4	69.50d

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

Table 2. Efficacy of certain treatments against *Bemisia tabaci* immature stages on cucumber plants at 2018 season

Tested compounds	Rate / feddan	%Reduction After				
		1-day	4-days	7-days	10-days	Mean
Sulfoxaflor	40 ml	88.9	95.4	98.1	95.5	94.48a
Flupyradifurone	240 ml	91.2	95.8	100.0	100.0	96.75a
Clothianidin	1000ml	88.8	94.2	100.0	98.1	95.28a
Thiamethoxam	60 g	76.5	90.1	89.2	88.5	86.08b
Acetamiprid	50 g	68.7	82.5	84.2	80.9	79.08c

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

In this study, field evaluation of some insecticides treatments against aphids on the cucumber plants at 2017 and 2018 seasons was carried out (Tables 3 and 4). In both seasons, the highest reduction percentages were achieved by flupyradifurone and sulfoxaflor treatments, where the mean reduction percentages were 98.33% and 96.00% at 2017 and 96.70% and 94.05% at 2018, respectively. The least reduction percentages were recorded by acetamiprid treatments where the mean reduction percentages were 64.45 and 73.60% at 2017 and 2018, respectively.

These results indicate that, neonicotinoids provide excellent control of many sucking pests as *B. tabaci* (Kuhar *et al*., 2002), and aphids (Daniels *et al*. 2009). Flupyradifurone and sulfoxaflor are also effective against a wide range of sap-feeding insect pests that are resistant to other classes of insecticides, including many that are resistant to the neonicotinoids (Zhu *et al*., 2011; Sparks *et al*., 2013; Jeschke *et al.* 2015; Liao *et al*. 2017 and Wang *et al.* 2017).

Data from Tables 5, 6, 7 and 8 indicate the reduction percentages of *C. carnea* and *Coccinella spp* caused by sulfoxaflor, flupyradifurone, clothianidin, thiamethoxam, and acetamiprid treatments. For *C. carnea* were 22.00, 29.95, 52.90, 46.90 and 43.08%, respectively at 2017 and 27.88, 27.15, 46.48, 40.96 and 36.88%, respectively at 2018. While reduction percentages of *Coccinella spp* caused by sulfoxaflor, flupyradifurone, clothianidin, thiamethoxam, and acetamiprid were 14.75, 14.38, 23.40, 20.60 and 21.35%, respectively at 2017 and 12.00, 15.78, 24.35, 22.73 and 19.48%, respectively at 2018. Concerning data, all treatments have moderate toxic effect on natural enemies except sulfoxaflor and flupyradifurone had slightly toxic effect.

Table 3. Efficacy of certain treatments against *Aphis gossypii* on cucumber plants at 2017 season

Tested compounds	Rate / feddan	%Reduction After				
		1-day	4-days	7-days	10-days	Mean
Sulfoxaflor	40 ml	91.4	95.1	100.0	97.5	96.00ab
Flupyradifurone	240 ml	95.1	98.2	100.0	100.0	98.33a
Clothianidin	1000ml	87.1	95.3	100.0	99.8	95.55ab
Thiamethoxam	60 g	82.4	90.2	93.1	90.8	89.13b
Acetamiprid	50 g	72.8	64.1	66.7	54.2	64.45c

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

Table 4. Efficacy of certain treatments against *Aphis gossypii* on cucumber plants at 2018 season

Tested compounds	Rate / feddan	%Reduction After				
		1-day	4-days	7-days	10-days	Mean
Sulfoxaflor	40 ml	89.5	96.5	95.3	94.9	94.05a
Flupyradifurone	240 ml	88.4	98.4	100.0	100.0	96.70a
Clothianidin	1000ml	82.4	95.4	100.0	92.8	92.65a
Thiamethoxam	60 g	78.3	88.5	81.4	86.0	83.55b
Acetamiprid	50 g	66.2	79.4	79.6	69.2	73.60c

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

Table 5. Efficacy of certain treatments against *Chrysoperla carnea* on cucumber plants at 2017 season

Tested compounds	Rate / feddan	%Reduction After				
		1-day	4-days	7-days	10-days	Mean
Sulfoxaflor	40 ml	22.1	26.3	20.3	19.3	22.00d
Flupyradifurone	240 ml	26.4	33.3	33.3	26.8	29.95c
Clothianidin	1000ml	52.3	71.6	45.6	42.1	52.90a
Thiamethoxam	60 g	45.9	55.3	45.5	40.9	46.90ab
Acetamiprid	50 g	42.1	46.3	44.8	39.1	43.08b

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

Table 6. Efficacy of certain treatments against *Chrysoperla carnea* on cucumber plants at 2018 season

Tested compounds	Rate / feddan	%Reduction After				
		1-day	4-days	7-days	10-days	Mean
Sulfoxaflor	40 ml	26.2	31.5	29.5	24.3	27.88c
Flupyradifurone	240 ml	33.3	26.5	26.5	22.3	27.15c
Clothianidin	1000ml	55.2	47.9	44.4	38.4	46.48a
Thiamethoxam	60 g	36.5	53.2	47.1	27.1	40.96ab
Acetamiprid	50 g	35.2	44.3	38.4	29.6	36.88b

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

Table 7. Efficacy of certain treatments against *Coccinella spp* on cucumber plants at 2017 season

Tested compounds	Rate / feddan	%Reduction After				
		1-day	4-days	7-days	10-days	Mean
Sulfoxaflor	40 ml	12.8	15.0	16.1	15.1	14.75b
Flupyradifurone	240 ml	13.5	15.0	17.1	11.9	14.38b
Clothianidin	1000ml	27.3	25.2	26.1	15.0	23.40a
Thiamethoxam	60 g	19.8	27.3	16.7	18.6	20.60a
Acetamiprid	50 g	18.3	25.4	25.0	16.7	21.35a

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

Table 8. Efficacy of certain treatments against *Coccinella spp* on cucumber plants at 2018 season

Tested compounds	Rate / feddan	%Reduction After				
		1-day	4-days	7-days	10-days	Mean
Sulfoxaflor	40 ml	11.3	13.8	12.5	10.4	12.00c
Flupyradifurone	240 ml	14.1	16.5	17.3	15.2	15.78bc
Clothianidin	1000ml	20.0	27.4	33.2	16.8	24.35a
Thiamethoxam	60 g	16.5	22.2	27.1	25.1	22.73a
Acetamiprid	50 g	20.2	22.2	16.0	19.5	19.48ab

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

Our results were comparable with Sparks *et al.*, 2013; Wanumen *et al*., 2016 and Nawaz *et al*., 2018, who reported that, sulfoxaflor is slightly harmful to biological control agents, including, *C. carnea* (Neuroptera: Chrysopidae), and *C. bipunctata* (Coleoptera: Coccinellidae). Flupyradifurone has an excellent profile concerning human- and environmental safety (Smith and Giurcanu 2013; Haas *et al.* 2014 and Jeschke *et al.* 2015).

It can be concluded that, sulfoxaflor and flupyradifurone are the preferred insecticides with less toxicity to the natural enemies and can be used to control sucking insects in IPM programs.

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الملخص العربي

الكفاءة الحقلية لبعض المبيدات الحديثة ضد بعض الحشرات الثاقبة الماصة على الخيار.

أحمد عبد الحكيم برانيه – مبروك عبد المنعم البسومى – عاطف طه المصري

أجرى هذا البحث لتقدير الكفاءة الحقلية لمبيدين جديدين هما السلفوكسافلور و الفلوبيراديفورون بالمقارنة بثلاثة مبيدات من مشابهات النيكوتين وهي كلوثيانيدين، ثياميثوكسام وأسيتامبريد وذلك رشا بالجرعات الحقلية ضد حشرتى الذبابة البيضاء والمن وبعض أعدائهما الحيوية على نبات الخيار خلال موسمي ٢٠١٧ و٢٠١٨ الصيفيين بمنطقة النوبارية بمحافظة البحيرة. أوضحت الدراسة أن مبيدى السلفوكسافلور و الفلوبيراديفورون أكثر كفاءة من كل المبيدات المستخدمة ضد حشرتى الذبابة البيضاء والمن، كما أوضحت النتائج ان مبيد أسيتامبريد كان اقلهم إبادة وذلك خلال كلا الموسمين. وتحت نفس الظروف أوضحت الدراسة أن مبيدات كلوثيانيدين، ثياميثوكسام وأسيتامبريد من مشابهات النيكوتين ذات تأثير سام ضد حشرتى اسد المن وأبو العيد في حين أن مبيدات السلفوكسافلور، الفلوبيراديفورون كان تأثيرهما الضار قليل للغاية على الأعداء الحيوية مما يوصى باستخدامهما لمكافحة الحشرات الثاقبة الماصة على نبات الخيار في إطار برامج المكافحة المتكاملة.