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Comparative of different formulations for some compounds (Neonicotinoids) against the aphid *Aphis gossypii* (Hemiptera: Aphididae) on zucchini and cucumber plants

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Abstract:

The aphid *Aphis gossypii* Glover (Hemiptera: Aphididae) is a polyphagous aphid found on more than 900 plant species. It is distributed throughout the world but prefers the warmer regions. It has been a pest in different locations in Egypt, particularly affecting vegetables. The present work was conducted in two field experiments in Etay-El-Baroud, Agricultural Research Station, Beheira Governorate, during 2019 and 2020 seasons to evaluate the efficiency of some different formulations of neonicotinoid insecticides against the aphid *A.gossypii* on zucchini and cucumber plants. The results showed that a decrease in the number of aphids in all treatments, insecticides that caused a significant decrease compared to the control. General mean of % reduction aphid number were 91.75, 90.79 and 88.10%, for imidacloprid, acetamiprid and thiamethoxam, respectively, at 2019, while were 91.94, 90.65 and 88.97%, respectively, at 2020 season on zucchini fields. On cucumber field general mean of % reduction was 91.94, 90.65 and 88.97%, for imidacloprid, acetamiprid and thiamethoxam, respectively, at 2019, while were 91.03, 92.71 and 92.36%, respectively, at 2020 season. The results confirmed the presence of small significant differences between the formulations of imidacloprid, acetamiprid and thiamethoxam, and while all formulations indicated a significant decrease in the number of aphids in zucchini and cucumber plants compared to control during the two seasons.

Introduction

The Cucurbitaceae family possesses economically important species including cucumber, melon, watermelon, calabash, squash, and pumpkin. Many hundreds of varieties and cultivars of these are grown around the world and are major agricultural commodities. The most important are used as food and industrial crops (El-Adawy and Taha, 2001; Acquaah, 2005 and Practices and Leffingwell, 2015). Zucchini (*Cucurbita pepo* L.) is one of the most popular vegetable crops for human nutrition, not only in Egypt. It is cultivated in Egypt all over the year, outdoor in summer and indoor either in green houses or in tunnels in winter (Seleim *et al.*, 2015). It is good source of minerals like iron, manganese, phosphorus, zinc and potassium in addition to its content of antioxidant vitamin-C and A (Abd El-Wareth and Ahmed, 2017). Cucumber one of the most important crops in Egypt and worldwide and during its growth stages is threatened by several pests including aphids which lead to deleterious effects growth, yield (Shams El Din *et al*., 2012).

Aphis gossypii Glover (Hemiptera: Aphididae), is a major pest of Cucurbitaceae production, often causing leaf yellowing, curling, plant wilting and stunting. The danger of aphids is not only the direct damage through sucking the sap from the leaves and stems, but also the indirect damage caused either by viruses transmission or by exuding honeydew which induce sooty mold growth on the greenish part of the plants (Abdu-Allah and Hashem, 2017).This damage causes a high loss of yield, so controlling aphids in crops is very important. Insecticides are one of the most effective traditional tools that have been usually applied by farmers to control aphids. Although, there are many advantages of these insecticides in controlling aphids (Casida and Durkin, 2013 and Xiaohua *et al.*, 2020).

Pest control with insecticides is widely used in the world to avoid pest damage to crops (Schiess *et al*., 2017). In recent years, selective insecticides, like neonicotinoids because insect pests became resistant to the most of conventional insecticides. Neonicotinoids represent the fastest-growing class of insecticides introduced to the market since the launch of pyrethroids (Nauen and Bretschneider, 2002). Because of their physicochemical properties, neonicotinoid can be useful for a wide range of application techniques, including foliar, seed treatment, soil drench and stem application. Neonicotinoids, a new class of insecticides, act preferably on insect nicotinic acetylcholine receptors (nAChRs) as their agonists (Elbert *et al*., 1998 and Viera *et al.*, 2019). These selective insecticides are environmentally friendly (Yeh *et al*., 1997), and have quick knock down effect on target pest by interfering with transmission of impulse in the nerve system. Neonicotinoid application reduces infection rate and spread of many crop viruses (Westwood *et al*., 1998; Bethke *et al*., 2001 and Elzen, 2001). Neonicotinoid insecticides represent the fastest-growing class of insecticides introduced to the market since the launch of pyrethroids (Nauen and Bretschneider, 2002). Because of their physicochemical properties, neonicotinoid can be useful for a wide range of application techniques, including foliar, seed treatment, soil drench and stem application.

In the short term, the intensive and careless use of insecticides has produced biological imbalance and increased environmental contamination (Schiess *et al*., 2017). The purpose of formulating pesticide active ingredients for crop protection is to uniformly spread a small amount of an active chemical over a large area and ensure safety in during application and to optimize pesticide efficacy (Hazra and Purkait, 2019). Pesticides are available in various formulations may be created according to the standard of the product for any of the purposes such as to achieve effects that cannot be obtained from its components when these are used singly, achieve a higher degree of effectiveness, facilitate any potential synergistic action of their components, and improve handling properties and often safety for the user. Consequently, the competently designed formulations for particular applications are safer, more effective and more economical than any of their components used singly (Sarwar, 2015).

Therefore, two field experiments were carried out in Etay-El-Baroud, Agricultural Research Station, Beheira Governorate, during 2019 and 2020 seasons to evaluate the efficiency of some different formulations of neonicotinoid insecticides against the aphid *A. gossypii* on zucchini and cucumber plants in field.

Materials and methods

1. Used Insecticides:

Imidacloprid (ImiDOR 35%SC), (JOUN 70%WG) and (Canopus 70%WG).

Acetamiprid (CETAM 20%EC), (Kera 20%WP) and (Mospilan 20%SP).

Thiamethoxam (Actara 25%WG), (Lex-Extra 25%WDG) and (Golden Horse 25%WDG).

2. The field trials:

The field trials were carried out in zucchini and cucumber plants in field at Etay-El-Baroud Agricultural Research station, Beheira Governorate, during 2019 and 2020 summer seasons. Experimental site was divided into 20×4 plots, each plot 1/100 feddan (42m²). Randomized complete blocks design was used with four replicates for each treatment with the control plots. Every plot was separated from the other plot by one meter to reduce interference from another treatment drift. Motor sprayer with used to spray the tested pesticides with the recommended dose. For counting the numbers of aphid, *A. gossypii*, samples of 25 leaves were collected at random in the morning for both diagonals of the inner square area of each experimental plot. Reduction percentages of numbers were calculated according to Henderson and Tilton equation (1955) and subjected to analysis of variance (ANOVA) (CoStat Statistical Software, 1998).

Results and discussion

Results presented in Tables (1 and 2) showed that the reduction percentages of aphids on zucchini plants after one, seven and ten days of treatment by some neonicotinoid formulations of imidacloprid (ImiDOR 35% SC, JOUN 70%WG and Canopus 70%WG), acetamiprid (CETAM 20% EC, Kera 20%WP and Mospilan 20% SP) and thiamethoxam (Actara 25%WG and Lex-Extra 25% WDG) during 2019 and 2020 seasons. General mean of % reduction was 92.09, 90.73 and 87.79 %, for imidacloprid, acetamiprid and thiamethoxam, respectively, at 2019, while were 91.81, 90.67 and 88.97%, respectively, at 2020 season. The results showed a decrease in the number of aphids in all treatments, insecticides that caused a significant decrease compared to the control.

Table (1): Reduction percentages of the aphid *Aphis gossypii* on zucchini plants treated with different formulations of neonicotinoids at season 2019.

Common Name	Formulations	Rate/200L/ feddan	% Reduction after treatment (day)				General mean
			1	7	10	Mean	
Imidacloprid	ImiDOR 35% SC	40ml	90.10	93.10	93.80	92.33a	92.09 a
	JOUN 70%WG	60gm	90.10	93.20	94.00	92.43a	
	Canopus70%WG	35gm	89.20	92.30	93.00	91.50a	
Acetamiprid	CETAM 20%EC	100ml	88.80	92.30	92.70	91.26a	90.73 ab
	Kera 20%WP	50gm	89.20	91.60	92.00	90.93a	
	Mospilan 20%SP	50gm	89.70	90.30	90,60	90.00a	
Thiamethoxam	Actara 25%WG	60gm	88.80	92.20	92.50	91.16a	87.79 b
	Lex-Extra 25%WDG	40gm	87.20	88.30	88.70	88.06ab	
	GoldenHorse 25%WDG	80gm	73.90	84.40	94.10	84.13b	
LSD 0.05						5.07	3.93

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 the aphid *Aphis gossypii* on zucchini plants treated with different formulations of neonicotinoids at season 2020.

Common Name	Formulations	Rate/200L /feddan	% Reduction after treatment (day)				General mean
			1	7	10	Mean	
Imidacloprid	ImiDOR 35% SC	40ml	89.90	91.90	92.10	91.30a	91.81a
	JOUN 70%WG	60gm	90.20	93.30	93.30	92.27a	
	Canopus70%WG	35gm	89.80	92.90	92.90	91.87a	
Acetamiprid	CETAM 20%EC	100ml	89.10	92.20	93.10	91.47a	90.67a
	Kera 20%WP	50gm	89.30	91.20	91.90	90.80ab	
	Mospilan 20%SP	50gm	88.00	90.80	90,40	89.73abc	
Thiamethoxam	Actara 25%WG	60gm	91.16	91.80	92.50	91.82a	88.97a
	Lex-Extra 25%WDG	40gm	83.40	84.10	93.10	86.87c	
	GoldenHorse 25%WDG	80gm	87.90	88.50	88.30	88.23bc	
LSD 0.05						2.91	3.61

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

Results presented in Tables (3 and 4) showed the reduction percentages of aphids on cucumber plants after one, seven and ten days of treatment by some neonicotinoid formulations of imidacloprid (ImiDOR 35% SC, JOUN 70%WG and Canopus 70%WG), acetamiprid (CETAM 20% EC, Kera 20%WP and Mospilan 20% SP) and thiamethoxam (Actara 25%WG and Lex-Extra 25% WDG) during 2019 and 2020 seasons. General mean of % reduction was 92.21, 92.73 and 92.40%, for imidacloprid, acetamiprid and thiamethoxam, respectively, at 2019, while were 91.93, 92.46 and 92.13%, respectively, at 2020 season.

Table (3): Reduction percentages of the aphid *Aphis gossypii* on cucumber plants treated with different formulations of neonicotinoids at season 2019.

Common Name	Formulations	Rate/200L /feddan	% Reduction after treatment (day)				General mean
			1	7	10	Mean	
Imidacloprid	ImiDOR 35% SC	40ml	91.90	92.10	92.40	92.13c	92.21a
	JOUN 70%WG	60gm	90.70	92.80	93.20	92.63bc	
	Canopus70%WG	35gm	91.20	92.00	92.40	91.87c	
Acetamiprid	CETAM 20%EC	100ml	92.00	92.00	92.80	92.26bc	92.73a
	Kera 20%WP	50gm	92.70	92.80	93.20	92.90ab	
	Mospilan 20%SP	50gm	92.10	93.40	93.60	93.03a	
Thiamethoxam	Actara 25%WG	60gm	92.60	92.60	93.30	92.83ab	92.40a
	Lex-Extra 25%WDG	40gm	92.00	92.50	92.90	92.47abc	
	GoldenHorse 25%WDG	80gm	91.20	92.10	92.40	91.90c	
LSD 0.05						0.68	1.03

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 the aphid *Aphis gossypii* on cucumber plants treated with different formulations of neonicotinoids at season 2020.

Common Name	Formulations	Rate/200L /feddan	% Reduction after treatment (day)				General mean
			1	7	10	Mean	
Imidacloprid	ImiDOR 35% SC	40ml	92.00	92.60	93.40	92.67a	91.93a
	JOUN 70%WG	60gm	90.70	92.00	92.40	91.70bc	
	Canopus70%WG	35gm	90.80	91.70	91.80	91.43c	
Acetamiprid	CETAM 20%EC	100ml	91.80	92.90	93.50	92.73a	92.46a
	Kera 20%WP	50gm	91.90	92.40	92.80	92.37a	
	Mospilan 20%SP	50gm	91.70	92.50	92.70	92.30ab	
Thiamethoxam	Actara 25%WG	60gm	92.40	92.30	93.20	92.63a	92.13a
	Lex-Extra 25%WDG	40gm	91.90	92.20	93.00	92.36a	
	GoldenHorse 25%WDG	80gm	90.20	91.10	92.90	91.40c	
LSD 0.05						0.63	0.70

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

In family Cucurbitaceae fields, pests with sucking mouthparts, especially *A. gossypii* have been the main cause of plant damage, seriously influencing zucchini production (Messing and Klungness, 2002). As major pests all over the world, aphids not only cause direct damage by feeding, but also lead to infection by acting as viral vectors (Brault *et al*., 2007). The morphological characteristics of plants could clearly influence the feeding and spawning behaviors of insects (Buchman and Cuddington, 2009 and Legrand and Barbosa, 2014). It has important effects on the landing and attachment of aphids, and predation of natural enemies (Dorry and Assad, 2001 and Larson and Whitham, 1997). Leaf hairs and thorns have been important anti-aphid characteristics of plants, thereby making them fly away because of lack of food (Harris and Bradley, 1973). Chemical pesticides have been long widely used as an effective approach for preventing aphid infestation (Ayala *et al*., 1996). However, the accumulation of pesticide residue due to overuse of chemical pesticide has become a major issue (Wu, 2005). The present results are agreement with those obtained by Chen *et al*., 2007; Subhash *et al*., 2017 ; Roditakis *et al*., 2017 and Wang *et al*., 2017. They found that, neonicotinoids were very toxic to sucking pests compared by conventional insecticides. Sarwar (2015) reported that, an insecticide formulation can be principally a wettable powder (WP), soluble powder (SP), water-dispersible granules (WDG), water soluble (WS) or emulsifiable concentrate (EC). These formulations are relatively easy to handle, transport, store, little agitation is required, do not settle out or separate when equipment is running, non-abrasive, cannot plug screens or nozzles, and leaves little visible residue on treated surfaces. Consequently, the competently designed formulations for applications are safer, more effective and more economical than any of their components used singly. Preftakes *et al*. (2019) suggested that spray drift was reduced by 37% when comparing the SC to the WP formulation. These findings can be used to develop a classification scheme for formulated products and tank additives based on their potential for reducing spray drift.

The results confirmed the presence of small significant differences between the formulations of imidacloprid, acetamiprid and thiamethoxam, and while all formulations indicated a significant decrease in the number of aphids in zucchini and cucumber plants compared to control during the two seasons.

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