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Toxicity Assessment of Certain Insecticides Against the Onion Thrips, *Thrips Tabaci* Lindeman (Thysanoptera: Thripidae) on Onion Crop Under Field Conditions

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Abstract

Onion is one of the most significant vegetable plants that cultivated on large areas in Egypt. The onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) is the most destructive insect pest causes significant damage to seed heads and reduce onion seed crop production about 50% annually. The combinationof Thiamethoxam + Abamectin has been recommended to control *T. tabaci* in Egypt. Herein, we evaluated the toxicity of eight selected insecticides [Abamectin (1.8% EC), Lufenuron (5% EC), Thiamethoxam (18.6% SC), and Thiamethoxam + Abamectin (18.6 EC+1.8% EC), Lambda-cyhalothrin+ Abamectin (5% EC+1.8% EC), Carbosulfan (20% SP), Lambda-cyhalothrin (5% EC) and *Bacillus thuringiensis kurstaki* (4.6% EC) against *T. tabaci* under field conditions. The results were recorded after 1, 2, 3, 7 and 14 days. Among all tested insecticides, the combination of Thiamethoxam + Abamectin was more potent to *T. tabaci* than separate application of Thiamethoxam or Abamectin solely, While, Lufenuron and *Bacillus thuringiensis kurstaki* were the least toxic insecticides. These insecticides *mixtures* gave promising results in controlling the onion thrips, *T. tabaci*.

Keywords: *Thrips tabaci*, Onion, Toxicity, Insecticides, Seed crops

Introduction

Onion account as one of the significant commercial vegetable plants cultivated in Egypt plus, it is the most significant export crops to European and other countries **(FAO, 2014)**. Egypt's productivity of onions is close to 3 million tons and ranked one of the top ten productive countries in the world **(FAO, 2014)**. The exports amounts of Egyptian onions at the end of 2019, reached to 550,000 tons, compared to 310,000 tons in 2018 (**FAO, 2014**).

Onion crops are vulnerable to attack with many insect pest species, causing serious losses and decrease of yield **(Awadalla, et al., 2011; Gill, et al., 2015; Grode et al., 2017 and Uddin et al., 2019).** Importantly, the major pest of onion in Egypt is *Thrips tabaci* Lindeman, 1889 (Thysanoptera: Thripidae) **(Schmutterer, 1990)**. The adult and nymphal stages feed on leaves and leaf buds by piercing the plant surface with their mouthparts and sucking the contents of plant cells, causing a silvering of the lower leaf surface and deformed or blackened leaves **(Boateng *et al.*, 2014; Gent *et al.*, 2004; Rueda *et al.*, 2007 and Birithia *et al.*, 2014).** In this regard, the onion thrips can also transmit numerous plant pathogens that reduce the size and quality of onions, such as the iris yellow spot virus (IYSV) and tomato spotted wilt virus (TSWV) **(Gent *et al.*, 2004 and Jones, 2005).** Reproduction of thrips either it is parthenogenesis or sexual, female lays 4-5 eggs per day individually inside the leaf tissues in the lower surface and hatches to larvae within 3-5 days, then they hatch in the soil and within 4-5 days they turn into whole insects **(Kobayashi and Hasegawa, 2012).**

The damage caused to seed heads presented reduction of onion seed crops about 50% in years **(Bailey, 1938 and Willcox et al., 1949)**. In this regard, the use of insecticides is significant to control *T. tabaci* **(Nault and Shelton, 2010; Bhargava, 2010; Reitz, 2014; Khaliq et al., 2014 and Gill et al., 2015).** The individuals of *T. tabaci* exposed to lambda–cyhalothrin or thiamethoxam showed greater rates of mortality than those exposed to malathion compound **Elalfy *et al.*, (2019)**. Furthermore the toxicity of some mixtured insecticides against thrips, *Frankliniella occidentalis* were highly effective in controlling *F. occidentalis* **Warnock and Cloyd (2005)**.

The aim of the study was to estimate the toxicity of eight insecticides [Abamectin (1.8% EC), Lufenuron (5% EC), Thiamethoxam (18.6% SC), and Thiamethoxam + Abamectin (18.6 EC+1.8% EC), Lambda-cyhalothrin + Abamectin (5% EC+1.8% EC), Carbosulfan (20% SP), Lambda-cyhalothrin (5% EC) and Diple (4.6% EC) against onion thrips under farm conditions.

Materials and Methods

The Experimental Design

The toxicity of certain insecticides against *Thrips tabaci* adult and nymph stages was evaluated under field conditions in Assiut, Egypt in the Wasta village during 2021. Insecticide concentrations were dissolved in distilled water upon use. The trial area was divided into plots; each was 3 ×2 meters. The experiment was performed in a randomized complete block design (RCBD) with six treatments including control. Each treatment was replicated thrice.

Insecticides/ Pesticides

The formulations of Abamectin (1.8% EC), Lufenuron (5% EC), Thiamethoxam (18.6% SC), and Thiamethoxam + Abamectin (18.6 EC+1.8% EC), Lambda-cyhalothrin+ Abamectin (5% EC+1.8% EC), Carbosulfan (20% SP), Lambda-cyhalothrin (5% EC) and Diple (4.6% EC) were evaluated against *Thrips tabaci*. These insecticides were gained from the Central Laboratory of Pesticides in Cairo, Egypt (**Table 1**).

Efficiency of Tested Insecticides

Data of treatments were recorded after 1, 2, 3, 7, 14, and 21 days. The insecticides were sprayed by 20-liter knapsack sprayers. Five plants were randomly selected from each replicate before and after spraying at periods of 1, 2, 3, 7, 14 and 21 days of treatment in order to examine the toxicity and the residual activity of these insecticides on thrips population. The reduction percentages were calculated according to the Henderson-Tilton's formula (Henderson and Tilton, 1955). Reduction % = 1– (r in C before treatment × n in T after treatment/ r in C after treatment × n in T before treatment) × 100, Where: r = pest numbers, T = treated, C = control

Statistical Analysis: Statistical Analysis: Data Were Analyzed Using One-way ANOVA and Presented as Mean ± S.E.M (Standard Error of Mean). Analysis Was Performed Using SPSS (Version 16.0).

Results and Discussion

The reduction percentages **(Tables 2, 3 and Fig.1)** of the eight selected insecticides showed that the reduction percentages of Abamectin (1.8% EC), Lufenuron (5% EC), Thiamethoxam (18.6% SC), and the mixtures of: Thiamethoxam + Abamectin (18.6 EC+1.8% EC), Lambda-cyhalothrin+ Abamectin (5% EC+1.8% EC), Carbosulfan (20% SP), Lambda-cyhalothrin (5% EC) and Diple (4.6% EC) after one day of treatment were 86.48, 78.70, 95.76, 94.31, 89.78, 98.76, 94.44 and 39.43%, respectively. While, after 3 days of treatment these numbers were: 84.41, 71.21, 94.49, 92.90, 87.23, 97.85, 93.06 and 35.38%, respectively. Furthermore, after 7 day of treatment were 80.53, 62.33, 93.38, 89.28, 81.65, 96.99, 92.02 and 28.19%, respectively.

However, the reduction percentages were 77.79, 49.20, 89.25, 79.92, 79.02, 94.82, 86.77and 25.38%, and 66.69, 44.28, 88.07, 78.64, 77.97, 91.08, 83.92and 20.53%, after 14 and 21 days, respectively.

The results indicate that the combination between Thiamethoxam + Abamectin was more toxic on *T. tabaci* than Thiamethoxam or Abamectin alone among all the pesticides tested, While, Lufenuron and Diple were the least toxic. Further, Some studies conducted in the control against thrips showed encouraging results, which were consistent with our current study **Elalfy *et al.*, (2019)** found that, the onion thrips exposed to lambda–cyhalothrin or thiamethoxam had greater rates of mortality than those exposed to malathion compound. Furthermore, **Warnock and Cloyd (2005)** investigated the toxicity of some insecticides mixtures against thrips, *Frankliniella occidentalis*. Results indicated that pesticide mixtures were effective in controlling *F. occidentalis*. In another study, In another study, found that Thiamethoxam and Imidacloprid were very effective for controlling *Thrips tabaci* by **Greenberg et al. (2009)**. **Nault and Shelton (2010)** tested the efficacy of pesticides for controlling Thrips tabaci.They found that, spinetoram was more toxic than lambda-cyhalothrin, methomyl hydrochloride. lambda-cyhalothrin was found to be more toxic against larvae of T. tabaci. While, **Broughton and Herron (2009)** tested the acetamiprid, and thiamethoxam against thrips, *F. occidentalis*. The results showed all tested insecticides were considered the most effective for controlling thrips.

Conclusions

The selected insecticides that have been evaluated in this study demonstrated effectiveness on *T. tabaci*. Interestingly, the combination of thiamethoxam + abamectin was more toxic to T. tabaci than either thiamethoxam or abamectin alone among all the pesticides tested, whereas, lufenuron and Bacillus thuringiensis kurstaki were the least toxic insecticide. However, these insecticides revealed promising tools in integrated pest management (IPM) to control *T. tabaci* in Egypt.

Conflicts of Interest/ Competing Interest

The authors declare that they have no competing interests.

Abbreviations

IPM	Integrated pest management
IYSV	Iris yellow spot virus
RCBD	Randomized complete block design
TSWV	Tomato spotted wilt virus

Table (1): Insecticides used in the field trials.

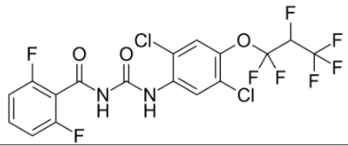
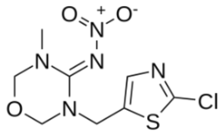
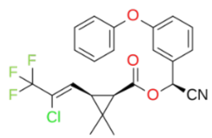
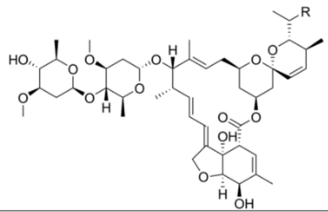
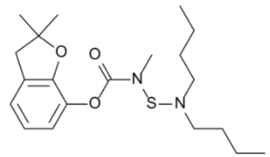
Common name	Group	(a. i.) % and formulation	Chemical Name	Chemical structure
Lufenuron	Benzoylurea	5% EC	1-[2,5-Dichloro-4-(1,1,2,3,3,3-hexafluoropropoxy)phenyl]-3-(2,6-difluorobenzoyl)urea	
Thiamthoxam	Neonicotinoids	18.6% SC	3-[(2-Chloro-1,3-thiazol-5-yl)methyl]-5-methyl-N-nitro-1,3,5–oxadiazinan-4-imine	
Lambda-cyhalothrin	pyrethroids	5% EC	(R)-cyano-(3-phenoxyphenyl)methyl] (1S,3S)-3-[(Z)-2-chloro-3,3,3-trifluoroprop-1-enyl]-2,2-dimethylcyclopropane-1-carboxylate	
Abamectin	Avermectin	1.8% EC	5-O-demethylavermectin B1a(i) mixture with 5-O-demethyl-25-de (1-methylpropyl) -25–(1 methylethyl) avermactin B1a(ii)	
Carbosulfan	carbonate	20% EC	2,2-Dimethyl-2,3-dihydro-1-benzofuran-7-yl [(dibutylamino)sulfanyl]methylcarbamate	

Table (2): Effect of eight selected insecticides against *T. tabaci* on onion crop during 2021.

Insecticides	Number of Thrips individuals/ 5 Plants					
	Before treatment	After treatment (days)				
		1	3	7	14	21
Control	47.33 CDE ±6.76	57.66 A±4.91	66.66 A±2.33	71.33 A±1.85	78.00 A±2.64	104.00 A±4.58
Abamectin	54.66 BCDE ±4.97	9.00 D± 0.57	12.00 D±1.15	16.00 E±0.00	20.00 CD±2.88	40.00 D±0.00
Lufenuron	61.66 BCD ±8.41	16.00 C±0.00	25.00 C±0.00	35.00 C±0.00	50.00 B±0.00	60.00 C±0.00
Thiamethoxam	90.33 A±7.96	4.66 DE±0.66	7.00 E±0.00	9.00 F±1.15	16.00 D±0.57	23.66 E±1.58
Carbosulfan	43.33 DE±3.84	3.00 DE±0.00	4.33 EF±1.33	7.00 FG±0.57	14.33 DE±1.76	20.33 EF±1.20
Lambada	72.33 AB±11.09	3.00 DE±0.57	13.00 D±0.57	20.00 D±1.15	25.00 C±2.30	35.00 D±3.21
Thiamethoxam + Abamectin	66.33 BC±4.09	0.00 E±0.00	2.00 F±0.57	3.00 H±0.00	5.66 F±1.20	13.00 G±1.15
Lambada + Abamectin	44.33 DE±5.45	3.00 DE±0.57	4.33 EF±0.33	5.33 GH±0.88	9.66 EF±1.76	15.66 FG±2.33
Bacillus thuringiensis kurstaki	40.66 E±0.88	30.00 B±3.21	37.00 B±1.15	44.00 B±2.08	50.00 B±2.08	70.66 B±1.20
Sig.F-test	**	**	**	**	**	**

±SE (Std. Error)

Table (3): The reduction percentages of eight selected insecticides against *T. tabaci* on onion crop during 2021.

Insecticides	Reduction percentages after				
	1 days	3 days	7 days	14 days	21 days
Abamectin	86.48	84.41	80.53	77.79	66.69
Lufenuron	78.70	71.21	62.33	49.20	44.28
Thiamethoxam	95.76	94.49	93.38	89.25	88.07
Carbosulfan	94.31	92.90	89.28	79.92	78.64
Lambada	89.78	87.23	81.65	79.02	77.97
Thiamethoxam + Abamectin	98.76	97.85	96.99	94.82	91.08
Lambada + Abamectin	94.44	93.06	92.02	86.77	83.92
Bacillus thuringiensis kurstaki	39.43	35.38	28.19	25.38	20.53

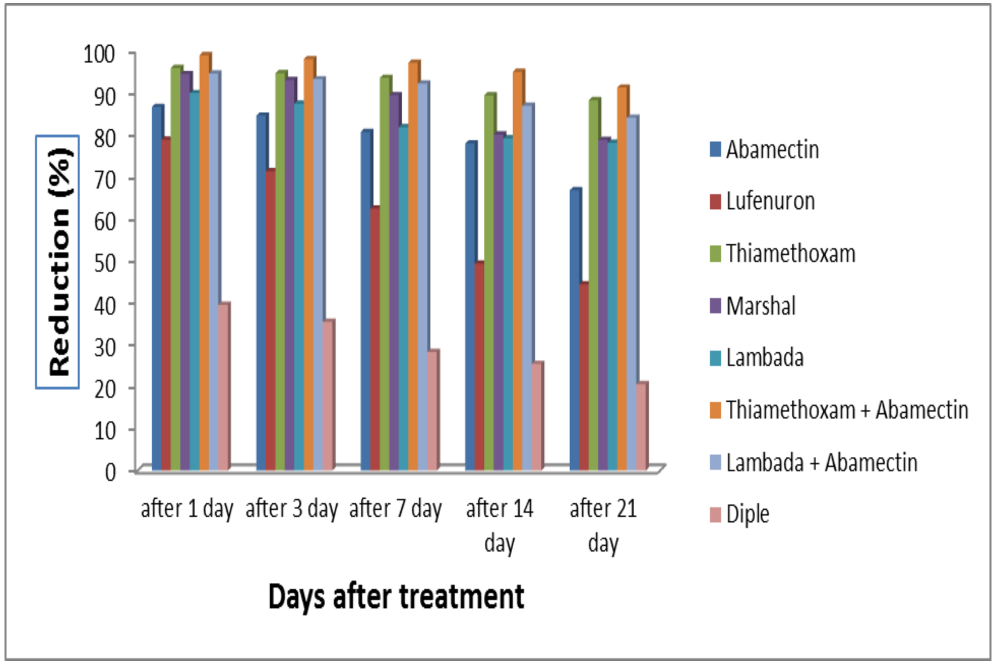


Figure (1): The reduction percentages of eight selected insecticides against *T. tabaci* after 1, 3, 7, 14 and 21 days of treatment on onion crop during 2021.

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