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Short paper

Susceptibility of western flower thrips *Frankliniella occidentalis* (Thysanoptera: Thripidae) to some synthetic and botanical insecticides under laboratory conditions

Zahra Gholami[1], Amin Sadeghi[1*], Aziz Sheikhi Garjan[2], Javad Nazemi Rafi[1] and Fatemeh Gholami[3]

1. Department of Plant Protection, Faculty of Agriculture, University of Kurdistan, Sanandaj, Iran.
2. Department of Agricultural Entomology Research, Iranian Research Institute of Plant Protection, Tehran, Iran.
3. Department of Plant Protection, Faculty of Agriculture, University of Mohaghegh Ardabili, Ardabil, Iran.

Abstract: This study was conducted to investigate commercial formulations of insecticides against western flower thrips, *Frankliniella occidentalis* (Pergande).The insects were collected from commercial greenhouses of cucumber in Varamin, Iran. The tested insecticides were diazinon (EC 60%), cypermethrin (EC 40%), fipronil (EC 2.5%), imidacloprid (SC 35%) and a botanical insecticide oxymatrine (Kingbo, AS 0.6%). Fipronil had the highest efficacy among all tested insecticides (LC_{50} = 17.97 ppm). However, imidacloprid had the lowest efficacy (LC_{50} = 2303 ppm). The oxymatrine was effective (LC_{50} = 69.94 ppm) after fipronil.

Keywords: bioassay, insecticides, *Frankliniella occidentalis*, fipronil, oxymatrine

Introduction

Western flower thrips (WFT), *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), is a major pest of horticultural crops all over the world (Bielza, 2008).It is a common pest in many countries of America, Europe, Africa and Asia (Kirk and Terry, 2003). Chemical control is the main strategy applied in order to control WFT. However, it is difficult to achieve because of several factors among which short generation time, high fecundity, thigmokinetic behavior, haplodiploid breeding system and development of insecticide resistance can be mentioned (Chung *et al.,* 2000; Jensen, 2000). As a result, insecticide resistance has been reported for several insecticides including: organochlorines, organophosphates, carbamates, pyrethroids and spinosyns (Immaraju *et al.,* 1992; Bielza, 2008). Frequent application of a narrow range of insecticides, along with a high level of selection pressure seem to have caused the emergence of this resistance (Immaraju *et al.,* 1992; Zhao *et al.,* 1994). Considering the high price of developing new insecticides, it is necessary to maintain current insecticides by implementing resistance management strategies and presenting effective insecticides (Bielza, 2008). Several studies have been done on the efficacy of insecticides to control western flower thrips. The assessment of WFT susceptibility to formetanate, methamidophos, dimethoate and spinosad indicated that WFT have the highest susceptibility to spinosad (Vargas and Ubillo, 2005). Moreover, the efficiency of abamectin, endosulfan and spinosad were examined on all life stages of thrips. It was finally found that increasing the rate of abamectin and endosulfan improved the control of adults and larvae, whereas increasing the rate of endosulfan only caused more larvae mortality rate (Broughton and

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[*] **Corresponding author**, e-mail: a.sadeghi@uok.ac.ir
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Herron, 2007). In the same vein, Broughton and Herron (2009) investigated the efficacy of acetamiprid, thiamethoxam, chlorfenapyr and spinosad on thrips. They argued that all products can control *F. occidentalis*; therefore, they can potentially control WFT. Another study by Kay and Herron (2010) suggested that fipronil and methamidophos are effective on nymph and adult stages, even 6 days after spraying process related to fipronil. An experiment has demonstrated that cypermethrin-resistance has increased by 28-and 139.3-fold at LC_{50} level on WFT population. In addition, cross-resistance has been discovered with endosulfan, malathion and methomyl (Dagh and Tunc, 2008).

Western flower thrips has been reported from Iran in 2004 (Jalili Moghadam and Azmayesh Fard, 2004). In fact, WFT is a new pest in Iran and hence, there is little information about any chemical control against it. Therefore, conducting more research related to effective insecticides for chemical control of WFT is highly desired. The aim of this study is to provide some information about effective insecticides. Hence, the efficacy of 5 recommended insecticides was evaluated on different stages of WFT. These insecticides belonged to different chemical classes including diazinon (orghanophosphates), cypermethrin (phyrethroid), fipronil (phenylpyrazole), imidacloprid (neonicotinoid) and oxymatrine (Botanical insecticide).

Materials and Methods

Insects

In the first phase, Western flower thrips were collected from cucumber greenhouses in Varamin, Iran in 2010. They were then grown in the laboratory without any pressure of insecticide. In the laboratory, all life stages of thrips were maintained on young green bean pods (*Phasaeolous vulgaris*) under standard conditions of the temperature and relative humidity, 25 ± 1 °C, 65 ± 5% and a photoperiod of 16h light. Some plastic containers were also used as the rearing containers (20 cm in length and 5 cm in width) in which two holes, 5 cm diameter, were created and screened with silk mesh to provide ventilation. Some tissues were also placed on the bottom as a shelter for thrips pupae. Green bean pods were later washed with water and liquid detergent to reduce insecticide residues. As the next step, adult thrips were introduced into the containers with two fresh green bean pods. Adult thrips knocked off the green bean pods and green bean pods with thrips eggs were transferred to another container after one day. All the rearing containers were held in a growing room at 25 ºC under 16: 8 light: dark photoperiod. Green bean pods were replaced daily.

Insecticides

The commercial formulations of the used insecticides are presented in Table 1.

Bioassay

Based on the method applied by Martin and Workman (2005), the filter paper-dipping method was used in the current research. A hole (3 cm in diameter) was made on each petri dish cover and was then covered with silk mesh to provide adequate ventilation. The filter papers, 4 cm in diameter and sections of green bean pod, 2 cm in length, were dipped for 10 seconds in insecticide solutions. The treated filter papers and sections of green bean pod were air-dried under laboratory condition. They were then put into a petridish and 20 thrips were introduced into each dish. After being covered with parafilm, petridishes were kept at 25 ± 1 ºC under a 16: 8 h (L: D). For each insecticide, an appropriate stock concentration was prepared. Then 5 concentrations (in minimum) was prepared and used to calculate LC_{50} values. Three replicates were used per concentration. Mortality rate was recorded 24 hours after treatment.

Data analysis

The corrected mortality was calculated by Abbott's formula based on the mortality rate in the control (< 15%) (Abbott, 1925). The probit analysis was conducted by the method of Finney (1971) using SAS software.

Results

Median lethal concentration (LC_{50}) values at 95% confidence limits were obtained for adults and larval stages at 24 hours after treatment. The findings of this study showed that fipronil had the highest and imidacloprid had the lowest efficacy among all the tested insecticides (LC_{50} = 17.97 ppm and 2303 ppm respectively). Oxymatrine was the next most effective (LC_{50} = 69.94 ppm) after fipronil (Table 2). The results on the second instar larvae showed that the lowestLC_{50}belonged to oxymatrine (4.21 ppm) and the highest value to imidacloprid (1840 ppm) (Table 3). Furthermore, LC_{50} values of fipronil and oxymatrine on the first instar larvae were 4.24 and 4.13 ppm, respectively (Table 4). In this study, the first instar larvae were more sensitive than the second instar larvae and adults.

Table 1 Common name, trade name, formulation and current supplier of insecticides tested.

Common name	Trade name	Formulation	Supplier
Diazinon	Diazinon	EC 60%	Partonaz Co., Ltd
Cypermethrin	Cypermethrin	EC 10%	Production of chemical products in Iran
Imidacloprid	Confidor	SC 35%	Bahavar shimi Co., Ltd
Fipronil	Agenda	EC 2.5%	Bayer Environmental Science SA Ltd
Oxymatrine or Matrine	Kingbo	As 0.2% + 0.4%	Beijing Kingbo Biotech Co., Ltd

Table 2 Acute toxicity of five insecticides on adult of western flower thrips.

Insecticides	Number of insects	Slope ± SE	LC_{50} (95% CL) (ppm a.i.)[1]	P-value	χ^2 (df = 4)
Fipronil	380	1.0912 ± 0.1105	17.97 (12.56 – 25.03)	0.9999	3.9847
Oxymatrine or matrine	380	1.1133 ± 0.1238	69.94 (47.07 – 98.88)	0.9718	8.4166
Cypermethrin	360	1.1466 ± 0.1347	205.98 (144.25 – 286.49)	0.9947	6.3223
Diazinon	360	1.1422 ± 0.1465	1502.00 (1014 – 2135)	0.9891	5.9056
Imidacloprid	360	1.3724 ± 0.2247	2303.00 (1712 – 3068)	0.6037	14.8863

[1] CL: confidence limits; a. i.: active ingredient.

Table 3 Acute toxicity of five insecticides on 2nd instar larvae of western flower thrips.

Insecticides	Number of insects	Slope ± SE	LC_{50} (95% CL) (ppm a.i.)[1]	p-value	χ^2 (df = 4)
Fipronil	451	0.8271 ± 0.1554	4.41 (1.62–9.40)	0.5224	12.2459
Oxymatrine or matrine	687	0.7821 ± 0.0672	4.21 (3.03–5.71)	0.5341	17.8251
Cypermethrin	925	0.9150 ± 0.044	31.34 (25.02–37.92)	0.9528	6.3965
Diazinon	445	0.9998 ± 0.0827	54.30 (30.01–92.23)	0.9493	7.9526
Imidacloprid	917	1.5089 ± 0.1037	1840 (1590–2109)	0.9530	11.4635

[1] CL: confidence limits; a. i.: active ingredient.

Table 4 Acute toxicity of two insecticides on1st instar larvae of western flower thrips.

Insecticides	Number of insects	Slope ± SE	LC_{50} (95% CL) (ppm a.i.)[1]	p-value	χ^2 (df = 4)
Fipronil	803	0.7574 ± 0.0590	4.24 (3.16 – 5.69)	0.7424	17.3738
Oxymatrine or matrine	541	0.7561 ± 0.0753	4.13 (2.81 – 5.90)	0.9999	4.6067

[1] CL: confidence limits; a. i.: active ingredient.

Discussion

The current study examined the effectiveness of five insecticides on WFT, which were selected from among different chemical classes. The results demonstrated that fipronil has a higher efficacy than the other tested insecticides. It was also found to be more toxic to adults. Moreover, monitoring fipronil resistance suggested that despite the undue use of fipronil in recent years, it is still a good way to control WFT (Herron and James, 2005). Next to fipronil, oxymatrine showed the highest efficacy against larvae (especially on the first instar larvae) than on adults. It was also found that the application of oxymatrine can control WFT after 7 days (PCT, 2008). Oxymatrine is a botanical insecticide affecting the nervous system. Also, it has almost no cytotoxic and genotoxic effects on plants (Akdeniz and Ozmen, 2011). Its active ingredient is derived from the roots of the *Sophora flavescens* (Fabales: Fabaceae). Insecticides extracted from plants have less negative environmental effects and create comparatively less risk of insecticide resistance than synthetic insecticides; therefore, they can be proposed as a safe tool for management of pests (Murray, 2006). In Kenya, for example, it was suggested that combining botanical and synthetic insecticides is helpful because of the less risk of insecticide resistance (Thoeming *et al.,* 2006). Also, comparison of confidence limits showed that there was no significant difference between oxymatrine and fipronil. Thus, there is a need for further research on the effects of the oxymatrine and fipronil on the western flower thrips and how to control them in both greenhouse and field. Diazinon and cypermethrin are also recommended for chemical control of WFT all over the world (Zhao *et al.,* 1994; Chung *et al.,* 2000). However, the use of high concentrations of diazinon and cypermethrin may result the highest mortality rate, but in turn, develop some resistance. Along the same line, the results from another study have shown resistance to α-cypermethrin (164 times) (Herron *et al*., 2008). In addition, previous studies have indicated that some organophosphates as well as most of the pyrethroids were ineffective against WFT (Helyer and Brobyn, 1992; Morishita, 2001).

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حساسیت تریپس غربی گل *Frankliniella occidentalis* (Thysanoptera: Thripidae) نسبت به تعدادی سموم شیمیایی و گیاهی در شرایط آزمایشگاه

زهرا غلامی[۱]، امین صادقی[۱*]، عزیز شیخی گرجان[۲]، جواد ناظمی رفیع[۱] و فاطمه غلامی[۳]

۱- گروه گیاهپزشکی، دانشکده کشاوزی، دانشگاه کردستان، سنندج، ایران.
۲- بخش تحقیقات حشره‌شناسی کشاورزی، مؤسسه تحقیقات گیاهپزشکی کشور، تهران، ایران.
۳- گروه گیاهپزشکی، دانشکده کشاورزی، دانشگاه محقق اردبیلی، اردبیل، ایران.
* پست الکترونیکی نویسنده مسئول مکاتبه: a.sadeghi@uok.ac.ir
دریافت: ۲۶ مرداد ۱۳۹۳؛ پذیرش: ۷ مرداد ۱۳۹۴

چکیده: این مطالعه به‌منظور بررسی سودمندی فرمولاسیونهای تجاری حشره‌کش‌ها جهت کنترل تریپس غربی گل انجام شد. حشرات از تعدادی گلخانه تجاری خیار در شهر ورامین (ایران) جمع‌آوری شدند. اثر حشره‌کش‌های دیازینون (۶۰٪ EC)، سایپرمترین (۴۰٪EC)، فیپرونیل (۲/۵٪ EC)، ایمیداکلوپراید (۳۵٪ SC) و حشره‌کش گیاهی اکسی‌ماترین (کینگ‌بو ۰/۶٪ AS) مورد آزمایش قرار گرفت. نتایج مشخص کرد که فیپرونیل (LC_{50}=۱۷/۹۷ ppm) مؤثرترین حشره‌کش در میان سایر حشره‌کش‌های آزمایش شده بود. درحالی‌که ایمیداکلوپراید (LC_{50} = ۲۳۰۳ ppm) کم‌ترین تأثیر را نشان داد. هم‌چنین، اکسی‌ماترین(LC_{50}=۶۹/۹۴ ppm) بعد از فیپرونیل موثرترین حشره‌کش بود.

واژگان کلیدی: زیست‌سنجی، حشره‌کش‌ها، *Frankliniella occidentalis*، فیپرونیل، اکسی‌ماترین