

CHEMICAL CONTROL

Susceptibility of *Liriomyza sativae* Blanchard (Diptera: Agromyzidae) melon populations to abamectin, cyromazine, and cyantraniliproleGLENDA DAMASCENO¹, TALIA C. DA SILVA², ODERLEI BERNARDI³, TIAGO C. DA COSTA-LIMA⁴¹Federal Rural University of Pernambuco (UFRPE), Dom Manuel de Medeiros, Dois Irmãos, 52171-900, Recife, PE, Brazil. glendabio.damasceno@gmail.com²Petrolina, PE, Brazil. talia-cordeiro@hotmail.com³Federal University of Santa Maria (UFSM), Cidade Universitária, Bairro Camobi 97.105-900, Santa Maria, RS, Brazil. oderlei.bernardi@ufsm.br⁴Brazilian Agricultural Research Corporation (Embrapa Semi-Arid Region), Rodovia BR-428, Km 152, Zona Rural, 56302-970, Petrolina, PE, Brazil. tiago.lima@embrapa.br*BioAssay 13: ba13001 (2022)*Suscetibilidade de populações de meloeiro de *Liriomyza sativae* Blanchard (Diptera: Agromyzidae) à abamectina, ciromazina e ciantraniliprole

RESUMO - O melão encontra-se entre as frutas mais exportadas pelo Brasil. Dentre os problemas que dificultam o incremento de produtividade na cultura destaca-se a ocorrência da mosca-minadora, *Liriomyza sativae* (Blanchard) (Diptera: Agromyzidae). O controle químico é o mais utilizado para o manejo desta praga, porém, produtores têm relatado uma redução na suscetibilidade a inseticidas. Assim, o objetivo deste trabalho foi avaliar a suscetibilidade de populações de *L. sativae* aos inseticidas abamectina, ciromazina e ciantraniliprole coletadas em melão no nordeste do Brasil (Juazeiro, BA e Icapuí, CE). A CL_{50} (concentração letal média) dos inseticidas foi obtida em estudos em laboratório usando o método de bioensaio de imersão de folhas com larvas de *L. sativae*. Com base nos valores de CL_{50} , não se observou diferenças na suscetibilidade das populações para os três inseticidas avaliados. Ambas as populações de *L. sativae* demonstraram baixa variação na suscetibilidade a abamectina, ciromazina e ciantraniliprole.

PALAVRAS-CHAVE: mosca-minadora, *Cucumis melo*, inseticidas

ABSTRACT - Melon is one of the most exported fruits from Brazil. The leafminer fly, *Liriomyza sativae* (Blanchard) (Diptera: Agromyzidae), is one of the major problems that negatively interfere in the productivity increase in this crop. Chemical control is the most adopted method for this pest; however, producers have reported reduced susceptibility to insecticides. Thus, this study aimed to evaluate the susceptibility of *L. sativae* larvae to abamectin, cyromazine, and cyantraniliprole from populations collected from two melon crop-producing regions in Northeast Brazil (Juazeiro, BA and Icapuí, CE). The insecticide's lethal concentration 50 (LC_{50}) was obtained in the laboratory using the leaf dip bioassay method with *L. sativae* larvae. No difference was observed in the LC_{50} between the populations for the three insecticides. Both populations showed low variation susceptibility for abamectin, cyromazine, and cyantraniliprole.

KEY WORDS: leafminer fly, *Cucumis melo*, insecticides.

Melons are one of the most exported fruits from Brazil, and in 2021, the country achieved US\$ 220 million in income (FAO 2021). The leafminer fly, *Liriomyza sativae* (Blanchard) (Diptera: Agromyzidae), is one of the major problems that negatively interfere in the productivity increase in this crop (Costa-Lima *et al.* 2015). As the number of larvae per melon

leaf increases, the photosynthesis rate, stomatal conductance, and transpiration decrease (Costa *et al.* 2017).

Synthetic insecticides are the most adopted method for *L. sativae* control by melon producers. However, the indiscriminate use of insecticides leads to select resistant populations and reduces the occurrence of natural enemies

(Guantai *et al.* 2015, Gao *et al.* 2017). Resistant populations of the *Liriomyza* genus were already reported in China to abamectin (Ferguson 2004, Wei *et al.* 2014) and the United States to pyrethroids, abamectin, cyromazine, and spinosad (Macdonald 1991, Ferguson 2004).

In the melon-producing regions in Brazil, the problematic control of *L. sativae* with synthetic insecticides has led to studies aiming to search for different control methods, such as botanical insecticides (Oliveira *et al.* 2020) and biological control (Costa-Lima *et al.* 2019). Therefore, the present study aimed to evaluate the susceptibility of populations of *L. sativae* to three major synthetic insecticides used in melon-producing regions in Northeast Brazil.

Material and Methods

Bioassays were performed using two *L. sativae* populations collected from melon-producing regions in Juazeiro (BA) and Icapuí (CE). In the laboratory, the populations were reared over cowpea plants, according to Costa-Lima *et al.* (2017).

Three insecticides were evaluated, all registered for melon crops in Brazil to control the larval stage of leafminers. Increasing concentrations were used until a minimum of five points were obtained, with mortality ranging from zero to 100%. Three products were evaluated with the following active ingredients and concentrations: abamectin (30 to 1,920 ppm), cyromazine (75 to 1,200 ppm), and cyantraniliprole (120 to 2,000 ppm).

For the bioassays, cowpea plants [*Vigna unguiculata* (L.) Walp.] were exposed to *L. sativae* breeding cages for 24 hours. After the infestation, the plants were moved to a glasshouse. Every day, the plants were observed under stereomicroscopes for the presence of larvae. For the experiments, plants with larvae with less than 24 hours were used. Distilled water was used as the control. A 500 mL solution was prepared using distilled water for each insecticide concentration test. The method used was adapted from Ferguson (2004), with the solution immersion of leaves with *L. sativae* larvae for five seconds. After that, the plants were maintained in a climatized room, at $25 \pm 2^\circ\text{C}$, RH of $50 \pm 20\%$, and a 12h photophase. After five days, the number of dead larvae was counted using the stereomicroscope (40x) with transmitted light.

The experimental design was completely randomized. Each larva was considered one repetition, with a minimum of 100 repetitions per treatment. To assess the relative toxicity of insecticides against *L. sativae* populations, the LC_{50} lethal concentration and its 95% confidence interval (CI) were estimated. Therefore, the probit analysis was conducted with the *Ecotoxicology* package (Gama 2015) from R Software. Significant differences in susceptibility were stated between populations when its 95 % confidence interval did not overlap.

Results and Discussion

No difference regarding the susceptibility of *L. sativae* was detected between the Juazeiro and Icapuí populations for the three insecticides evaluated. However, when comparing

the LC_{50} between the three insecticides, the susceptibility to abamectin was lower. No difference was detected in the lethal toxicity between cyromazine and cyantraniliprole for both populations (Table 1).

The LC_{50} in the present study for abamectin ranged from 434.45 to 603.51 ppm. These are high values compared to results from resistant *L. sativae* populations in China (Gao *et al.* 2017, Wei *et al.* 2014). In these studies, the highest LC_{50} for *L. sativae* was 1.00 ppm, obtained after a 16 selection cycle during 22 generations, from a population recovered from sponge cucumber in China (Wei *et al.* 2014). For the closely related species, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae), the LC_{50} achieved 30.52 ppm from a population obtained in cowpea plants in China (Gao *et al.* 2017). Abamectin has been registered for use in melon crops since the 1990 decade in Brazil for leafminer control (Agrofit 2021). The end of the patent had, consequently, new products with abamectin and reduced prices (Paiva 2011). Thus, abamectin became one of the major insecticides sprayed in melon crops for leafminer control. This long-term exposure to abamectin can be related to the low susceptibility observed for both *L. sativae* populations compared to the other two insecticides.

For cyromazine, the LC_{50} ranging from 127.17 to 159.17 ppm also was high compared to other studies with *L. sativae* (Gao *et al.* 2017, Wei *et al.* 2014). The highest LC_{50} found in these studies was 12.62 ppm, from *L. sativae* population collected from cowpea plants (Gao *et al.* 2017). The same authors obtained an LC_{50} of 71.81 ppm for an *L. trifolii* population. Abamectin and cyromazine were the only registered insecticides recommended to control leafminer larvae in melon crops in Brazil for many years (Guimarães *et al.* 2005). This long-term exposure could also be related to the low susceptibility from both *L. sativae* populations to cyromazine.

Diamides are one of the most recent insecticides classes with a different mode of action (Teixeira & Andaloro 2013). In Brazil, cyantraniliprole was registered in the 2010 decade to control *L. sativae* in melon crops (Agrofit 2021). There are no reports in the literature of *Liriomyza* spp. populations resistant to diamides or LC_{50} for leafminers populations.

The low susceptibility observed for both *L. sativae* populations for the tested insecticides could be related to resistance to the active ingredients and therefore explain the difficulty to control this pest in melon crops in northeast Brazil. Nonetheless, to elucidate these hypotheses, a study with more populations compared to a susceptible population would be necessary.

We conclude that there are no differences in susceptibility to abamectin, cyromazine, and cyantraniliprole by *L. sativae* populations from Icapuí and Juazeiro. However, abamectin showed lower toxicity for the populations tested than cyromazine and cyantraniliprole. In addition, high LC_{50} values were obtained for abamectin and cyromazine compared to previous studies.

Table 1. Concentration-mortality response (ppm) of two *L. sativae* populations to three insecticides (25 ± 1°C, RH 50 ± 20%, and 12h photophase).

Active ingredient	Population	n	Slope (± SE)	CL ₅₀ (95% CI) ppm	X ²	p-value
Cyromazine (750g/Kg)	Juazeiro	668	1,731 ± 0,215	159,17 (120,35; 199,08)	7,40	0,884
	Icapuí	671	1,70 ± 0,094	127,17 (90,54; 163,33)	1,40	0,156
Cyantranilprole (100g/L)	Juazeiro	671	1,83 ± 0,275	181,46 (136,20; 230,08)	8,99	0,970
	Icapuí	776	1,84 ± 0,098	156,70 (11,55; 200,99)	1,13	0,230
Abamectin (18g/L)	Juazeiro	847	1,404 ± 0,173	434,45 (350,85- 542,14)	13,49	0,788
	Icapuí	760	1,626 ± 0,177	603,51(493,62;733,80)	7,12	0,788

n = number of insects tested; SE = Standard error; CL₅₀ = lethal concentration to cause 50% mortality; CI 95 = 95% confidence interval; X² = Chi-square value; p-value = p-value for a given lethal concentration.

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