

Plant Extracts and Pesticides for the management of the American Serpentine Leafminer (*Liriomyza trifolii*)

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Abstract— Pesticides have been the most common method for management in the control of *Liriomyza trifolii*. However, some plants produce substracts with pesticide potential and could be used for the management of this pest. Therefore, the aim of this study was to assess the pesticide potential of tobacco, pepper, castor beans, and garlic extracts in the management of *L. trifolli*, comparing them to commercial pesticides (Milbeknock® and Vertimec®). The extracts were tested at a concentration of 2.5 mL/100mL of water and pesticides in the concentrations recommended by the manufacturer. The extracts were applied to 10 tomato plants (50 days after sowing), previously submitted to an infestation of *L. trifolli* for 4 hours. The assessments were initiated one day after pulverization, counting the presence of miners in the leaves, number of alive and dead larvae and the viability of pupae. To assess the effects of the extracts and the pesticides on larval phase, tomato plants with the same characteristics of the previous experiment were submitted to an infestation of the pest for 4 hours. After 72 hours, the extracts and pesticides were pulverized at its respective concentrations. The larval, pupae, and total mortality data were subject to variance analysis, regression, and means were compared by Tukey test at 5% probability. It was found that the pesticide Vertimec® was efficient in the management of *L. trifolli* both when applied over eggs and larvae. However, among the tested extracts, the garlic extract was more efficient on eggs and larvae, becoming a promising and viable alternative to the management of *L. trifolli*.

Keywords— Phytosanitary management, *Solanum lycopersicon*, Pesticide plants, Pest insects, Integrated management.

I. INTRODUCTION

With a higher demand for healthy foods, research has been developed aiming to find alternative pest management. Besides, the continuous and indiscriminate use of pesticides has led to a number of serious problems related to human and animal health (Perez & Iannacone 2006; Wamser *et al.*, 2008).

Pesticides have been the most commonly used method for management by producers in controlling the American serpentine leafminer (*Liriomyza trifolli*) (Diptera: Agromyzidae) (Wamser *et al.*, 2008). On the other hand, plants have been studied for their capacity to produce substracts with pesticide potential, especially those in the Solanaceae, Euphorbiaceae, Liliaceae, Meliaceae families, which have pesticide potential. Among those plants, the tobacco (*Nicotiana tabacum* L.), the habanero pepper

(*Capsicum chinense* Jacq.), the castor bean (*Ricinus communis* L.) and the garlic (*Allium sativum* L.) have been highlighted for having composts with pesticide properties (Yang *et al.*, 2017).

Therefore, studies with biopesticides based on plant extracts had shown promising results in pest management. Moreover, the development of new pesticide molecules by using secondary metabolites in plants may also offer repellent action in oviposition of pests (Pavela, 2016). Even though there viability for biopesticides using plant extracts, studies must be conducted since those vegetal origin products present limitations such as photosensitivity, temperature, humidity, and problems in active ingredient concentrations in plants (Machado *et al.*, 2007).

Given the aforementioned, this study aimed to assess the pesticide and repellent potential to the American serpentine leafminer, *L. trifolii*, for peper, garlic, tobacco, and castor bean extracts when compared to commercial pesticides (Milbeknock® Onu 1993 FR® and Vertimec®).

II. MATERIAL AND METHODS

The experiment was conducted in the Nucleus for Scientific and Technological Development in Phytosanitary Management (NUDEMAFI) at the Agronomic Sciences Center at the Federal University of Espirito Santo, Brazil (CCA-UFES), Alegre-ES and followed these phases:

2.1 *L. trifolii* breeding.

Leaves containing fly punctures were deposited in polyethylene trays for collection of pupae and posteriorly transferred to petri dishes covered in plastic film. After the emergence of *L. trifolii* adults were released in antiaphid net cages (50 x 50 x 50 cm) in a room at 12 hours of light and 25 °C, raised in leaves of jack bean (*Canavalia ensiformis*), according to the recommendations by Sombra *et al.* (2011).

2.2 Obtaining Castor Oil.

Castor fruit in the IAC 80 variety were submitted to oil extraction through cold press and filtering of impurities with thin screen filter (patent pending). Then, the oil was kept in a dated hermetically closed clear container in an acclimatized room at 25±2 °C and photophase of 12h. For oil dilution, distilled water was used with adhesive surfactant (Tween® 80) at concentration 0.5% (v/v).

2.3 Obtaining tobacco, garlic, and pepper extracts.

Rolls of tobacco leaf (Vieira - Ubá - MG), bulbs of garlic (São Gotardo - MG) and habanero peppers were dried in stove at 50°C until constant weight was achieved, later grinded in cutting mills (Oliveira & Vendramim, 1999). The dried and ground parts of the plants were taken into immersion with deionized water with the concentration of 10g powder in 90 ml water (10%). These were kept in homogenization for 24 hours in a transverse agitator (200RPM). The solution was then strained in voil cloth and it was complete to 100ml in the proportion of one gram of dry plant to 10mL of distilled water, obtaining then the aqueous extract of the plant.

2.4 Efficacy of natural products x chemical products applied to the egg phase.

The following formulations were tested: pepper extract (2.5 mL/100mL water), garlic extract (2.5 mL/100mL water), tobacco extract (2.5 mL/100mL water) and castor oil (2.5 mL/100mL water), Milbeknock Onu 1993 FR® (40 mL/100 L water) and Vertimec® (100 mL/100 L water) and witness (distilled water). Concentrations

superior to 2.5% presented traces of phytotoxicity in the plants and were not used in the experiments.

To assess the action of the extracts in the management of the American serpentine leafminer, tomato plants at 50 days after sowing (with five true leaves) were submitted to the pest infestation, in breeding cages for four hours. After this time, the plants were removed and immediately pulverized com the respective concentrations of each extract. A total of 10 plants were used, each one being one repetition. The process used an automated pressure pulverizer (pressure of 15 lb/pol²), releasing 6 mL solution with automated pipette of 2 to 10 mL, simulating a field inoculation.

2.5 Efficacy of natural products x chemical products applied to the larval phase.

The same formulations from the previous experiment were tested, however, the pulverizations occurred 72 hours after the plants were removed from the cages. For each concentration, 10 plants were used. The application of extracts and pesticides were similar to those in the previous experiment.

The assessments were started one day after pulverization, accounting for the presence of miners in the leaves and number of alive and dead larvae. It was also calculated the viability of pupae from larvae to survive the application. The larval, pupae, and total mortality data were used for analysis of variance (comparison among products), regression (comparison among the concentrations of one product), and means compared by Tukey's test at 5% probability using PROC ANOVA in Assistat (Silva & Azevedo, 2006).

III. RESULTS AND DISCUSSION

3.1 Efficacy of natural products x chemical products applied to the egg phase.

The larval mortality for *L. trifolii* when applied at the egg phase varied according to the product, with significant differences between the treatments (F6, 34= 244.9602; P = 0.001). Treatments with chemical products produced higher larval mortality but there were statistical differences between pesticides Milbeknock® and Vertimec® with 90% and 100% mortality, respectively. Among the extracts, the best results were obtained with the garlic extract with 60% larval mortality, but that was not significantly different from the tobacco extract (Figure 1-A).

On the pupae mortality, Vertimec® and garlic extract had the best results. The pesticide Milbeknock® and the castor bean, tobacco, and pepper extracts had statistically similar results with mortality ranging from 30 to 58% (Figure 1-B). These results indicate that the garlic

extract is more efficient on *L. trifolii* pupae phase when applied during the egg phase, when compared to other extracts.

For total mortality analysis, all extracts and pesticides used in the tomato culture presented adequate results. However, Vertimec® and Milbeknock® presented superior results with 90 and 100% efficacy, respectively, and statistically different from extracts (F6, 29 = 45.2572; $P < 0.0001$). The garlic, pepper, tobacco, and castor bean extracts showed efficacy ranging from 68 to 78%. However, the castor bean extract was statistically inferior from the other extracts (48%) (Figure 1-C).

Efficacy of natural products x chemical products applied to the larval phase. The results from extracts and chemical products when applied during larval phase presented variation in efficacy, significant among the treatments (F6, 34 = 28.8045; $P = 0.001$). The chemical products Vertimec® and Milbeknock® results in higher larval mortality. The pesticide Vertimec® presented efficacy of 100%, while the pesticide Milbeknock® presented efficacy of 80%. (Figure 2-A).

On the percentage of unviable pupae, there were no assessments to the plants treated with the pesticide Vertimec® since it resulted in total mortality of larvae. The garlic extract resulted in 78% unviable pupae, with efficacy statistically superior to the chemical product Milbeknock®. The remaining extracts presented results statistically inferior (Figure 2-B).

For all treatments, there was variation in total mortality of *L. trifolii* (F6, 29 = 27.9049; $P = 0.0001$). The garlic extract and the chemical product Vertimec® presented the best results, with 89 and 100 % total mortality, respectively. The efficacy of the pepper and tobacco extracts was statistically inferior to the garlic with values close to 70%. The pesticide Milbeknock® and the castor bean extract presented the lower results with 58% and 63% efficacy (Figure 2-C).

In general, the pesticide Vertimec® was efficient in the management of *L. trifolii* both in application on eggs and larvae. The pesticide Vertimec® has as its active ingredient the abamectin, a macrocyclic lactone with translaminar action, allowing the action on the eggs as well as larvae, even when those are inside the leaf parenchyma (Monnerat *et al.*, 2000). However, when facing the many cases of resistance of pests to pesticides and also the many environmental and human generated problems by the use of pesticides, studies suggest the use of plant extracts and essential oils such as biopesticides have been intensified around the world.

Therefore, the garlic extract showed to be efficient in the management of *L. trifolii* both during egg and larval

phases. The garlic extract has as a main composite the allicin that promotes the typical garlic aroma and which acts as a defense mechanism for the plant against herbivores (Szymack *et al.*, 2009). This extract is reported as a potential pesticide, insecticide, nematicide, and fungicide (Corrêa & Salgado, 2011). The allicin has action by contact and reacts in the cuticles of pests as well as a fumigating effect, being able to be absorbed through insects' airway (Corrêa & Salgado, 2011).

IV. FIGURES AND TABLES

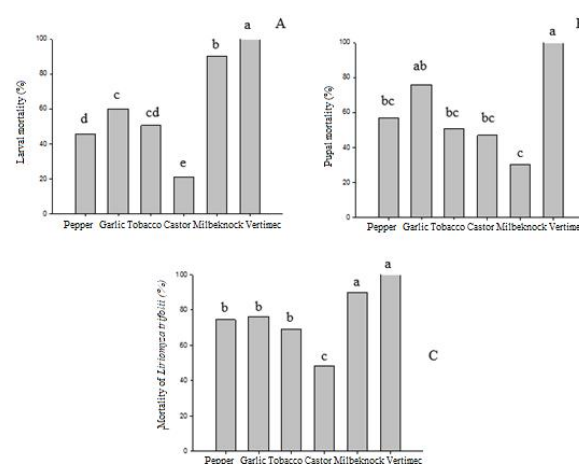


Fig. 1: Application of natural products from pepper, garlic, tobacco, and castor bean compared to chemical products at egg phase in *L. trifolii*. A) Larval mortality; B) Pupal mortality; C) Total mortality. Means (\pm SE) followed by the same letter in the column are not statistically significant through ANOVA at 5% probability with Tukey test.

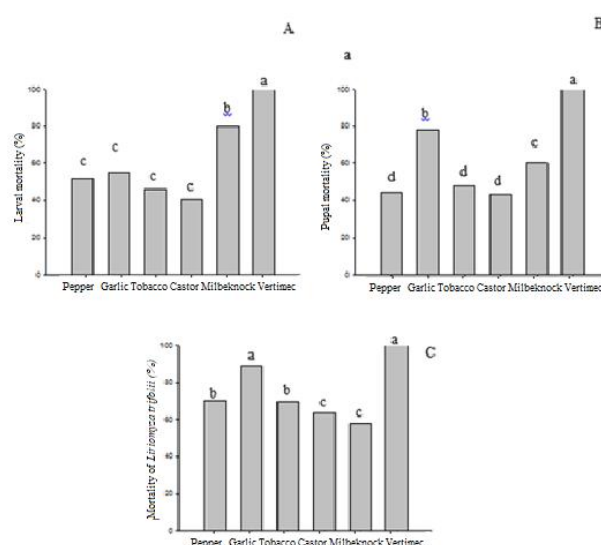


Figure 2. Application of natural products from pepper, garlic, tobacco, and castor bean compared to chemical products at larvae phase in *L. trifolii*. A) Larval mortality; B) Pupal mortality; C) Total mortality. Means (\pm SE) followed by the same letter in the column are not statistically significant through ANOVA at 5% probability with Tukey test.

V. CONCLUSION

The Vertimec® pesticide was efficient in the management of *L. trifolii* both for eggs and larvae. However, among the tested extracts, the garlic extract seemed more efficient on eggs and larvae, presenting promising and a viable alternative in the management of *L. trifolii*.

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