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Insecticide effects of *Ruta graveolens*, *Copaifera langsdorffii* and *Chenopodium ambrosioides* against pests and natural enemies in commercial tomato plantation

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ABSTRACT. The aim of this study was to evaluate the insecticide effect of watery leaf extracts of *Ruta graveolens* (Rutaceae), alcoholic leaf extracts of *Copaifera langsdorffii* (Caesalpinaceae) and *Chenopodium ambrosioides* (Chenopodiaceae) in the concentration of 5% under field conditions. The experiment design was randomized blocks with six replications. The parcels treated with plant extracts showed reduction in the population of pests when compared with the control parcels. The extract elaborated with *C. langsdorffii* presented greater insecticidal effect under *Bemisia tabaci* (Hemiptera: Aleyrodidae) and sum of pests. It was verified that after 24 hours of spraying, the parcels treated with the extract of *C. ambrosioides* presented minor numbers of adults of *Tuta absoluta* (Lepidoptera: Gelechiidae), followed by the parcels treated with extract of *R. graveolens*. There were smaller numbers of parasitoid eggs of lepidopterans *Trichogramma* sp. (Hymenoptera: Trichogrammatidae) and sum of natural enemies (predators + parasitoids) in the parcels that had received spraying with extracts from the plants of *C. langsdorffii* and *C. ambrosioides*, followed by *R. graveolens*, compared to the control. There were a smaller number of parasitoids from the family Eulophidae (Hymenoptera) attacking caterpillars of *T. absoluta* in plants treated with *R. graveolens*, followed by *C. langsdorffii* and *C. ambrosioides* than in the control.

Keywords: *Lycopersicon esculentum*, bioinsecticide, alternative control.

RESUMO. Ação inseticida de *Ruta graveolens*, *Copaifera langsdorffii* e *Chenopodium ambrosioides* sobre pragas de tomate. O objetivo deste trabalho foi avaliar o efeito inseticida dos extratos aquosos de folhas de *Ruta graveolens* (Rutaceae) e alcoólicos de folhas de *Copaifera langsdorffii* (Caesalpinaceae) e de folhas de *Chenopodium ambrosioides* (Chenopodiaceae) a 5%. O experimento foi em blocos casualizados com seis repetições. As parcelas tratadas tiveram redução na população de pragas, quando comparadas às parcelas sem nenhum tratamento. O extrato elaborado com *C. langsdorffii* apresentou maior efeito inseticida em *Bemisia tabaci* (Hemiptera: Aleyrodidae) e soma das pragas. Verificou-se que após 24h de pulverização, as parcelas tratadas com o extrato de *C. ambrosioides* apresentaram menores números de adultos de *Tuta absoluta* (Lepidoptera: Gelechiidae) seguido pelas parcelas tratadas com extrato de *R. graveolens*. Foram observados menores números do parasitoide de ovos de lepidópteros *Trichogramma* sp. (Hymenoptera: Trichogrammatidae) e da soma dos inimigos naturais (predadores + parasitoides) nos tratamentos que receberam as pulverizações com os extratos das plantas de *C. langsdorffii* e *C. ambrosioides* seguido por *R. graveolens* do que na testemunha; do parasitoide da família Eulophidae (Hymenoptera), que atacam lagartas de *T. Absoluta* em plantas tratadas com *R. graveolens*, seguido por *C. langsdorffii* e *C. ambrosioides* do que na testemunha.

Palavras-chave: *Lycopersicon esculentum*, bioinseticida, controle alternativo.

Introduction

Lycopersicon esculentum Mill. (Solanaceae) is one of the most important vegetables cultivated in the world, with regard to area as well as commercial value, being the second most produced vegetable in Brazil. The tomato is considered one of the few cultures for which pests and diseases are equally important, being a host plant to about 200 species of arthropods (CARVALHO et al., 2002).

Among the pests of tomato plants are the transmitters of viral diseases *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae), *Frankliniella schulzei* Trybom (Thysanoptera: Thripidae), *Myzus persicae* Sulzer and *Macrosiphum euphorbiae* Thomas (Hemiptera: Aphididae), leaf miners *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae) and *Liriomyza huidobrensis* Blanchard (Diptera: Agromyzidae), and fruit borers *T. absoluta*, *Neoleucinodes elegantalis*

Guenée (Lepidoptera: Crambidae) and *Helicoverpa zea* Bod. (Lepidoptera: Noctuidae) (GALLO et al., 2002). They can provoke high losses in tomato production, as verified by Picanço et al. (2007), in which some of these pests are capable of causing, directly or indirectly, a reduction of 58.39% in total income of culture.

For the control of these pests, successive applications of synthetic insecticides are used. This is undesirable due to elevated production costs, exposure of producers and consumers to harmful active ingredients, adverse effects on the environment, reduction of natural enemies, and selection of resistant individuals in the pest populations (THOMAZINI et al., 2000).

Therefore, there is a need to control pests without causing aggressions and unbalances in the environment through the search of alternative methods of pest control that favor the natural enemies that are indispensable to establish the biological balance and to reduce production costs, such as with the use of plant extracts (VIEGAS JÚNIOR, 2003). Thus, organic cultivation, since it uses environmentally safe technologies, constitutes a promising alternative (VENZON et al., 2006). Organic agricultural production seeks to maximize the social benefits, self-sustainment, the reduction or elimination of the dependence on inputs, non-renewable energy and preservation of the environment through optimization of the use of natural and socioeconomic resources available in a maintainable and rational way (HAMERSCHMIDT et al., 2000; PENTEADO, 2000).

Problems such as selectivity to natural enemies, persistence to the environment and toxicity to mammals can be minimized by the use of insecticide plants as an alternative method of suppression of the herbivore (VIEGAS JÚNIOR, 2003; TREVISAN et al., 2006). Barbosa et al. (2009) studied different extraction methods and concentrations of tree plants. This author observed satisfactory mortality of aqueous leaf extracts of *Ruta graveolens* L. (Rutaceae) and *Artemisia verlotorum* Lamotte (Asteraceae), alcoholic leaf extracts of *Petiveria alliacea* L. (Phytolaccaceae) against *Diabrotica speciosa* (Germar) (Coleoptera: Chrysomelidae), in laboratory conditions. However, it is necessary to evaluate the insecticide effect of those extracts on other pests found, the impact on natural enemies, and the persistence of those extracts after some time exposed to field conditions, as the natural enemies promote efficient biocontrol of pests and favor greater productivity of the culture by means of effect cascades (CARDINALE et al., 2003).

The objective of this work is to evaluate the insecticide effect of aqueous leaf extracts of *R. graveolens* and alcoholic leaf extracts of *C. Langsdorffii* and *C. ambrosioides* against pests and natural enemies in commercial plantations of *L. esculentum*.

Material and methods

The experiment was carried in the city of Montes Claros, state of Minas Gerais, Brazil, in April 2007. The analysis was accomplished in a commercial plantation of *L. esculentum* var. Santa Clara, cultivated in Red-Yellow Latosol, with four months of planting, and trellised obliquely. The last pulverization with organosynthetic pesticides had been done three weeks before.

The experimental block design was randomized, with six replications and four treatments. Each plot had five rows with 25 plants per rows. The 15 central plants of the medium row were used for data collection. The plants were spaced 0.50 m apart within rows and 1.0 m between rows. The treatments were: 1) control without pulverization, 2) alcoholic leaf extract of *C. langsdorffii*, 3) alcoholic leaf extract of *C. Ambrosioides*, and 4) aqueous leaf extract of *R. graveolens*. The extracts were used in a dilution of 5%. Due to this dosage, Barbosa et al. (2009) observed insecticide effect in *D. speciosa* in *R. graveolens*, and another two plants by preliminary testing.

The *R. graveolens* and *C. ambrosioides* plants were organically cultivated at the Horto Medicinal of ICA/UFMG, while *C. langsdorffii* adult trees, present at the campus, in dystrophic Red Latosol of average texture.

To obtain the aqueous leaf extract of *R. graveolens* with three months of age (reproductive phase), 200 g of fresh leaves plus 1 L of distilled water were used. It was triturated in an industrial blender until homogenization. Soon afterwards, the mixture was heated until the beginning of ebullition. The mixture was then left to cool down, filtered and stored in a tinted glass until use. To obtain the alcoholic extracts elaborated with leaves of *C. langsdorffii*, unkown age (reproductive phase), and *C. Ambrosioides*, with three months of age (reproductive phase), 250 g of fresh leaves of each plant plus 1 L of hydrated commercial ethyl alcohol were used. The leaves were cut in small pieces and put in tinted glass flasks. The alcohol was then added and the mixture was then briefly agitated twice a day for 15 days. After this period, the solution was filtered and stored in tinted glass flasks until application.

The insecticide effect of the plant extracts was verified 24 and 72 hours after application by evaluating the number of pests, natural enemies (predators and parasitoids) and ants in 15 plants per plot, using the beating tray method (MIRANDA et al., 1998).

This method consists of beating the first apical expanded leaf inside a 34 x 26 x 5 cm white tray and counting the insects inside. The number of mines of *T. absoluta* and *Liriomyza* sp. were evaluated by direct counting in the first expanded leaf of 15 plants per plot (PICANÇO et al., 1998).

To evaluate the possible effect of the extracts on the parasitoid of eggs *Trichogramma* sp. (Hymenoptera: Trichogrammatidae) by natural infestation in the field, two white cards (12.0 x 3.0 cm) with 3,500 eggs of *Ephestia kuehniella* Zell. (Lepidoptera: Pyralidae), not parasitized, were put in the apical part of the canopy height (1.6 m height) of tomato plants. In the plots that were sprayed with extracts, a pulverization jet was driven on the cards. After 72 hours, the cards were collected off the field, stored in transparent white plastic bags, sealed and transported to the laboratory. Rearing took place in an incubator at a constant temperature of 25ºC. After 15 days, the cards were evaluated with a 40x magnifying lens, counting the number of adults of *Trichogramma* sp. emerged from the parasitized eggs, number of eggs predated, eggs parasitized by *Trichogramma* sp. not emerged, eggs not parasitized and total eggs in the cards.

Field and laboratory data were transformed by $\sqrt{x+0.5}$ and arcsin, respectively, and later submitted to analysis of variance and Tukey test ($p < 0.05$).

Results and discussion

The smallest number of *B. tabaci* adults, mines of *T. absoluta* and sum of pests (sum of total pests found) was observed in the treatments that had received the extracts of *C. langsdorffii, C. ambrosioides* and *R. graveolens* and *T. absoluta* adults in the plants sprayed with *C. ambrosioides* and *R. graveolens* extracts after 24 hours spraying (Table 1). There were no significant effects ($p > 0.05$) 24 hours after spraying in *F. schulzei* (Table 1). 72 hours after spraying, a smaller number of *B. tabaci* adults were observed on the tomato plants treated with *C. langsdorffii* and *C. ambrosioides* than on the plants treated with *R. graveolens* and in the control group (Table 1). A smaller number of *F. schulzei* was noted in Table 1.

The control group, followed by the plants that had received treatments with the extracts of *C. ambrosioides*, *C. langsdorffii* and *R. graveolens* (Table 1). A smaller number of the sum of pests was observed in the tomato plants sprayed with *C. langsdorffii*, followed by *C. ambrosioides*, *R. graveolens* and the control group (Table 1). There were no significant effects ($p > 0.05$) noted in the number of mines and adults of *T. absoluta* (Table 1).

Table 1. Effect of extracts of *Copaifera langsdorfii*, *Chenopodium ambrosioides* and *Ruta graveolens* in the number (±standard error) of adults of *Bemisia tabaci* and *Frankliniella schulzei* (adults + nymphs)/tray, of small, medium, big and total mines/leaf and adults of *Tuta absoluta*/tray and sum of pests/tray on the *Lycopersicon esculentum*. Montes Claros, Minas Gerais State, Brazil, 2007.

Evaluation (h)	Control	*C. langsdorfii*	*C. ambrosioides*	*R. graveolens*
	Bemisia tabaci			
24	18.25±1,72Aa	13.90±1.22Ba	13.18±0.93Ba	14.45±1.83Ba
72	11.15±1,09Ab	7.80±0.58Bb	8.51±0.61Bb	9.97±0.94ABb
	Frankliniella schulzei			
24	1.44±0.14Aa	1.39±0.16Aa	0.98±0.10Aa	1.36±0.18Aa
72	1.03±0.11Ba	1.75±0.21Aa	1.29±0.13ABa	1.75±0.24Aa
	Small mines of *Tuta absoluta*			
24	6.26±0.40Aa	4.62±0.35Ba	4.9±0.43Ba	4.84±0.33Ba
72	4.66±0.33Aa	4.58±0.45Aa	5.09±0.47Aa	5.42±0.48Aa
	Medium mines of *Tuta absoluta*			
24	3.79±0.29Aa	2.74±0.22Ba	2.91±0.28Ba	3.36±0.33ABa
72	3.45±0.41Aa	3.14±0.27Aa	3.41±0.36Aa	3.7±0.44Aa
	Big mines of *Tuta absoluta*			
24	5.66±0.53Aa	2.99±0.30Ba	4.01±0.44Ba	4.03±0.43Ba
72	4.33±0.50Aa	3.47±0.31Aa	3.89±0.38Aa	4.41±0.45Aa
	Total mines of *Tuta absoluta*			
24	15.71±0.91Aa	10.35±0.59Ba	11.83±0.92Ba	12.23±0.87Ba
72	12.44±0.96Aa	11.18±0.77Aa	12.39±0.93Aa	13.53±1.08Aa
	Adults of *Tuta absoluta*			
24	0.05±0.02Aa	0.01±0.01ABa	0.00±0.00Ba	0.00±0.00Ba
72	0.03±0.01Aa	0.01±0.01Aa	0.05±0.03Aa	0.03±0.01Aa
	Sum of pests			
24	21.17±1.77Aa	16.48±1.26Ba	15.6±0.98Ba	17.58±1.89Ba
72	14.08±1.19Ab	10.83±0.64Bb	11.32±0.64ABb	13.51±0.94Ab

The average followed by the same capital letter within a row or lowercase letter within a column did not differ in Tukey test ($p < 0.05$).

Other pests found were observed, however, apparently not affected by the pulverizations separately (not sum of pests), such as *Diabrotica speciosa* (0.35 ± 0.02/tray) (Germar) and *Cerotoma* sp. (0.0036 ± 0.0019/tray) (Coleoptera: Chrysomelidae); *M. persicae* and *M. euphorbiae* (0.02 ± 0.01/tray) (Aphididae), *Empoasca* sp. (0.03 ± 0.01/tray) (Cicadellidae), Pentatomidae (0.01 ± 0.01/tray); Miridae (0.001 ± 0.001/tray); caterpillars of Noctuidae (0.05 ± 0.04/tray) and Geometridae (0.0013 ± 0.0013/tray) and *Liriomyza* sp. adults (Diptera: Agromyzidae) (0.008 ± 0.003/tray).

The insecticide effect on *C. langsdorffii* extract in this work is probably due to the presence of coumarin in their constitution (VEIGA JUNIOR; PINTO, 2002), showing effect against *Aedes aegypti* L. larvae (Diptera: Culicidae) (CHAITHONG et al., 2006).

The insecticide action of the plant *C. ambrosioides* that occurred in this study is probably the result of the flavonoids and terpenoids present in its structure (CRUZ et al., 2007). Silva et al. (2005) verified that 1.0 and 2.0% (p/p) concentrations of the *C. ambrosioides* extracts showed satisfactory insecticide effect against *Sitophilus zeamais* Mots. (Coleoptera: Curculionidae). They achieved 90.3 and 90.1% mortality, respectively.

The *R. graveolens* plants have glycosides (rutin), aromatic lactones (coumarin, bergapten, xantotoxine, rutaretine and rutamarine), anthocyanins glycosides, alkaloids (rutamine, rutalidine, cocusaginine, esquiamianine and ribalinidine), methyl ketones (methylnonil ketone and methyheptil ketone), flavonoids (hesperidine), rutaline, rutacridone and terpenes (a-pinene, limonene, cineole) (MARTINS et al., 2005). These compounds are probably responsible for insecticide effects on *S. zeamais* (ALMEIDA et al., 1999), *Ctenocephalides canis* Curtis (Siphonaptera: Pulicidae) (LEITE et al., 2006) and *D. speciosa* (BARBOSA et al., 2009) as well as on several pests observed in the tomato plants in field conditions in this work.

Aqueous leaf-branch extracts of *Trichilia pallida* Swartz (Meliaceae) presented harmful effects on the development of *T. absoluta* (THOMAZINI et al., 2000) and aqueous extracts of *Prosopis juliflora* (S.w.) D.C. and *Leucaena leucocephala* Wit. (Leguminoseae) in variable concentrations between 3 and 10%, provoking mortality and alterations in the fertility parameters of *B. tabaci* (CAVALCANTE et al., 2006), therefore proving efficiency of vegetable extracts as easy elaboration in the suppression of important pests in tomato plantations.

After 24 hours a smaller number of adults of *Trichogramma* sp. and sum of natural enemies (predators + parasitoids) per tray were observed on the tomato plants that had been sprayed with the extracts of *C. langsdorffii* and *C. ambrosioides* than on the plants that had been treated with *R. graveolens* and the control group (Table 2). A smaller number of Eulophidae (Hymenoptera, parasitoid of *T. absoluta* caterpillars) was noted on tomato plants sprayed with the extract of *R. graveolens* than on the ones that had been treated with *C. langsdorffii* and *C. ambrosioides* and the control (Table 2). A smaller number of sum of parasitoids than in the control was observed in the plots sprayed with the extracts studied (Table 2). On the other hand, a higher number of *Syrphus* sp. larvae (Diptera: Syrphidae, predators of aphids) than in the other treatments was noted on the tomato plants that had received the extracts of *R. graveolens* (Table 2). A higher number of sum of ants, basically *Crematogaster* sp. (Hymenoptera: Formicidae), than the other treatments was observed on the plants sprayed with extract of *C. langsdorffii*, followed by the control group (Table 2).

However, after 72 hours, significant effects were detected on *Chrysoperla* sp. larvae (Neuroptera: Chrysopidae, predator of aphids, nymphs of whitefly and eggs of lepidopterous), observing larger numbers on sprayed tomato plants with *C. langsdorffii* extracts (Table 2). No significant effects ($p > 0.05$) were observed in the sum of predators after 24 hours as well as after 72 hours like Carabidae (Coleoptera) (0.26 ± 0.02/tray), *Orius* sp. (Hemiptera: Anthocoridae) (0.05 ± 0.01/tray), Vespidae (Hymenoptera) (0.03 ± 0.01/tray) and spiders (0.28 ± 0.02/tray) as well as in parasitoids like *Encarsia* sp. (Aphelinidae) (0.01 ± 0.001/tray) and the parasitoid not identified (0.38 ± 0.03/tray) (Hymenoptera).

A higher number of eggs of *E. kuehniella*, parasitized and not emerged per total eggs, was observed in cards sprayed with *C. langsdorffii* extract, demonstrating a possible insecticide effect of this extract when compared with the extracts of *C. ambrosioides*, *R. graveolens* and control, as well as no preference of insect predators and parasitoids in the cards treated with *C. langsdorffii* (Table 3). It was verified that the cards with eggs of *E. kuehniella*, sprayed with the extract of the plant *R. graveolens*, presented a larger residual insecticide effect.

There was a larger number of parasitized eggs and without emergence of parasitized eggs, with approximately 75% of embryos dead, with a smaller number of *Trichogramma* sp. emerged compared with *C. langsdorffii*, *C. ambrosioides* and the control group (Table 3).

Table 2. Effect of extracts of *Copaifera langsdorfii*, *Chenopodium ambrosioides* and *Ruta graveolens* in the number (±standard error) of *Trichogramma* sp., Eulophidae, larvae of *Syrphus* sp., larvae of *Chrysoperla* sp., sum of ants, sum of parasitoids, sum of predators and sum of natural enemies/tray on the *Lycopersicon esculentum*. Montes Claros, Minas Gerais State, Brazil, 2007.

		Trichogramma sp.		
Evaluation (hours)	Control	*C. langsdorfii*	*C. ambrosioides*	*R. graveolens*
24	0.37±0.06Aa	0.20±0.05Ba	0.16±0.03Ba	0.26±0.05ABa
72	0.14±0.03Aa	0.18±0.05Aa	0.10±0.03Aa	0.20±0.04Aa
		Eulophidae		
24	0.52±0.09Aa	0.38±0.08ABa	0.34±0.07ABa	0.28±0.08Ba
72	0.72±0.06Aa	0.47±0.05Aa	0.48±0.06Aa	0.55±0.04Aa
		Syrphus sp.		
24	0.02±0.01Ba	0.00±0.00Ba	0.02±0.01Ba	0.10±0.03Aa
72	0.02±0.01Aa	0.02±0.01Aa	0.01±0.01Aa	0.05±0.02Aa
		Chrysoperla sp.		
24	0.04±0.02Aa	0.01±0.01Aa	0.00±0.00Aa	0.03±0.01Aa
72	0.00±0.00Ba	0.05±0.02Aa	0.01±0.01Ba	0.00±0.00Ba
		Sum of ants		
24	0.01±0.01ABa	0.04±0.01Aa	0.00±0.00Ba	0.00±0.00Ba
72	0.00±0.00Aa	0.01±0.01Aa	0.00±0.00Aa	0.00±0.00Aa
		Sum of parasitoids		
24	0.91±0.12Aa	0.58±0.10Ba	0.55±0.09Ba	0.54±0.10Ba
72	0.72±0.12Aa	0.47±0.07Aa	0.48±0.08Aa	0.55±0.11Aa
		Sum of predadors		
24	0.63±0.07Aa	0.51±0.07Aa	0.58±0.09Aa	0.74±0.09Aa
72	0.67±0.09Aa	0.71±0.09Aa	0.59±0.08Aa	0.72±0.10Aa
		Sum of natural enemies		
24	1.54±0.14Aa	1.08±0.13Ba	1.13±0.13Ba	1.27±0.13ABa
72	1.39±0.16Aa	1.17±0.11Aa	1.07±0.11Aa	1.28±0.16Aa

The average followed by the same capital letter within a row or lowercase letter within a column did not differ in Tukey test ($p < 0.05$).

Table 3. Effect of extracts of *Copaifera langsdorfii*, *Chenopodium ambrosioides* and *Ruta graveolens* on the percentages (±standard error) of eggs not parasitized, *Trichogramma* sp. emerged, eggs predated and eggs parasitized not emerged per total eggs and eggs parasitized not emerged per total eggs parasitized. Montes Claros, Minas Gerais State, Brazil, 2007.

		Treatments		
Characteristics	Control	*C. langsdorfii*	*C. ambrosioides*	*R. graveolens*
Eggs not parasitized (%)/total eggs	44.64±12.53A	67.34±9.36A	61.84±11.12A	43.15±11.03A
Trichogramma sp. emerged (%)/total eggs	0.55±0.37A	0.30±0.08A	0.27±0.13A	0.01±0.01A
Eggs predated (%)/total eggs	54.79±12.69A	32.29±9.42A	37.85±11.18A	56.81±11.04A
Eggs parasitized not emerged (%)/total eggs	0.02±0.00B	0.07±0.01A	0.04±0.01AB	0.03±0.01B
Eggs parasitized not emerged (%)/total eggs parasitized	17.59±11.13B	21.48±4.47B	15.49±4.92B	75.00±11.18A

The average followed by the same capital letter within a row did not differ in Tukey test ($p < 0.05$).

It is probable that the spots treated with *C. langsdorffii* extract presented selectivity to ants, and the spots treated with *R. graveolens* presented selectivity to Syrphidae in function of the dose and formulation of the extracts used, because the effect of the botanical insecticides on insects is variable (MOREIRA et al., 2006).

Works regarding alternative control of insects through vegetable extracts focus on their compatibility with other management tactics, mainly with biological control. However, the answers found in this experiment for low selectivity of the extract of *R. graveolens* and *C. langsdorfii* on insects of the genus *Trichogramma* were verified by Raguram and Singh (1999) and Reddy and Manjunatha (2000) by testing the insecticide effect of *Azadirachta indicates* A. Juss on natural enemies. Carvalho et al. (2001) studied the insecticide effect of commercial products used mainly in tomato plantations on *T. pretiosum*.

They verified, under laboratory conditions, that the chemicals clorfluazuron, teflubenzuron, triflumuron, cyromazine, benomyl, chlorothalonil, mancozeb, iprodione, dimetomorf, tebufenozide and pirimicarb were selective to the two lineages of *T. pretiosum*, as well as the biological commercial product *Bacillus thuringiensis*, reaching a mortality of up to 30%. However, it is known that those synthetic chemicals remain for a longer time in the environment than natural insecticides – a fact that should be considered at the moment of choosing the product to be applied, as well as the best application time.

Conclusion

We conclude that the extract from *C. langsdorffii* presents insecticide action after 24 hours and maintains a good residual effect until 72 hours after application. *C. langsdorffii* has a greater insecticide effect on natural enemies than *C. ambrosioides* and *R. graveolens*. The extract elaborated with *R. graveolens* shows to be more selective to natural enemies than *C. langsdorffii* and *C. ambrosioides*.

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