International Journal of Plant & Soil Science

Volume 35, Issue 8, Page 26-33, 2023; Article no.IJPSS.98095
ISSN: 2320-7035

Interaction between Castor Bean oil and Jatropha oil to Control the Brassica Aphids

Ana Beatriz Mamedes Piffer [a*], Anderson Mathias Holtz [a], Jéssica Mayara Coffler Botti [b], Jose Romário de Carvalho [c], Ronilda Lana Aguiar [a], Amanda Gonçalves Alves [a], Ana Clara Paiva Gomides [a], Johnatan Jair de Paula Marchiori [d], Bruna de Oliveira Magnani [a], Evellyn Zuqui Bolsoni [a] and Patricia Soares Furno Fontes [a]

[a] Agricultural Entomology and Acarology Laboratory, Federal Institute of Education Science and Technology of Espírito Santo - Campus Itapina, Colatina, Brazil.
[b] Department of Entomology, Federal University of Viçosa, Viçosa, Brazil.
[c] School Management, Secretary of State for Education of Espírito Santo, Guaçuí, Brazil.
[d] Environmental Sciences, Federal Rural University of Rio de Janeiro, Institute of Forests, Seropédica, Brazil.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i82879

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/98095

Original Research Article

Received: 28/01/2023
Accepted: 30/03/2023
Published: 01/04/2023

**Corresponding author: E-mail: ana.piffer123@gmail.com;*

ABSTRACT

The aim of this work was to study the effect of the interaction between castor bean oil (*Ricinus communis*) and jatropha oil (*Jatropha curcas*) on the aphid, *Myzus persicae*. The experiment was realized at the Institute Federal of Espírito Santo in Brazil. Tests were conducted in a completely randomized design, with 11 treatments and 10 repetitions, arranged in a factorial arrangement of 11 (interactions between oils) x 2 (application forms). The concentration used in this test was 3 %. Treatment interaction ratios were 0-100; 10-90; 20-80; 30 -70; 40-60; 50-50; 60-40; 70-30; 80-20; 90-10; 100-0 % jatropha and castor bean oil, respectively. Tests of direct and indirect application were performed. The evaluations were performed 24, 48, and 72 hours after the applications. For both forms of application, there were significant mortalities. Mortalities greater than 70 % were observed when the interaction contained more significant amounts of jatropha than castor bean. However, a negative interaction was observed between concentrations with similar proportions. In conclusion, for both application forms, the interaction between jatropha and castor bean oils effectively reduce the population of *M. persicae*.

Keywords: Alternative control; Brazil; Myzus persicae; Jatropha curcas; Ricinus communis.

1. INTRODUCTION

The brassica aphid, *Myzus persicae* (Sulzer, 1776) (Hemiptera: Aphidadae) is a generalist insect that attacks several agricultural species, mainly the Brassicaceae family [1,2]. In outbreak, *M. persicae* feed on the leaf tissue and reduce the host's photosynthetic potential, promoting the leaves' deformation and wilting [3]. Among these host species, kale (*Brassica oleracea* L. var. *acephala*) is one of Brazil's most cultivated and consumed plant. It contains a high concentration of nutrients, namely iron, vitamins, and vegetable fibers that contribute to better intestinal flow functioning, regulate blood sugar and help lower cholesterol [4-6].

The traditional kale cultivation system induces the resistance of these plants to pest attacks [7]. Currently, aphid control is done by indiscriminately applying synthetic insecticides [8]. As well, the misuse of these products contributes to the contamination of food and the environment due to the presence of residues that persist through time. Besides that, it causes harmful effects throughout the production chain of the culture, including natural enemies [8,9].

In this context, research related to the use of plant-derived formulations demonstrates satisfactory efficiency in controlling target organisms [10] and have been highlighted in the sustainable management of pests. These are part of the 17 Global Sustainable Development Goals that seek sustainable alternatives for food production [11].

The species belonging to the Euphorbiaceae family demonstrated an insecticidal activity against several pests. *Jatropha curcas* extracts were mentioned as having efficiency in pest control [12]. According to Holtz et al. [13], the essential oil of *J. curcas* was effective against *Brevicoryne brassicae* L.1758 (Hemiptera: Aphididae). Likewise, *Ricinus communis* demonstrated its effectiveness in controlling the corn leafhopper, *Dalbulus maidis* (Hemiptera: Cicadellidae) and *Macrosiphum rosae* L. (Hemiptera: Aphididae) [14].

Thus, since studies addressing the interaction between species of insecticidal plants are still scarce, the aim of this study was to evaluate the insecticidal activity of oils extracted from *R. communis* (Castor bean) and *J. curcas* (Jatropha) on the brassica aphid, *M. persicae*.

2. MATERIALS AND METHODS

2.1 Sampling

Myzus persicae breeding was established on kale plants (*B. oleracea* var. *acephala*) in a greenhouse, without any phytosanitary treatment at the Federal Institute of Education, Science, and Technology of Espírito Santo (IFES-Campus Itapina), located in the municipality of Colatina, the northwest region of Espírito Santo (Brazil). Geographic coordinates: 19°29'52" south latitude, 40°45'38" west longitude, and altitude 61 meters above sea level (Fig. 1).

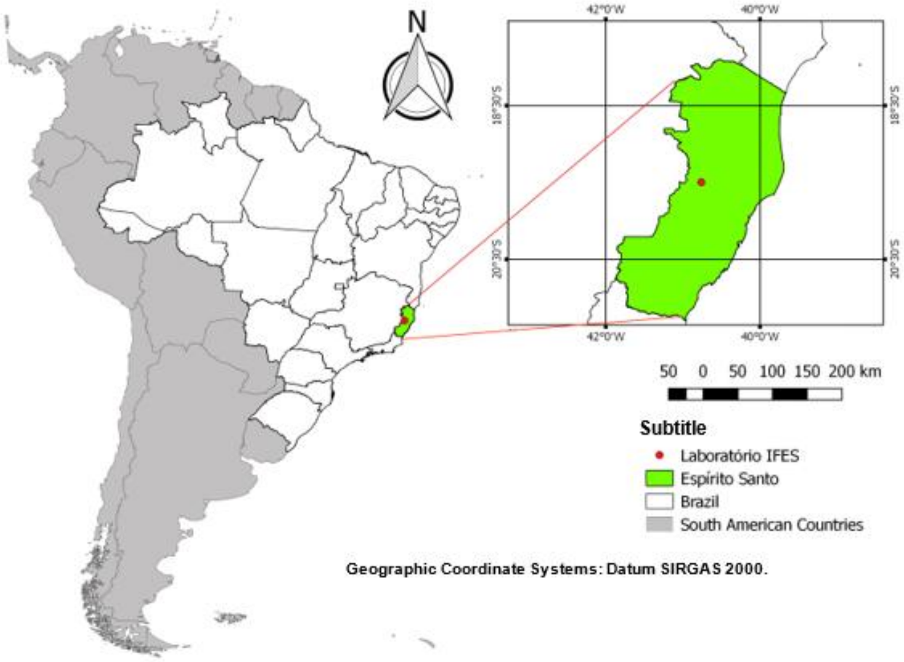

Fig. 1. Maps of study site
Source: Authors

2.2 Preparation of the Oils

Castor bean and Jatropha seeds were collected in the productive areas of the IFES-Campus Itapina and were subjected to oil extraction by cold pressing. According to Holtz et al. [13] protocol, the concentration used in these tests was 3 %. Treatment interaction rates were arranged in Table 1.

Dilutions of treatments were arranged in Table 2 of jatropha oil and castor oil, respectively, in 100 mL of solvent (distilled water). Then, the mixture remained under stirring (magnetic stirrer) for four hours at room temperature. For the dilution and application of jatropha and castor oil, distilled water with Tween® 80 adhesive spreader (0.05 %) was used.

Table 1. Treatment interaction rations of jatropha and castor oil

Treatments	Jatropha (%[1])	Castor Bean (%[1])
T1	0	100
T2	10	90
T3	20	80
T4	30	70
T5	40	60
T6	50	50
T7	60	40
T8	70	30
T9	80	20
T10	90	10
T11	100	0

[1]*Extract percentage*

Table 2. Dilutions of the interaction rations of jatropha and castor oil in volume/volume

Treatments	Jatropha	Castor Bean
T1	0.0	3.0
T2	0.3	2.7
T3	0.6	2.4
T4	0.9	2.1
T5	1.2	1.8
T6	1.5	1.5
T7	1.8	1.2
T8	2.1	0.9
T9	2.4	0.6
T10	2.7	0.3
T11	3	0.0

[1]*Extract dilutions (v/v)*

2.3 Bioassays and Application

To carry out the tests, kale plants were grown in a greenhouse in the IFES-Campus Itapina. The leaves were collected weekly and taken to the laboratory, where they were washed with distilled water, dried on paper towels, packed in gerbox-type plastic boxes, and two different application tests were performed; direct and indirect application of the interaction between castor oil and jatropha oil on *M. persicae*. The tests were carried out in acclimatized chambers at a temperature of 25 ± 1º C, relative humidity of 70 % ± 10 %, and a 12-hour photophase.

Each of the treatments was applied to 10 individuals of *M. persicae* kept in Petri dishes (10.0 x 1.2 cm), on discs (4 cm in diameter) of kale leaves (*B. oleracea* var. *acephala*). These discs were placed in Petri dishes on filter paper moistened (daily) with distilled water to maintain turgidity. A Potter's tower was used to apply the solutions on the aphids, with a pressure of 15 Lb/pol² and 6 mL volume per repetition. The experiment was conducted in an 11 x 10 factorial design (11 treatments and 10 repetitions), with each Petri dish constituting a repetition. In order to obtain a larger sample number, a greater number of repetitions were used so that the work has greater credibility and an efficient sampling effort for such objectives of this present work. Individual mortality was evaluated 24, 48, and 72 hours after spraying.

The indirect application test was performed under the same conditions as the previous test. However, in this experiment, the kale discs were immersed for 5 seconds in the different test treatments. Subsequently, they were placed on paper towels to dry the excess solution for 20 minutes. After that, the discs were gently wiped with paper towels to remove the excess solution. Then, the disks were placed in Petri dishes, on filter paper, as described above. Ten replicates were performed per treatment.

2.4 Statistical Analysis

The data from the different treatments from the interaction of jatropha oil and castor oil were submitted to the Scott-Knott test, at the 5 % probability level and, between the application form, they were submitted to the F test, at the level 5 % probability. The mortality was corrected by Abbott's formula [15].

3. RESULTS AND DISCUSSION

Mortality of *M. persicae* varied according to the form of application and proportion of jatropha and castor oils, with a significant interaction between these factors ($F_{(10, 198)} = 14.55$; $P < 0.0001$). The direct application test caused higher mortality of aphids in most of the evaluated proportions, equaling the indirect application only in the proportions of 30-70, 80-20, 90-10, and 100-0 (Table 1).

Table 3. Corrected mortality (%) of *Myzus persicae*, caused by the interaction of jatropha and castor oil in different proportions and forms of application, after three days. The temperature of 25 ± 1 º C, RH 70 ± 10 %, and photophase of 12 hours

Treatments	Forms of application[1,2,3]	
	Mortality (%) Direct	Mortality (%) Indirect
T1	56.1 ± 7.74Ba	2.6 ± 1.48Db
T2	57.23 ± 6.27Ba	4.7 ± 1.82Db
T3	65.6 ± 6.29Aa	12.6 ± 5.14Cb
T4	29.0 ± 3.98Ca	21.0 ± 5.82Ca
T5	56.6 ± 6.28Ba	1.4 ± 0.59Db
T6	49.8 ± 5.89Ba	8.6 ± 4.34Db
T7	77.0 ± 6.78Aa	4.3 ± 1.88Db
T8	74.0 ± 5.11Aa	2.3 ± 1.35Db
T9	74.4 ± 7.01Aa	70.0 ± 7.36Aa
T10	76.6 ± 7.84Aa	84.2 ± 5.46Aa
T11	59.2 ± 4.88Ba	54.3 ± 5.85Ba

[1]Averages (±SE) followed by the same capital letter, in the column, do not differ statistically from each other by the Scott-Knott test, at 5 % probability; [2]Averages (± SE) followed by the same lowercase letter, on the line, do not differ statistically from each other by the F test, at 5 % probability; [3]Data transformed to arc sin $(x/100)^{0.5}$

The form of direct application caused mortality rates greater than 74 %, in the treatments T7, T8, and T9 (77.0; 74.0; 74.4 and 76.6 % respectively) of jatropha and castor beans. As for the indirect application, the highest mortality rates were observed in the T9 and T10 ratios (70.0 and 84.2 % respectively). Therefore, in proportions with significantly higher amounts of jatropha, both application methods caused similar mortality rates.

This mortality can be attributed to the toxic effect of jatropha oil, which is mainly related to the presence of two components in *J. curcas* seeds [16,17]. Curcin is a toxic substance extracted from jatropha that acts by preventing a ribosome-inactivating protein, inhibiting the protein synthesis of organisms in contact [16]. Phorbol esters, on the other side, act on the cells of the digestive tract and the insects, also in nerve cells, preventing both feeding for survival and interrupting phases of metamorphosis, altering the organism's development cycle [18,12]. Jatropha leaf extract showed lethal efficacy in controlling *Aedes aegypti* (Diptera: Culicidae). Statistical data of our results demonstrated the efficiency of the extract in dependent and increasing doses up to a maximum concentration of 1000 µl (v/v) 100 %. The efficacy is associated with the aforementioned metabolites curcin and phorbol, as well as the presence of phytates, lectins, saponins, and co-carcinogenic substances [19].

According to Prabowo [18], the sublethal effect of jatropha seed oil applied on *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae) caused changes in the development of pre-pulps and pulps of individuals. In addition, the author found a sub-effect of changes in the oviposition of the descendant generation and in the metamorphosis of individuals from eggs to larvae.

In the intermediate proportions treatments T5, T6, and, T7, with similar amounts of jatropha and castor bean, the direct application form (56.6, 49.8, 77.0 % respectively) surpassed the presented mortality by indirect (1.4, 8.6, 4.3 % respectively). However, the interaction of the two substances in intermediate amounts in the different forms of application (Table 3) may be interfering negatively with the mortality of *M. persicae*, as there were higher mortalities in the interaction of the treatment T7 in the direct application, and the treatment T9 in indirect. When the oils are at a balanced or equal concentration, mortality is lower compared to the substances used separately.

Mortality at high concentrations of castor bean is probably related to the presence of ricin, a highly toxic protein isolated from castor bean seeds. It inhibits protein synthesis in living organisms [20,21]. Furthermore, the presence of 2S albumins, reserve proteins, and allergens in *R. communis* seeds may also be related to the mortality of *M. persicae*, as they act as inhibitors of the activity of the α-amylase enzyme of the *Zabrotes subfasciatus* Boheman (Coleoptera: Bruchidae), *Callosobruchus maculatus* Fab. (Coleoptera: Bruchidae) and *Tenebrio molitor* L. (Coleoptera: Tenebrionidae) insects [22].

Thus, probably, the substances existing in the different oils simultaneously affect the effect of mortality when they are in balance. The results obtained here demonstrate a high inhibition potential when high doses of castor bean are correlated with the substances of jatropha. Possibly the interaction of the different substances present in the oils nullifies their insecticidal effect, as some plant extracts when mixed with others, may present variations in their effect [23,24]. However, when there is a minimum concentration of castor oil, the action of jatropha oil occurs, with a positive synergistic interaction of the anti-food and insecticidal effects of the substances present in the oils of J. curcas and R. communis [19]. Research conducted by Feng et al. [25] found a positive interaction effect between two major compounds extracted from the essential oil of *Valerianaceae* spp. used against the flour beetle *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae).

4. CONCLUSION

The interactions of jatropha oil (*J. curcas*) and castor oil (*R. communis*) caused a mortality of 76.6 % for direct application, and 84.2 % for indirect application of *M. persicae*. This insecticidal activity may be useful in the research of synthetic product for better management of aphids.

ACKNOWLEDGEMENTS

This project was made possible by the Federal Institute of Espírito Santo and the National Council for Scientific and Technological Development.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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