Original Research Article

Interaction between Castor bean oil and Jatropha oil to control the brassica aphids

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ABSTRACT

The objective of this work was to study the effect of the interaction between castor bean oil (*Ricinus communis*) and jatropha oil (*Jatropha curcas*) on *Myzus persicae*. The experiment was realized at the Institute Federal of Espírito Santo, the 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. The arenas were composed of kale leaf discs (4 cm diameter) containing 10 aphids. Tests of direct and indirect application were performed. In the direct application test, the solution was applied to the aphids using a Potter's tower, with a pressure of 15 Lb.pol² -1 and a volume of 6 mL of solution per repetition. In the indirect application, the kale leaf disks were immersed in the defined solutions and then the aphids were inoculated on the leaf. For the dilution of the oils, distilled water was used with Tween® 80 adhesive spreader (0.05 %). 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 oil effectively manages *M. persicae*.

Keywords: Alternative Control, 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, among them plants of the Brassicaceae family [1,2]. When feeding on the leaf tissue in high infestations, they reduce the host's photosynthetic potential, promoting the leaves' deformation and wilting [3]. Among the species attacked, kale (*Brassica oleracea* L. var. *acephala*) is one of Brazil's most cultivated and consumed brassica species. The plant contains a high concentration of nutrients such as iron, vitamins, and vegetable fibers that contribute to better intestinal flow functioning. In addition, they fight diabetes and help lower cholesterol [4-6].

The traditional kale cultivation system induces the resistance of these plants to pest attacks since aphid control is done by indiscriminately applying synthetic insecticides [7]. As well, the incorrect use 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 [7,8].

In this context, plant-derived formulations have been highlighted in the sustainable management of pests. Research related to the use of extracts and substances obtained from plants demonstrates satisfactory efficiency in controlling target organisms [9]. These are part of the 17 Global Sustainable Development Goals that seek sustainable alternatives for food production [10].

One of the plants is jatropha (*Jatropha curcas*), which is mentioned as having efficiency in pest control [11]. According to Holtz *et al.* [12], the essential oil of *J. curcas* was effective against *Brevicoryne brassicae* L.1758 (Hemiptera: Aphididae) at all concentrations tested, with its toxicity attributed to the different secondary metabolites of the seeds.

Castor bean (*Ricinus communis*), another example of a plant with insecticidal activity, has demonstrated its effectiveness in controlling pests. Research has indicated the toxicity of castor bean extract on the corn leafhopper *Dalbulus maidis* (Hemiptera: Cicadellidae) and *Macrosiphum rosae* L. (Hemiptera: Aphididae). Probably the efficiency of formulations based on *R. communis* is associated with the presence of secondary compounds such as alkaloids and polyphenols present in the plant [13].

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

2. MATERIAL AND METHODS

The experiment was performed at the Federal Institute of Education, Science, and Technology of Espírito Santo - Campus Itapina (IFES-Campus Itapina), located in the municipality of Colatina, the northwest region of Espírito Santo, with geographic coordinates of 19°29'52'' south latitude, 40°45'38'' west longitude, and altitude 61 meters. Two types of tests were carried out in the laboratory: 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. For the laboratory tests, *M. persicae* breeding was established on kale plants (*B. oleracea* var. *acephala*) in a greenhouse, without any phytosanitary treatment.

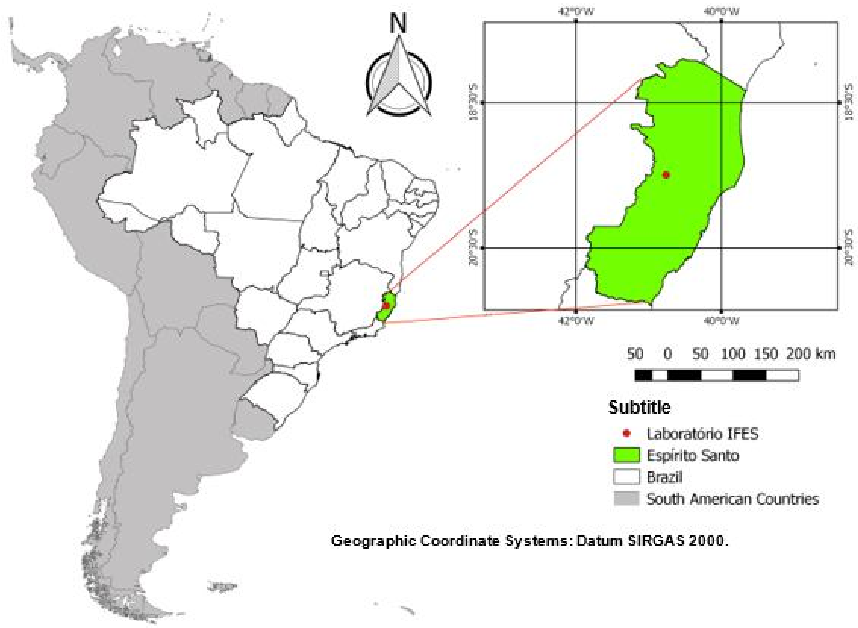

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Fig. 1. Maps of geographical coordinates of Federal Institute of Education, Science, and Technology of Espírito Santo - Campus Itapina (IFES-Campus Itapina).

2.1 Preparation of oils and interaction relationships of bioassays

To make the oils, castor bean, and jatropha seeds were collected in the productive areas of the IFES-Campus Itapina. After this procedure, the castor bean and jatropha seeds were subjected to oil extraction by cold pressing. The concentration used in these tests 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, and, 100-0 of jatropha oil and castor oil, respectively. Dilutions of treatments were found to be 0.0-3.0, 0.3-2.7, 0.6-2.4, 0.9-2.1, 1.2-1.8, 1.5-1.5, 1.8-1.2, 2.1-0.9, 2.4-0.6, 2.7-0.3, and 3.0-0.0 (v/v) 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.

2.2 Bioassays

To carry out the tests, kale plants were grown in a greenhouse in the Horticulture sector of the Federal Institute of Education, Science, and Technology of Espírito Santo - Campus Itapina (IFES-Campus Itapina), located in the municipality of Colatina, the northwest region of Espírito Santo, with geographic coordinates of 19°29'52'' south latitude, 40°45'38'' west longitude and 61 meters of altitude. 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.

2.3 Direct Application Test

Each of the treatments (previously determined) was applied to 10 individuals of *M. persicae*, which were 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/pol^2 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. Individual mortality was evaluated 24, 48, and 72 hours after spraying. 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 [14].

2.4 Indirect Application Test

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. The evaluations, the observed parameters, and the statistical analysis conformed with the previous test.

3. RESULTS AND DISCUSSION

Mortality of *M. persicae* varied according to the form of application and proportion of jatropha oil and castor oil, 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 1. 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.

Jatropha – Castor Bean (%)	Forms of application[1,2,3]	
	Direct	Indirect
0–100	56.1 ± 7.74Ba	2.6 ± 1.48Db
10–90	57.23 ± 6.27Ba	4.7 ± 1.82Db
20–80	65.6 ± 6.29Aa	12.6 ± 5.14Cb
30–70	29.0 ± 3.98Ca	21.0 ± 5.82Ca
40–60	56.6 ± 6.28Ba	1.4 ± 0.59Db
50–50	49.8 ± 5.89Ba	8.6 ± 4.34Db
60–40	77.0 ± 6.78Aa	4.3 ± 1.88Db
70–30	74.0 ± 5.11Aa	2.3 ± 1.35Db
80–20	74.4 ± 7.01Aa	70.0 ± 7.36Aa
90-10	76.6 ± 7.84Aa	84.2 ± 5.46Aa
100-0	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 proportions of 60-40, 70-30, 80-20, and 90-10 (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 80-20 and 90-10 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 [15,16]. Curcin is a toxic substance extracted from jatropha that acts by preventing a ribosome-inactivating protein, inhibiting the protein synthesis of organisms in contact [15]. 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 [17, 11]. Jatropha leaf extract showed lethal efficacy in controlling *Aedes aegypti* (Diptera: Culicidae). Statistical data 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 [18].

According to Prabowo [17], 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, 40-60, 50-50, and, 60-40, 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, as observed in Table 01, the interaction of the two substances in intermediate amounts in the different forms of application may be interfering negatively with the mortality of *M. persicae*, as there were higher mortalities in the interaction of 60-40 in the direct application, and 80-20 in indirect. Demonstrating that, if the oils are at a balanced or equal concentration, mortality is lower compared to the substances alone, with the need for interaction between them, but requiring a greater amount of jatropha oil than castor oil.

Mortality at high concentrations of castor bean is probably related to the presence of ricin, a highly toxic protein isolated from castor bean seeds (*R. communis*), this substance acts on two different polypeptide chains, with functions of inhibiting protein synthesis in living organisms [19, 20]. 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 [21].

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 [22, 23]. 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.* [24] 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).

In addition, we can observe similar actions by contact and ingestion of the extract causing mortality of *M. persicae* individuals. Pang *et al.* [25], when testing the essential oil of the leaves of *Mentha piperita* and some substances extracted from the essential oil against *T. castaneum, Lasioderma serricorne* (Coleoptera: Anobiidae) and *Liposcelis bostrychophila* (Psocoptera: Liposcelididae), found toxicity significant contact time at the highest concentration tested.

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, presenting insecticidal action in the management of *M. persicae*.

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