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Alternative management of *Tetranychus urticae* with extract of the jatropha pie

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Abstract
The two-spotted spider mite, *Tetranychus urticae* Koch, is one of the most important mite species in the world, this specie is related to attacking more than 250 crops of economic importance. This pest can occur year-round but grows best in warmer and drier times. This way, the objective of this work was to evaluate the acaricidal potential of the extract of the jatropha pie (*Jatropha curcas* L), in different concentrations, aiming for the pest management of *T. urticae*. The solutions were sprayed under sheets of *Canavalia ensiformis*, with the support of the Potter tower, consisting of direct application. In the indirect route of application, the leaf discs were immersed in the extract solution of the *J. curcas*, placed on a paper towel to dry, and subsequently, transferred to Petri dishes, with cotton moistened on the bottom and sides. Females of *T. urticae* were transferred to leaf discs. Ten replicates were used per treatment, evaluating the mortality as a function of post-spraying time. At all concentrations tested, the direct application treatment was superior to the indirect application, causing greater mortality of the two-spotted spider mite in laboratory conditions.

Keywords: *Jatropha curcas*, botanical insecticide, alternative control, two-spotted spider mite

1. Introduction
The two-spotted spider mite, *Tetranychus urticae* Koch, 1836 (Acari: Tetranychidae), is one of the most important mite species in the world, that causes diverse damages to cultures of economic interest, among them, the strawberry and papaya [1, 2]. Due to the sucking habit of the mite, there are yellowish spots on the leaves that, can evolve to necrosis and drought of the whole leaf blade, depending on the degree of the infestation, reducing the photosynthetic rate, affecting its growth and reducing the number and weight of fruits [3, 4].
Among the methods used to control mites in agriculture, chemical is the most usual [5]. However, the intensive use of these products, often, not registered for a particular organism, can cause the resurgence of the target pest, as well as the appearance of new pests, as well as human health problems, and environmental damage [6].
For these reasons, the search for alternative methods to control insect pests and mites has increased significantly, to minimize the use of insecticides/acaricides synthetic in the field. There are countless advantages to using products of natural origin, among them we can mention the fact that they are obtained from renewable resources, are rapidly biodegraded and the development of mite and insect resistance to these substances is a slow process [5].
Among the plant species that can be used in the alternative management of insect pests is the *Jatropha curcas* L., belonging to the Euphorbiaceae family, it is a fast-growing shrub, which can be found in several intertropical regions, besides its easy adaptation to different environments [7]. The jatropha pie has great importance since it has high oleaginous potential for biodiesel production. There are many advantages to its cultivation, including its high yield and productivity for about 40 years [8].
Thus, the objective of this work was to evaluate the acaricidal of the seed extract of *J. curcas*, aiming at the management of *T. urticae*.

2. Materials 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 (Fig. 1). Two types of tests were carried out in the laboratory: direct and indirect application of the extract of jatropha pie on *T. urticae*. The tests were carried out in acclimatized chambers at a temperature of 25 ± 1 ºC, relative humidity of 70% ± 10%, and a 12-hour photophase.

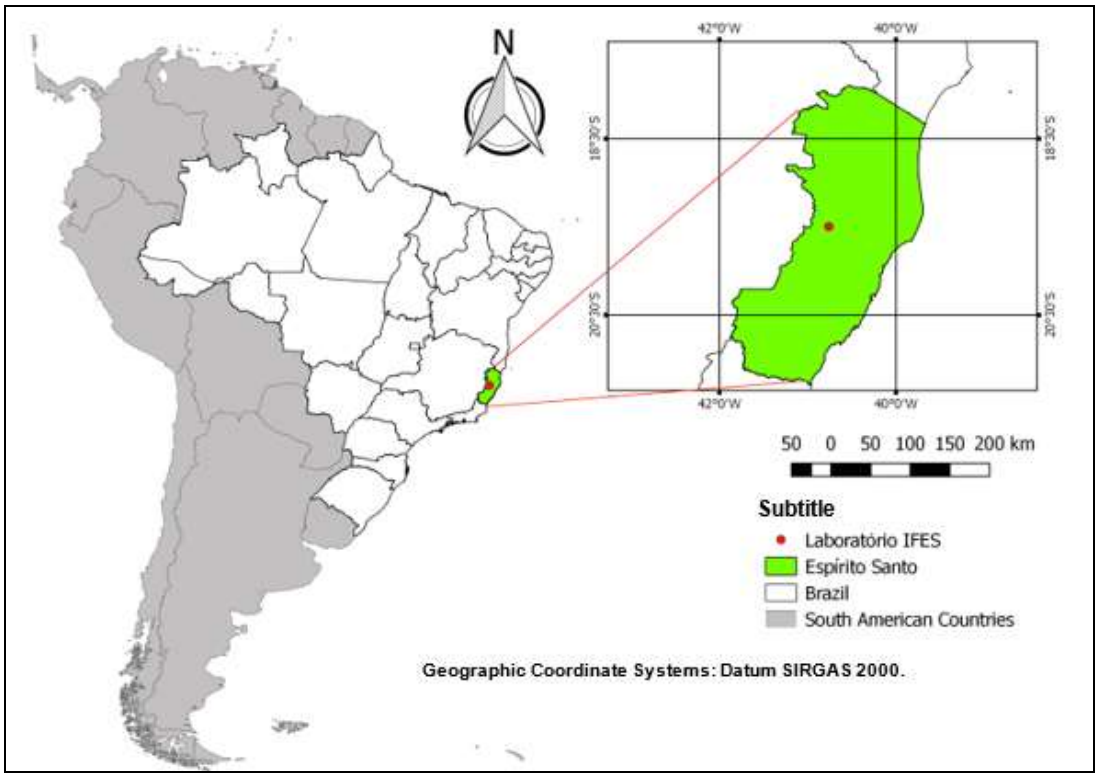

Fig 1: Map of the geographical position of the Federal Institute of Espírito Santo - Campus Itapina (IFES-Campus Itapina)

2.1 Preparation of oils and interaction relationships of bioassays

For the laboratory tests, *T. urticae* breeding was established on plants of *Canavalia ensiformis*, without any phytosanitary treatment, grown in pots. The jatropha pie was obtained from the cold pressing of the seeds collected in the experimental area of the IFES- Campus Itapina (Fig. 1), from which the extracts were prepared. The concentrations of the pie extract used in the experiment were 0,0, 0,5, 1,0, 1,5, 2,0, 2,5 e 3,0% (v/v). For dilution and application of the extract, distilled water with adhesive spreader Tween® 80 (0,05%) was used. Then, the mixture remained under stirring (magnetic stirrer) for four hours at room temperature. After that, the solution was strained and stored for the two different bioassays.

2.2 Direct Application Test

Leaves of *C. ensiformis* were removed periodically, washed with distilled water, dried on filter paper, and packed in gearbox plastic boxes. Subsequently, 10 females of *T. urticae* were transferred to the leaf discs (4 cm diameter) using a fine-bristled brush. These were packed in Petri dishes (10 x 1.2 cm). Each of the concentrations of the extract of the pie of *J. curcas* was applied to the leaf discs of *C. ensiforme.* The control treatment consisted of disks sprayed with the solution of distilled water, and adhesive spreader Tween® 80 (0,05%). For the application of the solutions, a Potter tower was used, whose pressure exerted was 15 Lb / in² and the volume of a solution of 6 mL per repetition, consisting of the direct route of application.

Mortality assessments were performed at 24, 48, and 72 hours after spraying. The data were submitted to linear regression analysis.

2.3 Indirect Application Test

For the indirect application route, the leaf discs were immersed for 5 seconds in the solution with the extract of the *J. curcas* cake. After this time, they were placed on a paper towel to dry the excess of the solution. Subsequently, wrapped in Petri dishes with cotton moistened at the bottom and sides of the disk to maintain the turgidity of the leaf disc. Then, 10 females of *T. urticae* were transferred for each Petri dish constituting each one a repetition, totalizing 10.

Mortality assessments were performed at 24, 48, and 72 hours after spraying. The data were submitted to linear regression analysis.

3. Results

There was no significant interaction between the forms of application (direct and indirect form) and the concentration of the extract of the jatropha cake ($F_{5, 108} = 0.458$, $p = 0.80684$). The treatment of direct application was superior to the indirect application, resulting in higher mortality of *T. urticae* at all concentrations tested (Fig. 2).

In both forms of application, the mortality of *T. urticae* varied according to the concentrations. For the direct application form, mortality ranged from 52.5 to 78.6%, assuming a quadratic effect, with a rising mortality curve from the 2% concentration. While, as an indirect application, mortality was adjusted to a linear model, indicating a dose-response effect of jatropha pie extract (Fig. 2).

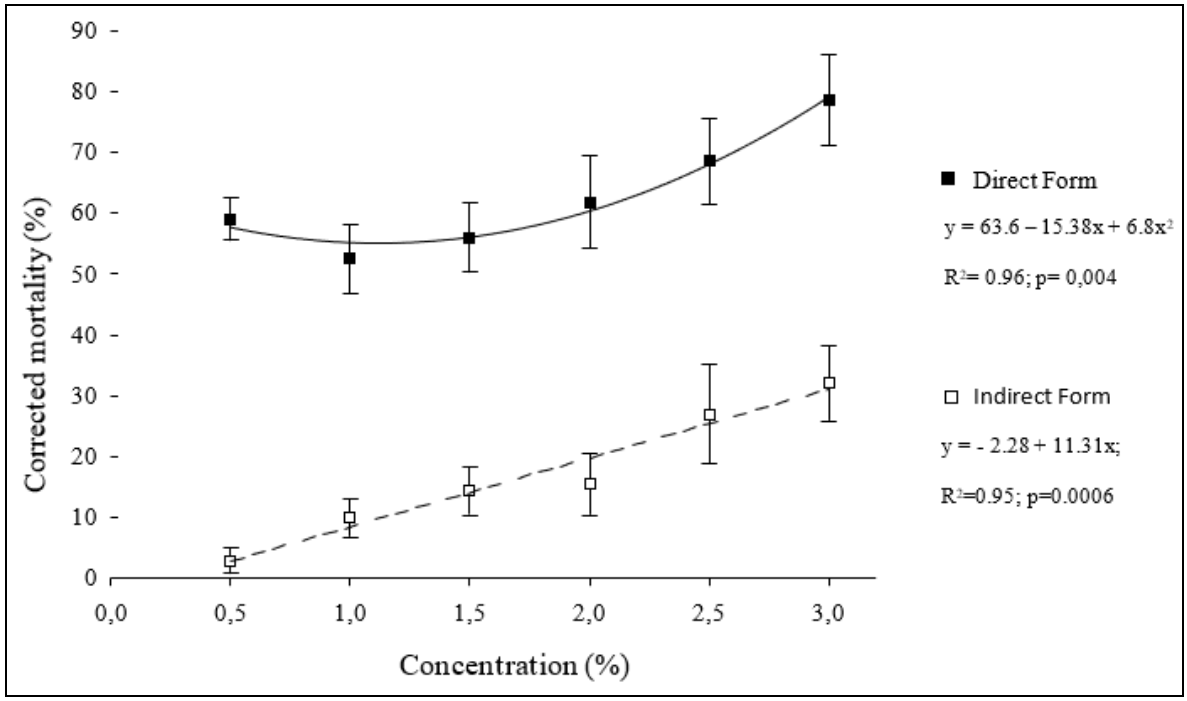

Fig 2: Mortality corrected about the control (Abbott, 1925) of *Tetranychus urticae* treated with extract of the jatropha pie cake in different concentrations, by direct application forms, and indirect. The temperature of 25 ± 1 ° C, RH 70 ± 10%, and photophase of 12 hours

4. Discussion

The toxic action of a plant is due to the presence of chemical constituents and toxic active principles found in plants, these are called secondary metabolites. These compounds are responsible for the defense system of plants, and they have a phytochemical importance to plants. They can be concentrated in leaves, bark, stems, roots, flowers, and seeds [9].

In this way, the mortality of the mites can be attributed to the toxic effect of jatropha, which is mainly related to the presence of two components, curcin, and phorbol esters. Curcin is a toxic substance extracted from jatropha that acts by preventing a ribosome-inactivating protein, inhibiting the protein synthesis of organisms in contact [10]. 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 [11]. Prabowo [12], studying the sublethal effect of jatropha seed oil applied on *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae) observed changes in the development of pre-pulps and pulps of individuals. Also, the authors found a sub-effect of changes in the oviposition of the descendant generation and in the metamorphosis of individuals from eggs to larvae.

Important factors that may have influenced the mortality of the mites are the plant part from which the secondary compounds were extracted and the form of application of the extract. Most of the plant's defense mechanisms are concentrated in the seeds, given their great importance as a vehicle for the propagation and survival of the species [13]. The higher or lower concentration of these compounds is generally determined by exogenous factors such as light, precipitation, place of cultivation, spacing, and sun, as well as by endogenous factors such as plant age and genetic variability in populations [14]. As this study used cold-pressed jatropha seeds, it is possible that there was a higher concentration of secondary compounds. Holtz *et al*. [3] tested the insecticidal potential of Jatropha seeds at different stages of maturation on the aphid *Myzus persicae* (Sulzer) (Hemiptera: Aphididae) and found higher mortality rates of the organism as the maturation stages progressed of the seed.

Furthermore, both forms of application at a concentration of 3.0% were the most efficient against *T. urticae*, causing a mortality of 78.3% when the cake extract was sprayed on the mites, and 32% when sprayed on the mite food (Fig. 2). This demonstrates that there is action in both ways (contact and ingestion). Some authors report that the mode of action of toxins in herbivores through contact is faster than the mode of action through ingestion, since the latter, to act on the target organism, depends on the digestion process for incorporation and action in the vital systems of the pest [15]. Neto *et al*. [16] studied the efficiency of different insecticide application methods on aphids and found significant efficiency of the direct spray form on the green peach aphid, *M. persicae*. The authors observed that the form of direct spraying on the organisms exceeded the estimated lethal concentration of 90% considered for the study, attributing that this method resulted in additional intoxication in aphids due to both ingestion and contact with the insecticide. Similarly, Pang *et al*. [17] 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.

5. Conclusion

In this way, it is concluded that the application of the extract of the jatropha pie is efficient in the management of two-spotted spider mites, thus enabling an alternative form of control of this pest.

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