

## Chapter

# Potent Insecticide Plant

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## Abstract

In this chapter, we will address the effectiveness of these two powerful insecticidal plant species on the survival of eggs and larvae of *Bemisia* spp. (Hemiptera), *Sordidus* spp. (Coleoptera) and *Spodoptera* spp. (Lepidoptera). To obtain the essential oil, the cold pressing method described by Pinheiro and adapted by Barroso was used, where 900 g of seeds of the plant material was placed in the oven at a temperature of  $45 \pm 2^\circ\text{C}$  for 48 h, then the seeds were crushed in a Britânia Diamante Black 4 blender at a speed of 900 W. It was pressed manually in an oil press machine. The resulting aqueous material was placed in a container and sealed with parafilm to prevent evaporation. It was left to rest in the dark at a temperature of  $18 \pm 2^\circ\text{C}$  in an oven for 48 h. It was decanted to separate the essential oil and then filtered to remove suspended solid particles. For the Bioensio with eggs and larvae, four flasks covered with fine mesh were used, each containing 50 eggs of each species, at a temperature of  $25 \pm 2^\circ\text{C}$ . For both cases, 2 ml of essential oil from the three prepared solutions was used. It was verified that: the essential oils of *Ricinus communis* are effective on the mortality of *Bemisia* spp., *Spodoptera* spp. and *Sordidus* spp. larvae, reaching 100% mortality in 7, 9 and 9 days of exposure, respectively; the essential oils of *Azadirachta indica* are effective on the mortality of *Bemisia* spp., *Spodoptera* spp. and *Sordidus* spp. larvae, reaching 100% mortality in 9, 7 and 6 days of exposure, respectively; the solution of *Azadirachta indica* and *Ricinus communis* was the most effective in achieving mortality on *Bemisia* spp., *Spodoptera* spp. and *Sordidus* spp. in 5, 4 and 5 days, respectively.

**Keywords:** plants, *Azadirachta indica*, *Ricinus communis*, mortality, insects

## 1. Introduction

Chemical warfare is a problem that has been going on for many decades. The effects of the use of chemical insecticides led Carson [1] to describe in his work Silent Spring the great environmental consequences resulting from the use of these substances.

For a long time, dichloro-diphenyl-trichloroethane (DDT) was used, but this compound has the ability to persist for a long time in the environment, accumulating in animal and vegetable organisms, thus its use was disapproved. However, the frequent use of insecticides (such as: organophosphates, carbamates and pyrethroids) can lead to the development of insect resistance to these compounds, compromising control and favoring the transmission of diseases [2]. In addition to the development of population resistance to insecticides, there may be a decrease in the population of natural enemies, health risks for humans and animals, contamination of groundwater and a decrease in biodiversity [3].

The environmental problems arising from the use of these chemicals, including public health, led researchers, scientists and others to direct the fight against vectors to another dimension, thinking about sustainability. As a result, background knowledge on phytopharmaceuticals used in some regions of the world for decades was used. For a long time, plants served as a medicinal base for human civilizations.

Therefore, the use of plants with insecticidal properties is not a recent practice. The first phytoinsecticides were pyrethrin extracted from *Chrysanthemum cinerariaefolium*, nicotine (*Nicotiana tabacum* L.), rotenone (*Derris* sp.), ryanodine (*Rhynchospora speciosa*) and sabadina (*Schoenocaulon officinale*) [4].

In this chapter, we want to evaluate the insecticidal effect of two plant species with great potential, *Azadirachta indica* and *Ricinus communis*.

*Azadirachta indica*: Also known as neem belonging to the *Meliaceae* family, it originates from Southeast Asia and is cultivated in all African countries, Australia and Latin America. Originally from a tropical climate, the plant develops well at temperatures above 20°C in well-drained, nonacidic soils and altitudes below 700 m [5, 6].

Researchers have discovered that neem works both in the pesticide and medicinal areas. Its seeds and leaves have been found to combat more than 200 species of insects, cockroach pests, moths, aphids, among others. The tree is probably the only and best source of biopesticide in existence, a potential plant.

*Ricinus communis*: It is a tropical and subtropical evergreen shrub belonging to the *Euphorbiaceae* family. In official Portuguese-speaking countries, the plant is also known as castor bean or castor oil plant [7]. This shrub comes from northeast Africa and the Middle East. It is a fast-growing plant that is distributed throughout tropical and subtropical climates in places such as old fields, rocky slopes and along roadsides. Castor grows best in full exposure to sunlight and can reach up to 6 m in height, but measures an average of 2.5 m [7].

There are studies conducted by researchers on the effect of castor on insects, for example, Barroso [5, 6] evaluated the effect of this plant on *Aedes* spp., verifying high mortality rates, and repellency and other significant effects. The author places this plant almost on the same level as neem, but it must be handled with great caution because of its active ingredient.

Specifically, we will address the effectiveness of these two powerful insecticidal plant species on the survival of eggs and larvae of *Bemisia* spp. (Hemiptera), *Sordidus* spp. (Coleoptera) and *Spodoptera* spp. (Lepidoptera).

## 2. Methodology

### 2.1 Collection and identification of plant material

For the bioactivity tests on *Lepidoptera*, *Coleoptera* and *Hemiptera*, two local plants were selected: *Azadirachta indica* (**Figure 1**) and *Ricinus communis* (**Figure 2**). They were collected in the province of Luanda in the municipalities of Viana, Luanda and Cacauco.

### 2.2 Obtaining essential oil from *Azadirachta indica* and *Ricinus communis* seeds

To obtain the essential oil, the cold pressing method described by Pinheiro (2003) and adapted by Barroso [5, 6] was used, where 900 g of seeds of plant material was



**Figure 1.**  
*Leaves and fruits of Azadirachta indica.*



**Figure 2.**  
*Leaves and fruits of Ricinus communis.*

placed in the oven at a temperature of  $45 \pm 2^\circ\text{C}$  for 48 h, then the seeds were crushed in a Britânia Diamante Black 4 blender at a speed of 900 W.

It was pressed manually in an oil press machine. The resulting aqueous material was placed in a container and sealed with parafilm to prevent evaporation. It was allowed to stand in the dark at a temperature of  $18 \pm 2^\circ\text{C}$  in an oven for 48 h. Subsequently, a heterogeneous compound was obtained with a light phase rich in oil on the surface, an intermediate phase rich in water and a heavy phase rich in insoluble solids. It was decanted to separate the essential oil and then filtered to remove suspended solid particles.

### 2.3 Bioassay

For the Bioensio with eggs, four flasks covered with fine mesh were used, each containing 50 eggs of each species, at a temperature of  $25 \pm 2^\circ\text{C}$ . For the bioassay with larvae, four flasks were used, each containing 50 eggs, waiting for hatching, where the larvae were obtained. For both cases, 2 ml of *Rinus communis* essential oil, 2 ml of *Azadirachta indica* and 2 ml of the mixture (containing 1 ml of ricinus solution and 1 ml of *Azadirachta indica* solution) were used. The fourth vial was used as a control (**Figure 3**).

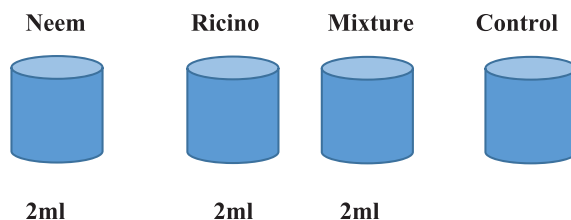


**Figure 3.** Schematic illustration of the experimental design of the bioassay used for the essential oils of the two species of plants: *Ricinus communis* and *Azadirachta indica*. Source: The author.

### 3. Results and discussions

#### 3.1 Effect on egg hatching rate

The analysis of the figure below demonstrates a weak correlation between the essential oils of *Ricinus communis* on the occlusion rate of *Bemisia* spp. eggs confirmed by the coefficient of determination ( $R^2 = 0.50$ ). It was observed that the normal periods of occlusion were not altered, with this process occurring between the 9th and 10th day (**Figure 4**).

Similarly, a weak correlation similarity was observed between the essential oils of *Ricinus communis* on the rate of occlusion of eggs of *Bemisia* spp., as confirmed by the coefficient of determination ( $R^2 = 0.62$ ). In this one, it was also verified that the periods of occlusion were not altered, all the eggs occlude between the 9th and 10th day (**Figure 5**).

It was observed that 5% of the population began to occlude on the 6th day of exposure. However, there were still no significant changes since, like the experiments described above, the joint action does not influence the occlusion rates of *Bemisia* spp., as confirmed by the coefficient of determination ( $R^2 = 0.58$ ). In this one, it was also verified that the periods of occlusion were not altered, 95% of the eggs occlude between the 9th and 10th day (**Figure 6**).

Regarding the effect of *Ricinus communis* oil on *Spodoptera* spp., the correlation was even weaker when compared with *Bemisia* spp. We can observe this effect by the coefficient of determination ( $R^2 = 0.49$ ). *Ricinus communis* oil has no effect on hatching, and it was found that the change to the larval stage occurs mostly (about 60%) on the 10th day (**Figure 7**).

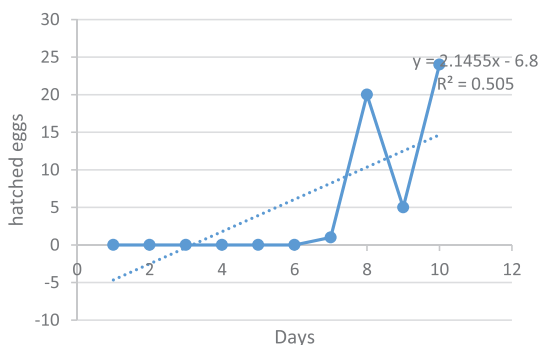


**Figure 4.** Graphic illustration of the effect of *Ricinus communis* essential oil on the hatching rate of *Bemisia* spp. eggs after 10 days.

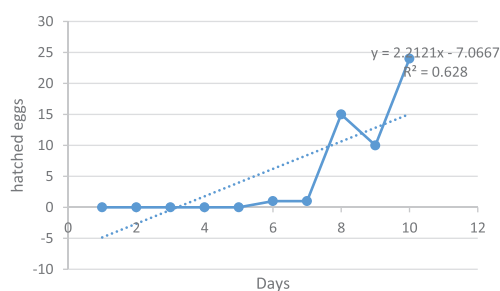


**Figure 5.**  
Graphic illustration of the effect of *Azadirachta indica* essential oil on the hatching rate of *Bemisia* spp. eggs after 10 days.

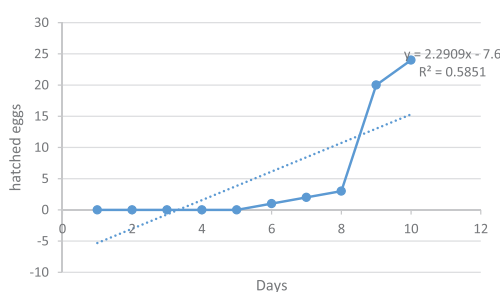


**Figure 6.**  
Graphic illustration of the effect of the joint action of the essential oils of *Azadirachta indica* and *Ricinus communis* on the hatching rate of *Bemisia* spp. eggs after 10 days.

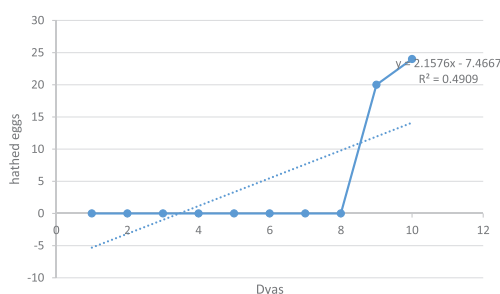


**Figure 7.**  
Graphic illustration of *Ricinus communis* essential oil on the hatching rate of *Spodoptera* spp. eggs after 10 days.

The effect of *Azadirachta indica* oil on *Spodoptera* spp. demonstrates that the correlation was even weaker when we compare the effect of *Ricinus communis*. It was observed by the coefficient of determination ( $R^2 = 0.41$ ). The change to the larval stage occurs mostly (about 80%) on the 10th day (**Figure 8**).

The effect of the joint action of essential oils on *Spodoptera* spp. demonstrates an even weaker correlation when we compare the isolated effects of *Ricinus communis* and *Azadirachta indica*. It was observed by the coefficient of determination ( $R^2 = 0.35$ ). The change to the larval stage occurs mostly (about 90%) on the 10th day (**Figure 9**).

The effect of *Azadirachta indica* oil on *Sordidus* spp. demonstrates similarity with previous experiments, as regards the coefficient of determination ( $R^2 = 0.48$ ), where

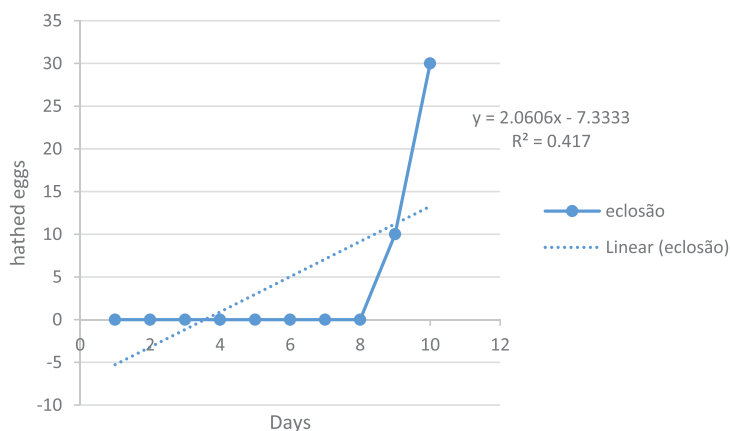


**Figure 8.**  
Graphic illustration of *Azadirachta indica* essential oil on the hatching rate of *Spodoptera* spp. eggs after 10 days.

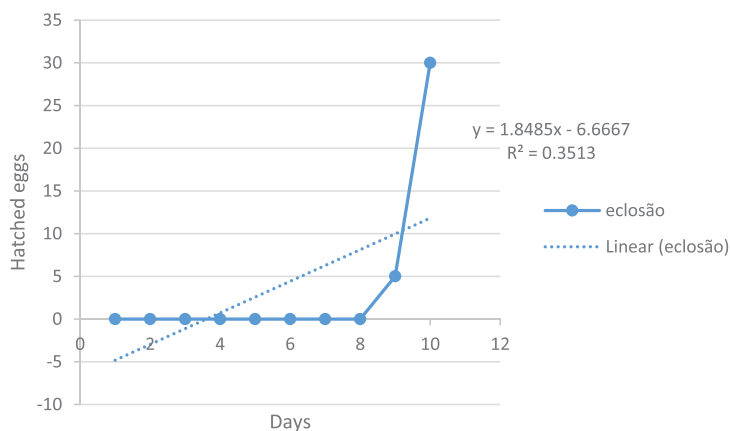


**Figure 9.**  
Graphic illustration of the effect of the joint action of the essential oils of *Azadirachta indica* and *Ricinus communis* on the hatching rate of *Spodoptera* spp. eggs after 10 days.

there was no influence on the hatching rates of eggs. The change to the larval stage occurs mostly between the 9th and 10th day (**Figure 10**).

The effect of *Ricinus communis* oil on *Sordidus* spp. demonstrates similarity with previous experiments, as regards the coefficient of determination ( $R^2 = 0.40$ ), where there was no influence on the hatching rates of eggs. The change to the larval stage occurs mostly on the 10th day (**Figure 11**).

The effect of the joint action of essential oils on *Spodoptera* spp. demonstrates an even weaker correlation when we compare the isolated effects of *Ricinus communis* and *Azadirachta indica*. It was observed by the coefficient of determination ( $R^2 = 0.37$ ). The change to the larval stage occurs mostly (about 90%) on the 10th day (**Figure 12**).

### 3.2 Effect on larval mortality

Regarding the effect of *Azadirachta indica* oil on the mortality of *Bemisia* spp., a strong correlation was observed in the experiment by the coefficient of determination

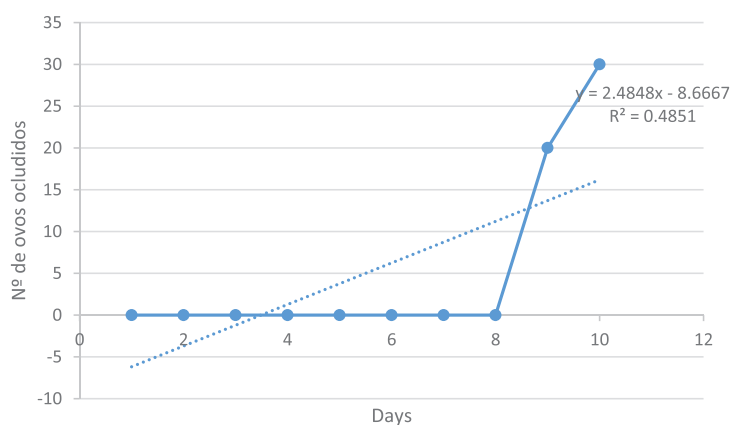


**Figure 10.**  
Graphic illustration of *Azadirachta indica* essential oil on the hatching rate of *Sordidus* spp. eggs after 10 days.

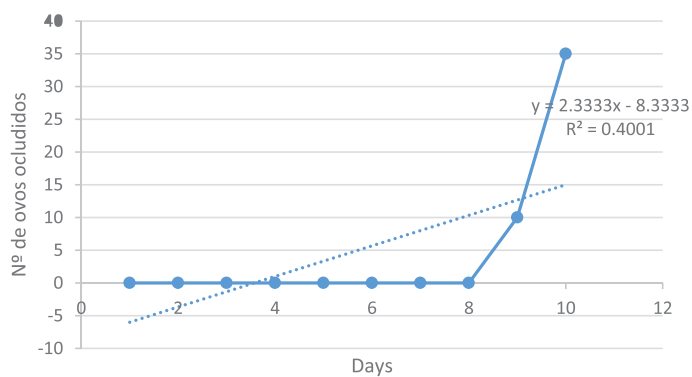


**Figure 11.**  
Graphic illustration of *Ricinus communis* essential oil on the hatching rate of *Sordidus* spp. eggs after 10 days.

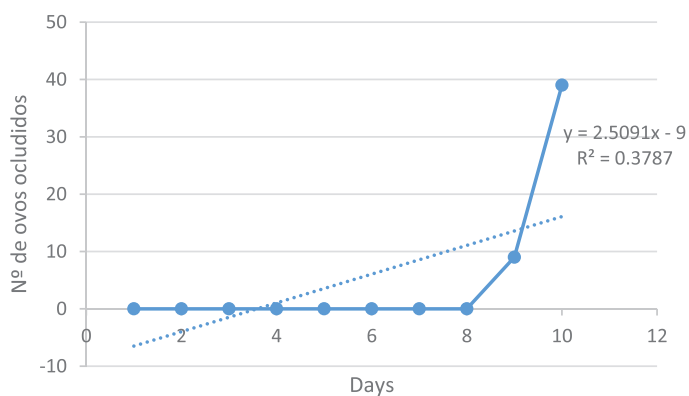


**Figure 12.**  
Graphic illustration of the effect of the joint action of the essential oils of *Azadirachta indica* and *Ricinus communis* on the hatching rate of *Sordidus* spp. eggs after 10 days.

( $R^2 = 0.85$ ). Fifty percent of the population of *Bemisia* spp. larvae dies on the 2nd day of exposure. Total mortality is finalized on the 7th day of exposure (**Figure 13**).

Regarding the effect of *Ricinus communis* oil on the mortality of *Bemisia* spp., a weak correlation was observed in the experiment by the coefficient of determination ( $R^2 = 0.025$ ). Fifty percent of the population of *Bemisia* spp. larvae dies on the 6th day of exposure. Weak effect if we compare with the previous experiment, as the entire population of larvae dies on the 9th day of exposure. Total mortality is finalized on the 7th day of exposure (**Figure 14**).

The combined action demonstrates a similar effect as the isolated action of *Azadirachta indica*. It was observed that 50% of the population dies on the second day of exposure, but the entire population disappears between the 5th and 6th day of exposure. A strong positive correlation was also observed by the coefficient of determination ( $R^2 = 0.82$ ) (**Figure 15**).

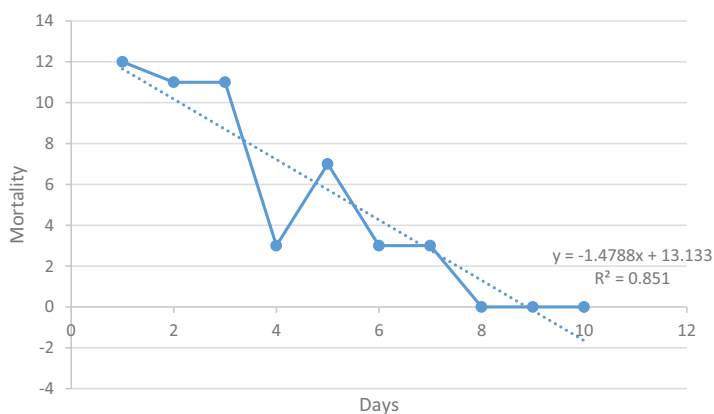


**Figure 13.**

Graphic illustration of the effect of the essential oil of *Azadirachta indica* on the mortality of *Bemisia* spp., during 10 days.

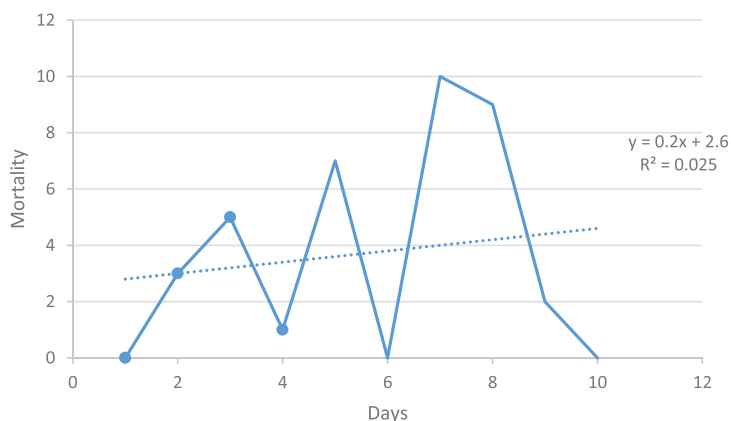


**Figure 14.**

Graphic illustration of the effect of *Ricinus communis* essential oil on the mortality of *Bemisia* spp., during 10 days.

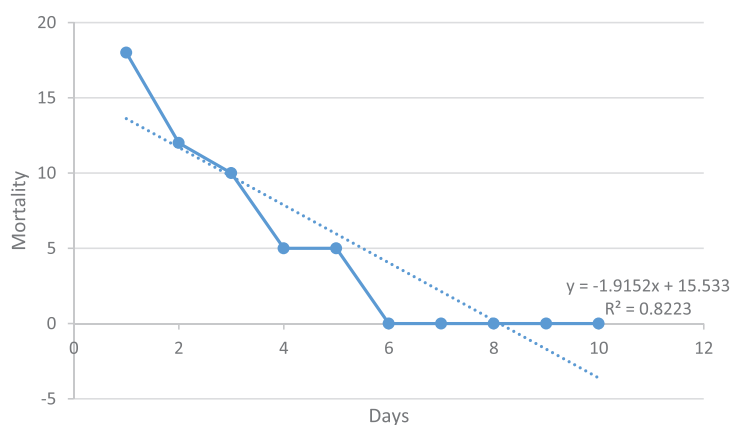


**Figure 15.**  
Graphic illustration of the effect of the joint action of *Azadirachta indica* and *Ricinus communis* essential oils on the mortality of *Bemisia* spp. after 10 days of exposure.

The effect of *Azadirachta indica* oil on the mortality of *Spodoptera* spp. was similar to the effect on *Bemisia* spp., where a strong correlation was observed in the experiment due to the coefficient of determination ( $R^2 = 0.73$ ). It was observed that around 50% of the population of *Spodoptera* spp. larvae dies on the 2nd day of exposure. Total mortality ends between the 7th and 8th day of exposure (Figure 16).

Similar to Figure 10, it was observed that the effect of *Ricinus communis* oil on the mortality of *Spodoptera* spp. is relatively smaller when compared to the effect of *Azadirachta indica*. For this experiment, 50% of the population dies on the 7th day, ending mortality on the 9th day of exposure (Figure 17).

The joint action proved to be very efficient on *Spodoptera* spp., as it appears that around 90% of the population dies on the 2nd day of exposure. Final mortality occurred on the 4th day of exposure (Figure 18).

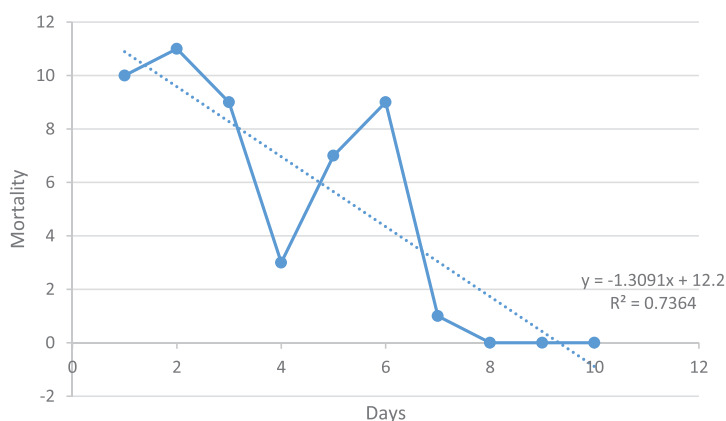


**Figure 16.**  
Graphic illustration of the effect of *Azadirachta indica* essential oil on the mortality of *Spodoptera* spp., for 10 days.

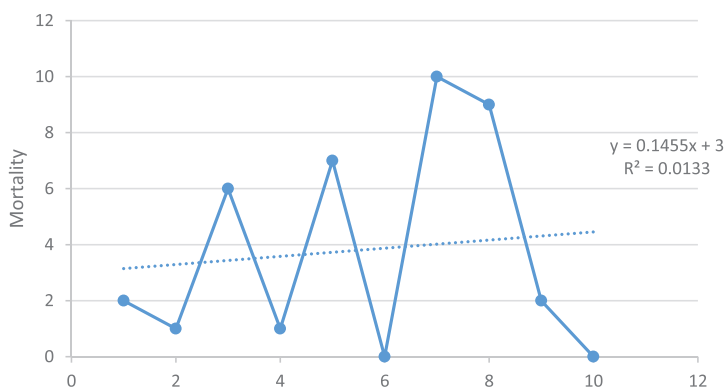


**Figure 17.**  
Graphic illustration of the effect of the essential oil of *Ricinus communis* on the mortality of *Spodoptera* spp., during 10 days.

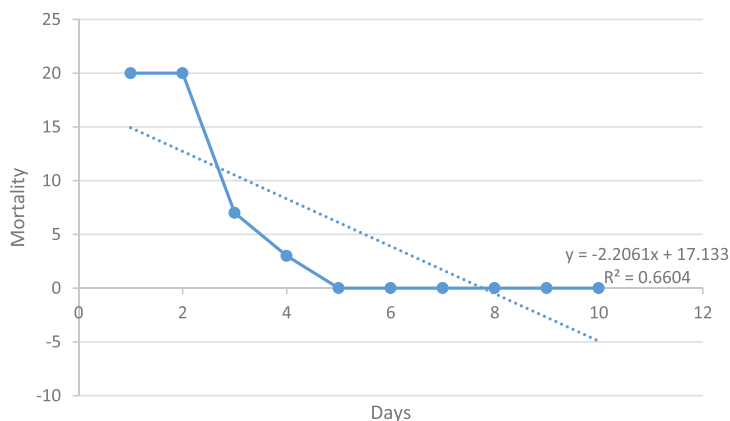


**Figure 18.**  
Graphic illustration of the effect of the joint action of the essential oils of *Azadirachta indica* and *Ricinus communis* on the mortality of *Spodoptera* spp. after 10 days of exposure.

The effect of *Azadirachta indica* oil on the mortality of *Sordidus* spp. was similar to the effect on *Benisia* spp., a strong correlation was observed in the experiment by the coefficient of determination ( $R^2 = 0.89$ ). It was observed that around 50% of the population of *Spodoptera* spp. larvae dies on the 2nd day of exposure. Total mortality is finalized on the 6th day of exposure (Figure 19).

Similar to previous *Ricinus communis* experiments, it was observed that the effect of *Ricinus communis* oil on the mortality of *Sordidus* spp. is relatively lower when compared to the effect of *Azadirachta indica*. For this experiment, around 50% of the larval population dies between the 7th and 8th day, with mortality ending on the 9th day of exposure (Figure 20).

The joint action proved to be very efficient on *Sordidus* spp., as it appears that around 90% of the population dies on the 2nd day of exposure. Final mortality occurred on the 5th day of exposure. A relatively minor result when compared to the graphs in Figure 14 (Figure 21).

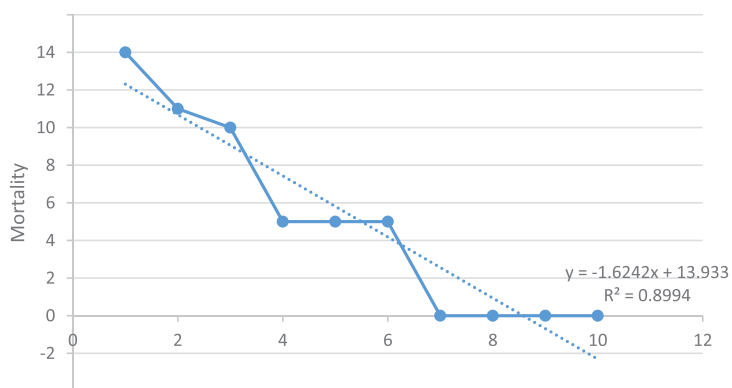


**Figure 19.**  
Graphic illustration of the effect of *Azadirachta indica* essential oil on the mortality of *Sordidus* spp. for 10 days.

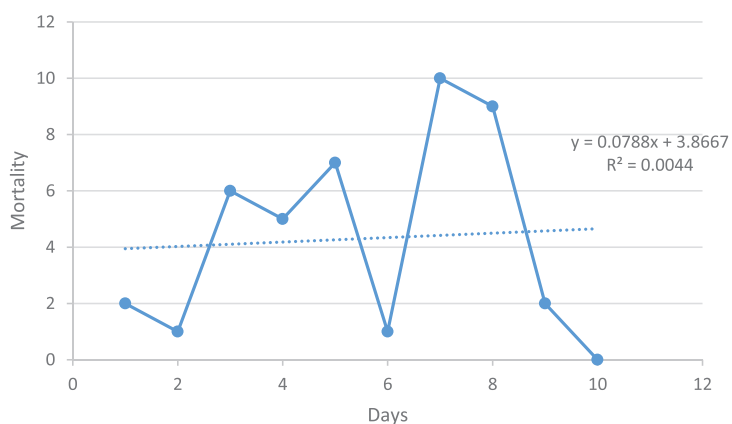


**Figure 20.**  
Graphic illustration of the effect of *Ricinus communis* essential oil on *Sordidus* spp. mortality, during 10 days.

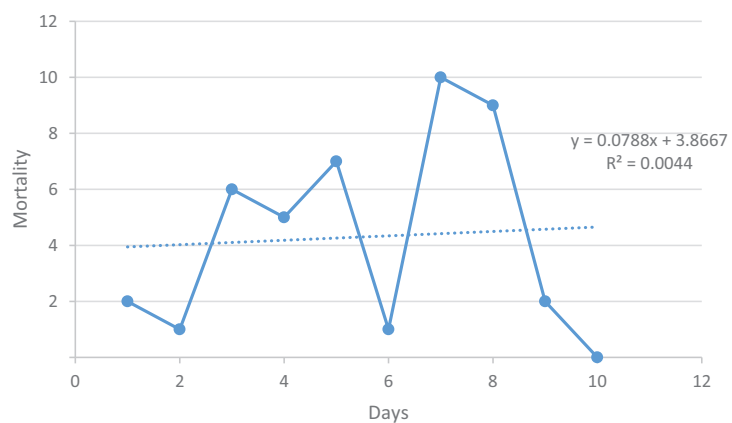


**Figure 21.**  
Graphic illustration of the effect of the joint action of *Azadirachta indica* and *Ricinus communis* essential oils on the mortality of *Sordidus* spp. after 10 days of exposure.

#### 4. Discussion

The effects of these plants have already been tested by other authors, like Peron and Ferreira [8], who evaluated the efficiency of *Ricinus communis* extract in controlling corn caterpillars, being more efficient at a concentration of 75%, where after eight days 75% of the caterpillars had died. Note that in this study similar results were obtained with *Ricinus communis* essential oil.

At higher concentrations of *Ricinus communis* extract, more precise results would be obtained, especially on occlusion rates. Santos et al. [9], when using an aqueous extract of castor bean leaves on eggs and fifth instar nymphs of the predator *Podisus nigrispinus*, showed that mortality from the extract was observed at concentrations of 7 and 10%, with the lowest survival rates being observed, with 30 and 10%, respectively.

The effect of *Ricinus communis* on other Hymenoptera has already been described, when Burg and Mayer [10], when studying the effect of *R. communis* seed oil on aphids and lice, described it as efficient in controlling these insects. The bioinsecticide activity of this vegetable was also studied by Murdue [11], in leaf-cutter ants, verifying its efficiency in combating them. Barroso [5, 6], when studying the effect of the aqueous extract of green castor beans on larvae and pupae of *Spodoptera frugiperda*, observed a reduction in the life span of these stages, and Góes et al. [12] identified a toxic effect of *R. communis* leaf extracts on *Apis mellifera* worker larvae, using castor oil.

The efficacy of *A. indica* seed oil on three stages of development of *Lutzomyia longipalpis* was evaluated, demonstrating insecticidal activity on all stages tested. With regard to ovicidal activity, Abdel-shafy and Zayed [13] observed, when treating eggs of the tick *Hyalomma anatolicum excavatum*, a significant deleterious effect on the embryonation of eggs with the compound Neem-Azal F with hatching rates varying from 34 to 60%, 15 days after treatment. Regarding the larvicidal effect,  $67.75 \pm 2.21\%$  of the larvae did not reach the pupal stage. The lethal concentration 50 (LC50) verified in these studies for larvae was 60.98 (45.93–91.62) mg mL<sup>-1</sup>.

Several studies have been carried out in recent years to elucidate the changes in the endocrine control mechanism induced by azadirachtin, which cause the effects observed in growth inhibition. These studies made it possible to identify changes in the levels of morphogenetic hormones such as ecdysone [14].

A marked structural similarity was identified between ecdysone and azadirachtin; however, it is not clear whether the effects on these hormonal levels are direct or indirect [14].

Some evidence indicates that azadirachtin can block the release of several substances located in the central nervous system, as well as the formation of chitin, a polysaccharide that forms the exoskeleton of insects, in addition to preventing sexual communication, causing sterility and decreasing intestinal motility [14].

Barroso [5, 6, 15] demonstrated that there is greater effectiveness of the joint action of essential oils, causing 96, 100 and 100%, in concentrations of 1, 1.5 and 2.0 ml, respectively, in 24 h. A relatively smaller difference when Azadirachta essential oil was used alone indicates that it caused mortality of 65, 97 and 100% at concentrations of 1, 1.5 and 2 ml, respectively. The lowest efficacy observed was that of *Ricinus communis* essential oil, causing mortality of 10, 63 and 100% at the same concentrations described and at the same time, but still with great significance.

Barroso's studies [5, 6, 15] also corroborate the results of Amer and Mehlhorn [16], where the authors evaluated the larvicidal potential of 41 essential oils, analyzing this effect after 1, 12 and 24 h. More than 48% of these oils only acted after 12 h of exposure, that is, not during the first few hours.

After this approach, it is logical to conclude that the fight against pests will be directed toward sustainability if we fully exploit the properties of *Ricinus communis* and *Azadirachta indica*. In the reported studies, it was possible to note that both have general effects against insects. More studies should be carried out on *Ricinus communis* and on the joint action of both plants.

Another fact is the abundance of these vegetables, where we can find them widely distributed, in most continents. This will allow, from an economic point of view, to promote and use more sustainable practices in the management and control of pests in agriculture.

## 5. Conclusion

After the experiments, the following was concluded:

The essential oils of *Ricinus communis* are effective on the mortality of *Bemisia* spp., *Spodoptera* spp. and *Sordidus* spp. larvae, reaching 100% mortality in 7, 9 and 9 days of exposure, respectively.

The essential oils of *Azadirachta indica* are effective on the mortality of *Bemisia* spp., *Spodoptera* spp. and *Sordidus* spp. larvae, reaching 100% mortality in 9, 7 and 6 days of exposure, respectively.

The *Azadirachta indica* and *Ricinus communis* solution was the most effective in achieving mortality on *Bemisia* spp., *Spodoptera* spp. and *Sordidus* spp. in 5, 4 and 5 days, respectively.

No significant effects of the essential oils on the hatching rates of eggs of the three evaluated species were observed, but the bibliography admits this possibility if the concentration of the active principle of azadirachtin or ricin is increased.

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