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Management of *Myzus persicae* with leaves of *Jatropha curcas* and *Ricinus communis* in different vegetative stages

Manejo da Myzus Persicae com folhas de Jatropha Curcas e Ricinus Communis em diferentes estágios vegetativos

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ABSTRACT

Although chemical insecticides are successfully used in agriculture, several problems may be related to their indiscriminate use. This has encouraged the development of alternative methods for pest insect control and societal pressure for pesticide-free products. The jatropha (*J. curcas*) and castor bean (*Ricinus communis*) are plants that have shown insecticidal potential. Thus, the objective of this work was to study the effects of leaves of *R. communis* and *J. curcas* of different ages on the cabbage aphid (*Myzus persicae)*. Five solution concentrations and five leaf types were used. Each treatment consisted of ten individuals *M. persicae*, kept in Petri dishes (10.0 x 1.2 cm), about kale leaf discs. Each Petri dish was considered a repeat, totaling ten. An airbrush connected to a compressor calibrated at constant pressure and 5 mL of solution per repetition was used for direct application. The cabbage discs were immersed in the different treatments for five seconds and offered to aphids in the indirect application. For both tests, evaluations were performed 72 hours after application. Data were submitted to linear regression analysis and means test. There was an interaction between the application type, leaf type, and concentrations for both plants. We argue that at their different ages, jatropha and castor bean leaves have insecticidal potential in the management of *M. persicae*.

KEYWORDS: botanical insecticide; alternative control; biological control; *Myzus persicae.*

RESUMO

Embora os inseticidas químicos sejam usados com sucesso na agricultura, vários problemas podem estar relacionados ao seu uso indiscriminado. Isso tem incentivado o desenvolvimento de métodos alternativos para o controle de pragas e insetos, bem como a pressão social por produtos livres de pesticidas. A jatropha (*J. curcas*) e a mamona (*Ricinus communis*) são plantas que apresentam potencial inseticida. Assim, o objetivo deste trabalho foi estudar folhas de *J. curcas* e *R. communis* de diferentes idades sobre o pulgão-da-couve (*Myzus persicae)*. Foram utilizadas cinco concentrações de solução e cinco tipos de folhas. Cada tratamento consistiu de dez indivíduos *M. persicae*, mantidos em placas de Petri (10,0 x 1,2 cm), sobre discos de folhas de couve. Cada placa de Petri foi considerada uma repetição, totalizando dez. Para aplicação direta, utilizou-se um aerógrafo conectado a um compressor calibrado a pressão constante e 5 mL de solução por repetição. Na aplicação indireta, os discos de repolho foram imersos por cinco segundos nos diferentes tratamentos e oferecidos aos pulgões. Para ambos os testes, as avaliações foram realizadas 72 horas após a aplicação. Os dados foram submetidos à análise de regressão linear e teste de médias. Para ambas as plantas houve interação entre o tipo de aplicação, tipo de folha e concentrações. Reiteramos que as folhas de pinhão-manso e mamona, em suas diferentes idades, apresentam potencial inseticida no manejo de *M. persicae*.

PALAVRAS-CHAVE: inseticida botânico; controle alternativo; controle biológico; *Myzus persicae.*

INTRODUCTION

Brassicas cultivation has a prominent production in the Brazilian olericulture due to the large production volume, economic return, and the nutritional value of crops (MELO et al. 2019), being a vegetable with high levels of vitamins A and C, as well as mineral salts (REIS et al. 2015, DOMÍNGUEZ-LAFARGA et al. 2018). Although, among the species of this family, we highlight the consumption of kale (*Brassica oleracea* L.), even adapted to the soil and climate conditions, production may be limited by pests, especially aphids, highlighting among these the species *Myzus persicae* (Sulzer 1778) (Hemiptera: Aphididae), considered a key pest in kale, potato (*Solanum tuberosum* L.) crops (CIVIDANES & SANTOS-CIVIDANES 2012, MPUMI et al. 2020) and sweet potato (*Ipomoea potatoes* (L.) Lam.). This pest is distributed worldwide and can cause direct damage by the consumption of sap and indirectly by transmitting viruses in their hosts (TARIQ et al. 2012), besides leaf curl, which hinders plant development (MINAS et al. 2013, PINHEIRO et al. 2017).

Usually, this pest control is mainly performed by chemical applications (MARGARITOPOULOS et al. 2021). However, conventional horticulture has been adopting technologies that seek immediate results and, while providing short-term profits to farmers (TRANI et al. 2018), problems arise in conserving the quality of the environment added to the binomial health-food. In this scenario, there has been an increased concern about preserving natural resources and the quality of life, resulting in consumers' search for healthier foods, particularly those free from pesticides (HORNE & MCDERMOTT 2013, RODRIGUES et al. 2020).

Research on plant extracts has been intensified, seeking new alternatives to conventional insecticides, thus reducing environmental impacts (ISMAN & GRIENEISEN 2014). Some advantages of these insecticides based on plant extracts are: they are obtained from renewable resources and are easily degraded; they have fast action, low to moderate toxicity to man, selectivity, low phytotoxicity, and low cost; and they do not have the known side effects typical of conventional insecticides (RAJ et al. 2021).

The jatropha, *Jatropha curcas* L. (Euphorbiaceae) is an example reported to be a plant that insects poorly attack due to caustic latex exudation (SOUZA-FIRMINO et al. 2014). Furthermore, the extract of its leaves has antifungal activity, as it contains phospholipids and antimicrobial compounds (OKOH et al. 2009, RAHMAN et al. 2014). In addition, it may be a potential insecticide since it causes food inhibition, repellency, inhibitory or suppressive action of oviposition, infertile eggs, inhibition of larval, nymph and pupal development, and inhibition of mating (ALMEIDA 2009). Finally, it may cause insect death by interfering with various metabolic pathways important for overall metabolism (ABUBAKAR 2021).

The castor bean (*Ricinus communis* L. (Euphorbiaceae)) has insecticidal properties in virtually all its plant parts, such as leaves, stems, roots, and seeds (RIOBA & STEVENSON 2020). For example, in the case of the seeds, they are rich in different inhibitors, which act on α-amylases and prevent starch absorption by the insect and may lead to starvation death (PACHECO-SOARES et al. 2018).

Thus, the objective of this study was to study the potential use of leaf extract of *R. communis* and *J. curcas*, at different vegetative stages in the management of *M. persicae.*

MATERIALS AND METHODS

The experiment was performed at Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo - Campus Itapina (IFES - Campus Itapina). Tests of direct and indirect application were performed, considering aqueous laboratory extracts of small, medium, large, yellowish, and dry leaves of *R. communis* and *J. curcas*. These tests were conducted in climate chambers at 25 ± 1 ºC, 70% ± 10 relative humidity, and 12 h photophase. A rearing of *M. persicae* has been established in kale (*Brassica oleracea* var. *acephala*) plants without any phytosanitary treatment, in a greenhouse, for the multiplication of this aphid to perform the tests.

Confection of plant extracts

To obtain the extracts, the different leaf stages of castor bean were determined by the leaf area LI-COR Biosciences LI-3100C, standardizing 85 ± 5 cm for leaves considered small, 140 ± 5 cm as medium, 600 ± 5cm as large, as well as ripe and dried castor leaves. These were collected from the upper third of the plants. The same measurement methodology was used to separate the different stages for the jatropha culture. We determined as standard 30 ± 5 cm for leaves considered small, 85 ± 5 cm as medium, and 150 ± 5 cm as large. Additionally, we also collected ripe and dried leaves. These leaves were collected in the upper third, middle, and base of the jatropha plants. The collections were performed in the experimental area of the Federal Institute of Education Science and Technology of Espírito Santo (IFES) in Itapina campus. After the collection and measurement procedure, the material was placed to dry in a forced air circulation oven at 40 ºC for 72 hours. Then, the different leaf stages were milled with the help of a knife mill to obtain a fine powder.

The aqueous extraction procedure consisted of the use of 1.0; 2.0; and 3.0 grams of powder of each leaf age in 100 mL of solvent (distilled water). The mixture was then stirred on a shaker table for four hours at room temperature. After this period, the material remained at rest for approximately 20 minutes for decantation, the supernatant was then separated from the solid by simple filtration using a cotton funnel.

Concentrations of aqueous extracts of each age of *J. curcas* and *R. communis* used in the experiment were 0.0; 1.0; 2.0 and 3.0% (weight/volume). Distilled water with Tween® 80 adhesive spreader (0.05%) was used to dilute and application of aqueous extracts.

Bioassays

For the tests, kale leaves were periodically removed and taken to the laboratory, where they were washed with distilled water, dried on filter paper, and packaged in gerbox type plastic boxes.

In the direct application test, 10 individuals of *M. persicae* were transferred to each of the treatments on 4 cm diameter kale leaf discs that were kept in Petri dishes (10.0 x 1.2 cm), on filter paper, moistened daily with distilled water to maintain their turgidity. An airbrush connected to a calibrated compressor was used as a constant sprayer pressure of 30 Lb / in² and 5 mL of solution per repetition.

The indirect application test was performed under the same conditions as the previous test. However, the kale discs were immersed in the different treatments for five seconds and placed on paper towels to remove excess solution. The discs were then placed in the Petri dishes, on the filter paper, as described above, being inoculated 10 individuals in each disc.

The experiment was conducted in a 5 x 4 factorial (five different stages, four concentrations), and consists of 10 repetitions, where each Petri dish constitutes one repetition. Subject mortality was assessed 24, 48, and 72 hours after spraying. The values of *Myzus persicae* corrected motality with different treatments were subjected to variance analysis (ANOVA) followed by Tukey's test at a significance level of 5% (α = 0.05). Subsequently, the data were submitted to regression analysis.

RESULTS AND DISCUSSION

Regarding *J. curcas* there was an interaction between the factors modes of application, leaf stages and extract concentrations (F12, 360 = 18.12; P = 0). Comparing the mortality of *M. persicae* among the application forms of all ages of jatropha leaves in the tested concentrations, higher mortality was observed in the form of direct application, except at concentrations of 1% of the small leaf extract, 2 and 3% in large leaf extracts, and 3% in medium leaf extracts, where mortality was higher in the indirect application form (Table 1).

Table 1. Corrected mortality (%) of *Myzus persicae* treated with *Jatropha curcas* leaf extracts at different concentrations[1].

Extract concentration [% (w v-1)]	Application	Leaf				
		Small	Medium	Large	Yellow	Dry
0.0	Direct	1.0 ± 1.00Aa	1.0 ± 1.00Aa	2.0 ± 1.33Aa	2.0 ± 1.33Aa	2.0 ± 1.33Aa
	Indirect	2.0 ± 1.33Aa	2.0 ± 1.33Aa	2.0 ± 1.33Aa	2.0 ± 1.33Aa	2.0 ± 1.33Aa
1.0	Direct	72.2 ± 5.28Ab	86.9 ± 3.66Aab	87.3 ± 4.74Aab	86.5 ± 4.05Aab	96.0 ± 2.21Aa
	Indirect	82.4 ± 6.32Aa	217.3 ± 4.10Bcd	62.0 ± 4.9Bb	2.0 ± 1.33bd	21.1 ± 4.96Bc
2.0	Direct	75.5 ± 5.84Aab	85.9 ± 3.70Aa	66.4 ± 6.63Bb	72.0 ± 5.37Aab	86.9 ± 5.00Aa
	Indirect	23.4 ± 5.55Bc	52.0 ± 8.50Bb	81.2 ± 4.82Aa	6.0 ± 2.21Bd	21.7 ± 5.74Bcd
3.0	Direct	75.2 ± 3.64Aab	66.8 ± 6.96Bb	85.9 ± 4.90Aa	85.6 ± 5.59Aa	90.8 ± 3.37Aa
	Indirect	48.0 ± 6.36Bb	85.6 ± 5.59Aa	89.0 ± 3.51Aa	14.4 ± 3.98Bc	34.8 ± 6.21Bb

[1]Each group of two means (± SE) followed by the same uppercase letter in the column and lowercase letter in the row do not differ statistically from each other by the Tukey test at 5% probability.

Superior mortality with the direct application is probably due to the fact that molecules with insecticidal properties contained in the jatropha leaf extract have action on the central nervous system, inhibiting acetylcholinesterase, the enzyme responsible for the transmission of nerve impulses, which may cause insect death in a short time (SALEEM et al. 2016).

In the direct application form, individual mortality reached 96% at a concentration of 1% (Table 1). The secondary metabolic synthesized by plants, act on insects by inhibiting their feeding, their synthesis of chitin, influence their growth, development, reproduction and their behavior (AGUIAR-MENEZES 2005, RASHID & CHUNG 2017).

There was also a difference in the mortality index between extracts of different leaf ages, which may be caused by the tendency of secondary metabolites to accumulate as a function of leaf age. According to**,** castor bean presents higher toxicity mainly in dry leaves, and possibly dried jatropha leaves may have higher toxicity compared to other leaf ages.

The opposite happened in the indirect mode of action and at the 1% concentration, the highest mortality was caused by small leaf extract (82.4%), 2% was caused by large leaf extract (81.2%) and at 3% concentration, the highest mortality rates were caused by medium and large leaves (85.6% and 89%, respectively) (Table 1).

In the direct application form, castor bean extract showed higher mortality (46.1%) 1% concentration of small leaf extract, while in the indirect, it was 34.5% with 3% small leaf extract (Table 2).

Table 2. Corrected mortality (%) of *Myzus persicae* treated with extracts of different leaf stages of *Ricinus communis* at different concentrations[1,2].

Extract concentration [% (w v^{-1})]	Application	Leaf				
		Small	Medium	Large	Yellow	Dry
0.0	Direct	1.0 ± 1.00Aa	1.0 ± 1.00Aa	1.0 ± 1.00Aa	1.0 ± 1.00Aa	1.0 ± 1.00Aa
	Indirect	1.0 ± 1.00Aa	1.0 ± 1.00Aa	1.0 ± 1.00Aa	2.0 ± 2.00Aa	2.0 ± 2.00Aa
1.0	Direct	46.1 ± 4.83Ab	43.0 ± 6.62Aab	27.3 ± 5.35Abc	15.0 ± 4.01Ac	11.6±3.23Ac
	Indirect	25.1 ± 6.34Ba	15.8 ± 2.58Bab	6.0 ± 1.63Bb	16.5 ± 2.44Aab	12.6 ± 1.34Aab
2.0	Direct	33.0 ± 5.48Aa	10.7 ± 2.72Ab	34.5 ± 3.85Aa	22.8 ± 5.05Aab	26.0 ± 5.42Aab
	Indirect	33.5 ± 7.83	20.0 ± 3.33Aab	1.0 ± 1.00Bc	8.7 ± 2.94Bbc	23.0 ± 6.35Aab
3.0	Direct	24.0 ± 5.55Aab	14.2 ± 4.48Ab	35.9 ± 4.76Aa	17.1 ± 3.98Ab	19.6 ± 5.68Ab
	Indirect	34.5 ± 6.93Aa	24.0 ± 6.00Aab	7.0 ± 3.00Bc	8.1 ± 2.02Ac	11.0 ± 4.07Abc

[1]Each group of two means (± SE) followed by the same capital letter in the column does not differ statistically from each other by the Tukey test at 5% probability; [2]Means (± SE) followed by the same lower case letter on the line do not differ statistically from each other by the Tukey test at 5% probability.

The highest mortality rates were generally achieved in the younger leaves (small, medium, and large) in the indirect application. This can be explained by the fact that they have higher constitutive levels of secondary compounds (TAIZ et al. 2017) that will act on the digestive system causing insect mortality.

Mortality from direct treatments increased with increasing concentrations up to 2%, reaching the highest rates and decreasing (Figure 1a). In the indirect application, mortality increased with increasing concentrations in all types of extracts and different leaf ages (Figure 1b). In higher concentrations, there are a greater number of molecules of the active substance of jatropha, probably causing the increase of aphid mortality and, according to the evaluation of the physicochemical composition of parts of the *J. curcas* plant the high levels of saponin, HCN, phytate, and tannin in the leaves may justify its toxicity (HARRY-ASOBARA & SAMSON 2014).

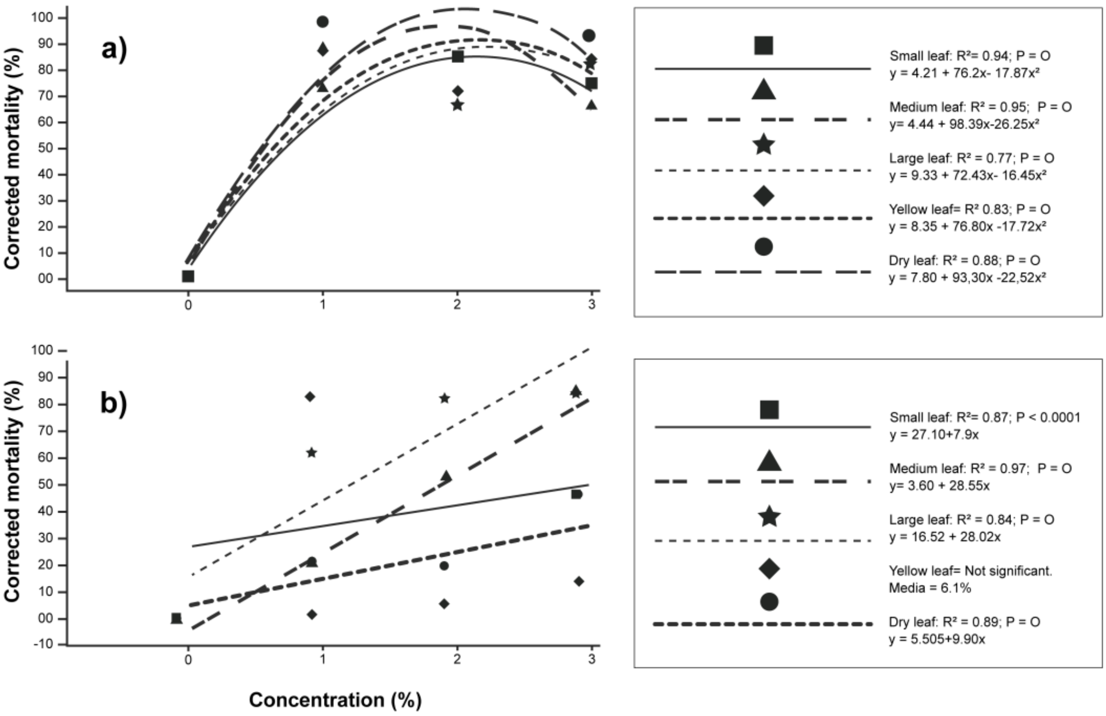

Figure 1. Corrected mortality (%) of *Myzus persicae* treated with extracts of different stages of *Jatropha curcas* leaves, at different concentrations, by direct (a) and indirect (b) application after 72 hours.

Regarding the extracts made from castor leaves, there was interaction between application factors, leaf type, and concentrations (F12, 360 = 6.41; P = 0). Comparing the mortality of *M. persicae* among the application forms of all leaf ages in the different concentrations, it is observed that the application forms did not present a significant difference except at concentrations of 1% in small, medium, and large leaves, in large and yellow leaves 2% and 3% concentration in large leaf extract, where mortality was higher in the direct application form (Table 2).

Regarding the extracts made from castor leaves, there was interaction between application factors, leaf type, and concentrations (F12, 360 = 6.41; P = 0). Comparing the mortality of *M. persicae* among the application forms of all leaf ages in the different concentrations, it is observed that the application forms did not present a significant difference except at concentrations of 1% in small, medium, and large leaves, in large and yellow leaves 2% and 3% concentration in large leaf extract, where mortality was higher in the direct application form (Table 2).

In the direct application form, the best results (46.1% and 43% mortality) were obtained in the concentration of 1% of small and medium leaves extract, respectively (Table 2).

As mentioned earlier, when insects ingest molecules with insecticidal properties, their effect on your body does not occur immediately; being incorporated through the digestive processes to exert some influence on it. Thus, mortality by ingestion depends on the accumulation of the active principle in the body, where a higher concentration probably tends to cause higher mortality and in a shorter time interval than lower concentrations.

When the action is directly on the insect, the substances affect the central nervous system, causing immediate death (BUSZEWSKI et al. 2019). This explains that lower concentrations of small and medium castor leaves cause higher contact mortality, exceeded by ingestion at higher concentrations (Table 2).

In the indirect application, the highest mortalities were found in younger leaves (34.5%) at 3% concentration on small leaves and 33,5% at 2% concentration on small leaves. Mortality of treatments applied directly was variable, depending on the different leaf types. For small, yellow and dry leaves, the highest mortality was reached at a concentration of 2% and 1% in medium leaves. On the other hand, mortality caused by large leaf extract increased as a function of the concentrations tested (Figure 2a).

In the indirect application, it can be observed that the mortality increased according to the increase in the concentration used with the extracts of small and medium leaves, showing a dose response effect. There was higher mortality at 2% concentration for dry leaves and decreased as the concentration increased. Large yellow leaves showed no significant results (Figure 2b).

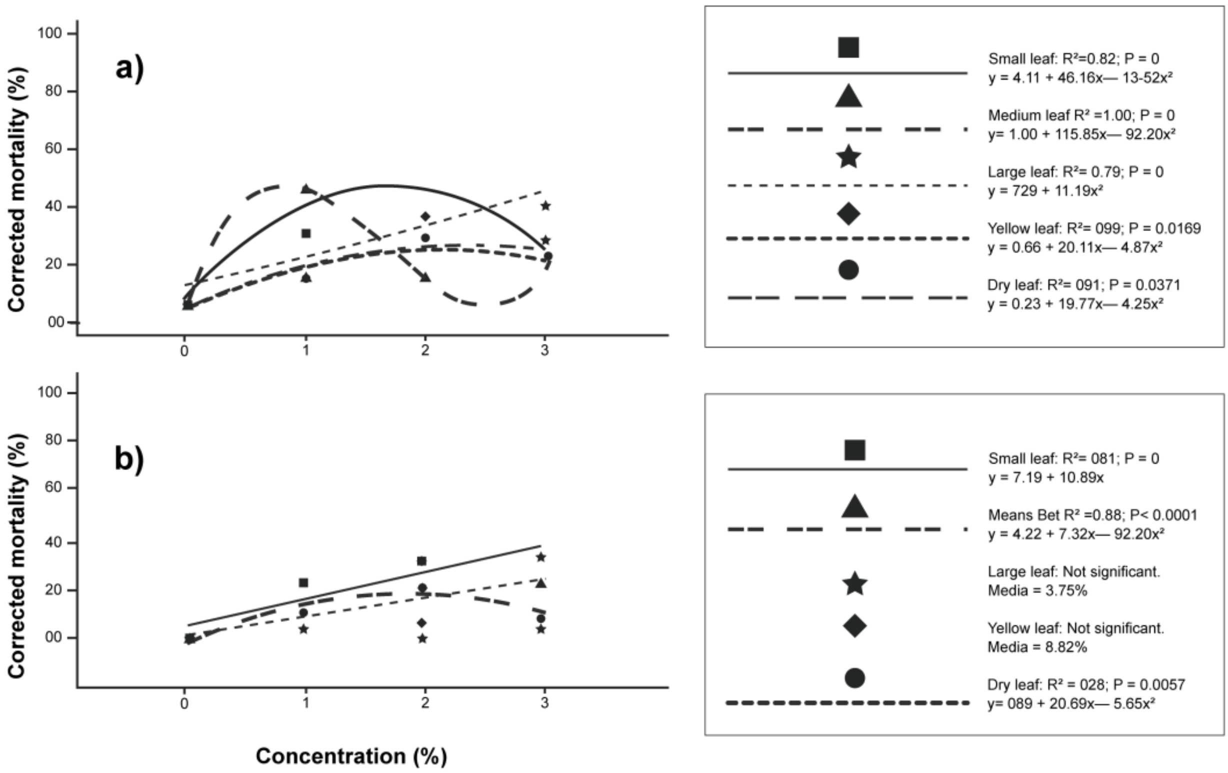

Figure 2. Corrected mortality (%) of *Myzus persicae* treated with extracts of different stages of leaves, at *Ricinus communis* different concentrations, by direct (a) and indirect (b) application after 72 hours.

CONCLUSION

The results obtained confirm the insecticidal potential of extracts of *J. curcas* and *R. communis*. Leaf age influences insecticidal activity due to the greater or lesser accumulation of secondary metabolites. However, further studies are needed to identify which components of the studied plants provide the insecticidal effect. Another point to be studied is identifying which insect body system suffers interference from the components that provide the insecticidal effect.

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