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Study of the Efficacy of Moringa Leaf Extract as an Insecticide against White Fly and Aphids Insects

Sadik K. Taaban

Ibn Sina Research Center/ Corporation of Research and Industrial Development – Iraq

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Corresponding Author:
Sadik K. Taaban
sadikmosawy@gmail.com

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Abstract

In this study, we demonstrate the effect of plant extracts on whitefly and aphid's insects that are economically harmful to crops and plants in greenhouse. A laboratory experiment was carried out to study the effect of four concentrations (0.5, 1.0, 2.0 and 3.0 g/l) of the alcoholic extract of the Moringa plant on whitefly and aphid's insects. The results showed that the concentration of 3 g/l was significantly superior to the other concentrations used in the experiment, achieving percentage mortality rates of 95% in the nymph's stage, where the account of insects decreased from 100 live insects before spraying to 5 live insects only after 72 hours of treatment with this concentration. In addition, the percentage mortality rate at the adult stage reached 91%, in which the counts of live insects decreased from 100 live insects before spraying to 9 insects after spraying with this concentration, where the rates of increase in the mortality efficiency rates reached at a concentration of 3 g/l compared to the other concentrations and at the nymph stage (13.09, 35.71, 50.79%), respectively, while the increase rates were at the nymph stage of aphids (16.25, 34.78, 47.61%), respectively. Whereas, the concentration of 0.5 g/l was the least effective in average efficiency of the concentrations used in the experiment in controlling the target insect, where it achieved a lower value of mortality rate, recording remarkable decrease, which reached at the nymphs and adults stages of whitefly and aphids insects (63, 60, 63, 61%), respectively. The chemical examinations for the detection of the plant extract content from the active compounds showed that it contains tannins, glycosides, phenols, resins, carbohydrates, saponins, alkaloids and terpenes.

1. Introduction

Aphids are harmful insects that attack crops and horticultural plants. They have a wide family range that exceeds 400 plant hosts in the world and cause extensive damage through nutrition and absorption of plant sap, as well as, their role in transmitting viruses, as they transmit more than 70 pathogenic viruses. These insects live on plants in the form of colonies that include all stages of the life of these insects, and they are reproduced by parthenogenesis during the year and are characterized by the multiplicity of their generations, which may reach more than 20 generations per year. It is a dangerous pest that is difficult to control and has developed mechanisms to resist the effects of industrial chemical pesticides [1].

The whitefly Bemisia Tabaci Gennadius (Hemiptera: Aleyrodidae) is a global plant pest that has caused huge losses in crop production. It is distinguished by its large number of specialties in attacking multiple types of economic agricultural crops, which number about 600 plant hosts, including various types of grain crops, vegetables, fruit trees and industrial crops. In addition, its great ability to produce huge number of flies during one season showed that one pair from this insect can produce 184 insects in each generation under temperatures reaching 29 C°. The whitefly is also distinguished by its high ability to absorb plant sap without stopping even if it lays eggs or reproduces, as it does not leave its host except in the event of the death of the insect or the death of the host [2].

The use of chemical pesticides was linked to industrial and agricultural development for the purpose of increasing production and controlling economically harmful insects, but this expansion collided with the negative effects resulting from the use of pesticides, which have toxic effect remaining on soil, water and plants, in addition to the emergence of resistance to insects towards these pesticides and the emergence of strains that are not affected by these pesticides [3].

The researchers indicate that the world is moving towards the use of pesticides of plant origin, as seven important plant families have been identified that will become the main factories for the production of these pesticides during the next ten years, such as the neem pesticide, whose production has developed by India to reach about a half million ton annually, in addition, it has been adopted to consider these pesticides to be safe from a health, and it has not been proven that they have toxic effects that cause serious diseases, or lead to genetic mutations or abnormalities in foetuses [4].

The effectiveness of pesticides of plant origin is attributed to the phytochemical composition of different plants, so they can be integrated into integrated pest management systems and contribute to sustainable agricultural production [5]. There is an increasing awareness of the negative environmental effects that manufactured chemical pesticides have on human health, as well as animals and plants [6]. The use of pesticides of plant origin gave efficiency and effectiveness similar to chemical pesticides in combating various insects that attack economically important crops [7].

The presence of active substances inside plants made it possible to use them in the control of harmful insects, as these active substances have a toxic effect that kills the targeted insects. In addition, it oxidizes quickly and decomposes under conditions of humidity and heat, and there is no toxic trace left of it, whether in soil, water or plants. Also, it has not been proven until now that the resistance trait by insects towards it has appeared. In addition, it has an anti-effect spectrum for a large number of insects that may reach 200 insects by a single plant pesticide [8, 9].

Moringa (*M. Oleifera*) plant belongs to the Moringaceae family and is cultivated in many regions of the world. It has many nutritional and therapeutic uses as nutritional supplements, treatment of male infertility, cardiovascular disease, blood pressure lowering and for the prevention of diabetes. Moringa leaf extracts are a rich source of vitamins and amino acids and have effective properties in inhibiting free ion generation processes, reducing lipid peroxidation density and enhancing the activities of antioxidant enzymes [10]. The effectiveness of Moringa leaf extract in controlling harmful insects has been studied by many researchers, as indicated by [11-13], where they have referred that the extracts of the Moringa plant had a significant effect against whitefly and aphids, as it contributes in controlling these insects in many experiments. Accordingly, and in order to demonstrate the importance of using plant extracts as an botanical insecticide and as an alternative to chemical pesticides with a toxic and environmental harmful effect, this experiment was carried out.

2. Experimental Procedure

2.1. Plant Collection

Moringa leaves were collected from the Zafaraniya region of the capital, Baghdad, from the botanical complex in the National Park of the Ministry of Agriculture and classified by the Iraqi National Herbarium at the Ministry of Agriculture. It was dried after being cleaned in laboratory conditions and ground with an electric grinder.

2.2. Preparation of the Plant Extract

Tooke 20 g from Moringa leaf powder, each separately, were placed in a thimble tube, then placed in a soxhelt extractor, then 200 ml of ethyl alcohol at a concentration of 70% was added for 24 hours, after which the sample was concentrated in a rotary evaporator at a temperature not exceeding 70 Celsius, and after obtaining a gelatinous solution, the sample was transferred to a glass bottle of known weight and placed in the oven at a temperature of 50 Celsius to obtain the dry extract, after which the sample was kept in the refrigerator until use. The basic solution (stock solution) was prepared at a concentration of 20 g/l, from which, the concentrations (0.5, 1, 2, 3) g /l were prepared [14].

Plastic petri dish size 9 mm was used, and inside each of them a filter paper was placed moistened with distilled water, then planted papers were placed on them and each dish was sprayed with the concentrations used in the experiment separately 0.5, 1, 2 and 3 g/l. The control treatment was sprayed with distilled water, and then the insects that were collected from the infected plants were transferred from both whitefly and aphids to the dishes at a rate of 20 insects in each dish and in 5 dishes for each treatment.
The experiment was repeated 3 reduplicates for each concentration of the plant extract. The dishes were left in the laboratory at a temperature of 25 ± 1 °C and a relative humidity of 60% +10%. The percentage of mortalities was calculated after 24, 48 and 72 hours of treatment. The percentage killings efficacy of the botanical pesticide was calculated using the Tilton and Henderson equation, which states the following:

$$\text{Corrected (\%)} = \left(1 - \frac{\boldsymbol{n\ in\ Co\ befor\ treatment} \times \boldsymbol{n\ in\ T\ after\ treatment}}{\boldsymbol{n\ in\ Co\ after\ treatment} \times \boldsymbol{n\ in\ T\ befor\ \ treatment}}\right) \times 100$$

Where: n is insect population, T is treated insects, and Co is the control.

2.3. Chemically Active Substances Analysis

Tests were conducted to reveal the chemically active substances in the extract of the Moringa alcoholic plant, and it was found that they contain the active substances as shown in Table (1) According to the methods used in [15, 16, 17, 18, 19, 20] to estimate and detect the important active ingredients shown in Table (1).

2.4. Design and Implement Transactions

The experiment was designed according to the randomized complete block design (RCBD) and the data were statistically analyzed using the ANOVA table. The averages were compared with the adoption of the Least Significant Difference Test (LSD) at the level of 0.05.

3. Results and Discussion

The results in Table (1) after conducting chemical analysis to detect the active compounds in the alcoholic extract of Moringa leaves showed the presence of many active compounds such as (Tannins, Carbohydrates, Glycosides, Phenols, Resins, Saponins, Alkaloids, Terpenes). Numerous studies have shown that these active compounds act in a variety of ways, as they act as nutrient-blocking, growth-inhibiting and repellent compounds, in addition to their toxic effect on harmful insects of various insect orders such as mosquitoes and lepidopteron larvae and the sugar beet worm. Where the presence of an active substance such as phenols causes a loss of muscle strength and affects the nutrition process by affecting oral components and other chemical receptors and on the contractions of the digestive tract and a decrease in the amount of digestive enzymes excreted in it.

The compounds present in the extract of the plants have a repellent and anti-feeding effect, also forms a layer of the extract around the wall of the nymph's body, preventing it from moving and feeding of white fly nymphs [21]. In addition to the presence of pectic and soapy materials, the previously mentioned compounds participate in killing and affecting the nymphs, and these results were consistent with what was indicated with [22, 23].

Table (1). Detection of the active compounds in the Moringa plant used in the study.

Moringa plant	
Detection type	The result
Tannins	+
Carbohydrates	+
Glycosides	+
Phenols	+
Resins	+
Flavonoids	_
Saponins	+
Alkaloids	+
Proteins	_
Coumarins	_
Terpenes	+
Steroids	_

The results in Tables (2 & 3) when studying the effect of using four concentrations of the alcoholic Moringa plant extract in controlling nymphs and adults of the whitefly insect showed that the concentration of 3 g/l achieved the highest killing efficiency rates for this extract, as it reached 95% at the nymph stage, and adults was 91%, after 72 hours of treatment with this concentration. While the lowest percentage of mortality for these insects was recorded at concentration of 0.5 g/l, which was at 63 and 60% adult nymph stages respectively, while the killing rates were zero in the control treatment that included spraying with distilled water only. The results also showed that the concentration of 3 g/l achieved the best results in the percentage of mortality and a significant increase over the other concentrations, which reached in the nymphs' stage (13.09, 35.71, 50.79%), respectively. While it reached 15.18, 33.82, and 51.66% in the adult stage, respectively.

Table (2). The effect of alcoholic Moringa extract on controlling B. tabaci nymphs in the laboratory.

Killed percentage	The number of dead insects after spraying in 72 hours	The number of dead insects after spraying in 48 hours	The number of dead insects after spraying in 24 hours	The number of insects before spraying (control)	Cons
63%	63	40	17	100	0.5 g/l
70%	70	58	30	100	1 g/l
84%	84	68	45	100	2 g/l
95%	95	83	55	100	3 g/l
	10			For interactions	L.S.D0.05

The results also indicate that the nymph stage was more sensitive when exposed to the pesticide, as it was affected to a greater degree than the adult stage in response to the alcoholic extract of the Moringa plant, as it was noted from the results in Tables (2 & 3) that the mortality rate of the insect increases with time of spraying and with the increase in concentrations.

This results agree with what was found by [24] the possibility of using alcoholic extracts of a number of plants in controlling the white fly, when the numeral of nymphs decreased by 36%.and that's agree with [25] who attributed the reason for the effectiveness of the plant pesticide in controlling insects, especially in the nymph stage, to the weakness of the Cuticle layer surrounding the nymphs at the beginning of their formation, or that the newly hatched nymphs need large quantities of food for the purpose of their growth, which causes the entry of large quantities of the extract into the digestive tract leading to the dead of the nymphs.

Table (3). The effect of alcoholic Moringa extract on controlling the whitefly (B. tabaci) adults in the laboratory.

Killed percentage	The number of dead insects after spraying in 72 hours	The number of dead insects after spraying in 48 hours	The number of dead insects after spraying in 24 hours	The number of insects before spraying (control)	Cons
60%	60	38	20	100	0.5 g/l
68%	68	58	32	100	1 g/l
79%	79	64	42	100	2 g/l
91%	91	78	51	100	3 g/l
	8.9			For interactions	L.S.D0.05

As for the results in Tables (4 & 5) when using the alcoholic Moringa plant extract in controlling an insect Aphid cowpea, the concentration of 3 g / L had the greatest significant effect compared to the other concentrations. In the nymphs' stage, the number of insects decreased at this concentration from 100 live insects before spraying to 7 live insects after 72 hours of treatment with this extract. With a killing efficiency rate of 93%, while in the adult stage, the number of live insects also decreased from 100 before spraying in the control treatment (spraying with distilled water) to 10 insects after spraying, with a killing efficiency rate of 90%.

The results also showed that the concentration of 3 g/l achieved a significant superiority over the other concentrations, at rates of 16.25, 34.78, and 47.61% in the nymphs of aphids, respectively, while it reached 15.38, 34.32, and 47.54% in the adult stage, respectively. These results agree with what it is found in [26, 27] for using Moringa plant extract against aphids and has contributed significantly to its control, in addition to that it contributed to the increase in the production of crops treated with this plant pesticide. It is also among the important reasons for the effectiveness of the pesticide through the increase in concentrations and the length of time of exposure to the pesticide by the insect. This is due to the effect of toxic active compounds on the vital activities inside the body of the insect during time which is the cause of the insect poisoning by the effect of the extract reaching the respiratory system, which leads to its disruption and the occurrence of suffocation cases, In addition to that the pesticide causes paralysis and slow movement of the insect and on the first day, then the toxic effect increases after three days, in which the effect of toxic compounds intensifies In terms of loss of movement and rotation in the same place and then death of the insect. This is results also confirmed by [28-30].

Table (4). Effect of Alcoholic Moringa Extract on the Control of Nymphs (Aphis craccivora) from Cowpea in the Laboratory.

Killed percentage	The number of dead insects after spraying in 72 hours	The number of dead insects after spraying in 48 hours	The number of dead insects after spraying in 24 hours	The number of insects before spraying (control)	Cons
63%	63	42	30	100	0.5 g/l
69%	69	54	38	100	1 g/l
80%	80	67	45	100	2 g/l
93%	93	81	55	100	3 g/l
	6.7			For interactions	L.S.D0.05

Table (5). The effect of the alcoholic Moringa extract on controlling the adults of aphid cowpea insect (Aphis craccivora) in the laboratory.

Killed percentage	The number of dead insects after spraying in 72 hours	The number of dead insects after spraying in 48 hours	The number of dead insects after spraying in 24 hours	The number of insects before spraying (control)	Cons
61%	61	39	28	100	0.5 gm/ L
67%	67	50	36	100	1 gm/L
78%	78	65	43	100	2 gm /L
90%	90	80	52	100	3 gm /L
	10.2			For interactions	L.S.D 0.05

4. Conclusions and Recommendations

Overall, results suggest that ethanolic extracts of *M. oleifera* showed the highest insecticidal effects on nymphs and adults of *B. tabaci* and *Aphis craccivora*. The extracts from *M. oleifera* represented to be as sources of natural insecticides for the management of immature *B. tabaci* and *A. craccivora* since their effects were comparable with that showed by the extracts of *M. oleifera*, a well-known plant species for its insecticidal activity *Moringa oleifera* leaf extracts is effective plant growth regulators and bio pesticides against different chewing and sucking insect pests, especially *B. tabaci* and *Aphis* craccivora. Moringa leaves contain several active bio compounds like phenols, terpens, alkaloids, carbohydrates, saponin that do not have any hazardous effects. The research shows the need to explore new aspects for eco-friendly sustainable agriculture, further need to identify the synergistic effects of moringa with other plant extracts and study effects as biological control agents.

This study also confirmed that the extracts of some plants contain materials with bio-activity, and these materials do not pollute the environment and can act as a basis for the manufacture of chemical compounds that are not harmful to environment, which differs from the usual compounds because of the absence of toxic residues on the plant and the ease of its disintegration, and it plays an important role in reducing impact of insects harmful to crops.

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