Assiut Journal of Agricultural Sciences 56 (1) 2025 (157-171) Website: http://ajas.journals.ekb.eg/
ISSN: 1110-0486 / EISSN: 2356-9840 E-mail: ajas@aun.edu.eg

(Original Article)

Biochemical Control of the Two-Spotted Spider Mite, *Tetranychus urticae* Koch using some Plant Extracts on Eggplant Crop

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DOI: 10.21608/AJAS.2025.312208.1387
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Abstract

The study herein explores the possible uses of plant extracts obtained from common milkweed, Egyptian henbane, neem, sweet clover, datura, and ashwagandha, which were applied at concentrations of 0.5%, 1%, 2%, and 4% to control the two-spotted spider mite, *T. urticae*. The laboratory experiments assessed the mortality rates of adult females exposed to different concentrations of acetone and methanol extracts were calculated *in vitro*. Datura, ashwagandha, neem, and sweet clover extracts performed better when extracted with methanol solvent than with acetone at a concentration of 4%. These extracts caused mortality rates of 85.71, 83.52, 75.82, and 46.15 % for methanol solvent and 84.62, 78.02, 69.23, and 13.18 % for acetone solvent, respectively. These results were further validated in field experiments on eggplant crops, where ashwagandha extracted by Methanol solvent was a potent extract against *T. urticae* when applied at 4% concentration, reducing the pest population by 68.06, 60.58, 75.29, 54.80, and 68.66 % after 1, 3, 7, 14, and 21 days, respectively, with an average of 65.47%. Datura extract reduced the pest population by 59.34%, 63.14%, 72.03%, 78.75%, and 62.77% after the above-mentioned periods, with an average of 67.20%. While neem and Egyptian henbane extracts gave similar reduction rates of 54.32, 58.71, 62.44, 54.19 and 62.87% for neem and 45.58, 53.16, 61.11, 67.86 and 52.77 % for Egyptian henbane, with an average of 58.50% and 56.09 % for neem and henbane, respectively. The observed efficacy among plant extracts emphasizes the importance of considering laboratory and field conditions for pest management strategies in agriculture.

Keywords: *Biocontrol*, *Datura*, *Egyptian henbane*, *Tetranychus urticae.*

Received: 1 October 2024/ Accepted: 1 December 2024/ Published online: 13 January 2025

Introduction

The two-spotted spider mite, *T. urticae* (Tetranychidae) is a major pest for many crops. This pest can infests more than 180 different plant species in both greenhouses and fields (Chakraborty *et al.*, 2009, and Jakubowska *et al.,* 2022) This pest can causes great damage to a variety of plants, including beans, cotton, pears, plums, and many other horticultural and ornamental plants (Rabbinge,1985), in addition to many vegetable crops such as: tomatoes, squash, eggplant, and cucumber ((Fasulo and Denmark, 2003, and Kaimal, 2021), and many economically important plants (Jeppson *et al.*, 1975, and Sarwar, 2019). Moreover, infestation with this pest results in financial damage, especially when it feeds on vegetable crop leaves, which leads to a reduction in the process of photosynthesis, transpiration, and the levels of chlorophyll and nitrogen in the leaves (Guo *et al*., 1998, and Kaimal 2021).

Synthetic acaricides are commonly used to control red spider mite, as these chemicals are highly effective in reducing mite densities (Manu *et al*., 2021). Taking into account, many disadvantages of using these synthetic acaricides, including high costs, damage to the pasts natural enemies, negative effects of on the surrounding environment, health risks to the farmers, and the development of resistance that the mite acquires from repeated use of these compounds(Norval *et al*., 1992, and Overton *et al.*, 2021).

Plants produce a variety of secondary metabolites that are thought to help them defend themselves from harmful parasites (Divekar *et al.,* 2022). Therefore, plants are a rich source of natural compounds with pesticides properties, often referred to as botanical pesticides (Lengai *et al.*, 2020). Plants are becoming increasingly popular in pest control due to their low toxicity to non-target organisms, safety to humans, and ease of biodegradation (Damalas and Koutroubas, 2020; Ngegba *et al*., 2022; Souto *et al.,* 2021). several botanical pesticides are now available for the control of arthropod pests in agriculture and homes. This has led to a growing interest in the use of plants as part of integrated pest management programs. (Dara, 2019, and Guo *et al.*, 2023).

Essential oils, extracted from plants, have been studied for their potential in controlling red spider mite. (Nollet, 2024). These oils are used as repellents or pesticides and can be act as antifeedant or inhibitory to some biological characteristics of the pests (reproduction, egg-laying and hatching rates), and affects the spread of these pests and reduces their numbers (Hikal *et al.*,2017, and Aouini *et al*., 2023). Plant derivatives include a variety of compounds including nicotine and pyrethrum which likely act as a protective property against herbivores in the foundation plant (Elshafie *et al.*, 2023).

Therefore, the current study aimed to estimate the effectiveness and toxicity of some plant extracts against the two-spotted spider mite, *T. urticae* in both laboratory and field.

Materials and Methods

1-Rearing of *T. urticae*

The two-spotted spider mite, *T. urticae* was reared by collecting individuals of the mite stages from eggplant cultivated at the Faculty of Agricultural farm, Al-Azhar University, Assiut, Egypt. The pest was maintained in Petri dishes (10 cm in diameter) on bean leaves with a piece of cotton dipped in pure water to maintain the relative humidity in the rearing dishes. These dishes were placed at a temperature and relative humidity suitable for the growth and development of the pest (25 ± 1 °C and 70 ± 5%). On the other side, bean plants (*Phaseolus vulgaris*) were grown in 25 cm diameter pots under sunlight, and once they developed six to eight true leaves, they were infested with the two-spotted spider mite, *T. urticae* to serve as stock culture to be a permanent source of the pest.

2-Preparation of plant extracts

In this study, five plant species were selected: Egyptian henbane (*Hyoscyamus muticus*) flowers, neem (*Azadirachta indica*) leaves, sweet clover (*Melilotus alba*), datura (*Datura stramonium*), milkweed (*Asclepias fruticosa*), and ashwagandha (*Withanias omnifera*). The leaves and flowers of these plants were collected from the farm of the Faculty of Agriculture, Al-Azhar University, Assiut, Egypt. Five hundred grams of each plant were shade-dried at room temperature for two weeks, and ground into a fine powder using an electric blender. The powders were stored in tightly sealed containers, and the extraction process was carried out by treating 200 grams of each powder in a Soxhlet apparatus using acetone and methanol as solvents.

3-Efficacy of plant extracts against of *T. urticae* adult females under laboratory conditions

This study was conducted in the laboratory of the Department of Agricultural Zoology and Nematology, Faculty of Agriculture, Al-Azhar University where the efficacy of the previously prepared plant extracts on adult females of *T. urticae* was tested by transferring ten newly emerged adult females to the upper surface of kidney bean leaf discs (3cm in diameter) placed on wet cotton pads inside Petri dishes (10 cm in diameter). Each treatment was repeated ten times (ten Petri dishes for each treatment). Adult females were exposed to one of the four concentrations of the plant extracts (0.5%, 1%, 2%, and 4%), while untreated control groups were sprayed with water and dimethyl sulfoxide (DMSO) solvent at a rate of 0.1%. A hand sprayer was used for this purpose and the dishes were kept at room conditions (27±2°C and 65±5% R.H.) and were evaluated by counting the number of dead females after 1, 2, and 3 days.

4-Experimental Design and Treatments

To study the effect of plant extracts on *T. urticae* populations in the field, experiments were conducted at the research farm of the Faculty of Agriculture, Al-Azhar University, Assiut. A randomized block design with three replicates was used. The experiment consisted of four treatments and one control, each with three

replicates. Plot size was 4 m wide and 5.5 m long (22 m² per plot). The total experimental area was 330 m² [5 treatments × 3 replicates].

The soil was sterilized before planting using 238 kg/ha of agricultural sulfur (Abu Qir Fertilizer and Chemical Industries). A specific basal dose of 142.8 kg/ha P_2O_5 (15.5% $CaH_6O_9P_2$) and 47.6 m³ of decomposed organic fertilizer were incorporated into the soil. The field was plowed twice vertically, flattened, and divided into experimental plots. In addition, 238 kg/ha of nitrogen (33.5% NH_4NO_3) and 238 kg/ha of K_2O (50% potassium sulfate) were divided into two equal applications 30 and 60 days after transplanting, according to the recommendations of the Egyptian Ministry of Agriculture (Hassan 2011). Certified eggplant seedlings were obtained from a private greenhouse and were manually planted with a 30 cm distance between hills on March 14, 2022.

5-Field efficacy of plant extracts on *T. urticae* adult females

Plant extracts were used to evaluate their efficacy against *T. urticae* populations at a concentration of 4% for each extract (i.e., Ashwagandha, Neem, Datura, and Egyptian henbane) on eggplant plants. This concentration was selected based on the results of the laboratory experiments. The entire plant was covered with the spray liquid, keeping a distance of about 25 cm between the nozzle and plant parts. The treatments were applied using a knapsack sprayer fitted with a single nozzle boom.

The numbers of *T. urticae* (motile stages) were counted before and after spraying using a binocular microscope (model N-400M, Nanjing Everich Medicare Import and Export Co., China). Samples of 10 leaves were taken, focusing on both the upper and lower surfaces from each plot in three replicates. Samples were collected at intervals of 1, 3-, 7-, 14-, and 21-days post-spraying. The reduction percentages in the *T. urticae* numbers were calculated according to Abbott's (1925) equation as follows:

$$\textbf{Percentage of mortality} = \frac{\textbf{\%tested mortality} - \textbf{\%control mortality}}{\textbf{100} - \textbf{\%control mortality}} \textbf{X 100}$$

6-Statistical analysis

The obtained data were subjected to a one-way analysis of variance (ANOVA), followed by an F-test, according to procedures outlined in IBM SPSS Statistics for Windows (version 20, 2011). Mean square values were calculated, and comparisons between treatments were made at a 5% significance level. Reduction percentages in the *T. urticae* population were calculated according to Abbott's (1925) to assess the efficacy of the plant extracts.

The toxicity index (Ti) was determined by using the method described by (Sun, 1950). Lethal concentrations (LC50) were estimated through Probit analysis, following the approach outlined by (Aitchison and Silvey, 1957). These analyses help evaluate the relative toxicity of the plant extracts against *T. urticae* and determine the effective concentration required to control the mite populations.

Results

1-Effect of plant extracts (when used acetone solvent) on *T. urticae* adult females under laboratory conditions

The results in Table (1) indicated that, the Egyptian henbane plant showed the highest mortality rates, which reached 91.21, 75.82, 56.04, and 36.26% when using concentrations of 4, 2, 1, and 0.5%, respectively. While the datura extract came second place with average mortality rates of 84.62, 71.43, 45.05, and 36.26%, for the same concentrations, respectively. Ashwagandha extract followed with 78.02, 61.54, 47.25, and 34.04%. Neem extract caused 69.23, 57.14, 45.05, and 30.77%. The extracts for common milkweed and sweet clover recorded the lowest mortality rates, (53.85, 51.65, 35.16 and 31.87 %) for common milkweed and (13.18, 9.89, 7.69, and 2.19%) for sweet clover at the same concentrations (4, 2, 1 and 0.5 %). There were statistical differences in concentrations and extracts in all plant extracts.

Table 1. Mortality percentages of *T. urticae* adult females treated with plant extracts when extracted by using acetone under laboratory conditions

Plant extracts	Conc .%	Avg. no. of dead adult of T. urticae adult females after 1,2,3 days			Corrected mortality (%)
		One day	Two days	Three days	
Common milkweed	0.5	1.20±0.24	1.80±0.35	0.80±0.29	31.87 ij
	1	1.40±0.33	1.70±0.94	1.00±0.29	35.16 hij
	2	3.70±0.49	1.10±0.17	0.80±0.20	51.65fgh
	4	3.50±0.70	0.80±0.32	1.50±0.37	53.85efg
Egyptian henbane	0.5	2.10±0.54	1.00±0.30	1.10±0.30	36.26 hij
	1	3.40±0.48	1.10±0.22	1.50±0.21	56.04d-g
	2	4.60±0.26	1.60±0.16	1.60±0.30	75.82 ab
	4	6.60±0.54	2.00±0.2	0.60±0.16	91.21a
Neem	0.5	2.00±0.33	1.50±0.22	0.20±0.13	30.77 ij
	1	3.00±0.33	0.90±0.17	1.10±0.17	45.05 f-i
	2	3.80±0.38	1.30±0.30	1.00±0.21	57.14 d-g
	4	5.40±0.40	1.50±0.30	0.30±0.15	69.23 b-e
Sweet clover	0.5	0.50±0.16	0.30±0.15	0.30±0.15	2.19 l
	1	0.50±0.16	0.90±0.31	0.20±0.13	7.69 kl
	2	1.10±0.27	0.40±0.16	0.30±0.15	9.89 kl
	4	1.40±0.49	0.30±0.15	0.40±0.16	13.18 k
Datura	0.5	2.60±0.88	1.40±0.16	0.20±0.16	36.26 hij
	1	3.40±0.40	1.00±0.21	0.60±0.16	45.05 f-i
	2	6.60±0.85	0.40±0.26	0.40±0.16	71.43 bcd
	4	8.20±0.38	0.20±0.13	0.20±0.13	84.62 ab
Ashwagandha	0.5	2.30±0.33	1.50±0.22	0.20±0.13	34.07 ij
	1	3.40±0.30	1.00±0.21	0.80±0.20	47.25 f-i
	2	5.00±0.54	0.90±0.40	0.60±0.26	61.54 c-f
	4	7.00±0.39	0.70±0.30	0.30±0.15	78.02 ab

Data are presented as mean value Mortality percentage a, b Different letters indicate high significant difference according to Duncan's multiple range tests. Values are significant at p= 0.05 levels, df =239, F-value= 21.37 (after 3 days

2-Effect of plant extracts (when used methanol solvent) on *T. urticae* adult females under laboratory conditions

The results in Table (2) showed that datura extract gave the highest mortality rates of 85.71, 65.93, 58.24 and 39.56% at concentrations of 4, 2, 1 and 0.5 % when using methanol solvent, respectively. Ashwagandha extract came in second

place with average mortality rates of 83.52, 68.13, 59.34 and 43.96 % at the same concentrations, respectively. It was followed by neem extract, which recorded mortality rates of 75.82, 59.34, 47.25 and 36.26 % for the same concentrations, respectively. The Egyptian henbane extract recorded 73.63, 60.44, 35.16 and 18.68 %. While the extracts of common milkweed and sweet clover gave the lowest mortality percentages (49.45, 43.96, 28.57 and 21.98 %) for common milkweed and (46.15, 27.47, 21.97, 20.87%) for sweet clover at the same concentrations of 4, 2, 1 and 0.5 %, respectively. It was found that there were significant differences between the concentrations and extracts for all tested extracts.

Table 2. Mortality percentages of *T. urticae* adult females treated with plant extracts when extracted by using methanol under laboratory conditions

Plant extracts	Conc. %	Avg. no. of dead adult of T. urticae adult females after 1,2,3 days			Corrected mortality (%)
		One day	Two days	Three days	
Common milkweed	0.5	0.90±0.27	1.40±0.33	0.60±0.26	21.98 ij
	1	1.20±0.29	1.30±0.30	1.00±0.29	28.57 hij
	2	2.30±0.47	1.20±0.20	1.40±0.22	43.96 fgh
	4	3.00±0.49	0.90±0.31	1.50±0.34	49.45 ef
Egyptian henbane	0.5	1.00±0.39	0.90±0.27	0.70±0.30	18.68 j
	1	2.10±0.40	0.70±0.21	1.30±0.21	35.16 ghi
	2	3.90±0.50	1.30±0.21	1.20±0.20	60.44 cde
	4	4.80±0.35	2.00±0.21	0.80±0.20	73.63 ab
Neem	0.5	2.30±0.26	1.30±0.15	0.60±0.22	36.26 ghi
	1	3.50±0.42	0.90±0.17	0.80±0.20	47.25 fg
	2	2.90±0.36	1.50±0.26	1.90±0.22	59.34 cde
	4	5.10±0.31	1.60±0.26	1.10±0.23	75.82 ab
Sweet clover	0.5	1.40±0.30	0.50±0.22	1.00±0.21	20.87 ij
	1	0.90±0.23	1.20±0.29	0.70±0.21	21.97 ij
	2	1.20±0.32	1.10±0.17	1.10±0.27	27.47 hij
	4	2.70±0.26	1.00±0.25	1.40±0.22	46.15 fg
Datura	0.5	2.40±0.51	1.40±0.16	0.70±0.13	39.56 gh
	1	3.10±0.37	1.50±0.22	1.60±0.21	58.24 de
	2	4.90±0.56	0.80±0.26	1.20±0.16	65.93 cd
	4	5.50±0.40	1.60±0.31	1.60±0.35	85.71 a
Ashwagandha	0.5	2.50±0.22	1.70±0.26	0.70±0.26	43.96 fgh
	1	3.80±0.35	1.00±0.21	1.50±0.26	59.34 cde
	2	4.60±0.65	1.20±0.38	1.30±0.33	68.13 bcd
	4	6.00±0.44	1.10±0.30	1.40±0.30	83.52 ab

Data are presented as mean value Mortality percentage a, b Different letters indicate high significant difference according to Duncan's multiple range tests. Values are significant at p= 0.05 levels, df =239, F-value= 29.77 (after 3 days).

3-Toxicity of plant extracts (when used acetone solvent) against *T. urticae* adult females

Data in Fig. 1 showed that datura extract was the most effective one against *T. urticae*, while common milkweed extract was the least effective one among all the extracts tested. Based on LC_{50}values of the extracts tested, the extracts can be arranged in descending order as follows: datura, Egyptian henbane, ashwagandha, neem and common milkweed where LC50 values were: 0.78, 0.80, 0.86, 1.04 and 1.66 %, respectively (Fig. 1a) When considering the toxicity index at LC50, Datura extract was the most effective (100%) followed by Egyptian henbane extract (97.50%), Ashwagandha (90.69%), Neem (75%) and common milkweed

(46.98 %) (Fig. 2a). The slope values were: 1.47, 1.85, 1.19, 1.00 and 1.63 for the tested extracts at the same trend (Fig. 1a).

4-Toxicity of plant extracts (when used methanol solvent) against *T.urticae* adult females

Data in Fig.1 showed that ashwagandha extract was the most effective one against *T. urticae*, while common milkweed extract was the least effective one among all the extracts tested. Based on LC_{50} values of the extracts tested, the extracts can be arranged in descending order as follows: ashwagandha, datura, neem, Egyptian henbane and common milkweed, LC_{50} values were: 0.67, 0.78, 1.09, 1.59, and 3.72 %, respectively (Fig. 1b).when considering the toxicity index at LC50, ashwagandha extract was the most effective (100%), followed by datura extract (85.89), neem (61.49%), Egyptian henbane (42.13%) and common milkweed (18.00 %) (Fig.2b). The slope values were: 1.18, 1.36, 1.14, 1.73 and 0.89 for the abovementioned plant extracts, respectively.

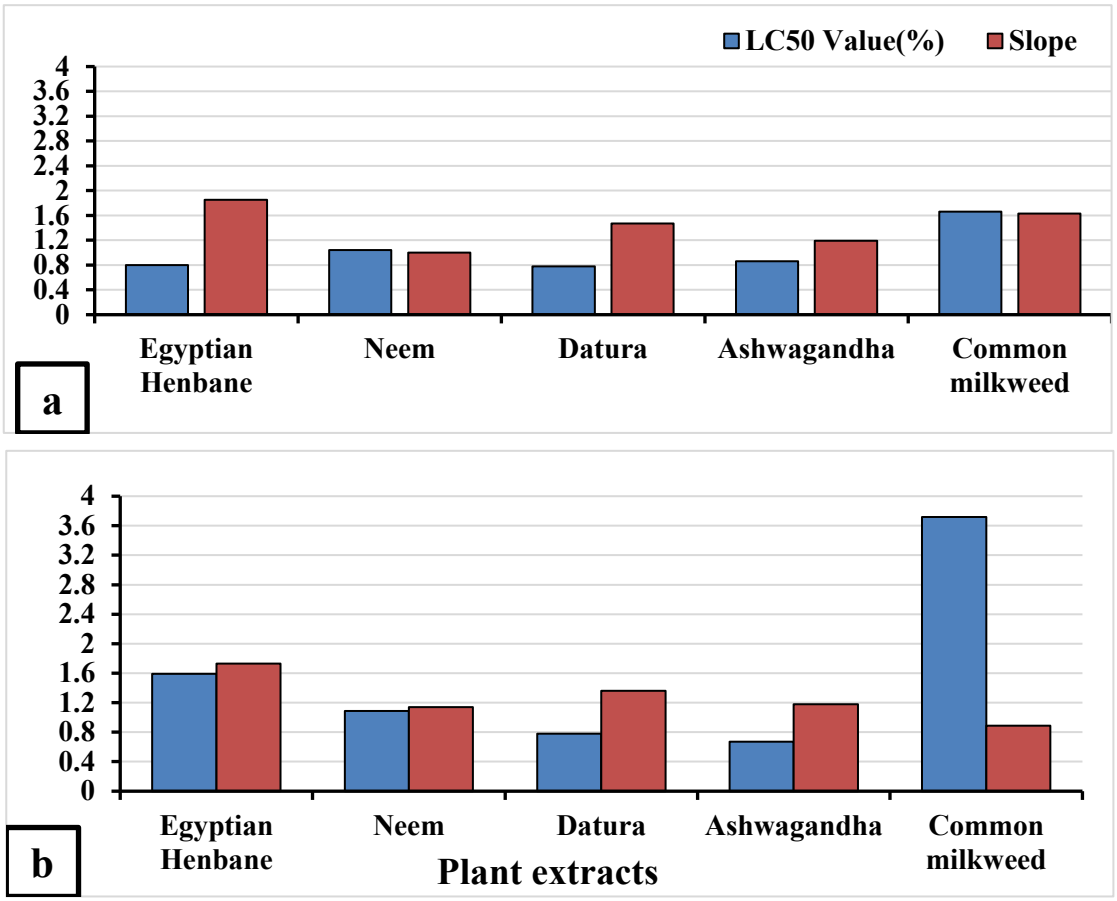

Fig 1. Estimates of the LC_{50} and slope values of *T. urticae* adult females treated with the plant extracts when used acetone (a) and methanol (b) solvents.

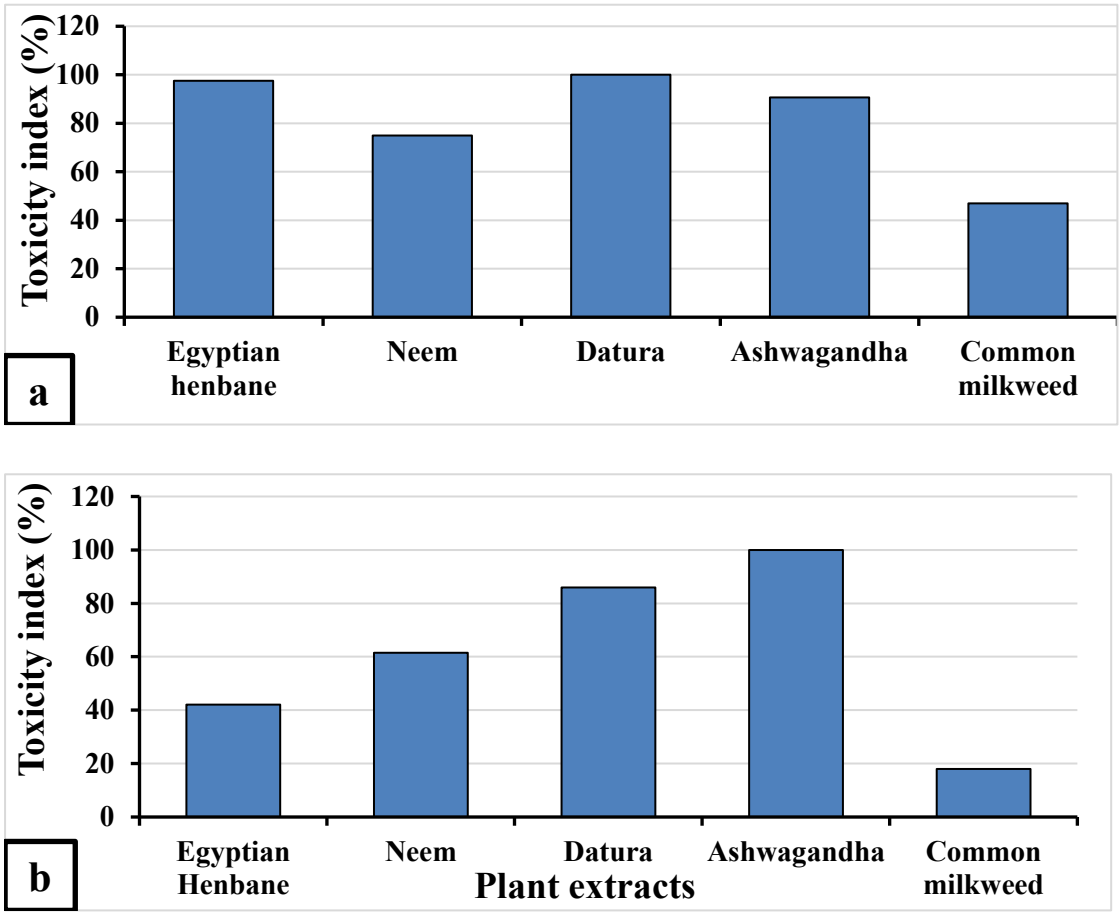

Fig 2. Estimates of toxicity index of plant extracts when used acetone (a) and methanol (b) solvents on *T. urticae* adult females.

5- Effect of plant extracts on density *T. urticae* infested eggplant under field conditions

The data presented in Fig. 3 showed the effectiveness of different plant extracts in reducing the density of *T. urticae* on infested eggplant under field conditions when using a concentration of 4%. Ashwagandha extract showed the highest effectiveness, achieving a reduction in mite numbers by 68.06%, 60.58%, 75.29%, 54.80%, and 68.66% after 1, 3, 7, 14, and 21 days, respectively, with an average reduction of 65.47%.

Datura extract also showed strong efficacy, recording reductions of 59.34%, 63.14%, 72.03%, 78.75%, and 62.77% over the same time periods, with an average reduction of 67.20%

In contrary, neem and Egyptian henbane extracts showed more moderate, but with similar rates of reduction. Neem reduced mite numbers by 54.32%, 58.71%, 62.44%, 54.19%, and 62.87% over the same time periods, respectively, with an average reduction of 58.50%. Similarly, Egyptian henbane showed reductions of 45.58%, 53.16%, 61.11%, 67.86%, and 52.77%, with an overall average reduction of 56.09%.

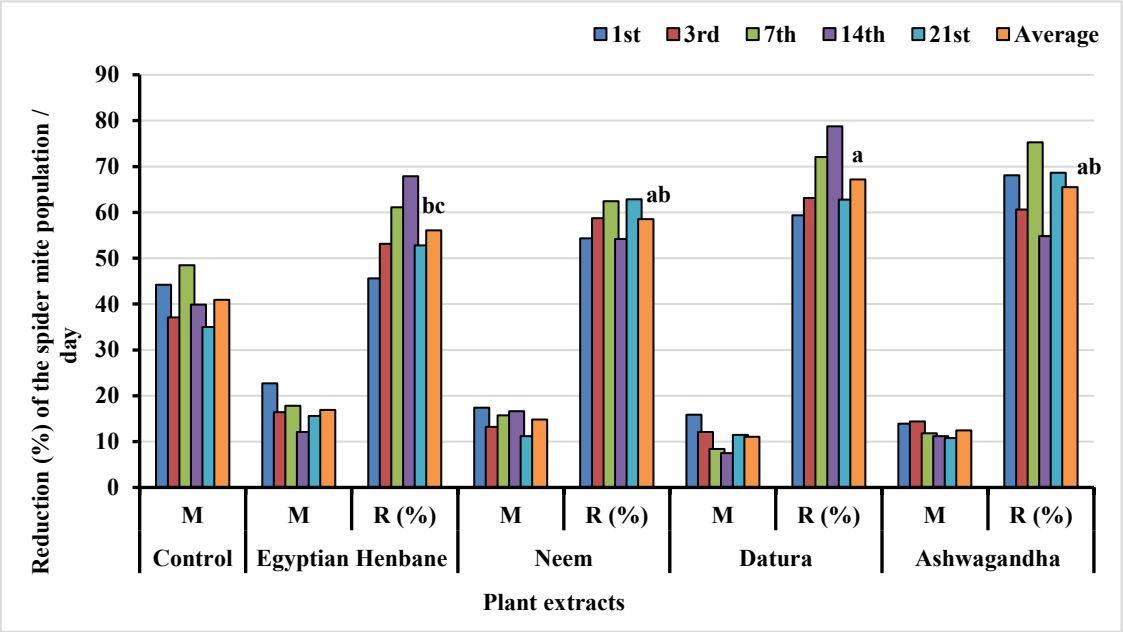

Fig 3. Mean numbers (M)/10 leaves and reduction percentages (R %) of the two-sotted spider mite using different plant extracts on eggplant under field conditions. Different letters indicate a significant difference between the means according to Duncan's multiple range tests. Values are significant at p= 0.05 levels, df =19, F-value= 2.64.

Discussion

Several authors (Alpkent *et al.,* 2023*;* Gnedy *et al.,* 2023*;* Mérida-Torres *et al*., 2023) have shown the potential of using plant extracts in controlling the red spider mite, *T. urticae*. They confirmed that plant leaves extracts showed similar effect as that of *T. urticae* acaricides

Ashwagandha, Datura, Neem, and Egyptian henbane in this study were highly effective in increasing of mortality rates of adult females and inhibition of eggs hatching at high concentrations and showed efficiency in controlling *T. urticae*. Some studies have shown the importance of natural compounds (plants extract) that could suppress mite's populations (Alpkent *et al*., 2023; Liao *et al*., 2023; Mammadova *et al*., 2023).

The toxicity index at LC_{50} showed that datura and ashwagandha extracts were the most effective against *T. urticae*. The presence of toxic compounds in these plants, such as mithanoloids in ashwagandha seeds (Afraze *et al.,* 2020) and several phytochemicals in datura (Tabet *et al*., 2018) , may contribute to their high toxicity against *T. urticae*. Sharma *et al.* (2023) showed that *Datura stramonium* leaf and seed extracts exhibit lethal effects on *T. urticae*, with mortality rates of adult females exposed to the leaf extract ranging from 29% to 98% after 48 h. This highlights the strong acaricidal properties of datura extracts in controlling *T. urticae*. Similarly, Mateeva *et al*. (2003) reported that datura extract had toxic effects on all motile stages of *T. urticae* under laboratory conditions. Furthermore, it has been shown that some alkaloids present in different parts of *Datura spp*. may explain the effectiveness of the leaf extracts in this study (Cinelli and Jones, 2021; Lelago and Assefa, 2023). These results are consistent with Abou-Shosha (2020)

who found that *Datura stramonium* leaves and Egyptian henbane (*Hyoscya musmuticus*) flowers extracted with acetone significantly affected *T. urticae* populations on eggplant and kidney bean crops. When applied at concentration of 4%, *Datura stramonium* achieved mortality rates of 92.30% on eggplant and 94.12% on kidney beans after treatment periods of 1, 3, 7, 14, and 21 days.

Based on the results of the present study, the plant extracts showed great promise in controlling *T. urticae*, with acetone and methanol being proving to be suitable solvents for extraction. The results of the neem extract are consistent with those reported by Davidson and Chinniah (2023), who evaluated Neem Gard, an acaricidal formulation derived from Neem (*Azadirachta indica*), for its efficacy against the phytophagous mite, *T. cinnabarinus* in preventing damage to *Jasminum sambac* plants, Their study showed that the neem oil recorded a mortality rate of 78.13% for *T. cinnabarinu*. In a separate study, Sivira *et al.* (2011) demonstrated the acaricidal effects of ethanolic extracts of wild oregano and gliricidia on *T. cinnabarinus*, with mortality rates of 96.6% and 100% at a 20% concentration

These results suggested the potential of gliricidia and wild oregano as alternatives for *T. cinnabarinus* management, although further field studies are needed

Furetheremore, Hammad *et al.* (2017) compared the biological activity of two neem seed kernel extracts, Margosan-O and Neem Azal-S, against *T. urticae*. Both extracts demonstrated deterrent, toxic, and repellent effects, and similar results are believed to be found on *T. cinnabarinus*, given the common biological and behavioral characteristics of these phytophagous mites.

Although the present study focused on the effect the plant extracts on *T. urticae*, the results are likely to be similar to those of *T. cinnabarinus*, as both species are phytophagous mites and are biologically and behaviorally similar. The main active ingredient in neem, azadirachtin, has several negative effects on arthropods, such as repellent and feeding inhibition (Rajput *et al.*, 2023). Neem extracts have been shown to have repellent effects on *T. cinnabarinus*, causing the mites to avoid the treated area (Rincón *et al*., 2019).

This can lead to a reduction in the mite population on the host plant. Neem extracts can inhibit the feeding of *T. cinnabarinus*, leading to a reduce growth and reproduction (Jakubowska *et al*., 2022). This can be attributed to the presence of azadirachtin in neem, which interferes with the digestive system of the mites (Verma *et al.,* 2023). Some studies have reported that neem extracts possess antifungal properties, which could be useful in controlling *T. cinnabarinus*, as fungal infections can be a common issue for mites and their hosts (Grabka *et al.*, 2022).

Overall, this study demonstrates the potential of using plant extracts such as Ashwagandha, Datura, Neem, and Egyptian henbane to control the two-spotted spider mite, *T. urticae*. Their increasing efficacy with high concentrations paves the way for alternative and sustainable solutions to control pests without resorting to the use of pesticides that are harmful to plants and the surrounding

environments. It may require more field experiments and reaching the optimal extraction of natural active ingredients, which provides a promising future for safer and more environmentally friendly pest management.

Conclusion

In this study, plant extracts of Egyptian henbane, neem, sweet clover, datura, and ashwagandha were evaluated for their efficacy against the two-spotted spider mite, *T. urticae* in both laboratory and field conditions. In laboratory tests, the extracts showed varying efficacy in reducing adult females' mortality of the pest. The extracts of henbane and datura gave the highest mortality rates, followed by ashwagandha and neem, while common milkweed and sweet clover showed low efficacy. The concentrations of these plant extracts also had a significant effect. When used acetone or methanol solvents for extraction, datura consistently showed high mortality rates, regardless of the solvent used. Ashwagandha and neem extracts also showed high efficacy, while Egyptian henbane showed moderate ones. Meanwhile, common milkweed and sweet clover extracts consistently produced low mortality rates. When studying the toxicological analyses, including LC_{50} values and toxicity indices in the laboratory, the effectiveness of datura and ashwagandha extracts showed high levels of toxicity compared to other extracts. Field experiments conducted on this pest infesting cultivated eggplant confirmed the laboratory results, as extracts of both ashwagandha and datura caused a significant reduction in *T. urticae* numbers over various observation periods. Neem and Egyptian henbane also showed effectiveness, but to a lesser extent. In general, the results indicate that datura and ashwagandha extracts are important and promising extracts as effective agents for controlling *T. urticae* numbers in its areas of presence. More field experiments are needed on large scale to enhance the role of these extracts, in integrated pest management strategies for sustainable agriculture.

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المكافحة البيوكيميائية للعنكبوت الاحمر ذو البقعتين (*Tetranychus urticae* Koch) باستخدام بعض المستخلصات النباتية على محصول الباذنجان

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الملخص

تناولت هذه الدراسة إمكانية استخدام المستخلصات النباتية المشتقة من نباتات (الصقلاب و البنج المصري والنيم، والحندقوق والداتورا والأشواجاندا التي تم استخلاصها بمذيبي الاسيتون والميثانول حيث تم استخدامها بتركيزات (0.5% ، 1% ، 2% ، 4%) لمكافحة الاناث الكاملة للعنكبوت الأحمر ذو البقعتين . كانت مستخلصات الداتورا والأشواجاندا والنيم و الحندقوق هي الأفضل عند استخلاصها بمذيب الميثانول مقارنة بمذيب الأسيتون بتركيز 4% حيث وصلت نسبة الموت الي 85.71 ، 83.52، 75.82 ، 46.15% لمذيب الميثانول في حين كانت 84.62، 78.02، 69.23 ، 13.18% لمذيب الأسيتون على التوالي. وقد تم التحقق من صحة هذه النتائج في التجارب الحقلية على محصول الباذنجان، حيث كان مستخلص نبات الاشواجندا فعالا ضد العنكبوت الاحمر ذو البقعتين بتركيز 4٪، حيث ادي الي نسبة خفض وصلت الي 68.06 ، 60.58 ، 75.29 ، 54.80 ، 68.66٪ بعد 1 ، 3 ، 7، 14 ، 21 يومًا على التوالي، بمتوسط انخفاض 65.47٪. ، سجل مستخلص الداتورة 59.34 ، 63.14 ، 72.03 ، 78.75 ، 62.77٪ في نفس الفترات على التوالي، بمتوسط 67.20٪. ولكن مستخلصات النيم والبنج المصري اعطي معدل موت منخفض حيث بلغ 54.32 ، 58.71 ، 62.44 ، 54.19 ، 62.87% للنيم ، 45.58 ،53.16 ، 61.11 ، 67.86 ، 52.77% للبنج المصري بمتوسط 58.50 ، 56.09% على التوالي. تشير هذة النتائج الي امكانية ادراج المستخلصات النباتية ضمن برامج المكافحة المتكاملة للعنكبوت الاحمر.

الكلمات المفتاحية : *الاستدامة الزراعية ، أكاروس الخضر، المستخلصات النباتية*