Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2022; 10(1): 224-232

Received: 16-11-2021
Accepted: 18-12-2021

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Comparison of an insecticide and its alternatives on cotton and soybean plants of two-spotted spider mite *Tetranychus urticae* in laboratory and field

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DOI: https://doi.org/10.22271/j.ento.2022.v10.i1c.8939

Abstract
This study used a standardised method for bioassay on cotton and soybean plants to assess the relative toxicity of three chemicals: one known acaricides (Abamectin), one fungal extract (*Aspergillus Niger* extract), and one plant extract (Neem oil) against the eggs and adult females of the two-spotted spider mite *Tetranychus urticae*. The impact of sub lethal doses of these chemicals on some biological and behavioral aspects of the mite was also assessed. Abamectin occupies a unique position in mite chemical control or integrated mite management due to its highly toxic effect and toxicity index, whereas neem extract was the most minor toxic compound to eggs and adult females *T. urticae* on two host plants. As a result, it could be recommended in IPM programmes. The impact on the mite's biological and behavioral characteristics. The current investigation results showed that abamectin was the most efficient chemical against the motile stages, whereas *Aspergillus niger* extract had a modest effect on *T. urticae*. The motile stages of the studied pest were less affected by neem extract. During the two seasons 2020-2021, all chemicals successfully reduced the population density of motile stages of the spider mite, *T. urticae*, in lab and field trials.

Keywords: Two-spotted spider mite *Tetranychus urticae*, acaricides, fungal extract, plant extract, cotton plants, soybean plants

Introduction
Tetranychus spider mites (Acari: Tetranychidae) are major crop pests that impact more than 1,100 plant species from 140 different plant families [1]. Tetranychid mites are major agricultural pests, producing more economic losses than any other arthropod pest in certain circumstances. *Tetranychus urticae*, a two-spotted spider mite, is a severe pest that attacks various agricultural products, including cotton, soybeans, vegetables, fruits, and ornamental plants. Mite infestation caused significant harm to these affected plants, which was followed by a secondary infection by viruses, bacteria, and fungus. The latter creature, in other words, fungi has produced significant problems in agriculture. The survey and control of both pests receive a lot of attention to safeguard the crops and, as a result, to minimise the loss in agricultural economy income production. Two-spotted spider mite *T. urticae* Koch is piercing-sucking pests that infest cotton and soybean plants. This feeding activity leads to the production of characteristic yellow-chlorate spots on the leaves. The leaves begin with pale yellow stripes along the midrib and veins, then turn greenish or silvery and to red. Biological control has been demonstrated to be a cost-effective and environmentally friendly alternative to pesticides in many agricultural systems [2]. The severity of spider mite-caused plant damage is determined by various factors that influence the mites' eating and reproduction. Of particular importance are the nature and circumstances of the host plants, as well as the influence of physical elements on both the host and the mite. *T. urticae* (Koch), a two-spotted spider mite, has been extensively examined, and evaluated the early studies [3]. *T. urticae* infests many agricultural crops, including cotton plants [4]. In more severe infestations, mites feed and oviposit across the whole surface of the leaf, producing leaf fall and branch die-back, which can result in defoliated plants [5].

The severity of spider mite-caused plant damage is determined by a variety of factors that influence the mites' eating and reproduction of particular importance are the nature and circumstances of the host plants, as well as the influence of physical elements on both the host and the mite. *T. urticae* (Koch), a two-spotted spider mite, has been extensively examined. Due to its broad impact on diverse types of arthropods, as well as biodegradability, low toxicity to mammals, and lack of contamination of the environment, the use of formulations whose active ingredient is derived from plants, such as essential oils (EOs), has been intensively researched [6].

For managing the two-spotted spider mite a variety of chemicals have been marketed. The widespread use of chemical compounds has led to many issues, including population epidemics and chemical resistance, all of which have harmed human health and wealth. Integrated pest management (I. P. M) programmes worldwide are attempting to reduce the use of insecticides by introducing predators and entomopathogens such as viruses, bacteria, and fungi. The spider mite problem was not handled only by applying acaricidal drugs, as mites quickly developed resistance to many of them [7]. In greenhouse and field trials, commercialised *B. bassiana* strains ATCC74040 and GHA were used as conidial suspensions or as a manufactured product (Naturalis, strain ATCC74040) to prevent piercing-sucking insects on grapevine (*Vitis vinifera* (L.)) leaves [8].

Materials and Methods

Culture techniques

Tetranychus urticae (koch) (Acarina: Tetranychidae), a two-spotted spider mite, was grown according to [9]. Before beginning the trials, *T. urticae* colonies were gathered from castor bean plants on the farm of the Agricultural research station, Sakha. Kafr E1-Sheikh Egypt and cultured in the laboratory on cotton and soybean plants free of chemical contamination. Seeds of castor beans were planted, and the seedlings were infested with a clean culture of red mites. Mites were transferred from old to new plants by chopping badly contaminated leaves into small bits and placing them on new plants. Red spider mite adult females were taken from stock cultures and allowed to oviposit on castor bean leaves overnight. After that, the females were removed, and the eggs-infested leaves were planted on clean plants. After 16 days of oviposition, groups of plants carrying eggs laid during 24 hours were transplanted to tiny cages. Adult females of a similar age were selected from the cultures for use in the experiment. To promote plant growth, the prey culture was kept at 25 2 °C with a 16-hour photoperiod and 70 5 R.H. Mites did not enter diapause due to the provision of 16/days length. Mites were transferred from one plant to another using an artist's brush (No. 0).

Compounds tested

Tested compounds

The tested compounds	Common name	The chemical name (IUPAC)	Source
Abamectin 1.8%	Abamectin	Avermectin B, a (5-o-deinethyl avermectin A_1a).	It was supplied by EL-Help Pesticides and Chemicals Company, Egypt

Fungal extracts

Fungal extracts	Common name	Plant used	Source
Aspergillus *niger* extract	**Aspergillus *niger* extract**	**extract**	It was supplied by Plant Diseases Institute

Plants extracts

Plant extracts	Common name	Plant used	Source
Neem extracts	Azadirachta indica	extracts	It was supplied by EL-Help Pesticides and Chemicals Company, Egypt

Fungi extract

Each fungal isolate's prepared culture was inoculated into 300 mL of potato dextrose broth media and cultured for 10 days in a shaking incubator at 28 °C. Each fungal culture was filtered and extracted with ethyl acetate (1:1) thrice after the incubation period. According to [10]. In procedure, the crude extract was dried with a rotary evaporator and kept frozen until use.

Preparation of plant extracts:

The plant components were air-dried at room temperature before processing into a fine powder with a blender. 100 g of powdered neem were macerated in 300 ml of the solvent system (ethanol and acetone, 1:1, v/v) in batches of 100 g. For one week, neem was macerated. Using an electronic shaker, neem extract was shaken for 6 hours during the maceration time. The extract was filtered using sterile cotton and filter paper (Wathman No: 101). The extract was dried using anhydrous sodium sulphate and a rotary evaporator until it was completely dry. To achieve the appropriate concentration, the residue was weighed, dissolved in acetone, ethanol, and stored at 4 °C [11].

Experimental techniques

Advantages of leaf discs as experimental arenas

Leaf discs are a practical way to create standard-sized experimental arenas. The advantage of standardizing arena size is that it automatically delivers a known number of preys at a predetermined density (number/unit area).Discs, rather than complete leaves, can be sliced to offer a more homogeneous surface for eating and oviposition locations.

Preparation of discs

Cork borer was used to cut cotton and soybean discs. So that the midrib was bisected, the bottom surface was placed on water-soaked cotton wool bad in petri dishes, and the upper surface was placed on water-soaked cotton wool bad. Depending on the nature of the experiment, the disc size changed. Leaf disc studies were carried out at 25-2 °C with a 16-hour photoperiod.

Fig 1, 2: Laboratory experiment and forms of replicates from cotton and soybean plants

Fig 3, 4: For laying eggs and hatching eggs, a laboratory experiment and types of replicates from cotton and soybean plants were used.

Techniques for the assessment of tested compounds

The most important aspect with any bioassay technique is to reduce variation between tested animals and between environmental variables before, during, and after testing to achieve consistent results. Provides a thorough examination of the most relevant biological and environmental elements that may influence the susceptibility of test organisms [12]. During the course of this investigation, special attention was made to ensure that the tested mites, as well as the experimental circumstances and procedures, were as uniform as feasible.

Toxicity of tested chemicals to adult females of two-spotted spider mite *Tetranychus urticae* (Koch)

To assess the toxicity of the substances tested on the two-spotted spider mite *T. urticae*, all compounds were examined using leaf discs dip technique [13]. The active component was diluted to specific quantities (p.p.m) in the formulated chemicals. All dilutions were done with distilled water. Four cotton and soybean leaf discs were immersed for five seconds in each concentration and then dried. After that, 10 adult female mites were placed on each disc. The discs were placed on moist filter paper, which was then placed on moist cotton wool packed in Petri plates and housed in the same breeding chamber conditions. Counts of deaths were taken 24 hours following therapy, it useded to correct for the control mortality **[14]**. Each therapy was carried out four times in total.

Toxicity of tested compounds to eggs of two-spotted spider mite *T. urticae*

Approximately 10 adult females *T.urticae* were placed on a clean cotton and soybean leaf disc placed upper side upon a water soaked cotton wool pad in a Petri dish to get red spider mite eggs as prey. Enough discs were stacked to provide enough eggs for the experiments the next day. After allowing the adult mites to oviposit overnight, they were removed. At the outset of each trial, prey eggs were never older than 24 hours. This prevented them from hatching during the experiment. Prey eggs were used instead of other stages during the study period, which was never longer than 72 hours [15, 16].

Effect of compounds residues on *T. urticae* egg deposition and egg- hatching

The technique recommended by [17]. Determined the residual effect of each tested chemical at the LC_{25} level on adult prey mites. After dipping each disc in the LC_{25} concentration of each tested chemical, five mature female *T. urticae* mites of known age were inserted on each disc. After 24 and 48 hours, the number of eggs laid on different discs was measured separately. Four days after egg deposition, the number of hatching eggs was also counted. The experiment was carried out at a temperature of 252 °C and a photoperiod of 16 hours. Each therapy was carried out four times in total.

Field experiments

Two studies were conducted at the farm of Agricultural research station, Sakha. Kafr E1-Sheikh Egypt. The study's goal was to see how effective the tested compounds were against the spider mite *Tetranychs urticae*, which infested cotton Giza 194 and soybean plants of the variety Giza 111. Each 1/42 hectare plot was laid out in a completely randomised blocks design, with four replicates assigned to each treatment. Using a knapsack sprayer (20 L volume) with one nozzle, all tasting components were administered at half the prescribed rate. Water was used to dilute the compounds at a rate of 200 litres per Fadden. Before, two days, and one week after treatment, ten soybean leaves were randomly taken from each plot. The equation was used to compute the percentage reduction in infestation for each treatment [18]. Duncan's multiple range test was performed to compare the statistically different means at the 5% level.

Statistical analysis and equations:

Used to reduce the % mortality rate to account for natural mortality [14].

$$\text{Mortality (\%)} = \frac{\text{Mortality \% of treatment- mortality \% of control X 100}}{\text{100 - Mortality \% of control}}$$

Egg mortality

The following formula was used to compute the mortality rate:

Egg mortality = (a/b) X 100

where
a= unhatched eggs.
b= The total number of eggs counted before toxicant treatment.

Toxicity index
According to [19]. The toxicity index of the substances studied was calculated as follows:

$$\text{Toxicity index} = \frac{LC_{50} \text{ of the most effective compound}}{LC_{50} \text{ of the tested compound}} \times 100$$

The reduction percentage of eggs laying.
According to [20]. The percentage reduction in egg laying was determined as follows for each treatment:

$$\% \text{ Reduction} = \frac{\text{Number of control- Number of treatment}}{\text{Number of control}} \times 100$$

Or comparing the statically different means

Results and Discussion

Laboratory

The Adult females of two-spotted spider mite *T. urticae* on cotton leaf discs as effected by Toxicity of tested compounds: The purpose of this study was to see how well various chemicals (abamectin, *Aspergillus niger* extract, and Neem extract) worked against adult female *T.urticae*. Abamectin was highly toxic to adult-females of the examined pest, with "LC_{50} values" of 18.71 ppm; aspergillus extract was moderately toxic to adult-females, with LC_{50} values of 746.75 ppm, according to the data in (Table 1). With "LC_{50} values" of 2712.97 ppm, neem extract appeared to be less harmful to adult females of the studied insect. The purpose of this study was to see how well various chemicals (Abamectin, *Aspergillus niger* extract, and Neem extract) worked against adult female *T. urticae*. Abamectin was highly toxic to adult-females of the examined pest, with "LC_{50} values" of 16.48 ppm; aspergillus extract was moderately toxic to adult-females, with LC_{50} values of 718.78 ppm, according to the data in (Table 1). With "LC_{50} values" of 2869.49 ppm, neem extract appeared to be less harmful to adult females of the tested insect.

Table 1: Toxicity of different compounds to adult females of two- spotted spider mite *T. urticae* (koch) on cotton leaf discs:

Compound		Cotton				Soybean			
		LC_{50} (PPM)	C.L.forLC_{50}		Toxicity index	LC_{50} (PPM)	C.L.forLC_{50}		Toxicity index
			lower	upper			lower	upper	
Abamectin	1.8ml/ 100 ml	18.71	15.44	22.60	100	16.48	14.13	18.69	100
Aspergillus niger extract	3*10^2 spores/ml	746.75	679.41	839.39	5.12	718.78	666.77	779.07	5.47
Neem extrac	200ml/ 100 ml	2712.97	2246.96	3269.40	1.40	2869.49	2237.60	3787.28	1.37

Toxicity-index data at the "LC_{50} level" revealed that abamectin was the most hazardous against adult-females of *T. urticae*, with a toxicity-index of 100.0, while aspergillus extract was moderately toxic against adult-stage *T. urticae*, with a toxicity-index of 5.12. With a toxicity-index of 1.40, neem oil appears to be the least hazardous chemical against mature females of *T. urticae*. Toxicity-index data at the "LC_{50} level" revealed that abamectin was the most hazardous against adult-females of *T. urticae*, with a toxicity-index of 100.0, while aspergillus extract was moderately toxic, with a toxicity-index of 5.47. With a toxicity-index of 1.37, neem oil appears to be the least hazardous substance against mature females of *T. urticae*.
[21]. Discovered that a 0.7105 conidia/ml concentration of *B. bassiana* was highly effective in *T. urticae* adults, with a mortality rate of 63.2–72.1%. According to [22]. *B. bassiana* induced 15 to 70% mortality in *T. urticae*, with LC_{50} and LC90 values of 3.3 106 and 7.8 109 conidia/ml, respectively. *B. bassiana* was also found to cause 56.4–82.6% mortality in *Tetranychus evansi*, with an LC_{50} value of 1.1107 conidia/ml on the 7th day.The toxicity of the chemical composition of essential oils from Salvia officinalis and Eucalyptus globulus against the adults of two spotted spider mites, *T. urticae*, is investigated by [23]. Both oils boosted spider mite mortality in adults, according to the data. *S. officinalis* and *E. globulus* have the potential to be developed as ecologically friendly and effective botanical acaricides for *T. urticae* management [24]. Studied the efficiency of various essential oils against two spotted spider mite on mulberry, including eucalyptus oil, Ocimum oil, Lavendula oil, Mentha oil, Rosemarinus oil, Cymbopogon oil, and Syzygium oil. The results showed that eucalyptus and ocimum oils were the most beneficial, followed by rosemarinus oil. Mentha oil and Cymbopogon oil, on the other hand, produced similar outcomes. Under laboratory conditions, [25]. Evaluated the effect of neem essential oil and aqueous neem extract on adult females of *Tetranychus urticae*. The active essential oil of neem was shown to be more effective than the aqueous neem extract.

Effect of compounds residue on biology of two-spotted spider mite *T. urticae*

The compound-residues effect against egg-deposit of adult-females *T. urticae.*

Sub-lethal effect of tested-compounds conc., and studied, the LC_{25} on egg-deposit of adult-female-mites *T. urticae*. Five adult female mites were allowed to oviposite on different compounds-treated discs for a period of 5 days. The deposited eggs were counted daily for five days. Each treatment was replicated four times. The data shown in Table (2 and 3). The integrated-pest-management was studied, the effect of some chemicals and biological-agents against mite-egg-deposit and some sensitivities for the agents. The accumulated eggs deposited by the adult females of mite *T. urticae* through the first to fifth day exhibited about the same trend. From the mean number of eggs deposited by adult female mites *T. urticae treated* by different compounds Table (2), result suggested that abamectin was giving higher value with 88.4%. *Aspergillus niger* extract has moderately toxic effects against adult-stage of *T. urticae* with 75.6.Neem oil appear least toxic compounds against adult-females of *T. urticae*, with 70.10.Result suggested that abamectin was giving higher value with 76.6%. *Aspergillus niger* extract has moderately toxic effects against adult-stage of *T. urticae* with 65.43. Neem oil appears least toxic compounds against adult-females of *T. urticae*, with 55.32.The LC_{25} was used to determine the sub-lethal effect of the tested chemicals on egg-deposit in

adult female *T. urticae* mites. For five days, five mature female mites were allowed to oviposit on various compounds-treated discs. For five days, the deposited eggs were counted every day. Each therapy was carried out four times in total. Table 1 shows the data (2 and 3). The effect of several chemicals and biological agents against mite-egg-deposit, as well as some sensitivity to the agents, were investigated. From the first to the fifth day, the collected eggs deposited by adult females of the mite *T. urticae* followed a similar pattern. The average number of eggs deposited by adult female mites *T. urticae* treated with various chemicals (Table 2) revealed that abamectin was the most effective, with an 88.4 percent success rate. The adult-stage of *T. urticae* is mildly toxic to *Aspergillus niger* extract (75.6). With a score of 70.10, neem oil appears to be the least harmful ingredient against mature females of *T. urticae*. The results indicated that abamectin had a higher value of 76.6 percent. Toxicity of *Aspergillus niger* extract against adult-stage *T. urticae* is moderate (65.43). With 55.32, neem oil appears to be the least harmful chemical against mature females of *T. urticae.*

Table 2: Effect of various substance residues on *T. urticae* egg deposition on cotton leaf discs

Compounds	NO, of eggs deposited /5 adults					Mean
	1st day	2nd day	3rd day	4th day	5th day	
cotton						
Control	18.00±0.50^{a}	20.50±0.82^{a}	24.25±1.41^{a}	26.50±0.50^{a}	30.00±1.26^{a}	26.85±0.35^{a}
Abamectin	2.50±0.57f	3.75±0.50e	5.75±0.95e	8.00±0.81d	11.25±1.25e	6.25±0.816e
Aspergillus niger extract	5.25±1.50e	7.25±0.95d	11.50±1.91d	16.50±1.91c	19.00±1.51d	11.90±1.556d
Neem extract	3.75±0.50^{d}	5.00±0.50^{d}	6.25±0.58^{d}	9.75±0.96^{d}	12.50±0.96^{d}	8.70±0.35^{d}
soybean						
Control	18.00±0.50^{a}	20.50±0.82^{a}	24.25±1.41^{a}	26.50±0.50^{a}	30.00±1.26^{a}	26.85±0.35^{a}
Abamectin	4.75±0.50d	5.25±0.50e	6.75±1.25e	9.50±1.00f	13.75 ±1.25f	8.00±0.90f
Aspergillus niger extract	4.00±0.82^{cd}	5.75±0.50^{c}	7.25±0.82^{d}	11.50±0.82^{c}	14.75±0.82^{d}	12.55±0.53^{e}
Neem extract	6.50±0.86^{d}	7.25±0.86^{d}	9.00±1.53^{d}	12.50±1.35^{c}	16.00±1.35^{b}	9.86±0.48^{d}

Table 3: Reduction percentage in eggs laying capacity of *T.urticae* /5females due to compounds on cotton leaf discs:

Compounds	Reduction%					Mean
	1st day	2nd day	3ndday	4thday	5thday	
Cotton						
Abamectin	75.9	65.7	70.7	77	83.6	88.4
Aspergillus niger extract	54	42	39.5	54	68.2	75.6
Neem extract	79.16	75.60	74.22	63.20	58.33	70.10
Soybean						
Abamectin	70.7	60.8	68.4	75.5	77.7	76.6
*Aspergillus niger e*xtract	77.7	71.95	70.10	56.60	50.83	65.43
Neem extract	63.8	64.63	62.88	52.83	46.66	55.32

There is no denying that modest doses of chemicals that cause death can have an impact on this personality. The current laboratory treatments are designed to mimic field situations in which mites are exposed to chemical residues on plant leaves through direct touch or through stomach action from feeding on tainted cell contents. And in another way [26]. Used the leaf disc method to test the acaricidal activity of aqueous extracts of 20 plant species at a concentration of 10% on red spider mite, *T. urticae*, in a laboratory setting. The aqueous extract of sesbania grand flora induced the highest mortality of *T. urtecae* after 72 hours following treatment, with a rate of 94.43%, which was statistically superior to all other treatments. The effects of garlic, *Allium sativum*, Linn., aqueous extract on two spotted spider mites, *T. urticae*, were studied by [27]. The garlic-aqueous-extract was found to be beneficial in lowering egg-deposition and egg-hatching in the pest investigated, And also these experiments also showed that garlic-aqueous-extract had a modest effect on *T. urticae*. The effect of seven plant essential oils were examined for their toxicity against *Tetranychus urticae* Koch eggs by [28]. Water distillation was used to extract essential oils from lemon grass, spearmint, rosemary, marjoram herbs, fennel and coriander seeds, and chamomile flowers. *T. urticae* eggs had LC_{50} values of 1.54, 6.44, 0.96, 1.72, 1.30, 14.67, and 0.95 percent for these oils, respectively. The average number of deposited eggs reduced dramatically as concentration increased, according to the findings.

Table 4: Effect of different compounds residues on egg deposition of *T. urticae* on soybean leaf discs:

Compounds	No. of egg deposited/5 adults					Mean
	1st day	2nd day	3 rd day	4th day	5th day	
Cotton						
Control	21.50±0.50a	22.75±0.375a	25.00±0.50a	27.25±0.75a	32.75±1.375a	25.85±0.070a
Abamectin	18.75±0.95b	21.00±1.41ab	22.50±1.29b	25.75±1.70a	28.25±0.50bc	23.25±1.17b
Aspergillus niger extract	10.75±0.95d	12.50 ±0.57c	17.00±81c	21.25±0.95b	26.50±1.29c	17.60±0.91c
Neem extract	14.75±0.95b	18.50±1.29b	21.25±1.50b	24.75±2.06b	29.25±2.06b	21.70±1.572b
Soybean						
Control	19.50±1.29a	24.50±0.57a	29.00±0.81a	31.75±1.25a	34.75±0.95a	27.90±0.974a
Abamectin	9.25±0.95c	13.00±1.15c	17.50±1.00c	20.75±0.95c	25.25±0.50c	17.15±0.91c
Aspergillus niger extract	16.25±2.21c	19.25±0.95b	22.75±0.95b	25.50±1.29a	29.50±0.57b	22.65±1.194b
Neem extract	19.25±0.5a	20.75±0.50b	23.50±0.57b	26.25±1.25b	29.75±1.50b	23.90±0.864b

Table 5: Compounds on soybean leaf discs reduce egg laying capacity of *T.urticae*/5females by a certain percentage:

Compounds	Reduction%					Mean
	1st day	2nd day	3 rd day	4th day	5th day	
cotton						
Abamectin	88.4	83.6	77	70.7	65.7	75.9
Aspergillus niger extract	50	45.1	32	22.1	19.1	32
Neem extract	19.8	14.3	11	9.2	13	13.2
soybean						
Abamectin	75.6	68.2	54	39.5	42	54
Aspergillus niger extract	24.5	15.4	9	6.5	10	12.4
Neem extract	12.8	7.7	10	5.6	13.8	10.1

Sub-lethal effect of tested-compounds conc., and studied, the LC_{25} on egg-deposit of adult-female-mites *T. urticae*. Five adult female mites were allowed to oviposite on different compounds-treated discs for a period of 5 days. The deposited eggs were counted daily for five days. Each treatment was replicated four times. The data shown in Table (4 and 5). The integrated-pest-management was studied, the effect of some chemicals and biological-agents against mite-egg-deposit and some sensitivities for the agents. The accumulated eggs deposited by the adult females of mite *T. urticae* through the first to fifth day exhibited about the same trend. From the mean number of eggs deposited by adult female mites *T. urticae* treated by different compounds Table (4 and 5), result suggested that abamectin was giving higher value with 75.9%. *Aspergillus niger* extract has moderately toxic effects against adult-stage of *T. urticae* with 32.00.Neem oil appears least toxic compounds against adult-females of *T. urticae*, with 13.20.Result suggested that abamectin was giving higher value with 54.00%. *Aspergillus niger* extract has moderately toxic effects against adult-stage of *T. urticae* with 12.40.Neem extract appears least toxic compounds against adult-females of *T. urticae*, with 10.10.The LC_{25} was used to determine the sub-lethal effect of the tested chemicals on egg-deposit in adult female *T. urticae* mites. For five days, five mature female mites were allowed to oviposit on various compounds-treated discs. For five days, the deposited eggs were counted every day. Each therapy was carried out four times in total. Table 1 shows the data (4 and 5). The effect of several chemicals and biological agents against mite-egg-deposit, as well as some sensitivity to the agents, were investigated. From the first to the fifth day, the collected eggs deposited by adult females of the mite *T. urticae* followed a similar pattern. The average number of eggs deposited by mature female *T. urticae* mites treated with various chemicals Table of contents (4 and 5), the study indicated that abamectin had a higher value, at 75.9%. With a score of 32.00, *Aspergillus niger* extract is moderately toxic to adult-stage *T. urticae.* With 13.20, neem oil appears to be the least harmful chemical against mature females of *T. urticae*.The results indicated that abamectin had a higher value of 54.00 percent. With a toxicity of 12.40 *Aspergillus niger* extract is moderately harmful to adult-stage *T. urticae.* With a score of 10.10, neem extract appears to be the least hazardous substance against mature females of *T. urticae*. The oviposition rate of *T. urticae* was significantly affected by spiromesifen, according to [29]. Studied toxicity tests with spiromesifen at different life stages of *T. urticae*. Eggs less than 72 hours old were more sensitive than other development stages, and the oviposition rate of *T. urticae* was significantly affected by spiromesifen. Experiments on the impact of spiromesifen on *T. urticae* growth rates. [30]. Assessed the biological effects of sublethal doses of the tested treatments (egg deposition of two spotted spider mite *Tetranychus urticae*). The results demonstrated that the tested materials reduced *Tetranychus urticae* egg deposition when compared to the control. In terms of egg deposition and hatchability, cyhalothrin was the most effective chemical against *Tetranychus urticae*. [31]. Investigated the ovicidal and nymphicidal effects of various acaricides. When eggs were sprayed with one-third of the acceptable spiromesifen concentration, no eggs hatched. This was statistically significant in comparison to the other treatments (fenpyroximate, chlorfenapyr, propargite, dicofol, and hexythiazox), which were statistically equivalent. The ovicidal activity of spiromesifen (100%) was followed by dicofol (7.78% egg mortality) and hexythiazox (hexythiazox) (6.67%). Both abamectin and chlorfenapyr therapy had almost no effect on hatching (0.54%). The efficiency of garlic (*Allium sativum* Linn.) aqueous extract in the control of the two-spotted spider mite (*Tetranychus urticae* Koch) was examined by [27]. (Acari: Tetranychidae). Garlic aqueous extract significantly reduced egg deposition and hatchability in *T. urticae*. In these experiments, garlic aqueous extract was found to be effective in reducing *Tetranychus urticae*.

Field studies

On order to evaluate the relative susceptibility of motile stages of mites *T. urticae* to different tested substances, field tests on soybean plants were conducted in the farm of Agricultural Research Station, sakha, governorate of Kafr El-Sheikh, Egypt. All of the substances in the study were used at half the prescribed dosage. At two-day and one-week intervals, samples of 10 soybean leaves were randomly taken from each plot before and after treatment. According to **[18]**.Equation, the percentage reduction in infestation was computed for each treatment. Multiple range test was used to assess all of the data collected [32].

The effect of the investigated chemicals on the motile stages of the spider mite *T. urticae* on cotton

The population density of *T. urticae* motile stages decreased one to four weeks after application, as shown in Tables 6 and 7 reduction of motile-stages of *T. urticae*, with 45.65%, *Aspergillus niger* extract was moderate-effective with 45.65, and neem extract was least-effective with 29.88% on population In the second season (2021), "abamectin" was the most-effective chemical on population-density-reduction of spider-mite *T. urticae* motile-stages, with a score of 59.20%, followed by " *Aspergillus niger* extract " with a score of 40.06%, and neem extract with a score of 32.92%. The population-density of *T. urticae* motile-stages decreased after one week of administration. Based on this reduction, all-treatments were the most effective in population-density-reduction; all-compounds were effective in population-density-reduction of mite, *T. urticae* motile-stages.

Table 6: The effect of the investigated chemicals on the motile stages of the spider mite *T. urticae* on cotton plants in field conditions

Compounds	Mites numbers pre-treatment	Mites numbers post-treatment/weeks			
		1st week	2nd weeck	3rd weeck	4th weeck
Season "2020"					
Abamectin	198.44	45.37	67.53	81.05	76.83
Aspergillus niger extract	203.53	71.63	88.03	97.28	101.28
Neem extract	196.86	96.41	108.58	119.22	124.34
Control	242.48	236.73	208.36	185.58	173.66
Season "2021"					
Abamectin	194.79	52.83	64.48	78.49	72.55
Aspergillus niger extract	199.45	87.36	96.71	105.92	112.37
Neem extract	206.52	93.76	113.26	125.63	132.52
Control	232.64	218.47	203.18	190.11	178.28

Table 7: The reductions effect of tested-compounds on motile-stages of on motile-stages of spider mite *T. urticae*, on cotton plant in field condition

Compounds	%reduction				General mean
	1st week	2st weeck	3st weeck	4st weeck	
Season "2020"					
Abamectin	76.67	60.52	46.90	46.18	57.56
Aspergillus niger extract	64.10	49.82	37.86	30.83	45.65
Neem extract	50.04	36.01	21.27	12.20	29.88
Season "2021"					
Abamectin	71.25	63.14	50.84	51.58	59.20
Aspergillus niger extract	53.57	44.72	35.21	26.75	40.06
Neem extract	51.87	37.47	25.78	16.58	32.92

And also mentioned [33]. Investigated the effects of plant extracts and essential oils on mature female *Tetranychus urticae* on cotton. Aqueous extracts (AE), hydroethanolic extracts (HE), and essential oils were used to examine fourteen plants (EO). 24 hours, 48 hours, 72 hours, 96 hours, and 120 hours following spraying, evaluations were conducted. The findings revealed that plant aqueous extracts caused *Tetranychus urticae* females to die [34]. Investigated the efficacy of three neonicotinoid insecticides (nitenpyram, imidacloprid, and acetamiprid) as well as three conventional insecticides (profenophos, -cyhalothrin, and bifenthrin) against sucking insect pests in cotton fields. Acetamiprid had the best results against thrips after one week of treatment, followed by nitenpyram and Profenophos. Cotton Bug Nitenpyram was the most effective against Dusky, followed by Profenophos. In the case of Red Cotton Bug, Imidacloprid outperformed Lambda after one week of application.During the two growing seasons of 2016 and 2017 [35]. Evaluated the efficacy of six acaricides against the two spotted spider mite, *T. urticae*, infesting eggplant and pepper plants in both laboratory and field environments. Abamectin 1.8% EC, buprofezin 25% WP, Abamectin 5% EC, chlorfenapyr 24% SC, hexythiazox 5% WP, and fenpyroximate 5% EC were the acaricides studied. The most effective acaricide was abamactin 1.8%, followed by buprofezin, abamactin 5%, chlorfenapyr, hexythiazox, and fenpyroximate, in that order. During the first and second seasons, the tested acaricides showed a considerable reduction in *T. urticae* population in the field.

The effect of the investigated chemicals on the motile stages of the spider mite *T. urticae* on soybean

Data recorded in Tables 8 and 9, showed that, in 1st season (2020), "abamectin" gave most effective on population-density-reduction of motile-stages of spider mite *T. urticae*, and recorded 59.89% while "*Aspergillus niger* extract" gave moderate-effects was 46.04, while neem extract was least-effective compounds with 32.74% on population-density-reduction of motile-stages of tested pest. In the 2nd season (2021), "abamectin" was most-effective on population-density-reduction of motile-stages of spider-mite *T. urticae*, recorded 64.23%, followed-by "*Aspergillus niger* extract" recorded 35.69, while neem extract appears lowest-effective compounds on population-density-reduction of motile-stages of spider-mite *T. urticae*, recorded 27.69%. After application of one-week, observed that, decreasing in population-density of motile-stages of *T. urticae*. Generally, all-treatments were most effective in population-density-reduction, based-on of this reduction; the all-compounds were effective in population-density-reduction of motile-stages of mite, *T. urticae* Tables 8 and 9 show that in the first season (2020), "abamectin" was the most effective on population-density-reduction of motile-stages of spider mite *T. urticae*, with a score of 59.89%, " *Aspergillus niger* extract " had a score of 46.04%, and neem extract was the least-effective compound, with a score of 32.74% on population-density-reduction of mot In the second season (2021), "abamectin" was the most-effective chemical on population-density-reduction of spider-mite *T. urticae* motile-stages, with 64.23%, followed by " In lab and field during the two seasons 2020-2021,females of two spotted spider mite *Tetranychus urticae* after treatment with one known acaricides (Abamectin), one fungal extract (*Aspergillus Niger* extract), and one plant extract (Neem oil) The results showed that abamectin had high toxic effect and toxicity index 100, whereas neem extract was the least toxic compound to eggs but abamectin was the most efficient chemical against the motile stages, whereas *Aspergillus niger* extract had a modest effect on *T. urticae*.

"With 35.69%, and neem extract with 27.69%. After one week, the population density of *T. urticae* motile-stages was shown to be declining. Based on this reduction, all-treatments were most successful in population-density-reduction; all-compounds were effective in population-density-reduction of mite motile-stages, *T. urticae.*

Table 8: The effect of the investigated chemicals on the motile stages of the spider mite *T. urticae* on soybean plants in field conditions

Compounds	Mites numbers pre-treatment	Mites number post-treatment/weeks			
		1st week	2nd weeck	3rd weeck	4th weeck
Season "2020"					
Abamectin	188.53	43.74	61.48	77.04	86.30
Aspergillus *niger* extract	201.57	74.38	89.61	102.48	121.06
Neem extract	197.68	88.87	117.07	124.66	143.51
Control	237.62	228.26	219.04	207.20	199.06
Season "2021"					
Abamectin	193.47	38.75	51.25	68.11	81.25
Aspergillus *niger* extract	198.46	81.36	109.18	120.16	133.84
Neem extract	209.73	112.19	128.35	136.04	153.81
Control	240.10	232.57	218.83	201.48	194.44

Table 9: The reductions effect of tested-compounds on motile-stages of on motile-stages of spider mite *T. urticae*, on soybean plant in field condition.

Compounds	%reduction				General mean
	1st week	2st weeck	3st weeck	4st weeck	
Season "2020"					
Abamectin	75.87	64.78	53.41	45.52	59.89
Aspergillus *niger* extract	61.62	51.98	42.04	28.53	46.04
Neem extract	53.24	36.04	28.10	13.60	32.74
Season "2021"					
Abamectin	79.37	71.12	58.10	48.34	64.23
Aspergillus *niger* extract	57.77	40.03	27.95	17.04	35.69
Neem extract	44.90	33.29	22.81	9.79	27.69

The active essential oil of neem was shown to be more effective than the aqueous neem extract.According to [36], 3 isolates of *B. bassiana* administered at a concentration of 108 conidia/ml killed 55–82% of *T. urticae*.The toxicity of essential oil chemical compositions of Salvia officinalis and eucalyptus globulus against the adults of two spotted spider mites, *T. urticae*, is investigated by [23]. *T. urticae* was shown to be more vulnerable to *P. marginatum* essential oils than its predator, *N. californicus*, in this investigation. This study shows that treating *T. urticae* with *N. californicus* can be combined with the use of a plant-based acaricide containing *P. marginatum* essential oil [37]. The effect of three essential oils on adult mites was studied: thymbra spicata L. (Labiatae), Laurus nobilis L. (Lauraceae), and Myrtus communis L. (Myrtaceae). Myrtus communis was shown to be the most effective on adults (*Tetranychus urticae*).Various essential oils, such as eucalyptus oil, Ocimum oil, Lavendula oil, Mentha oil, Rosemarinus oil, Cymbopogon oil, and Syzygium oil, were tested against two spotted spider mite on mulberry by [24]. The most effective oils were eucalyptus and ocimum, followed by rosemarinus oil. Mentha oil and Cymbopogon oil, on the other hand, yielded similar outcomes.

Conclusions

In lab and field during the two seasons 2020-2021,females of two spotted spider mite *Tetranychus urticae* after treatment with one known acaricides (Abamectin), one fungal extract (*Aspergillus Niger* extract), and one plant extract (Neem oil) The results showed that abamectin had high toxic effect and toxicity index 100, whereas neem extract was the least toxic compound to eggs and so abamectin was the most efficient chemical against the motile stages, whereas *Aspergillus niger* extract had a modest effect on *T. urticae*.

Acknowledgement

The author is deeply grateful to them. For Prof. Dr. Abd El-Salam. A. Farag, Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt. for his keen interest in reviewing the manuscript. Deep appreciation is also given to Prof. Dr. Hoda. T. Salim, Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt, for her kind efforts.

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