J. Plant Prot. and Path., Mansoura Univ., Vol. 9 (1), 1 – 7, 2018

Toxicological Effects of Garlic Bulbs Aqueous Extract on Two Tetranychid Mites (Acari: Tetranychidae)

Mariam G. Habashy

Crops and Cotton Mites Department, Plant Protec. Res. Institute, Agric. Res. Center, Giza, Egypt.

ABSTRACT

Experiments were conducted in the laboratory to assess the ability and stability of garlic (*Allium sativum* Linn.) aqueous extract to control the two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), and the carmine spider mite, *Tetranychus cinnabarinus* (Boisduval) in Egypt. Natural plant extracts, as (*Allium sativum* Linn.), have minimum-risk to the environment, so they can considered as an easy alternative to pesticides. Seven concentrations ranging from 2000 to 40000 ppm garlic were used to measure extract toxicity. Data showed that the maximum mortality values were 83.33and 86.67 % after 7 days, for *T. urticae*, and *T. cinnabarinus,* respectively. The effect of storage periods on the efficacy of different six concentrations of aqueous garlic extract on the same mite species was studied. Results indicated that the extract acaricidal activity decreased throw time for all tested concentrations. After four weeks it lost about 30% of its activity. Garlic aqueous extract significantly reduced egg deposition and egg hatchability of *T. urticae* and *T. cinnabarinus*. Regarding mites' mortality and fecundity, there were no statistically significant differences between the two species. These experiments demonstrated that garlic aqueous extract is effective in the control of both tetranychid mite pests.

INTRODUCTION

A well-known fact is that the two-spotted spider mites, *Tetranychus urtica*e Koch and the carmine spider mite, *Tetranychus cinnabarinus* (Boisduval) have become the most important agricultural pests through the last century. Actually, their riskiness is due to their large diversity of host plants including vegetables, fruits and ornamentals (Le Goff *et al*. 2009); Migeon and Dorkeld (2007) recorded 3877 host species around the world for *T. urtica*e. These pests are known to be controlled using synthetic acaricides, which are the most effective method to control the acarid pests till nowadays. Random uses of these acaricides cause adverse effects on human health and many other non-target organisms. Also, they are responsible for the development of acaricide -resistance mites and this may be due to their short developmental period and high fecundity to produce successive generations. So, Tetranychid mites' pest management became difficult, because of this resistance to acaricide (Beers *et al*.1998).

Hence, the Integrated Pest Management (IPM) aims to use a few selective acaricides for preventing damage of ecological system (Van Pottelberge *et al.* 2009). Therefore, it was serious to develop new methods to control tetranychid mites' attacks. Using natural products is an excellent alternative to the synthetic acaricides because of their low environmental pollution levels, low toxicity to human and their compatibility to the environmental components than synthetic pesticides (Liu *et al.* 2000).

The new approaches are to use the plants derived essential oils because of their safety to human (Isman and Machial, 2006). Garlic is a common food widely distributed and used all over the world as a spice and herbal medicine for the prevention and treatment of different diseases, ranging from infections to heart diseases (Rivlin, 2001). Dabrowski and Seredynska (2007) used Garlic (*Allium sativum*) aqueous extract to control *T. urticae.* Also, *A. sativum* showed a repellent effect against human ticks and *T. urticae* (Catar 1954; Boyd and Alverson 2000; Carlos *et al*. 2008).

Many studies had been conducted to review the relationships between sulfur-containing compounds found in garlic and human health (Corzo-Martinez and Villamiei 2007). For example, Kim *et al.* (2004) recorded antimicrobial properties against different bacteria and fungi using some of the organic sulfur compounds found in *A. sativum*. The acaricidal activity of garlic extracts has little attention (Seufi *et al*. 2007). Therefore, the purpose of this study was to evaluate the efficacy and stability of garlic aqueous extract to control *T. urticae* and *T. cinnabarinus*.

MATERIALS AND METHODS

Mites culturing

T. urticae and *T. cinnabarinus* were collected from the unsprayed green bean (*Phaseolus vulgaris*) in Dakahlia governorate. Mites identification was carried out at Acarology Laboratory, Plant Protection Research Institute, ARC using detailed descriptions recorded by Zhang, (2003), and Zhang& Jacobson (2000). Collected mites were put on green beans leaves upside down on dampening cotton in Petri-dishes (9 cm in diameter), cotton was moistened daily. Petri-dishes were kept under controlled conditions at 25±2°C, and 16:8 h (L:D) in the Acarology Laboratory in a closed box containing a saturated solution of NaCl to maintain the humidity in the box at 75±5% RH. Every 3 days the green beans leaves were replaced.

Preparation of aqueous garlic extract

To prepare an aqueous extract of garlic, a freshly harvested garlic plants were collected and stored at room temperature for three months. These plants were free of any pre-harvest chemical treatments. Twenty grams of peeled garlic cloves were weighed and rinsed then crushed and completely blended using the electric grinder for three minutes at very high speed with 40 ml of distilled water. The homogenate was then filtered after one hour by passage through Whatman's filter paper No. 1. Two ml of the extract was dried to obtain the concentrate. Then it was kept in the fridge in a sterile brown bottle at 4°C prior to use. Different concentrations of garlic aqueous extract 2000, 10000, 15000, 20000, 25000, 30000 and 40000 ppm were

prepared by diluting the stock solution with distilled water.

Measuring the acaricidal effect of the extract on mites

To determine the acaricidal activity of garlic, seven concentrations and an untreated control were used. Uninfested green beans leaves were transferred to the laboratory and cleaned carefully with sterilized water. Experiments were carried out at room temperature (25±2°C, 60±5% RH) using leaf discs 1.2 cm in diameter. Disks were placed upside down on moisten cotton pads and each disk was infested with ten adult newly emerged females. Mites were treated by spraying the prepared extract concentrations. Control variants were sprayed using distilled water. Each concentration was replicated 5 times. Mite mortality was checked one, three, five and seven days after spray.

Stability of garlic aqueous extract

To assess the effects of storage on the acaricidal activity of garlic extract different concentrations (10000, 15000, 20000, 25000, 30000 and 40000 ppm) of aqueous garlic extract were left in the refrigerator at 2-5°C for 72 h, 1, 2, 3, 4, 5 and 6 weeks. At the end of each period, the acaricidal activity of each concentration was measured by the same bioassay described before.

Effect of garlic aqueous extract on mites' egg-laying capacity

The LC_{25} concentration of aqueous garlic extract was calculated and prepared. Twenty quiescent female deutonymphs were transferred to lower surface of green beans leaf discs. Twenty males were transferred to each deutonymph to allow mating. Mites were treated with the prepared concentration (LC_{25}) using hand vaporizer sprayer and were allowed to deposit eggs. The fecundity of treated females was compared with (distilled water sprayed females) control. All Petri-dishes were maintained at room temperature (25±2°C, 60±5% RH).

Impact of garlic aqueous extract on egg hatching

Green bean leaf discs 1.5 cm in diameter were used as a substrate to ovipositor. Five leaf discs were used for each treatment. Five mite females of the same age were transferred to each disc and left for 12 h to lay eggs, and then females were removed. Ten eggs, on each disc, were treated with LC_{50} of garlic aqueous extract. Eggs were sprayed by a glass atomizer. Control variants were sprayed with distilled water. Eggs were incubated at (25±2) °C for seven days till hatching. The numbers of hatching and non-hatching eggs were recorded.

Statistical analysis

The effect of garlic aqueous extract on mortality was evaluated as percentages of daily and total mortality, corrected for mortality in control variant according to Abbott's formula (Abbott, 1925). Lethal effect of the extract was determined based on median lethal concentration (LC_{50}) after three days of treatment calculated by probit analysis according to (Finney, 1971). A computerized software program (LDP line) a copyright by Ehab, M. Bakr, Plant Protection Research Institute, ARC, Giza, Egypt, were used to calculate LC_{50} at p-level < 0.05. The same program was used to calculate Toxicity index (Ti) according to Sun (1950) equation as follow:

$$Ti = \frac{\text{LC}_{50} \text{ of the most toxic insecticide}}{\text{LC}_{50} \text{ of less toxic insecticide}} \times 100$$

All data concerning mortality, fecundity, and hatchability were analyzed by analysis of variance (ANOVA) according to Snedecor and Cochran (1981), and student t-test; least significant difference (LSD) was used to evaluate differences between means at $P < 0.05$ using SAS (2004) software.

RESULTS AND DISCUSSION

Mortality

The toxicity of seven tested concentrations of garlic aqueous extract to *T. urtica*e and *T. cinnabarinus* was represented in Table (1). Generally, the mortality was high at 24 hours and three days post-treatment. There was no effect observed on mortality percentage after five and seven days of treatment. Control variants show no mortality through the experiment. The mortality ratio is proportionately increased with the increased concentrations.

Table 1. Mortality percentage of *Tetranychus urticae* and *Tetranychus cinnabarinus* adult females after treatment with different concentrations (ppm) of garlic aqueous extract over time.

Tested mites	Conc. (ppm)	Mortality % after application (day)					L.S.D
		1day	3days	5days	7days	Total	
Tetranychus urticae	control	0	0	0	0	0	0.0196
	2000	10	6.67	0	0	16.67	
	10000	23.33	3.33	0	0	26.67	
	15000	33.33	6.67	0	0	40	
	20000	43.33	3.33	0	0	46.67	
	25000	56.67	3.33	0	0	60	
	30000	60	3.33	0	0	63.33	
	40000	76.67	6.67	0	0	83.33	
Tetranychus cinnabarinus	control	0	0	0	0	0	
	2000	10	10	0	0	20	
	10000	20	10	0	0	30	
	15000	33.33	10	0	0	43.33	
	20000	46.67	3.33	0	0	50	
	25000	56.67	3.33	0	0	60	
	30000	63.33	6.67	0	0	70	
	40000	83.33	3.33	0	0	86.67	

Individuals of *T. urticae* showed mortality values 10, 23.33, 33.33, 43.33, 56.67, 60 and 76.67% 24 hours after treatment using garlic aqueous extract concentrations 2000, 10000, 15000, 20000, 25000, 30000 and 40000, respectively (Table 1). Using the same concentrations against the carmine spider mite *T. cinnabarinus* gave 10, 20, 33.33, 46.67, 56.67, 63.33and 83.33% mortality.

Table (2), showed the toxicity of garlic aqueous extract based on values of median lethal concentration (LC_{50}) which calculated for mites treated with extract concentrations at *p*-level < 0.05. Results indicated that *T. cinnabarinus* were less tolerant to the extract than *T. urticae*. Whereas the calculated LC_{50} after three days of treatment was $14.62(10^3)$ ppm with a toxicity index (Ti= 100) and $17.22(10^3)$ with a toxicity index (Ti= 84.92) for *T. cinnabarinus* and *T. urticae*, respectively.

Table 2. Toxicity of garlic aqueous extract against adult females of *Tetranychus cinnabarinus* and *Tetranychus urticae,* three days after treatment.

Treatment	Lc_{50} ppm	Lc_{90} ppm	Slope	Toxicity index%
Tetranychus cinnabarinus	$14.62(10^3)$	$13.05(10^4)$	1.3483±0.2584	100.00
*Tetranychus urtica*e	$17.22(10^3)$	$14.45(10^4)$	1.3873±0.2683	84.92

Our results are in agreement with Habashy *et al.* (2016) who studied the effect of garlic aqueous extract against *T. urtica*e and *T. cinnabarinus* and recorded that *T. urtica*e was more tolerant than *T. cinnabarinus*, in the laboratory. They recorded mortality reached to 90 and 100% after 24 hours of treatment for mites mentioned before, respectively. The effect of water extract of *Allium sativum* was studied also by Dabrowski and Seredynska (2007) who showed a high activity as a feeding suppressant for *T. urticae*. They recorded that garlic extracts caused 48–57% mite mortality. On the other hand, Attia *et al.* (2011) examined the efficacy of garlic distillate concentration as a natural pesticide against *T. urticae*, by determining the effects of different concentrations of distillate. They recorded that low concentrations of garlic distillate lead to significant mortality in *T. urticae* populations, with values 7.49 and 13.5 mg/l, of LD50 and LD90, respectively. The ethanolic extract of *A. sativum* was evaluated against *T. urticae* by Erdogan *et al.* (2012) who recorded mortality reached to 78% using concentration 12%. Geng *et al.* (2014) recorded 76.5% mortality of adult females of *T. urticae* using a concentration 20 g/L of garlic-straw extract, 48 h after treatment with an LC50 value of 7.2 g/L. Also, they studied the repellent effects of the extract and 95.6% repellency was recorded after 24 h for the same extract concentration. There were no much records of *T. cinnabarinus* mortality using garlic extracts. Actually, there is a strong possibility that the garlic essential oils have more than one site of action, especially because they contain complex mixtures (Miresmailli and Isman 2006).

Stability of garlic aqueous extract

Table (3&4) shows the stability of garlic aqueous extract when stored at 4°C over time. The extract found to be relatively stable even after seven days of preparation.

Table 3. The acaricidal activity of different concentrations of garlic aqueous extract against *Tetranychus urticae* over time.

		Mortality %							
Time	Conc. (ppm)	directly	3 days	7 days	Two weeks	Three weeks	Four weeks	Five weeks	Six weeks
One day after treatment	Control	0	0	0	0	0	0	0	0
	10000	23.33	20	16.67	16.67	10	10	3.33	0
	15000	33.33	26.67	23.33	23.33	20	20	6.67	3.33
	20000	43.33	36.67	30	30	26.67	26.67	13.33	6.67
	25000	56.67	46.67	40	36.67	40	36.67	20	10
	30000	60	53.33	46.67	43.33	43.33	40	26.67	16.67
	40000	76.67	70	63.33	56.67	56.67	53.33	36.67	23.33
Three days after treatment	Control	0	0	0	0	0	0	0	0
	10000	3.33	3.33	3.33	3.33	3.33	3.33	10	6.67
	15000	6.67	10	3.33	3.33	3.33	6.67	13.33	10
	20000	3.33	6.67	6.67	6.67	6.67	6.67	13.33	10
	25000	3.33	13.33	16.67	6.67	10	6.67	10	10
	30000	3.33	10	10	6.67	6.67	6.67	13.33	10
	40000	6.66	6.67	13.33	6.67	6.67	6.67	13.33	10
Total mortality%	Control	0	0	0	0	0	0	0	0
	10000	26.67	23.33	20	20	13.33	13.33	13.33	6.67
	15000	40	36.67	26.67	26.67	23.33	26.67	20	13.33
	20000	46.67	43.33	36.67	36.67	33.33	33.33	26.67	16.67
	25000	60	60	56.67	43.33	50	43.33	30	20
	30000	63.33	63.33	56.67	50	50	46.67	40	26.67
	40000	83.33	76.67	76.67	63.67	63.33	60	50	33.33

The results indicated that the acaricidal activity of garlic extract was decreased by time. The optimal effect was obtained at the period 0-72 hrs. after extraction. The extract lost its acaricidal activity slowly over a period of three weeks. Four weeks after preparation the extract was not found to be relatively

stable. It is observed that the total mortality percentage caused by concentration 40000 ppm reaches 83.33 and 86.67% for *T. urticae* and *T. cinnabarinus*, respectively, directly post extraction decreased to 33.33 and 23.33% for the same pests mentioned before, after six weeks.

Table 4. The acaricidal activity of different concentrations of garlic aqueous extract against *Tetranychus cinnabarinus* over time.

Time	Conc. (ppm)	Mortality % directly	3 days	7 days	Two weeks	Three weeks	Four weeks	Five weeks	Six weeks
One day after treatment	Control	0	0	0	0	0	0	0	0
	10000	20	16.67	13.33	13.33	6.67	10	3.33	0
	15000	33.33	33.33	33.33	23.33	23.33	16.67	10	3.33
	20000	46.67	43.33	40	30	26.67	23.33	13.33	6.67
	25000	56.67	53.33	50	40	36.67	26.67	23.33	6.67
	30000	63.33	60	56.67	46.67	43.33	36.67	26.67	10
	40000	83.33	80	73.33	60	56.67	50	43.33	13.33
Three days after treatment	Control	0	0	0	0	0	0	0	0
	10000	10	10	6.67	6.67	6.67	3.33	10	6.67
	15000	10	10	6.67	10	6.67	6.67	10	6.67
	20000	3.33	3.33	6.67	10	10	6.67	10	6.67
	25000	3.33	3.33	6.67	10	13.33	6.67	6.67	6.67
	30000	6.67	6.67	6.67	10	10	6.67	10	6.67
	40000	3.33	3.33	6.67	10	10	6.67	3.33	10
Total mortality%	Control	0	0	0	0	0	0	0	0
	10000	30	26.67	20	20	13.33	13.33	13.33	6.67
	15000	43.33	43.33	40	33.33	30	23.33	20	10
	20000	50	46.67	46.67	40	36.67	30	23.33	13.33
	25000	60	56.67	56.67	50	50	33.33	30	13.33
	30000	70	66.67	63.33	56.67	53.33	43.33	36.67	16.67
	40000	86.67	83.33	80	70	66.67	56.67	46.67	23.33

There were no references in the literature of other studies studying the stability of garlic extracts against *T. urticae* and *T. cinnabarinus*. However, it had been investigated against different bacteria and Candida species, Iwalokun, *et al.* (2004). Belguith, *et al.* (2010) recorded the stability and the effect of aqueous garlic extract against Salmonella, their findings were similar to those of our study.

Effect of garlic aqueous extract on mites' egg-laying capacity

The fecundity of *T. urticae* and *T. cinnabarinus* females were clearly affected by the low concentration of the extract (LC_{25}), (table 5). The numbers of eggs laid by the two species of mites were significantly reduced compared to control. There was a very highly statistically significant difference in egg numbers of *T. urticae* as it changed from 49.83 in control to 21 eggs in treated mites with P-value <0.0001. On the other hand, there was a statistically significant difference in egg numbers of *T. cinnabarinus* as it changed from 41.73 in control to 26.47 eggs in treated mites with P-value 0.016.

Impact of garlic aqueous extract on egg hatching

The treated eggs for both species were found to be significantly affected. Results indicated that the garlic aqueous extract has an ovicidal effect. Data shown in Table (5) indicated that there was a decrease in egg hatchability comparable to the control treatment in the two species; *T. urticae* was significantly affected than *T. cinnabarinus*, as the percentage of egg hatchability was 31.4 and 75%, respectively. No doubt that an ovicidal effect of garlic extract may be due to preventing embryo formation or if this embryo has already formed the extract may be toxic to the developing nymph inside the egg before hatching.

Table 5. Effect of garlic aqueous extract on egg-laying capacity and egg-hatching of *Tetranychus urticae* and *Tetranychus cinnabarinus*.

Pest	Total No of eggs Mean± S.E		P. value	L.S.D	% of hatched eggs		P. value	L.S.D
	control	extract			control	extract		
Tetranychus urticae	49.83 ± 3.05	21 ± 2.13	<0.0001***	7.42	100	31.4	<0.0001***	0.14
Tetranychus cinnabarinus	41.73 ± 4.55	26.47 ± 3.67	0.016*		100	75	0.003**	

*** showed statistically significant difference (P<0.05)**
**** showed highly statistically significant difference (P<0.01)**
***** showed very highly statistically significant difference (P<0.0001)**
Egg hatching percentage= (no of hatched egg/ total no of treated egg)X100

Some investigators found similar results to that of the present experiments. Attia *et al.* (2011) examined the efficacy of garlic steam distillate on *T. urticae* female fecundity and demonstrated that it was significantly affected by low concentrations of the extract. Roobakkumar *et al.* (2010) evaluated the ovicidal action and ovipositional deterrence of garlic aqueous extract (GAE) in the laboratory against the tea red spider mite (RSM), and they recorded 50% egg mortality. Barakat *et al.*, (1986) applied acetone extract

of garlic bulb on *Phaseolus vulgaris* leaves and recorded reduction in *T. urticae* fecundity. On the other hand, Ismail, *et al.* (2011) recorded that the sub-lethal concentration of pure essential oil of garlic has no effect on *T. urticae* fecundity. Regarding hatchability, also they recorded the same results.

Results of analysis of variance (ANOVA) in Table (6) showed that there were no significant differences between two species in mites' mortality and fecundity, but it showed highly statically significant differences in egg hatchability. Regarding different durations of storage of garlic, concentration treatments and time of observations, a very highly statically significant difference were detected, which demonstrated the presence of high effect of these factors. Also, in fecundity and egg hatching experiments very highly statically significant differences were detected between the two treatments.

With regard to the interaction between different durations of storage and different concentrations, there were very high statically significant differences in mites' mortality, but there was no statically difference in the interaction between other factors. Concerning the interaction between the two species and treatments it showed non-significant differences in mites' fecundity, but it was highly significant in egg hatchability.

Although few natural products are useful in controlling arthropods, some of those are forbidden because of their phytotoxicity. The phytotoxicity of garlic essential oil was studied by Cloyd *et al.* (2009) and showed that it is not phytotoxic. The effectiveness of garlic as a potential biopesticide was highlighted by Dodia *et al.*, (2000) because of the presence of volatile oil which contained diallyl trisulphide, diallyl disulphide, diallyl sulphide, allyl methyl trisulphide, allyl methyl disulphide, and sulphoxides which are derived from allicin. Likewise, (Roy *et al.* 2006; Attia *et al.* 2011; Mohammed, 2013; Habashy *et al.* 2016; Wang *et al.* 2016) recorded the presence of the same organosulphur compounds.

Table 6. Analysis of Variance (ANOVA) for mites' mortality and fecundity, and egg hatching under different factors.

	Source of variation	P.value
Mites mortality	Factor A (Species)	0.2849 ^{ns}
	Factor B (Duration of garlic storage)	<0.0001***
	Factor C (concentrations)	<0.0001***
	Factor D (Time of observation)	<0.0001***
	A B	0.1986 ^{ns}
	A C	0.9268 ^{ns}
	B C	<0.0001***
	A B C	1.000 ^{ns}
	A D	1.000 ^{ns}
	B D	0.9865 ^{ns}
	A B D	0.9881 ^{ns}
	C D	0.2892 ^{ns}
	A C D	0.9923 ^{ns}
	B C D	1.000 ^{ns}
	A B C D	1.000 ^{ns}
Fecundity	Species	0.3221 ^{ns}
	Treatment (control & extract)	<0.0001***
	Species X Treatment	0.1413 ^{ns}
Egg hatching	Species	0.0002**
	Treatment (control & extract)	<0.0001***
	Species X Treatment	0.0017**

*** showed significantly different (P<0.05)**
**** showed highly significantly different (P<0.01)**
***** showed highly significantly different (P<0.0001)**
ns not significantly different

Panella *et al.* (2005) and Isman (2008) recorded garlic extracts as safe because of its little risks to the environment. Garlic-seed extract considered as the most suitable extract for IPM because it's minimal effect on the predatory mite *Phytoseiulus persimilis* and high mortality in populations of *T. urticae,* (Nour El-Deen *et al.,* 2013).

Finally, many of essential oils have short residual activity due to UV light degradation and temperature (Miresmailli and Isman 2006). So that, aqueous extract of garlic can be useful to control populations of the two-spotted spider mites, *T. urticae*, and carmine spider mite, *T. cinnabarinus* on different host plants through Integrated Pest Management (IPM).

REFERENCES

Abbott, W. S. A. 1925. Method of computing the effectiveness of an insecticide, J. Econ. Entomol, 18: 265-267.

Attia, S., Grissa, K.L., Mailleux, A.C., Lognay, G., Heuskin, S., Mayoufi, S. and Hance, T. (2011). Effective concentrations of garlic distillate (Allium sativum) for the control of Tetranychus urticae Koch (Tetranychidae). J. Appl. Entomol. 136: 302–312.

Barakat, A.A., Shereef, G.M., Abdullah, S.A. and Amer, S.A. A. (1986). Effects of some pesticides and plant extracts on some biological aspects of *Tetranychus urticae* Koch. Bull. Entomol. Soc.Egypt. 14: 225–232.

Beers, E.H., Dunley, J.E. and Rield, H. (1998). Resistance to abamectin and reversion to susceptibility to fenbutatin oxide in spider-mite (Acari: Tetranychidae) populations in the Pacific-Northwest. J. Econ. Entomol. 9, 352–360.

Belguith, H., Kthiri, F., Chati, A. and Abu Sofah, A. (2010). Study of the effect of aqueous garlic extract (*Allium sativum*) on some Salmonella serovars isolates. Emir. J. Food Agric 22(3):189–206.

Boyd, D.W., and Alverson, D.R. (2000). Repellency effects of garlic extracts on two-spotted spider mites, Tetranychus urticae Koch. J. Entomol. Sci. 35, 86–90.

Carlos, A.H.L., Gloria, E.L.P. and Ricardo, Y.T.C.H. (2008). Comparison and characterization of garlic (Allium sativum L.) bulbs extracts and their effect on mortality and repellency of Tetranychus urticae Koch (Acari: Tetranychidae). J. Agric. Res. 68, 317–327.

Catar, G. (1954). Effect of plant extract on Ixodes ricinus. Bratisl. Med. J. 34, 1004.

Cloyd, R.A., Galle, C.L., Keith, S.R., Kalscheur, N.A. and Kemp, K.E. (2009). Effect of commercially available plant-derived essential oil products on arthropod pests. J. Econ. Entomol. 102, 1567–1579.

Corzo-Martinez M.C.N., Villamiei M., (2007). Biological properties of onions and garlic. Trends Food Sci. Technol. 18, 609–625.

Dabrowski, T.Z. and Seredynska, U.S. (2007). Characterisation of the two-spotted spider mite (*Tetranychus urticae* Koch, Acari: Tetranychidae) response to aqueous extracts from selected plant species. J. Plant. Prot. Res. 47, 113–124.

Dodia, D.A., Patel, I.S. and Patel, G.M. (2000). Botanical pesticides for pest management. Scientific Publishers (India), Jodhpur.

Erdogan, P., Yildirim, A. and Sever, B. (2012). Investigations on the effects of five different plant extracts on the Two-Spotted Mite *Tetranychus urticae* Koch (Arachnida: Tetranychidae). Psyche, Vol 2012, Article ID 125284, 5 pages.

Finney, D. J. (1971). Probit Analysis. Univ. Press, London, Cambridge, UK, pp 1-32.

Geng, S., Chen, H., Zhang, J. and Tu, H. (2014). Bioactivity of garlic-straw extracts against the spider mites, *Tetranychus urticae,* and *T. viennensis*. J. Agric. Urban Entomol. 30: 38–48.

Habashy, M.G., Al-Akhdar, H.H., Boraie, D.M. and Ghareeb, Z.E. (2016). Laboratory and semi-field evaluation of garlic aqueous extract as acaricide against two Tetranychid mites (Acari: Tetranychidae). J. plant prot. & path., Mansoura Univ., 7(10), 623-628.

Ismail, M.S.M, Ghallab, M.A.M., Soliman, M.F.M. and AboGhalia, A.H. (2011). Acaricidal activities of some essential and fixed oils on the two-spotted spider mite, *Tetranychus urticae*. Egypt. Acad. J. biology. Sci., 3(1): 41-48.

Isman, M.B. (2008). Botanical insecticides: for richer or poorer. Pest Manag. Sci. 64, 8–11.

Isman, M.B., and Machial, C.M. (2006): Pesticides based on plant essential oils: from traditional practice to commercialization. In M. Rai and M.C. Carpinella (eds.), Naturally Occurring Bioactive Compounds, Elsevier, BV, pp 29-44.

Iwalokun, B.A., Ogunledun, A., Ogbolu, D.O., Bamiro, S.B. and Jimi-Omojola, J. (2004). *In vitro* antimicrobial properties of aqueous garlic extract against multidrug-resistant bacteria and *Candida* species from Nigeria. J. Med. Food, 7: 327-333.

Kim, J.W., Kim, Y.S., Kyung, K.H. (2004). Inhibitory activity of essential oils of garlic and onion against bacteria and yeasts. J. Food Prot. 67, 499–504.

Le Goff, G., Mailleux, A.C., Detrain, C., Deneubourg, J.L., Clotuche, G. and Hance, T. (2009). Spatial distribution and inbreeding in *Tetranychus urticae*. Biologies, 332:927-933.

Liu, S.Q., Shi, J.J., Cao, H., Jia, F.B., Liu, X.Q. and Shi, G.L. (2000). Survey of pesticidal component in plant. In: Entomology in China in 21th century. Ed. by Dianmo L, Proceedings of 2000 Conference of Chinese Entomological Society, Science & technique Press, Bejing, China, 1098–1104.

Migeon, A. and Dorkeld, F. (2007). Spider mites web: a comprehensive database for the Tetranychidae. http://www.montpellier.inra.fr/CBGP/spmweb.

Miresmailli, S. and Isman, M.B. (2006). Efficacy and persistence of rosemary oil as an acaricide against two-spotted spider mite (Acari: Tetranychidae) on greenhouse tomato.J. Econ. Entomol. 99, 2015–2023.

Mohammed, K.S. (2013). Antibacterial activity of *Allium Sativum* (Garlic) and identification of active compound by GC-MS analysis. Int J Pharm Bio Sci; 4(4): (B) 1071 – 1076.

Nour El-Deen, M.E.M. and Abdallah, A. A. M. (2013). Effect of different compounds against *Tetranychus urticae* Koch and its predatory mite *Phytoseiulus persimilis* A. H. under laboratory conditions. J. Appl. Sci. Res. 9: 3965–3973.

Panella, N.A., Dolan, M.C., Karcchesy, J.J., Xiong, Y., Peralta-Cruz, J., Khasawneh, M., Montenieri, J.A. and Maupin, G.O. (2005). Use of Novel compounds for pest control: insecticidal and acaricidal activity of essential oil components from heartwood of Alaska yellow cedar. J. Med. Entomol. 42, 352–358.

Rivlin, R. S. (2001). Historical perspective on the use of garlic. J. Nutr. 131(3s):951S-954S.

Roobakkumar, A., Subramaniam, M.S.R., Babu, A. and Muraleedharan, N. (2010). Bioefficacy ofcertain plant extracts against the red spider mite, *Oligonychus coffeae* (Nietner) (Acarina: Tetranychidae) infesting tea in Tamil Nadu, India. International Journal of Acarology 36,255–258.

Roy, J., Shakleya, D.M., Callery, P.S. and Thomas, J.G. (2006). Chemical constituents and antimicrobial activity of a traditional herbal medicine containing garlic and black cumin. Afr . J. Trad. CAM 3 (2): 1 – 7.

SAS Institute Inc. (2004), *SAS/STAT 9.1 User's Guide*, Cary, NC: SAS Institute Inc.

Seufi, A.M., Swidan, M.H. and Elsayed, E.H. (2007). Identification of novel defense genes expressed in Sitophilus oryzae (Coleoptera: Curculionidae) and Callosobruchus chinensis (Coleoptera: Bruchidae) treated with diallyl disulphide from the essential oil of garlic. J. Appl. Sci. Res. 3, 161–168.

Snedecor, G.W. and Cochran, W.B. (1981). Statistical Methods, 7th ed. Iowa State Univ. Ames, USA.

Sun, Y.P. (1950). Toxicity index on improved method of comparing the relative toxicity of insecticides. J. Econ. Entomol., 43:45-53.

Van Pottelberge, S., Van Leeuwen, T., Nauen, R. and Tirry, L. (2009). Resistance mechanisms to mitochondrial electron transport inhibitors in a field-collected strain of Tetranychus urticae Koch (Acari: Tetranychidae). Bull. Entomol. Res. 99, 23–31.

Wang, X., Yang, Y., Liu, R., Zhou, Z. and Zhang, M. (2016). Identification of antioxidants in aged garlic extract by Gas Chromatography-Mass Spectrometry and Liquid Chromatography-Mass Spectrometry. Int. J. Food Prop., 19: 474–483.

Zhang, Z. Q. 2003. Mites of greenhouses: identification, biology and control. CABI Publishing, Wallingford, pp 47-64.

Zhang, Z.Q. & Jacobson, R. J. 2000. Using adult female morphological characters for differentiating *Tetrancyhus urticae* complex (Acari: Tetranychidae) from greenhouse tomato crops in UK. Syst. Appl. Acarol., 5: 69–76.

التاثيرات السامة للمستخلص المائى لابصال الثوم على نوعين من العناكب الحمراء العادية

مريم جرجس صادق حبشى

قسم بحوث أكاروس القطن و المحاصيل ، معهد بحوث وقاية النباتات ، مركز البحوث الزراعية ، الجيزة

لقد تمت التجارب المعمليه لمعرفه مدى ثبات و قابليه المستخلص المائى لابصال الثوم لمكافحه نوعين من أهم أنواع الحلم النباتية و هما *Tetranychus urticae* و*Tetranychus cinnabarinus* . و ترجع أسباب خطورتهما الى كفاءتهما الجيدة على المقاومة و لذا فهما الأكثر انتشارا. و لذلك فان الاتجاهات الحديثة تهدف الى عمل الكثير من الدراسات لتطوير طرق المكافحة البيولوجية لاستخدامها فى مكافحة الأكاروس، و تعد المستخلصات النباتية كمستخلص الثوم أقل خطورةعلى البيئة لذا ينصح باستخدامة فى برامج المكافحة المتكاملة كبديل للمبيدات. فى هذة الدراسة تم عمل سبع تركيزات من المستخلص تتراوح بين ٢٠٠٠ و ٤٠٠٠ جزء فى المليون لقياس مدى سمية المستخلص. و أظهرت النتائج أن النوع و*T cinnabarinus* أكثر حساسية للمستخلص عن *T urticae* حيث تم تسجيل أعلى قيم الموت بعد سبع أيام و كانت ٨٦,٦٧ و ٨٣,٣٣ ٪ لكل من النوعين على التوالى. كذلك تم دراسة طول فترات التخزين على كفاءة ستة تركيزات من المستخلص المائى على نفس النوعين السابق ذكرهم من الأكاروس، و أظهرت النتائج أن كفاءة المستخلص تقل بمضى الوقت و ذلك لكل التركيزات حيث تفقد حوالى ٣٠٪ من كفاءتها بعد أربعة أسابيع. كذلك فان المستخلص المائى للثوم أثر تأثيرا معنويا على البيض حيث قل وضع البيض و كذلك نسبة الفقس فى كلا النوعين. و لكن بالنسبة لنسب الموت أو الخصوبة فلا يوجد فروق معنوية بين النوعين، و بذلك فان التجارب قد أثبتت أن لمستخلص الثوم فاعلية فى مكافحة كلا النوعين من الأكاروس.