



Biological and toxicological studies of predatory mite *Phytoseiulus persimili* athias-henriot s (Host preference) on *Tetranychus urticae* koch and *Tetranychus cucurbitacearum* on soybean plants

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Abstract

Four compounds were evaluated for their toxicity to the adult stage of the two-spotted spider mite *T. urticae*, *T. cucurbitacearum* and the predator mite, *Phytoseiulus persimilis*. Thus, field trails were performed during the seasons 2020 and 2021 on soybean plants in Sakha Agriculture Research Station. Moreover, to evaluate all stages of *P. persimilis*, when feeds on *T. urticae* and *T. cucurbitacearum*, following exposure to different concentrations of these compounds on soybean plants in the field and the most toxic compound was abamectin, whereas biofly had a moderate toxicity, moringa and garlic oil were the least toxic. Also, abamectin had the highest toxicity index followed biofly had a moderate toxicity to adult of mites. In case applied abamectin on *T. urticae* and *T. cucurbitacearum*, the immature stages of *P. persimilis* were 5.34 and 4.40 days compared to the control of 6.4 and 6.05 days, respectively. Longevity was 4.80 and 4.20 days compared to the control of 12.4 and 12.00 days, respectively. The proportion of hatching eggs in abamectin was 30.23 % and 31.21%, respectively compared to the control of 98.48 and 95.61% when a predator consumption *T. urticae* and *T. cucurbitacearum*, respectively. In the field experiments, the results showed that the most toxic compound on the predator mite was abamectin, caused reduction 72.16 and 75.76 % in the first and second season, respectively.

Keywords: *Phytoseiulus persimilis*, *Tetranychus urticae*, *Tetranychus cucurbitacearum*, athias-henriot s

Introduction

Predators are thought to be one of the biological control strategies for pests including phytophagous mites, scale insects, and whiteflies. Phytoseiid mites are natural enemies of tetranychid mites that play a key role in biological control (Croft 1997). Because of their well-known ability to decrease pest mite populations, primarily tetranychids, phytoseiid mites are important biological control agents in a variety of cropping systems (Colfer *et al.*, 2004). Because of their high predaceous efficiency on biological control, members of the phytoseiidae family have shown to be the most effective. There are about 1700 species in the world, with a global range (Walter, 1992). Some are crucial in the control of phytophagous mites. The predator used in this study was *phytoseiulus presimilis* (Athias-Hennoit) (Acari; phytoseiidae), which has a high oviposition and predation rate and has one of the higher development rates (Sabelis, 1981). It has attracted the curiosity of biologists working on the development of IPM systems. The biological control of two spotted spider mites [*Tetranychus urticae* Koch (Acari: Tetranychidae)] was investigated using Papatya Tiftikçi (2020) *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae) at release ratios of 1:10, 1:20, and 1:40 predator prey. *Tetranychus urticae* is a polyphagous insect that has been seen eating over 1100 plant species (dermauw *et al.*, 2012). Spider mites eat by penetrating plant tissue with their needle-like sucking mouthparts, and they prefer to feed on the lower leaf surface (Attia *et al.*, 2013). They also inject phototoxic chemicals that cause chloroplast damage and necrotic areas on the leaf surface. Chemical pesticides are the most frequently utilised method of spider mite control. Due to the widespread use of acaricides against this pest, as well as its high reproductive ability, Resistance

eventually developed due to the short life cycle and arrhenotokous mating mechanism (Van leeuwen *et al.*, 2009). Based on the total number of pesticides to which it has developed resistance, it is considered the most resistant arthropod species. Because the widespread use of synthetic chemical pesticides, which has resulted in resistance and contamination, there is a developing demand for more selective pesticides with novel modes of action. less environmental risks, and greater compatibility with natural enemies and biocontrol agents (Steiner *et al.*, 2011). The point of the study was to see how some chemicals affected *T. urticae* and *T. cucurbitacearum*, and determining the life span of *Phytoseiulus persimilis* after exposure to different compounds on soybean plants.

Materials and Methods

Compounds tested Abamectin 1.8 %: Chemical name (IUPAC name): Abamectin; containing (80%) avermectin, B,a. (“5-0deinethyl-avermectin-Aia”) at minimum and (20%) avermectin, B,b. {“5-0-demethyl-25-de-(1-methyl-propyl)25-(1-methylethyl) avermectin, A,a.”} at maxmum. It was supplied by Merck Company, Inc., Rahway, New Jersey, U.S.A

Biofly A liquid microbial pesticide containing 3x10⁷ conidia of the entomopathogenic fungus *Beauveria bassiana* (Balasamo). El-Nasser for Fertilizers and Pesticides-Egypt provided it.

Plant oils and investigated in the present study.

Family	Scientific name	Common name	Arabic name	Part used
Moringaceae	Moringa	Moringa oil	زيت المورينجا	Seeds
Allioideae	<i>Allium sativum</i>	Garlic oil	زيت الثوم	Seeds

Culture of *T. urticae* and *T. cucurbitacearum*.

The two-spotted spider mites, *T. urticae* and *T. cucurbitacearum*, infected soybean leaves were collected from a soybean plants at the farm of Sakha Agriculture Research Station in Kafr El-Sheikh, Egypt and placed in paper bags. The samples were brought to laboratory on soybean plants untreated, which fed on *T. urticae* and *T. cucurbitacearum*. Adult females were released overnight on fresh and clean mulberry soybean plants and all of the adult females were removed the next day to get newly deposited eggs. According to Dittrich, the colony was grown in an incubator at 27± 2°C and 65± 5% R.H. (1962)

Rearing of the predatory mite; *Phytoseiulus persimilis*

The predatory mite was obtained from soybean plants and leaf discs with a diameter of 2.5 cm were used as a substrate for rearing the predator and were deposited in Petri-dishes on cotton wool, with each disc coated with a dry cotton barrier. Every day, a few drops of water were added to keep the predator wet. When the leaf substrate began to decay, it was replaced with a new one and a sufficient number of *T. urticae* and *T. cucurbitacearum* were given as prey at various stages. The studies were done out in a controlled setting. According to Overmeer *et al* were raised at 27^o C and 65.5% R.H. (1982).

Bioassay testes

Feeding *Phytoseiulus persimilis* on different kind food

The arenas used in this study were made from (2.5 cm.) soybean leaf discs treated by cemical compounds put on a water-soaked sponge pad with the upper surface down. Around the outside edge of the leaves, a strip of moistened absorbent cotton was placed. Individual venues with the food supply to be evaluated were fed with single freshly hatched larvae. Every day, the arenas were checked, and the development and survival of predators were recorded. Freshly collected pollen was made available to the predator by placing a small amount of test pollen in each arena, which was replaced each 48-72 hours. When used as a food source for mite rearing, the pollen must keep well and preferably have a low water content to minimize molding. Fresh prey tetranychid mites were replaced on a daily basis. Female newly emerged from the eggs, mated, and kept to individual test venues with food to be tested. The leaf was given by a single leaf (1 cm) placed on the large veins of each leaf (arena). The duration of immature stags' life, as well as their longevity and fertility, were all recorded.

Effect of prey density on egg laying, longevity and feeding behavior of *P. persimilis*

The predatory mite, *P. persimilis* were kept separate from the tetranychid mite *T. urticae* and *T. cucurbitacearum*

soybean plant leaves (Basha *et al.*, 2007). Mature virgin females and newly emerged males of the four species (within 24 - 48 hours of their last moult) were copulated and allowed enough time to mate on mulberry leaves with enough prey. *T. urticae* and *T. cucurbitacearum* adult females were used as prey, with densities of 5, 10, and 15 per leaf disc with 10 replicates separately of each prey density leaf disc.

Field experiments

During the summer seasons of 2020 and 2021, two tests were performed at the farm Sakha Agric. Research Station in Kafr El-Sheikh, Egypt. The purpose of this study was to see *P.persimilis*, four chemicals, abamectin, biofly, and two oils (moringa and garlic oil) infesting soybean plants of the variety Giza 111 [each of 1/42 hectare] were considered as a plot laid out in a completely randomized blocks design, with four replicates for each treatment. Using a knapsack sprayer (20 L volume) with one nozzle, all tasted compounds were applied at half the recommended rate. Water was used to dilute the compounds at a rate of 200 liters per fadden. Before, two days, and one week after treatment, ten soybean leaves were randomly selected from each plot.

Statistical analysis

ANOVA, one-way analysis of variance, was used to statistically analysis the data (Duncan 1955). The mortality was calculated using Abbott's formula (1925), plotted on a logconcentration probit paper, and the regression lines were statistically evaluated using Litchfield and Wilcoxon (1949). Henderson and Tilton (1955) equation was used to calculate the percentage reduction.

Results and Discussion

Toxicity of the compounds on biological aspects of the predator mite, *P. persimilis* when fed on *T. urticae*

The data presented in Table (1) indicated that abamectin was the most toxic compound, with an LC50 value of 1.4 ppm. and toxicity index 100. While biofly exhibits a moderate toxicity to adult females of *T. urticae*, with an LC50 of 5.8 ppm. Moringa and garlic oil, with LC50 values of 97.50 and 146.44 ppm, respectively. On the other hand, biofly was moderate toxicity to adult female *T. urticae*, with a toxicity index of 24.13. While moringa and garlic oil have low toxicity indices of 1.43 and 0.95, respectively. This experiment on adult female spider mites was carried out not only to obtain the most toxic compound, but also to record the continuous variations in the reaction of different chemicals towards the main pest belonging to phytophagous Tetranychide, which has been studied and will be studied in the future by many inve stigators. Without a doubt, these investigations reflect one of the essential stages in a successful IPM programme.

Table 1: Susceptibility of *P.persimilis*, biological aspects to acaricides and their alternatives when fed on *T. urticae* treated.

Compounds	Toxicity to <i>T. urticae</i>				Control
	Abamectin	Biofly	Moringa oil	Garlic oil	
LC ₅₀ (PPM)	1.4	5.8	97.50	146.44	-----
Toxicity index	100	24.13	1.43	0.95	-----
Development stages of <i>P. persimilis</i> feeding on <i>T. urticae</i>					
Incubation period	2.06	5.80±0.11	4.20±0.45	5.40±0.31	3.80±0.32
Larva	1.36	2.80± 0.21	3.20±0.23	4.20±0.25	2.20±0.46
Protonymph	1.88	2.60± 0.21	2.80±0.31	3.20±0.71	2.00±0.51

Dutonymph	2.10	2.40± 0.32	3.80±0.29	4.00±0.42	2.20±0.51
Total immature stages	5.34	7.80± 0.31	9.8±0.41	11.40±0.42	6.4±0.81
Life cycle	7.40	13.60±0.32	14.00±0.81	16.80±0.31	10.2±0.31
Longevity	4.80	6.80± 0.61	8.40±0.32	9.4±0.21	12.4±0.27
Life span	12.2	20.4± 0.42	22.40±0.81	26.2±1.5	22.60±0.4
Average no. of lading egg-females	34.4	43.6± 0.51	55.20±0.91	63.41±0.62	66.00±0.9
% hatching of eggs	30.23	36.69	45.45	70.97	98.48
% Reduction of lading	47.87	33.93	16.36	3.92	0.00

The effects of four chemicals on *T. urticae* were studied in the biological aspects of *P. persimilis*, which feeds on *T. urticae*. The results showed that when we faded with *T. urticae*, the duration of immature stages was 5.34 days and adult longevity was 4.80 days, but when we used garlic oil, the duration of immature stages was 11.40 days and adult longevity was 9.4 days, but abamectin was 4.80 when compared to moringa and garlic oil, and had the highest effect on the rate of hatching eggs to abamectin, moringa and garlic oil with ratios of 30.23 % to 45.45 % and 70.97 % compared to the control (98.48%), respectively. However, the predator's life span was influenced by the concentrations of four compounds, which led to a decrease life span in the control group, where the control diet was 98.48%. The life cycle significant were 13.60, 14.00 and 16.80 days both biofly, moringa and garlic, respectively) when the predator was feeding on *T. urticae*. Hosam *et al.* (2019) determined the direct and residual effects of two natural plant extracts on *T.urticae*. The effect on the biological features of *T.urticae* was studied at two concentrations of 0.25 % and 0.5 %. Habashi (2018) investigated the ability and stability

of the aqueous garlic extract (*Allium sativum linn.*) To combat the spider mite. *tetranyus urticae* in Egypt. The data showed that the maximum mortality of *T.urteca* was 83.33 ± 7 days.

Toxicity of the compounds on biological aspects of the predator mite, *P. persimilis* when fed on *T. cucurbitacearum*

The data presented in Table (2) showed that abamectin was the most toxic compound with an LC50 value of 2.3 ppm, while biofly has moderate toxicity adult female, *T. cucurbitacearum* with LC50 value of 7.5ppm. *cucurbitacearum*. While Moringa and garlic oil were the least toxic to adult *T. cucurbitacearum* with LC50 values of 112.33 and 158.36 ppm, respectively. confirmed that abamectin was the most toxic compound for adult *T. cucurbitacearum* in with a toxicity index of 100, and biofly moderate toxicity to adult *T. cucurbitacearum* females with a toxicity index of 30.66. Moringa and garlic oil are weakly toxic to adult female *T. cucurbitacearum*, with toxicity indexes of 2.04 and 1.45, respectively.

Table 2: Susceptibility of *P.persimilis*, biological aspects to acaricides and their alternatives when fed on *T. cucurbitacearum* treated

Compounds	Toxicity to <i>T. cucurbitacearum</i>				Control
	Abamectin	Biofly	Moringa oil	Garlic oil	
LC ₅₀ (PPM)	2.3	7.5	112.33	158.36	-----
Toxicity index	100	30.66	2.04	1.45	-----
Development stages of <i>P.persimilis</i> feeding on <i>T. cucurbitacearum</i>					
Incupation period	1.70	4.60±0.11	4.00±0.45	5.20±0.31	3.70±0.32
Larva	1.30	2.40± 0.21	2.80±0.23	4.00±0.25	2.00±0.46
Protonymph	1.70	2.5 0± 0.21	2.60±0.31	2.85±0.71	2.05±0.51
Dutonymph	1.40	2.35± 0.32	3.75±0.29	3.80±0.42	2.00±0.51
Total immature stages	4.40	7.45± 0.31	9.15±0.41	10.65±0.42	6.05±0.81
Life cycle	6.10	12.05±0.32	13.15±0.81	15.50±0.31	9.75±0.31
Longevity	4.20	6.20± 0.61	7.80±0.32	10.30±0.21	12.00±0.27
Life span	10.30	18.25± 0.42	20.95±0.81	19.30±1.5	21.75±0.34
Average no. of lading egg-females	37.80	40.20± 0.51	48.40±0.91	57.60±0.62	63.80±0.69
% hatching of eggs	31.21	35.32	47.93	71.87	95.61
% Reduction of lading	40.75	36.99	36.67	9.71	0.00

The duration of immature stages and longevity of adults decreased significantly depending on the type of foraging *P. persimilis*: 4.40 days and 4.20 days, both immature stage and longevity, respectively. it can be seen when fed *P.persimilis* on *T.cucurbitacearum*. The results showed that when we used moringa and garlic oil, the duration of the immature stages were 9.15 and 10.65 days and the longevity were 7.80 and 10.30 days, respectively. The rate of hatching eggs to abamectin was 31.21%, while garlic oil was 71.87 % compared to the control was 95.61 %. Life span of a predator was affected by the concentrations of this compounds which led to a decrease in the life span in the control where the ration in the control was 21.75 %. Life cycle was significantly with 6.10, 13.15 and 15.50 days, for abamectin, moringa and garlic oil when a predator fed on *T.*

cucurbitacearum respectively. The study found that these extracts used to have a beneficial effect on tick life aspects, changing and extending tick life cycles while also reducing the number of generations each year. Moreover, the extracts used had a high mortality rate, with 65.52 % and 51.72 %, respectively, before and after the infection when they were treated. Habashy (2018) [13] studied the effect of storage periods on the effectiveness of various six concentrations of aqueous garlic extract on *T.urticae*. The results showed that the acaricidal activity of the extract shortened the release time for all tested concentrations. After four weeks, he lost about 30% of his activity. Aqueous garlic extract significantly reduces the egg deposition and hatchability of *T.urticae*. Pascoli *et al.* (2019) described the preparation and characterization of neem oil-loaded zein nanoparticles,

together with evaluation of their toxicity towards nontarget organisms, using *Allium cepa*, soil nitrogen cycle microbiota, and *Caenorhabditis elegans* aiming to achieve the safer by design strategy. The spherical nanoparticles showed an average diameter of 278 ± 61.5 nm and a good stability during the experiments. In the toxicity assays with *A. cepa*, the neem oil-loaded zein nanoparticles mitigated the increase in the DNA relative damage index caused by the neem oil. Molecular genetic analysis of the soil nitrogen cycle microbiota revealed that neem oil-loaded zein nanoparticles did not change the number of genes which encode nitrogen-fixing enzymes and denitrifying enzymes. In *C. elegans*, the neem oil-loaded zein nanoparticles had no toxic effect, while neem oil interfered with pharyngeal

pumping and GST-4 protein expression. Sibel and Irfan (2017). Determined the side effects of four acaricides (acequinocyl, etoxazole, bifenthrin and milbemectin) on the predator mites *phytoseiulus persimilis* and *Neoseiulus californicus*. The result indicated that effects of the different acaricides doses applied on predator mite adults increased according to the acaricides and counting daily. It was also found that the acaricides used in the study had significant side effects on predator mite adults. They were found that all of the acaricides used in the study showed high levels of toxic effect on *N. californicus* and *P. persimilis* adults.

Toxicity of tested compounds to adult females of predatory mite *p. persimilis*

Table 3: Toxicity of different compounds to adult females of predatory mite *p. persimilis*:

Compound	<i>p. persimilis</i>	
	LC ₅₀ (PPM)	Toxicity index
Abamectin	0.55	100
Biofly	9.66	5.69
Moringa oil	112.67	0.48
Garlic oil	122.44	0.44

The results from Table (3) revealed that abamectin was the most toxic chemical, having an LC₅₀ value of 0.55 ppm. While biofly was a moderate toxicity to adult females of *P. persimilis* with LC₅₀ of 9.66 ppm but garlic oil with LC₅₀ value of 122.44 ppm was the least toxic to adult females of *P. persimilis*. Abamectin was the most toxic compound to adult females of *P. persimilis*, with a toxicity index of 100.00%, followed by biofly with toxicity indexes of 5.69. Garlic oil had a low toxic effect on adult females of the *p. persimilis* with toxicity indexes of 0.44 %. (Sun, 1950) [18] of any toxic compound was suggested mainly to pool different information about this compound against different mite species and mite stages by comparing their LC₅₀ values. The final values concluded from their calculation is the efficiency of the compound tested in integrated pest management. Duygu Cevizci *et al.* (2020).

Phytoseiulus persimilis and *Neoseiulus californicus* (Acari: Phytoseiidae). Experiments were conducted at 25 ± 1 °C, 70 ± 5 % relative humidity, and 16:8h light dark conditions. Our data showed that the bioactive acaricidal compound is most effective (86.5 to 89% mortality) when the entire integument of *T. urticae* comes in contact with it compared

to contact of the ventral side only (26.5–34%). Against *P. persimilis* Sibel and Irfan (2017). Found that all of the acaricides used in the study showed high levels of toxic effect on *N. californicus* and *P. persimilis* adults. Papatya Tiftikçi *et al.* (2020). *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae) at release ratios of 1:10, 1:20 and 1:40 predator:prey were evaluated to reveal its potential for biological control of two spotted spider mites [*Tetranychus urticae* Koch (Acari: Tetranychidae)].

Field studies

Effect of tested compounds on motile stages of *p. persimilis* on soybean field.

The results in Tables 4 and 5 showed that abamectin was the most effective compound in reducing the population density of motile stages of the mite, *P. persimilis*, with (72.16 % and 75.76%) in the first and second seasons, respectively. While biofly (61.82% and 69.83%) in two seasons but garlic oil was the least effective compound in reducing the population density of motile stages of *p. persimilis* with (34.64 % and 35.31 %) in the first and second seasons, respectively.

Table 4: Effect of tested compounds on motile stages of *p. persimilis* on soybean plant in the field.

Compounds	No. of <i>p. persimilis</i> before treatment	No. of <i>p. persimilis</i> after treatment (weeks) of			
		1 st week	2 nd week	3 rd week	4 th week
Season 2020					
Abamectin	165.60	22.68	30.43	38.75	52.57
Biofly	153.65	29.33	37.46	48.35	68.88
Moringa oil	172.44	48.15	62.49	73.64	98.32
Garlic oil	168.35	74.86	86.74	102.43	117.55
Control	240.5	222.25	198.75	186.33	172.53
Season 2021					
Abamectin	168.77	16.63	24.15	31.55	56.23
Biofly	165.54	23.56	34.64	46.33	68.63
Moringa oil	167.34	41.56	56.58	68.56	96.22
Garlic oil	172.00	61.37	72.55	98.58	122.64
Control	248.22	236.00	207.13	192.77	180.43

Table 5: reduction of tested compounds on motile stages of *p. presimilis* on soybean plant in the field.

Compounds	% reduction				General mean
	1st week	2st weeck	3st weeck	4st weeck	
2020					
Abamectin	85.20	77.76	69.81	55.87	72.16
Biofly	79.38	70.50	59.72	37.68	61.82
Moringa oil	69.84	56.15	45.33	20.77	48.01
Garlic oil	51.19	62.34	22.12	2.94	34.64
2021					
Abamectin	89.65	82.97	76.07	54.35	75.76
Biofly	85.05	79.07	72.01	43.20	69.83
Moringa oil	73.92	59.76	47.55	21.22	50.61
Garlic oil	62.53	49.80	26.63	2.31	35.31

References

- Abbott WS. A method of computing the effectiveness of an insecticide. *J. Economic Entomology*,1925:18:265-267.
- Attia S, Grissa KL, Maillieux AC, Lognay G, Heuskin S, Mayoufi S *et al.* Effective concentrations of garlic distillate (*Allium sativum*) for the control of *Tetranychus urticae* (Tetranychidae). *Journal of Applied Entomology*,2012-2013:136: 4, 302-312.
- Busvine JR. A critical review of the techniques for testing insecticides. Commonwealth Inst. Entomol,1971:345(3) 348-896.
- Duncan DB. selected lipid profile in the serum &Tissues of weaned male Albino Rts fed on processed Atlantic horse mackerel (*trachurus trachurus*) *Journal. Advances in bioscience and biotechnology*,1955:6(4)11:1-5.
- Dittrich V, Stribert P, Bathe PA. An old case reopened mite stimulation by insecticide residues. *Environ. Entomol*,1962:3:534-540.DOI 10.1007/s10493-0160074-x.
- Giboney F. A laboratory evaluation on *Amblyseius fallacis* (Garman) (Acarina: Phytoseiidae) as a control agent for tetranychid mites. Ph. D. Thesis, U. C. N. W. Bangor, 1981.
- Habashy G. Mariam. Toxicological Effects of Garlic Bulbs Aqueous Extract on tetranychid Mites (Acari: Tetranychidae). *J. Plant Prot. And Path., Mansoura Univ*,2018:9(1):1-7.
- Handerson CF, Telton EW. Test with acaricides against the brown Wheat mite. *J. Econ. Entomol*,1995:(48):157-161.
- Khairia M, Saleh M, AAA. Aioub.; A.A.A.Shalaby and M.A. Hndawy Efficiency of some acaricides on the two spotted spider mite on Laboratory and field conditions . *Zagzig. J.Agric. Res*1377:(5)46,,1386, 2019.
- Keratum AY, Anber H, Essawy MM, El-Shahawi FL. The effect of permethrin residues on the activity of the predators *Phytoseiulus persimilis* and *Amblyseius fallacis*. *Alex. Sci. Exch*,1994:15(1):67-82.
- Keratum AY, Ibrahim SIA. The relationship between spider mites and their predators in the presence of pesticides. *Egy.J. Plant. Pro> Res*,2018:4(3):1-19.
- Lubna BR, Gilal AA, Bukero A, Wahocho NA. Impact of Different Oils as Biopesticide against Sucking Insect Pests in Soybeen. *J. Basic & Applied Sciences*,2017:13:34-40.
- Mariam G. Habashy. Toxicological Effects of Garlic Bulbs Aqueous Extract on Two Tetranychid Mites (Acari: Tetranychidae) *J. Plant Prot. and Path., Mansoura Univ*,2018:9(1):1-7.
- Migon A, Dorkeld F. Spider mites Web: A comprehensive database for the Tetranychidae. *Exb. Applied Acarol*,2007:35:2-15. DOI:10.1007/s10493004-5082-6.
- Premalathe K, Nelson SJ, Vishaupriya R, Balakrishnan S, santhana KVP *et al.* Acaricidal activity of plant extracts on two spotted spider mite, *Teranychus urticae* *KOCh. Journal of Entomolgy and zoology Studies*,2017:6(1):1622-1625.
- Seliman, Laila EM, Abd EL-Rhman HA. Toxicological and Biological studies on cotton mite (*TETRANYCHUS URTICAE*) *Egy. j. plant pro.Res*.3(3):50-69
- Siegler EH. Leaf-disc technique for laboratory tests of acaricides. *J. Econ. Entomol*,1947:(40):441-442.
- Sun YP. Toxicity indox-an improved method of comparing the relative toxicity of insecticides.*J. Econ. Entomol*,1950:43(1):45-53.
- Steiner MY, Spohr LJ, Goodwin S. Impact of two formulations of the acaricide bifentazate on the spider mite predator *Phytoseiulus persimilis* Athias-Henriot a. (Acari: Pyhtoseiidae). *Australian J. Entomol*,2011:50:99-105.
- Tarikul Islam. Host plant- Induced Susceptibility of two-spotted spider mite *Tetranychus urticae* (Acari: Tetranychide) to some Reducd-Risk Acaricide. *American Journal of Agricultural and Biolgical Scineces*,2018:14:11.15 DIO: 10.3844.