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Controlling of Two Spotted Spider Mite *Tetranychus urticae* Koch on *Phaseolus vulgaris* L. Using Growth Stimulants Versus Acaricide

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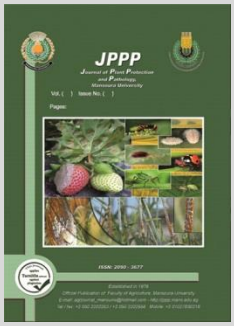

ABSTRACT

The experiments were conducted to study the effect of foliar fertilizer (NPK), two types of organic fertilizers (farmyard manure and compost), two growth regulators (salicylic acid, Paclobutrazol) and one recommended acaricide (Biomectin) on population of two spotted spider mites *Tetranychus urticae* Koch in bean plants, *Phaseolus vulgaris* L. var Nibraska. The number of mites was recorded before and after treatments Biomectin caused the highest reduction in mite population (96.72 %) followed by Surfactant as a pesticide adhesive and Biomectin plus Surfactant which were recorded 92.09 and 70.45 %, respectively . The effect of fertilizers showed that the highest reduction (47.49 %) was occurred under soil addition of compost. Paclobutrazol as a growth regulator achieved the highest reduction (96.95%) of *T. urticae*..

Keywords: *Phaseolus vulgaris* var Nibraska, two spotted spider mite *Tetranychus urticae* Koch, foliar fertilizers, organic manure, growth regulators, Biomectin.

INTRODUCTION

Common bean (kidney bean plant), *Phaseolus vulgaris* is one of the most important economic vegetable crops cultivated in many countries of the world as a main source of protein and also in Egypt. This crop is infested by many pests causing damage in both quantity and quality. *T. urticae* is from the majority pests infesting kidney bean cultivars (Santos, *et al*., 2002). *T. urticae* is a major pest decreasing plant growth and yield on different agricultural crops including bean plants (Farouk & Osman 2009). Fertilizers are normally added to the soil, but it is known that the plants can absorb nutrition, which is applied directly into the leaves. The possibility of killing other insects by plant nutrient supplements is to be explored further (Sung-Ching, 1995). The control is difficult to manage since this spider mite has high reproductive potential and products used to kill mites show low efficiency in several populations which are resistant to acaricides as abamectin (Sato *et al.*, 2009). The application of plant growth regulators to crops modifies hormonal balance and growth leading to increased yield, enhanced crop tolerance against abiotic stress and improved physiological trait of crops. Salysalic acid acts as a regulator in biological processes in plants, including defense (Kumar *et al.*, 2015). It acts on the accumulation of superoxide and hydrogen peroxide in the apoplast, causing cell death at infection site, promoting lignin synthesis in the cell wall, making it difficult stylet penetration and chewing of insects, due to cell wall stiffening (Datnoff *et al.*, 1991; Epstein, 1994; Marschner, 1995), acting in the establishment of systemic acquired resistance (Gao *et al.*, 2015). Abamectin belongs to the macrocyclic lactone family of insecticides/acaricides and is produced during the fermentation of *Streptomyces avermitilis*, a soil microorganism (Burg and Stapley, 1989, Riga *et al*., 2014). Abamectin has also been developed as a broad-spectrum insecticide/acaricide with activity on several mite species, including *T. urticae* (Putter *et al*., 1981).

The aim of this study was to evaluate the populations and reduction percentages of *T. urticae* submitted to different agricultural treatments, as alternative methods to control it on bean plants. Treatments were applied to screen the effectiveness of different fertilizers (NPK fertilizer, organic manure, and compost), and growth regulators (Salicylic acid and Paclobutrazol). The previous agricultural treatments were compared with recommended acaricide (Biomectin), which used with and without a surfactant along with using surfactant only.

MATERIALS AND METHODS

The experiment was conducted in Fayoum governorate (Demo farm, Faculty of Agriculture, Fayoum University). *Phaseolus vulgaris* var Nibraska was sown in March in an area of about 450 m^2, divided into equal ten plots, which received different treatments and control.

Forty five days after sowing, bean plants were infested with two spotted spider mite individuals, and within few days the applications of NPK fertilization (3 g/L), salicylic acid (0.069g /0.5mM), Paclobutrazol (0.09 g/ 0.3 mM), Biomectin (0.2 cm/L), Surfactant (2.5 cm/L), Biomectin + Surfactant (0.2 cm/L + 2.5 cm/L) were started with aid of manual sprayer, all over the leaf surface was sprayed, while farmyard manure fertilizer (1/4 m^2/1 m^2) and compost (1 K/1 m^2) were added directly to soil. The number of mites was recorded before and after treatment.

Treatments with the tested materials were evaluated after 1, 3, 7 and 10 days except of organic fertilization was evaluated after 15, 20, 25 and 30 days.

Seven plots were used for foliar application namely, NPK fertilization, salicylic acid, Paclobutrazol, Biomectin, Surfactant, Biomectin+Surfactant and their control using water.

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The other three plots were used for soil application namely, farmyard manure fertilizer, compost and their control.

To determine the efficiency of each treatment to reduce the population of *T. urticae*, five plants per plot were randomly collected from each plot and movable stages of spider mite were counted 24 hours before and 1, 3, 7 and 10 days after treatment.

Reduction% were evaluated according to Henderson & Tilton formula (Henderson & Tilton, 1955)

$$\text{Reduction\%} = 1 - \frac{Ta \times Cb}{Tb \times Ca} \times 100$$

Where:

Ta = number after treatment in treated plot.
Tb = number before treatment in treated plot.
Ca = number after treatment in check plot.
Cb = number before treatment in check plot.

RESULTS AND DISCUSSION

Reduction percentages of *Tetranychus urticae* populations on *Phaseolus vulgaris* var Nibraska treated with some agricultural treatments:

1- Fertilizers:

NPK fertilizer:

Data presented in Table (1), showed that, the recorded number of mites varied according to the time after treating with NPK fertilizer which caused reduction on *T. urticae* population on bean plants after 1, 3, 7, and 10 days compared with control treatment. The reduction percentages were 31.43, 38.48, 30.98 and 31.71 %, respectively after 1, 3, 7 and 10 days of treatment with general reduction 33.50 %.

In this respect, Andrade, *et al.*, (1997) found that the greatest spotted spider mite population occurred with no fertilizer, followed by NPK + sulfur, and sulfur alone. The treatments with cow manure had the fewest mites.

Also, Najafabadi, *et al.*, (2011) investigated the impact of nitrogen fertilization on bean plants *Ph. vulgaris* and *T. urticae* population. Results of analysis of variance for numbers of adult or immature stages of *T. urticae* showed significant variations among nitrogen treatments and among six bean cultivars.

As proved by Khaghani, *et al.*, (2014) who studied the interaction effects of nitrogen and phosphorus in two-spotted spider mite, *T. urticae* on chiti and sadri bean varieties, in 2012-13 in Iran. Results showed that nitrogen increased the establishment of the plant mite in days after infection.

Farmyard manure

The obtained result presented in Table (1), cleared that, the dose of farmyard manure caused reduction in mites population infested bean plants after 15, 20, 25 and 30 days. The reduction percentages were 38.82, 43.64, 43.79 and 40.66 %, respectively with general reduction 42.54%.

Table 1. Reduction percentages of *T. urticae* populations on *P. vulgaris* var Nibraska treated with some fertilizers.

Fertilizers / Foliar fertilizer	Dose	Pre- Count	After 1Day	R %	After 3days	R %	After 7Days	R %	After 10days	R %	General Mean	General Reduction%
NPK	3g/L	25	24	31.43	29	38.48	35	30.98	40	31.71	34.67	33.50
Control	--	35	49	--	66	--	71	--	82	--	73	--
Organic fertilizer	--	Pre-count	After 15 days	R%	After 20 days	R%	After 25 Days	R%	After 30 days	R%	--	--
Farmyard manure	1/4m^2 / 1m^2	25	26	38.82	31	43.64	37	43.79	45	40.66	37.67	42.54
Compost	1k / 1m^2	27	26	43.36	36	39.39	39	45.15	43	47.49	39.33	44.45
Control	--	30	51	--	66	--	79	--	91	--	78.67	--

Compost

As shown in Table (1) the organic fertilization (compost) affected the reproduction of mites on bean plants that could be decreased and the highest reduction in mite population was achieved after 20 days of application which recorded 39.39 % while the general reduction was recorded 44.45%.

These results are inagreement with Nour-Eldin and Sholla, (2015) who indicated that the treatment of Animal Neem Manure (A. N. M.) caused highest reduction in mites population (95 % reduction) comparing with the control treatment (water) at the first season. While at the second season, recorded 93 % reduction. Novatreen and Potassen-F recorded reduction of 86 & 81 % and 84 & 83 % comparing with the control during the two successive seasons (2012 & 2013), respectively.

1- Growth regulators:

Salicylic acid:

Data obtained in Table (2), revealed that, the salicylic acid treatment reduced the population of *T. urticae* with recorded numbers 31 , 39 , 45 and 49 individuals after 1, 3, 7, and 10 days, respectively with reduction percentages of 23.65 , 28.69 , 23.51 and 27.88 %, respectively and with general reduction of 26.71% .

Table 2. Reduction percentages of *T. urticae* populations on *Phaseolus vulgaris* var Nibraska treated with some growth regulators.

Growth Regulators	Recommended Dose	Pre-Count	After 1day	R %	After 3days	R %	After 7days	R %	After 10days	R %	General mean	General Reduction%
Salicylic acid	0.069g/0.5mM	29	31	23.65	39	28.69	45	23.51	49	27.88	44.33	26.71
Pacloputrazol	0.09g/0.3mM	28	22	43.88	17	67.80	10	82.39	2	96.95	9.67	83.44
Control		35	49	--	66	--	71	--	82	--	73	--

In this respect, Favaro, *et al.*, (2019) evaluate the effect of salicylic acid (SA) on resistance induction against two-spotted spider mite in strawberry cultivars (Aromas and Sweet Charlie) where a reduced number of mites in the two strawberry cultivars was noticed.

Paclobutrazol:

In Table (2), data obtained showed that, the reduction percentages% were increased gradually by increasing the time of application to record 43.88 , 67.80 , 82.39 and 96.95 % after 1, 3, 7, and 10 days with general reduction of 83.44%.

Latimer, G.J. and D. Oetting (1999) indicated that treatment with paclobutrazol (45 mg·L–1) or brushing (40 strokes twice daily) reduced the number of two-spotted spider mites per marigold plant after 4 weeks of treatment.

Also, Saenz –De -Cabezon, *et al*., (2002) evaluated the effects of triflumuron (growth regulator) on the mortality, fecundity, and fertility of the two-spotted spider mite, *T. urticae*, in the laboratory. No differences in toxicity for larvae, protonymphs and deutonymphs were observed, but immature stages were 3.8-times more susceptible than adults at the LC50. The compound exhibited a direct contact ovicidal activity influenced by eggs age. 48–72 h old eggs were significantly more sensitive than eggs of the other age classes. The toxicity for immatures and eggs, and the sublethal effects described suggest that triflumuron could be an interesting incorporation in integrated pest programs of *T. urticae.*

These results agreed with the results which obtained by Farouk and Osman (2011) who applied a foliar application of salicylic acid (SA) or methyl jasmonate (MeJA) on common bean plants before or after two spotted spider mite infestation that proved to be effective in reducing infestations. SA or MeJA could be used for controlling TSSM infestation, to improve plant growth and to improve bean yield in the field.

3- Chemical treatment using acaricide (Biomectin):

Effect of Biomectin on *T. urticae* population.

Data in Table (3) revealed that, Biomectin caused the highest reduction among treatments, the reduction percentages were increased gradually by increasing the time of application to record 45.05 , 69.41, 84.83 and 96.72 % after 1 , 3 , 7 and 10 days respectively.

Effect of Surfactant on *T. urticae* population.

Data presented in Table (3), cleared that, the reduction percentages% were increased gradually by increasing the time of application to record 46.09 % after one day followed by 74.47, 87.72 and 92.09%, after 3, 7 and 10 days, respectively.

Effect of Abamectin and Surfactant on *T. urticae* population.

As shown in Table (3), the reduction percentages % were increased gradually by increasing the time of application to record the highest reduction (70.45%) after 10 days .

Table 3. Reduction percentages of *T. urticae* populations on on *Phaseolus vulgaris* var Nibraska treated with acaricides and Surfactant.

Chemical Treatments	Recommended Dose	Pre-Count	After 1day	R%	After 3days	R %	After 7days	R %	After 10days	R %	General Mean	General Reduction%
Biomectin	0.2cm/L	26	20	45.05	15	69.41	8	84.83	2	96.72	8.33	84.64
Surfactant	2.5 cm/L	27	20	46.09	13	74.47	7	87.72	5	92.09	8.33	85.21
Biomectin+ Surfactant	0.2cm/L+ 2.5cm/L	26	25	31.31	23	53.09	20	62.08	18	70.45	20.33	62.51
Control	--	35	49	--	66	--	71	--	82	--	73	--

In this respect, Duchovskienė and Darzininkyste (2007) studied the effects of abamectin insecticide (18 g/litre) on the seasonal abundance of two-spotted spider mite (*T. urticae*) in greenhouse cucumbers during 2005-06. At 0.12%, the efficiency of 18 g abamectin/litre against two-spotted spider mite was 81.7-100% 3 days after treatment, 98.4-100% 7 days after treatment, 100% 9-10 days after treatment, and 98.7-100% 14 days after treatment. At 0.1%, the efficiency of 18 g abamectin/litre against two-spotted spider mite was: 77.5-90.1% 3 days after treatment, 96.7-100% 7 days after treatment, 99.2-99.4% 9-10 days after treatment, and 88.1-100% 14 days after treatment. At 0.075%, the efficiency of 18 g abamectin/litre against two-spotted spider mite was: 72.7-81.0% 3 days after treatment, 87.0-100% 7 days after treatment, 100% 9-10 days after treatment, and 84.7-100% 14 days after treatment. At 0.05%, the efficiency of 18 g abamectin/litre against two-spotted spider mite was: 45.6-78.0% 3 days after treatment, 88.5-100% 7 days after treatment, 82.3-100% 9-10 days after treatment, and 85.5-100% 14 days after treatment. While, Tawfik, Alyaa and Elgohary (2015) tested Abamectin, Emamectin benzoate, Acequinocyl, Chlorfenapyr and Hexythiazox against *T. urticae* and its natural enemies, *Phytoseiulus persimilis* and *Stethorus gilvifrons*. Reviewing the obtained results, it can be noticed that Abamectin was the quickest in its action against *T. urticae* and the slowest against *P. persimilis* and *S. gilvifrons* compared with other tested acaricides. The efficacy of the tested acaricides on the population density of *T. urticae* could be arranged according to the general mean of reduction percentage in a descending order as follows: Abamectin, Acequinocyl, Hexythiazox, Emamectin benzoate and Chlorfenapyr which recorded 83.29, 66.06, 56.40, 53.02 and 25.67% reduction, respectively. Xu, *et al*., (2018) used a leaf dip assay to assess the resistance of seven field populations of *T. urticae* to 11 pesticides in China. The mutation frequencies of target genes related to pesticide resistance were also determined. The results showed that all seven field populations had high or extremely high resistance to abamectin and had low or moderate resistance to newly developed pesticides including bifenazate, cyenopyrafen, chlorfenapyr, B azolemiteacrylic, and spinetoram. Ebrahimi and Shiri (2018), evaluated the lethal effects of abamectin on *T. urticae* leaf dipping method. Then *T. brassicae* adults were treated with LC_{10} and LC_{50} values obtained from probit analysis of the mite bioassay results using toxicity bioassay with fresh residue method. Results of residual effects experiment showed that mite mortality was 100% in 1 day after plant spraying which decreased to 55.62% in 21 days after spraying. LC_{10} and LC_{50} values of abamectin tended to 53.87 and 72.57% mortality of *T. brassicae*, respectively.

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مكافحة العنكبوت الأحمر *Tetranychus urticae* koch على نبات الفول *Phaseolus vulgaris* L. باستخدام منظمات النمو ومبيد أكاروسى

ندى مجدى عبدالعظيم حسن ، أشرف عبد الحفيظ رضوان رحيل ، ماهر فؤاد رمضان محمود و شيرين حسن محمد صفر

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تم اجراء عديد من المعاملات الزراعية والكيميائية لخفض تعداد العنكبوت الاحمر *Tetranychus urticae* Koch ، وهذه المعاملات متمثلة في استخدام سماد NPK و التسميد الارضي باستخدام الكمبوست والسماد البلدى وتم اخد العينات لمعرفه مدى تأثير المعاملات علي تعداد العنكبوت ومقارنتها بالكنترول (النبات السليم الغير معامل) كذلك تمت المعاملة باستخدام منظمات النمو النباتية والتي استخدم فيها "حمض السالسيلك" كمنظم نمو للنبات واستخدم ايضا مادة "باكلوبيوترازول" وهذه المادة تعمل علي تأخر نمو النبات ودراسة مدى تأثير هاتين المادتين علي تعداد العنكبوت الاحمر *T. urticae* ، أما المعاملة الكيميائية متمثلة في استخدام مبيد اكاروسي في معاملة واستخدام مادة لاصقة معاملة اخرى كما تم الجمع بين المبيد الاكاروسي والمادة اللاصقة في معاملة واحدة . وقد تم تعداد العنكبوت الأحمر قبل وبعد المعاملات ، وأوضحت النتائج أن مبيد "البيومكتين" سجل أعلى انخفاض في عدد الحلم 96.72٪ يليه المادة اللاصقة ثم "البيومكتين" مع المادة اللاصقة حيث كانت نسبة إنخفاض التعداد 92.09 و 70.45٪ على التوالى . كما أظهرت النتائج أن أعلى نسبة انخفاض 47.49٪ حدثت عند إضافة السماد للتربة. وكان حقق مركب "باكلوبيوترازول" كمنظم نمو أعلى نسبة إنخفاض 96,95٪ في تعداد العنكبوت الأحمر *T. urticae* .