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. Salicylic 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 stable 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 m², 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 m²/1 m²) and compost (1 K/1 m²) 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.
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)

\[
\text{Reduction\%} = 1 - \left( \frac{T_a \times C_b}{T_b \times C_a} \right) \times 100
\]

Where:

- \( T_a \) = number after treatment in treated plot.
- \( T_b \) = number before treatment in treated plot.
- \( C_a \) = number after treatment in check plot.
- \( C_b \) = number before treatment in check plot.

**RESULTS AND DISCUSSION**

**Reduction percentages of Tetramychus urticae populations on Phaseolus vulgaris var Nibraskta 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.

<table>
<thead>
<tr>
<th>Fertilizers</th>
<th>Dose</th>
<th>Pre-Count</th>
<th>After 1Day</th>
<th>R %</th>
<th>After 3Days</th>
<th>R %</th>
<th>After 7Days</th>
<th>R %</th>
<th>After 10days</th>
<th>R %</th>
<th>General Mean</th>
<th>General Reduction%</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPK</td>
<td>3g/L</td>
<td>25</td>
<td>24</td>
<td>31.43</td>
<td>29</td>
<td>38.48</td>
<td>35</td>
<td>30.98</td>
<td>40</td>
<td>31.71</td>
<td>34.67</td>
<td>33.50</td>
</tr>
<tr>
<td>Control</td>
<td>--</td>
<td>35</td>
<td>49</td>
<td>--</td>
<td>66</td>
<td>--</td>
<td>71</td>
<td>--</td>
<td>82</td>
<td>--</td>
<td>73</td>
<td>--</td>
</tr>
<tr>
<td>Organic fertilizer</td>
<td>--</td>
<td>Pre-count</td>
<td>After 15Days</td>
<td>R%</td>
<td>After 20Days</td>
<td>R%</td>
<td>After 25Days</td>
<td>R%</td>
<td>After 30days</td>
<td>R%</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Farmyard manure 1/4m²</td>
<td>25</td>
<td>26</td>
<td>38.82</td>
<td>31</td>
<td>43.64</td>
<td>37</td>
<td>43.79</td>
<td>45</td>
<td>40.66</td>
<td>37.67</td>
<td>42.54</td>
<td>--</td>
</tr>
<tr>
<td>Compost</td>
<td>1k / lm²</td>
<td>27</td>
<td>26</td>
<td>43.36</td>
<td>36</td>
<td>39.39</td>
<td>45.15</td>
<td>43</td>
<td>47.49</td>
<td>39.33</td>
<td>44.45</td>
<td>--</td>
</tr>
<tr>
<td>Control</td>
<td>--</td>
<td>30</td>
<td>51</td>
<td>--</td>
<td>66</td>
<td>--</td>
<td>79</td>
<td>--</td>
<td>91</td>
<td>--</td>
<td>78.67</td>
<td>--</td>
</tr>
</tbody>
</table>

2. **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 in agreement 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>
<thead>
<tr>
<th>Growth Regulators</th>
<th>Recommended Dose</th>
<th>Pre-Count</th>
<th>After 1Day</th>
<th>R %</th>
<th>After 3Days</th>
<th>R %</th>
<th>After 7Days</th>
<th>R %</th>
<th>After 10days</th>
<th>R %</th>
<th>General Mean</th>
<th>General Reduction%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salicylic acid</td>
<td>0.069g/0.5mM</td>
<td>29</td>
<td>31</td>
<td>23.65</td>
<td>39</td>
<td>28.69</td>
<td>45</td>
<td>23.51</td>
<td>49</td>
<td>27.88</td>
<td>44.33</td>
<td>26.71</td>
</tr>
<tr>
<td>Paeclotrazol</td>
<td>0.09g/0.3mM</td>
<td>28</td>
<td>22</td>
<td>43.88</td>
<td>17</td>
<td>67.80</td>
<td>10</td>
<td>82.39</td>
<td>2</td>
<td>96.95</td>
<td>9.67</td>
<td>83.44</td>
</tr>
<tr>
<td>Control</td>
<td>--</td>
<td>35</td>
<td>49</td>
<td>--</td>
<td>66</td>
<td>--</td>
<td>71</td>
<td>--</td>
<td>82</td>
<td>--</td>
<td>73</td>
<td>--</td>
</tr>
</tbody>
</table>

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.

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 Khaghami, 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. Farnyard 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 Nibraskta treated with some fertilizers.**

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

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.

<table>
<thead>
<tr>
<th>Chemical Treatments</th>
<th>Recommended Dose</th>
<th>Pre- Count</th>
<th>After 1day</th>
<th>R%</th>
<th>After 3days</th>
<th>R%</th>
<th>After 7days</th>
<th>R%</th>
<th>After 10days</th>
<th>R%</th>
<th>General Mean</th>
<th>General Reduction%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomectin 0.2cm/L</td>
<td>26</td>
<td>20</td>
<td>43.05</td>
<td>13</td>
<td>69.41</td>
<td>8</td>
<td>84.83</td>
<td>2</td>
<td>96.72</td>
<td>8.33</td>
<td>84.64</td>
<td></td>
</tr>
<tr>
<td>Surfactant 2.5 cmL</td>
<td>27</td>
<td>20</td>
<td>46.09</td>
<td>13</td>
<td>74.47</td>
<td>7</td>
<td>87.72</td>
<td>5</td>
<td>92.09</td>
<td>8.33</td>
<td>85.21</td>
<td></td>
</tr>
<tr>
<td>Biomectin+ 0.2cm/L+</td>
<td>26</td>
<td>25</td>
<td>31.31</td>
<td>23</td>
<td>53.09</td>
<td>20</td>
<td>62.08</td>
<td>18</td>
<td>70.45</td>
<td>20.33</td>
<td>62.51</td>
<td></td>
</tr>
<tr>
<td>Surfactant 2.5 cmL</td>
<td>26</td>
<td>25</td>
<td>31.31</td>
<td>23</td>
<td>53.09</td>
<td>20</td>
<td>62.08</td>
<td>18</td>
<td>70.45</td>
<td>20.33</td>
<td>62.51</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>35</td>
<td>49</td>
<td></td>
<td>66</td>
<td>71</td>
<td>71</td>
<td>82</td>
<td>73</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this respect, Duchovskiené and Darzininkysté (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 Elghohary (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.

### REFERENCES


