Foliar Spray of Zinc, Manganese and Iron for *Tetranychus urticae* Control in *Phaseolus vulgaris* Plant

Walaa R. Abou Zaid
doaA. Abou E1-Atta and Amira E. Mesbah

Plant protection research Institute, Agriculture research center, Egypt.

ABSTRACT

Mites control via micronutrients spray represents a good alternative for acaricides in terms of cost, efficiency and preservation of the environment. In this study, two concentrations (65 & 130 ppm) of zinc, manganese and chelates of iron have been used to control the population of *Tetranychus urticae* in *Phaseolus vulgaris* plants. The highest conc. of each mineral led to higher reduction % that reached to 39.56, 44.93 and 42.72 % respectively in response to the third spraying and the treatments in general did not show instantaneous effect. The positive effect of these parameters on the plant has been confirmed by the observed increase in the contents of chlorophyll, soluble carbohydrates and protein compared with that of the control that have been evaluated after the third spraying. These results support the use of foliar spray of minerals to replace acaricides. The benefits behind that extended to coast-reduction, efficient alternative that would be supportive to plant nutrition that would increase the yield and at the same time environmentally-friendly.

Keywords: Chelates of iron, foliar spray, manganese, *Tetranychus urticae*, and zinc

INTRODUCTION

Cultivated crops across the world are usually threatened by pests such as mites, insects, nematodes, parasitic weeds, bacteria and fungi. The intensive use of pesticides helped the farmers for some extent to control; however, Long-term damage has become more of its benefits as the use of pesticides affect human health (Senthil-Nathan, 2015) as well as the biodiversity in the environment (Pavela, 2015). Spider mites such as *Tetranychus urticae* are among the pests threatening crop production (20-45% of the yield might be lost depending on season)as growth, chlorophyll contents and fruit size as well as quality are greatly affected in case of severe mites infection (Rhodes et al., 2006; Premalatha et al., 2018). The danger of this pest was heightened since World War II. *T. urticae* has a high rate of fecundity and a short developmental time that can be as brief as one week at high temperatures of about 32°C. *T. urticae* greatly affect strawberries, hops, mint, citrus and apple (Van de Vrie et al., 1972; Rhodes et al., 2006). The long term intensive use of acaricides leads to the dominance of resistant population that cannot be affected by chemical pesticides and that would be reflected on plant yield (Fraulo and Liburd, 2007).

Plant nutritional status and structural features would afford a favorable microenvironment for mites propagation (Mworia et al., 2017). Drought stress has been suggested to decrease susceptibility to mites, although, *Panonychus ulmi* population has been retarded on apple trees under this stress (Specht, 1965). Recently it has been found that high level of nitrogen fertilization (300 kg N/ha/year) led to a high infestation level.

Mineral elements whether macro or micro nutrients as a part of plant nutrition are also in the play. Essential micronutrients supplied mainly by soil are important for almost all metabolic and cellular functions of plants. Generally iron, manganese, zinc, copper, boron, chloride, molybdenum and nickel are regarded as essential micronutrients for almost all higher plants.

Iron plays a vital role in several components of the redox system such as cytochrome and Fe-S clusters. Additionally, it acts as a cofactor for several oxidoreductases beside its involvement in chlorophyll formation and chloroplast biogenesis (Said-Al Ahl and Mahmoud, 2010; Marschner, 2012). Manganese acts as a cofactor for several proteins such as acid phosphatase, superoxide dismutase, allantoteamidohydrtase, arginase, RNA-polymerase and protein-photosystem II (Marschner, 2012). In higher plants, zinc activates several dehydrogenases, aldolases and isomerases (Marschner, 2012). In this study, the aim was to evaluate the effect of foliar application of iron, manganese and zinc on *T. urticae* infestation of common bean plant.

MATERIALS AND METHODS

Materials

Oto manganese (13%) and oto zinc (13%) were obtained from Misr El Dawlia for Agricultural & Industrial Development Company and use as sources for the corresponding minerals. The iron containing nutrient used in this study was obtained from Pioneers Fertilizers Production Company, Jordan. Max fert (13 % Fe) was used as a source of iron.

*Tetranychus urticae* culture

The culture of *T. urticae* (TSSM) was obtained from a laboratory pure colony that was maintained on common bean leaves incubated in petri-dishes at 25 ± 2°C.

Experimental design

Pure strains of apparent uniform *Phaseolus vulgaris* seeds were obtained from the Agricultural Research Center, Ministry of Agriculture, Giza, Egypt. The experiment has been started in April 2017 in the experimental field of Faculty of Agriculture, Mansoura University. The used soil was a mixture of clay and sand (2:1 v/v) and the pots used in this study were filled with equal amounts of this soil. Before cultivation, the soil was supplied with super phosphate fertilizer (1g/ each pot). In the age of 14 days, plants were infected with TSSM obtained from large sensitive laboratory colony as mentioned previously. The required number of TSSM was transferred from the colony to a 1.5 cm diameter common bean leaf disc that was then placed onto a leaf of each experimental plant.

The pots were divided into 8 groups including control one as shown in Table 1. Each group was sprayed with its represented treatment three times during the course of the experiment. The control plants were subjected to water spray at the same time other groups received their spraying treatments. Additionally and to act as a positive control, another group was sprayed three times too with
Abamectin (Vertimec® 1.8% EC) with 40 cm³/100 liter water at the same time of spraying other groups with the designed treatments.

Table 1. The materials used and their concentrations.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Used concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oto zinc (13%)</td>
<td>65 ppm</td>
</tr>
<tr>
<td></td>
<td>130 ppm</td>
</tr>
<tr>
<td>Oto manganese (13%)</td>
<td>65 ppm</td>
</tr>
<tr>
<td></td>
<td>130 ppm</td>
</tr>
<tr>
<td>Max fert (13% Fe)</td>
<td>65 ppm</td>
</tr>
<tr>
<td></td>
<td>130 ppm</td>
</tr>
<tr>
<td>Abamectin (Vertimec® 1.8% EC)</td>
<td>40 cm³/100 liter water.</td>
</tr>
<tr>
<td>Control</td>
<td>Water spraying</td>
</tr>
</tbody>
</table>

The first spraying treatment was committed for plants in the age of 20 days, followed by another treatment after 2 weeks (34 days old plant) and finally the last treatment was given for 48 days old plants. From each group, 20 leaves were collected randomly and the number of TSSM was counted by using stereo-binocular microscope. The leaves were collected 3, 7 and 14 days after each spraying treatment. The number of moving stages, corrected mortality and the reduction percentages of mites were calculated by using the Henderson -Tilton formula (Henderson and TILTON, 1955).

- Estimation of photosynthetic pigments:

Chlorophyll a and chlorophyll b were determined at the late flowering stages "after the third spraying" of plant growth using the spectrophotometric method as recommended by (Dye, 1962) for pigments as adopted by (Taylor and Achanzar, 1972). A known fresh weight of plant leaves was cut and ground with 80 % acetone. After centrifugation, the supernatant absorbance was measured at 644 and 663 nm.

- Estimation of total soluble carbohydrates:

For plants at the late flowering stage "after the third spraying", a known volume of the dry leaf powdered tissue was submerged overnight in 10 ml 80 % (v/v) ethanol at 25°C with periodic shaking. After one day, the obtained ethanol mixture was filtered, made up to 20 ml and kept in the refrigerator (Vedder, 1915). Total soluble sugars (TSS) content was determined using the procedures described previously (Hansen and Møller, 1975). An aliquot of 0.1 ml of the alcoholic extract was added to 3 ml of freshly prepared anhydrous and incubated in a boiling water bath for 10 min and the absorbance was obtained at 625 nm. The amounts of TSS in plant extracts were obtained using the standard curve of glucose.

- Estimation of total proteins:

The method of protein extraction was adopted by (Scarponi and Perucci, 1986). For plants at the late flowering stage "after the third spraying", a known weight of fresh plant tissue was cut into small pieces and homogenized in five volumes of chilled acetone using a homogenizer for one minute followed by sonication. The crude homogenate was filtered and the residue was used for determination of protein content after re-suspension in 50 mM tris-HCl buffer pH 9. Protein content was determined spectrophotometrically according to the method adopted by (Bradford, 1976). Bovin serum albumin was used as standard in this experiment.

- Estimation of mineral elements:

For plants at the late flowering stage "after the third spraying" and after washing with de-ionized water and drying at 90°C, 0.5 gm of the dry ash of each plant sample was digested in 10 ml HNO₃ for 10 h. After filtration, the supernatant volume was raised by de-ionized water to 20 ml and then Fe, Mn and Zn were measured by Atomic Absorption Spectrometry (Mazumdar and Das, 2015).

RESULTS

Generally, TSSM number has been reduced in response to all nutrients spraying and the reduction percent increased in response to higher concentrations of nutrients (Table 2). Expectedly, the reduction increased by time passing after each spray and the highest reduction percent was attained after the third spray. It is observable that 130 ppm Mn gave the highest reduction % after the first and the third spraying (28.69 & 44.93 % respectively); however, Fe treatment gave the highest reduction percent, 40.13%, after the second spraying.

Table 2. % Reduction of TSSM individuals/ plant leaf in response to nutrients foliar spray.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% reduction after 1st spray</th>
<th>Total % reduction</th>
<th>% reduction after 2nd spray</th>
<th>Total % reduction</th>
<th>% reduction after 3rd spray</th>
<th>Total % reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 days</td>
<td>7 days</td>
<td>14 days</td>
<td>%</td>
<td>3 days</td>
<td>7 days</td>
</tr>
<tr>
<td>Zn 65 ppm</td>
<td>4.20</td>
<td>14.85</td>
<td>16</td>
<td>11.68</td>
<td>12.5</td>
<td>18.33</td>
</tr>
<tr>
<td>Zn 130 ppm</td>
<td>3.8</td>
<td>22.36</td>
<td>36.38</td>
<td>20.86</td>
<td>20</td>
<td>35.48</td>
</tr>
<tr>
<td>Mn 65 ppm</td>
<td>4.76</td>
<td>26.92</td>
<td>39.29</td>
<td>23.65</td>
<td>18.3</td>
<td>32.66</td>
</tr>
<tr>
<td>Mn130 ppm</td>
<td>9.52</td>
<td>34.23</td>
<td>42.32</td>
<td>28.69</td>
<td>21.02</td>
<td>30.52</td>
</tr>
<tr>
<td>Fe 65 ppm</td>
<td>4.49</td>
<td>30.98</td>
<td>35.91</td>
<td>23.79</td>
<td>21.40</td>
<td>33.45</td>
</tr>
<tr>
<td>Fe130 ppm</td>
<td>3.86</td>
<td>31.49</td>
<td>40.63</td>
<td>25.32</td>
<td>28.62</td>
<td>44.8</td>
</tr>
<tr>
<td>Abamactin</td>
<td>91.38</td>
<td>89.56</td>
<td>87.07</td>
<td>89.33</td>
<td>88.33</td>
<td>84.95</td>
</tr>
</tbody>
</table>

As regard to photosynthetic pigments, proteins and total carbohydrates there was a general non-significant increase in response to different elements treatments. In response to nutrients spraying, these minerals contents has increased in their corresponding treatments as shown in table 3. However, Mn treatments did not show any synergetic effect to other elements. That means, in case of Mn spraying, neither Zn nor Fe increased in the plant tissue compared with that of control or Abamectin. Zn did not show any synergism to the other elements and Fe treatments increased Mn significantly.
DISCUSSION

There is no doubt that *Tetranychus urticae* (Koch) is one of the most polyphagous species with a long list of hosting plants including vegetables, fruits and weeds. Acaricides was and still the most prominent way to control *T. urticae* although their side effects on the environment as well as coast. It has become necessary to find alternative ways to resist this pest in an environmentally friendly way and it is desirable to supply plant with beneficial nutrients to achieve duel benefits. An earlier observation of the complete absence of spider mites from the treated leaves was the start to use such nutrients as an alternative control method (Terriere and Rajadhyaksha, 1964). It has been shown that foliar spray of Calcium, Zinc, and magnesium led to 90% reduction in the fecundity of *T. urticae* (Terriere and Rajadhyaksha, 1964). On the other hand, the number of eggs was not affected by spraying bean leaves with Zn, Mn or Fe (Cannon Jr and Terriere, 1966). Most recently in 2018 it has been shown that the foliar spray with Calcium, Magnesium, Zinc, Copper, Iron, Manganese, and Boron led to a reduction in the population of *Panonychus citri* and *Phyllocoptruta oleivora* on citrus (Cávaza-Dulanto et al., 2018).

The treatments of this study did not show an instantaneous effect as the reduction % gradually and slowly increased and often the maximum value was attained in the third observation after two weeks. This might be attributed to the slow absorption of the nutrients and then their effect on metabolism slowly appeared (Terriere and Rajadhyaksha, 1964). Using the chelates of iron (EDTA chelated) may lead to a duel effect due to EDTA and due to Iron (Terriere and Rajadhyaksha, 1964) although iron itself was reported as effective agent against citrus mites (Cávaza-Dulanto et al., 2018). Basically the nutrients used in this study are playing a vital role in several metabolic processes particularly as activators for several enzymes. The availability of such nutrients via foliar spray may lead to strengthen the reinforcement of these metabolic processes that might be extended to produce secondary metabolites of antibiosis activity against mites (Cávaza-Dulanto et al., 2018). The general increase in chlorophyll, proteins and soluble carbohydrates in response to our treatments may support this assumption although these increases did not extend to the significant level.

Summering up, these results support that the foliar spray of minerals represent a potential acaricides alternatives that could control mites population on different crops. The benefits behind that extended to cost-reduction, efficient alternative that would be supportive to plant nutrition that would increase the yield and at the same time environmentally-friendly.

REFERENCES


الزنك والمنغنزيوس الحديث لمكافحة العنكبوت الأحمر

ولاء رشدي أبو زيد، د. عبد العظيم أبو العطا، و.A. السباعي، مصباح

معهد بحوث وفقية النباتات، مركز البحوث الزراعية، مصر.

تمك مكافحة العنكبوت الأحمر عن طريق المغذيات الصغري عبر جهازه للمبيدات من حيث النكافة والكفء والمحافظة على البيئة. في هذه الدراسة تم استخدام ذيفانين (د) و (د) 120 جزء في المليون لكل من المغذيات والزنك والمنغنزيوس الحديث للسيطرة على الأصابات بـ Tetranychus urticae في النباتات الفاصوليا. أظهرت النتائج أن تركز على مساعدة ازد. يدل إلى الانخفاض الأكبر لعدد الأفكار بنسبة تصل إلى 69.56% و 44.93% للاصاصس سلاقة الكرمية التولية كنسبة لرش ثلاث مرات بدأ ان هذه المعاملات لم تظهر تأثيراً فورياً. وقد تأثر الأذى الأرجعي لهذه المعاملات على النباتات مع زيادة في محاصيل الكرمية والكربوبروبوات الشرقية والبروتين بلغة مع النباتات. هذه النتائج تدعم استخدام الزینك الحيواني مع العناصر الفسفورية والكربوبروبوات الشرقية والبروتين بلغة مع النباتات. وراء ذلك إلى تخفيض النكافة فضلاً عن فعالية هذا الديج الذي من شأنه أن يدعم العناصر الفسفورية ويزيد من إنتاجه بطريقة صديقة للبيئة.