Population dynamics of *Tetranychid* mite and its predator on watermelon and muskmelon and effect of mite feeding on the phytochemical components of the host plants

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Experiments were conducted to determine levels of infestation of two cultivars of watermelon (Sakata and Giza (6)) and muskmelon (Gal (3) and Dahaby) to infestation with the tetranychid mite, *Tetranychus urticae* Koch and its predatory phytoseiid mite, *Typhlodromips swirskii* (Athias-Henriot) during two successive seasons of years (2014 and 2015) at Behera Governorate. In early season “off-season”, results showed that the infestation of four melon cultivars by *T. urticae* was early started in the third week of January under plastic low tunnels conditions gradually increased and reached their peaks in the third week of April (watermelon) and the first week of May (muskmelon) in the open field conditions during two successive seasons. “Off-season” vegetables produced under plastic low tunnels can fetch very high price in the market. During two successive season, Giza (6) cultivar was the most highly susceptible recording average of 113.09 mite moving stages, followed by Sakata (81.75) and the lowest infested were Dahabi (38.34) and Gal (3) (28.52), respectively. Watermelon cultivars (Sakata and Giza (6)) harboured remarkable rates of the predatory mite *T. swirskii* than muskmelon cultivars (Gal (3) and Dahabi) during two successive seasons. Chemical contents were estimated in fresh plant material (healthy leaves) and infested leaves at peak infestation and the late season of 2015. Infested leaves of melon cultivars contained more decrease concentrations percentage of amino acid, tannins, protein, chlorophyll and carbohydrates ranged from 5.36% to 41.33% at the late season, compared with the interval of peak infestation, which ranged from 4.50% to 16.10%.

Keywords: Melon cultivars, *Tetranychus urticae*; predatory phytoseiid *Typhlodromips swirskii*, chemical contents, fertilizers

**INTRODUCTION**

Watermelon, *Citrullus lanatus* var. *lanatus* Matsun & Nakai and muskmelon, *Cucumis melo* L. are members of the family Cucurbitaceae and very important vegetable crops for Egyptian growers. Quality of melons is a function of the sugar content of the fruits. High sugar content is achieved by avoiding all stress during the growing season. Stress comes from several factors such as: foliar diseases, insect pests, phytophagous mites, weeds, poor nutrition and excess or lack of water. Different cucurbits can be transplanted in the second week of December as an early melon production. “Off-season” fruits produced under plastic low tunnels can fetch very high price in the market. This technology is quite economical for growing “off-season” vegetables in Egypt.

The two-spotted spider mite, *Tetranychus urticae* Koch is considered a major mite pest species on agricultural crops. It feeds on more...
than 1100 plant species, from which about 150 are of great economic value including field and greenhouse crops, ornamentals, annual and perennial plants all over the world (Gribic et al., 2011). It is also one of the most destructive to its host; strands of webbing spun by the mites can cover infested leaves and stems, often killing them very rapidly (Jeppson et al., 1975). Problem of spider mite increased when natural enemies were destroyed by applications of board spectrum pesticides against different pests (Mainul Haque et al., 1993 and van Houten et al, 2007). Evaluation susceptibility of some melon cultivars to infestation with the two-spotted spider mite is considered very important to select the more resistant ones, as well as, to avoid using acaricides, for getting a good product quality without residues.

Several workers demonstrated that sucking phytophagous mites drain chemical contents or nutrients from their host plants and can lead to changes in the leaf phytochemical components (Sharma & Pande, 1986; Lee et al, 1988; Luczynski et al, 1990; Pradhan & Saha, 1997; Aggour et al, 2001; Hanafy, 2004; Aiad et al, 2014 and Abou-Awad et al, 2012 & 2016). However, the present work was determined to evaluate the susceptibility of four melon cultivars with *T. urticae* infestation during two successive seasons 2014 and 2015 when plants grown in early season and to assess the effect of the feeding of spider mite on leaf phytochemical contents. These data are necessary to predict the levels of infestation and the severe damage of *T. urticae* on melon cultivars.

**MATERIALS AND METHODS**

This study was performed in an area of two feddans, located in Badr centre, Behera Governorate. The area was divided into four equal plots, with one melon cultivar per each plot. Two cultivars of both watermelon (Sakata & Giza (6)) and muskmelon (Gal (3) & Dahabi) were cultivated in open field during the two successive early seasons "off-season" of years 2014 and 2015. Transplanting of the seedlings is done in a single row in each bed at a planting distance of 50cm and 75cm for muskmelon and watermelon cultivars, respectively. Width of bed was two and two and half metres for the same melon cultivars, respectively. Melon cultivars transplanted in the second week of December of years 2013 and 2014, under plastic low tunnels, and the plastic is completely removed from the plants in the second week of February of years 2014 and 2015. The plastic is usually covered in the afternoon to enhance plant growth by warming the air around the plants. Recommended fertilizers are applied through drip irrigation.

Population density of *T. urticae* and its phytoseiid predator *T. swirskii* were studied on the four previous melons cultivars during two successive seasons. The first and second seasons began from the first January up to the end of May of years 2014 and 2015, respectively. Thirty leaves/one melon cultivar/plot were randomly picked up weekly. Leaves samples were placed directly into labelled perforated polyethylene bags, closed with rubber bands and transported to the laboratory for examination, using a stereomicroscope. The population dynamics of all stages of *T. urticae* and cited phytoseiid predatory mite were recorded and monitored weekly.

Two sets of infested leaves at peak infestation and the late season, as well as, another set of healthy leaves (normal) were collected and taken to the Mineral Nutrition of Plants Laboratory for foliar analysis. Total amino acids were determined according to Etsushiro et al., 1981 method; total phenolic compounds according to Folin-Ciocalteu, described by Meda et al, 2005; total tannins by using Vanillin hydrochloric acid method according to Burn, 1971; total protein according to Alam et al, 2013; total chlorophyll according to Lichtenthaler et al, 1987; total alkaloids titrmetrically according to Sabri et al, 1973; total carbohydrates according to Collins et al, 1945. Chemical analysis was carried out during the second growing season (2015) of the four melon cultivars. T-test and correlation coefficient were used for comparison.

**RESULTS AND DISCUSSION**

Population dynamics of *T. urticae* and its associated phytoseiid predatory mite *T. swirskii* on leaves of the two cultivars of both watermelon (Giza (6) & Sakata) and muskmelon (Gal (3) & Dahabi) for two successive seasons 2014 and 2015 were given in figure (1).

Infestation of the two watermelon cultivars Giza (6) and Sakata in early season "off-season" under plastic low tunnels conditions during the first and second seasons 2014 and 2015 started in the third week of January, gradually increased...
and reached their peaks in the third week of April in the open field conditions. The highest numbers of adults, immatures and eggs of spider mite averaged (245, 246, 265.3); (220, 234.17, 244.10) and (250.11, 264.11, 255.14); (214.15, 236.20, 248.19) individuals/leaf compound on Giza (6) and Sakata cultivars during two successive seasons, respectively; while in the muskmelon cultivars Gal (3) and Dahabi, the infestation also started in the third week of January, but increased gradually till reaching their peaks in the first week of May. The highest numbers of the same previous stages averaged (67.11, 146.22, 118.32); (78.92, 165.43, 196.16); (65.20, 144.11, 117.9); (78.30, 164.43, 195.9) individuals/leaf compound, respectively. The population then decreased till it reached its lowest rate in the fourth week of May for the two successive seasons. The most suitable months for population growth were during March, April and May (figure 1). In this regard, Green et al. (1987) reported that the infestation on strawberry starts from March in all seasons in New Zealand. In Egypt, Rizk et al. (1990) recorded the peak infestation of *T. urticae* on Soya bean cultivar during May and June, while Waheeb (1998) mentioned that the peak infestation by spider mite on the same previous host occurred at May population. El-Saiedy (1999) also found that April Soya bean plantations had higher infestation than that of May plantations. We can conclude that the rate of infestation was higher in the watermelon cultivars than that of the muskmelon ones during two successive seasons. Therefore, it could be concluded that tested melon cultivars were variably infested with *T. urticae*.

Data in table (1) also demonstrated that the four melon cultivars significantly (P < 0.05) differed in their susceptibility to *T. urticae* motile stages infestation. During two successive seasons 2014 & 2015, it could be arranged in a descending order as follows: Giza (6) highly susceptible (113.089 ± 14.97) followed by Sakata (81.749 ± 11.15) and the lowest infested were Dahabi (38.34 ± 4.34) and Gal (3) (28.52 ± 3.45) cultivars, respectively. Statistical analysis also revealed that the mean numbers of the two-spotted spider mite was significantly high on the watermelon leaves of cultivars Giza (6) and Sakata in comparison to muskmelon Dahabi and Gal (3) leaves. These results are in agreement with those obtained by, Tomczyk et al, 1996; Edelstain et al, 2000; Castagnoli et al, 2003; Maklad, 2004; Ibrahim et al, 2008, Abdallah et al, 2009 and El-Saiedy et al, 2011.

Predatory mite of the family Phytoseiidae *T. swirskii* is economically important predator of *T. urticae* either under plastic low-tunnels or in open field conditions. Its weekly occurrence during two successive years is presented in figure (1). These illustrations showed that the predator density gradually increased from the beginning of February under plastic low-tunnels to a remarkable rate during March, April and May with a peak reached in the first week of April during the first and second seasons 2014 & 2015 being of (3.87 & 2.91) and (3.90 & 2.91) individuals per leaf on Giza (6) and Sakata watermelon cultivars, respectively. While its density at peak infestation was (3.11 & 1.98) and (3.17 & 2.00) individuals per leaf of muskmelon cultivars Dahabi and Gal (3) in the fourth week of April during two successive years, respectively. The population then fluctuated and decreased till it reached moderate rate in late May or at the late season.

Table (1): Susceptibility of two cultivars of both watermelon (Sakata & Giza (6)) and muskmelon (Gal (3) & Dahaby) to *Tetranychus urticae* infestation during 2014 and 2015 seasons.

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SE</th>
<th>T-value</th>
<th>Mean ± SE</th>
<th>T-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIZA (6)</td>
<td>113.089 ± 14.97 a</td>
<td>1.679 **</td>
<td>28.523 ± 3.45 a</td>
<td>1.772 **</td>
</tr>
<tr>
<td>SAKATA</td>
<td>81.749 ± 11.15 a</td>
<td></td>
<td>38.34 ± 4.34 a</td>
<td></td>
</tr>
<tr>
<td>GAL (3)</td>
<td>28.523 ± 3.45 b</td>
<td>5.504 **</td>
<td>18.749 ± 11.15 a</td>
<td>3.627 **</td>
</tr>
<tr>
<td>DAHABI</td>
<td>38.34 ± 4.34 b</td>
<td></td>
<td>28.523 ± 3.45 b</td>
<td></td>
</tr>
</tbody>
</table>

** Highly significant NS= Insignificant DF= 0.78

Means in a horizontal row followed by the same letter are insignificantly different at 5% level of probability.
Figure. (1): Population density per leaf of the two-spotted spider mite, *T. urticae* and its predatory mite, *T. swirskii* on two cultivars both watermelon (Giza-6 & Sakata) and muskmelon (Gal-3 and Dahabi) during two successive seasons, 2014 and 2015.
Table 2: Correlation coefficient between Phytochemical components of two cultivars of both watermelon (Sakta & Giza (6)) and muskmelon (Gal (3) and Dahabi) leaves and population of *Tetranychus urticae* during 2015 season.

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Infestation</th>
<th>Mean of <em>T. urticae</em> movable stage</th>
<th>Total amino acid g/100g</th>
<th>Total phenolic compounds g/100g</th>
<th>Total tannins g/100g</th>
<th>Total protein g/100g</th>
<th>Total chlorophyll g/100g</th>
<th>Total alkaloids g/100g</th>
<th>Total carbohydrates g/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sakata</td>
<td>Peak</td>
<td>463.31</td>
<td>27.14</td>
<td>2.86</td>
<td>1.78</td>
<td>19.51</td>
<td>119.13</td>
<td>0.21</td>
<td>12.51</td>
</tr>
<tr>
<td></td>
<td>Late season</td>
<td>118.31</td>
<td>17.31</td>
<td>2.90</td>
<td>1.54</td>
<td>15.34</td>
<td>114.23</td>
<td>0.23</td>
<td>12.00</td>
</tr>
<tr>
<td>Giza (6)</td>
<td>Peak</td>
<td>514.22</td>
<td>30.18</td>
<td>2.31</td>
<td>1.89</td>
<td>21.60</td>
<td>112.20</td>
<td>0.19</td>
<td>14.31</td>
</tr>
<tr>
<td></td>
<td>Late season</td>
<td>212.31</td>
<td>19.44</td>
<td>2.18</td>
<td>1.60</td>
<td>17.20</td>
<td>113.10</td>
<td>0.21</td>
<td>13.11</td>
</tr>
<tr>
<td></td>
<td>Correlation Coefficient values</td>
<td>0.994</td>
<td>-0.156</td>
<td>0.984</td>
<td>0.974</td>
<td>0.235</td>
<td>-0.843</td>
<td>0.655</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Healthy Sakata leaves</td>
<td>29.50</td>
<td></td>
<td>1.94</td>
<td>1.94</td>
<td>22.13</td>
<td>127.14</td>
<td>0.16</td>
<td>13.42</td>
</tr>
<tr>
<td></td>
<td>Healthy Giza (6) leaves</td>
<td>32.14</td>
<td></td>
<td>1.87</td>
<td>1.98</td>
<td>23.25</td>
<td>119.50</td>
<td>0.17</td>
<td>15.51</td>
</tr>
<tr>
<td>Gal (3)</td>
<td>Peak</td>
<td>213.33</td>
<td>26.13</td>
<td>2.91</td>
<td>1.73</td>
<td>20.33</td>
<td>116.11</td>
<td>0.29</td>
<td>12.95</td>
</tr>
<tr>
<td></td>
<td>Late season</td>
<td>116.28</td>
<td>17.51</td>
<td>2.78</td>
<td>1.43</td>
<td>17.15</td>
<td>107.13</td>
<td>0.22</td>
<td>12.14</td>
</tr>
<tr>
<td>Dahaby</td>
<td>Peak</td>
<td>244.35</td>
<td>28.31</td>
<td>2.70</td>
<td>1.90</td>
<td>23.10</td>
<td>112.14</td>
<td>0.23</td>
<td>14.51</td>
</tr>
<tr>
<td></td>
<td>Late season</td>
<td>170.26</td>
<td>18.41</td>
<td>2.51</td>
<td>1.45</td>
<td>19.15</td>
<td>106.31</td>
<td>0.19</td>
<td>14.16</td>
</tr>
<tr>
<td></td>
<td>Correlation Coefficient values</td>
<td>0.939</td>
<td>0.113</td>
<td>0.930</td>
<td>0.970</td>
<td>0.720</td>
<td>0.695</td>
<td>0.704</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Healthy (Gal 3) leaves</td>
<td>28.55</td>
<td></td>
<td>1.68</td>
<td>1.86</td>
<td>24.23</td>
<td>123.10</td>
<td>0.24</td>
<td>13.92</td>
</tr>
<tr>
<td></td>
<td>Healthy Dahaby leaves</td>
<td>30.63</td>
<td></td>
<td>1.97</td>
<td>2.13</td>
<td>26.10</td>
<td>126.23</td>
<td>0.22</td>
<td>15.90</td>
</tr>
</tbody>
</table>
Table (3): % increase / decrease of phytochemical components at peak infestation and late season in healthy and infested both watermelon (Sakata & Giza (6)) and muskmelon (Gal (3) & Dahaby) cultivar leaves by *T. urticae* during 2015 season.

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Infestation</th>
<th>Amino acid</th>
<th>Phenolic Compounds</th>
<th>Tannins</th>
<th>Protein</th>
<th>Chlorophyll</th>
<th>Alkaloids</th>
<th>Carbohydrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sakata</td>
<td>Peak</td>
<td>-8</td>
<td>47.40</td>
<td>-8.25</td>
<td>-11.80</td>
<td>-6.30</td>
<td>31.25</td>
<td>-6.79</td>
</tr>
<tr>
<td></td>
<td>Late season</td>
<td>-41.33</td>
<td>49.50</td>
<td>-20.60</td>
<td>-30.68</td>
<td>-10.15</td>
<td>43.75</td>
<td>-10.58</td>
</tr>
<tr>
<td>Giza (6)</td>
<td>Peak</td>
<td>-6.10</td>
<td>23.50</td>
<td>-4.50</td>
<td>-7.10</td>
<td>-6.10</td>
<td>11.76</td>
<td>-7.74</td>
</tr>
<tr>
<td></td>
<td>Late season</td>
<td>-39.52</td>
<td>16.60</td>
<td>-19.20</td>
<td>-26.02</td>
<td>-5.36</td>
<td>23.53</td>
<td>-15.47</td>
</tr>
<tr>
<td></td>
<td>Late season</td>
<td>-38.67</td>
<td>65.47</td>
<td>-23.12</td>
<td>-29.51</td>
<td>-12.97</td>
<td>8.33</td>
<td>-12.79</td>
</tr>
<tr>
<td>Dahaby</td>
<td>Peak</td>
<td>-9.57</td>
<td>37.10</td>
<td>-10.80</td>
<td>-11.49</td>
<td>-11.17</td>
<td>4.50</td>
<td>-8.74</td>
</tr>
</tbody>
</table>

El-Saiedy (2003) recorded *T. swirskii* on strawberry plants during March and April season (2000-2001), February first and April (2001-2002) in all localities. However, fair numbers of predator per leaf of the four melon cultivars, at the interval of peak infestation, could be due to the difficulty of finding *T. swirskii* in the webbing of tetranychid mites in open field. This observation was reported by van Houten et al. (2007) and El-Saiedy et al. (2015) who stated that the phytoseiid predator was hardly found in the webbing of *T. urticae*.

The obtained data of chemical analysis at the interval of peak infestation and the late season during year 2015, revealed that there were higher changes occurred in the phytochemical contents of the infested leaves of the four melon cultivars. As we know, leaf chemical contents are considered one of most important factors which play a role in the susceptibility of watermelon and muskmelon cultivars to *T. urticae* infestation. As shown in table (2) there was negative correlation occurring between movable mite infestation levels and totals of phenolic and alkaloids in only watermelon cultivars. These results are in agreement with Edelstain et al, 2000; Cactagnoli et al, 2003; Maklad, 2004; Abdallah et al, 2009; Afad et al, 2014 and Fatma et al, 2015. Presented in table (3); the increase/decrease percentage of phytochemical content concentrations in leaves of melon cultivars. Infested leaves of melon cultivars contained decreased concentrations percentage of amino acid, tannins, protein, chlorophyll and carbohydrates ranged from 5.36% to 41.33% at the late season, when compared with peak infestation period which ranged from 4.50% to 16.10%. On the other hand, there was increased concentrations percentage in phenolic and alkaloids contents in almost all melon cultivars ranged from 16.60% to 73.21% and 4.50% to 43.75%, respectively. Healthy leaves contained more or less concentrations of these aforementioned chemical contents when compared with infested leaves at peak infestation and the late season of melon cultivars (Table 2). In conclusion, it is suggested that clear understanding of some phytochemical components removed from the infested leaves of four melon cultivars by the two-spotted spider mite *T. urticae* might enable some deficiencies caused by its severe feeding to be made up by special program applications of specific fertilizers.

**CONCLUSION**

The results showed that the infestation of melons by *T. urticae* was early started in January under plastic low tunnels conditions. Peak infestations were in the third week of April (watermelon) and the first week of May (muskmelon) during the two successive seasons. Giza (6) cultivar was the most highly susceptible. Watermelon cultivars harboured remarkable rates of the predatory mite *T. swirskii*. Infested leaves of melon cultivars contained more decrease concentration percentages of amino acid, tannins, protein, chlorophyll and carbohydrates at the late season compared with the interval of peak infestation.

**CONFLICT OF INTEREST**

This study was performed in absence of any conflict of interest.

**ACKNOWLEDGEMENT**

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AUTHOR CONTRIBUTIONS
BA, designed and wrote the manuscript. SIA, performed the experiments and reviewed the manuscript and EE, data analysis and analysed the phytochemical components. All authors read and approved the final version.

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