Susceptibility of Three Strains of Green Peach Aphid Myzus Persicae Sulzer (Homoptera: Aphididae) for Four Pesticides

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ABSTRACT

Laboratory bioassays were conducted to evaluate the toxicities of four pesticides, traditional and recent used for controlling green peach aphid. This aphid was collected from Maddba and Deir-Alla as two field strains. The sensitive strain was collected from far away valleys in Um-Al-Ammed on the wild mustard, then it was reared in greenhouse in Jordan University for ten generations. The pepper plants were used as hosts for the three strains. The LC50, LC90 for Calypso, Karate, Evisect and Dimethoate were: (34.97,100.14), (18.34, 40.17), (2.13, 7.45) and (17.95, 37.97) in ppm, respectively. The ratio between LC50 for sensitive strain divided by LC50 for field strains (RF), for Calypso, Karate, Evisect and Dimethoate were: (1.32, 3.88, 5.07 and 35.9), respectively. According to these values, Calypso was the most effective pesticide followed by Karate, then Evisect. Dimethoate was significantly less toxic compared with the other tested pesticides. It might be most probably that the green peach aphid has been gained resistance to Dimethoate.

Key words: Toxicity, Green peach aphid, Pesticides, Pepper, Jordan.

Introduction

The green peach aphid *Muzus persicae* Sulzer (Homoptera:Aphididae) is globally an important pest. It causes a destructive damage to vegetables and fruit trees in the world [16,23]. In Jordan [19] recorded the green peach aphid on many host plants. Many of planted vegetables in Jordan are considered hosts for the green peach aphid [2]. [13] investigated factors affecting the green peach aphid populations on economic vegetables in Jordan. This aphid is a polyphagous species. It is an economic pest, because of its ability to transmit viruses to plants.

It reproduces sexually year around on large secondary hosts including potatoes tomatoes, brassicas, beets, cereals, pasture clovers, peas, peppers Roses [8]. Direct feeding damage by low numbers of green peach aphid causes little damage to plants. Low numbers of plant viruses may be in the absence of virus reservoirs infested with peach aphid populations [8]. Green peach aphid is capable of becoming resistant to a wide range of insecticides groups. Pest management strategies aimed at preventing or minimizing resistance will help maintain control and conserve the effectiveness of existing products [7].

Green peach aphid is distributed world wide and several resistant strains have been identified using molecular techniques. A form with a chromosomal translocation is wide spread in glass houses and has been shown to have very high levels of resistance [4].

It is the aim of the study to investigate the toxicity of four insecticides from different groups on three strains of the green peach aphid to reduce aphid resistance problem and help in applying integrated pest management strategy in green peach control.

Materials and Methods

**Pesticides:**

Four commonly used pesticides in Jordan for pepper protection were evaluated for their effects on green peach aphid. A fresh stock solution of each pesticide was prepared in tap water on each test day. All further dilutions were prepared from the stock solution. Tap water was used as control. The pesticides used in this study as commercial formulations were:

1. **Calypso 480 SC:**

   It belongs to neonicotinoids chemical group. Common name is thiacloprid. Trade name is Calypso 480SC.

   The mode of action acts as agonists of the acetylcholine receptor. That is they mimic the action
of the neurotransmitter acetylcholine (Ach) (Insect Resistance Action Group, 2004).

2. Karate 5% EC:

It belongs to pyrethroids. Common name is lambda-cyhalothrin. Trade name is Karate 5 EC. The mode of action in this pesticide is acting on tiny channels through which sodium is pumped to cause excitation of neurons. They prevent the sodium channels from closing, resulting in continual nerve impulse transmission tremors and eventually death (Insect Resistance Action Group, 2004).

3. Evicect 50 SP:

It belongs to thithiane. Common name is thiocyclam. Trade name is Evicect 50SP. The mode of action acts by the interruption of transmission of nerve impulses in the synapses of the nervous system central. A few minutes pre-poisoned insects feel signs of paralysis leading to their death (Insect Resistance Action Group, 2004).

4. Dimethoate 40 EC:

It belongs to organophosphates. Common name is Dimethoate. Dimethoete as trade name was used in the experiments. The mode of action acts as cholinesterase inhibitors. They bind to the enzyme that is normally responsible for breaking down the acetylcholine (Ach) after it has carried its message across the synapse affecting the chloride channel by inhibiting GABA receptor (Insect Resistance Action Group, 2004).

Sweet Pepper Plant Production:

Seeds of sweet pepper "California Wander" were continuously and regularly planted in seed trays until it reached 7-8 true leaves. The seedlings were transplanted in plastic pots containing 50% soil and 50% peatmoss, irrigated and fertilized as usual until they reached 30-35 cm in length.

Green Peach Aphid, Culture:

The Susceptible Strain:

This strain was obtained from wild mustard (Sinaps arvensis L.) (Crucifera) growing naturally in mountainous regions of Madaba (Aum-Al-Ammed) in Jordan away from insecticides use, 5-10 Km from the nearest fields and then were transferred in to the paper bags and maintained at the Entomology Laboratory, Plant Protection Department, Faculity of Agriculture University of Jordan, started in March 2010. This aphid strain was reared regularly on the peppers in the lab where the temperature ranged from 25-30 C°. The plants were irrigated regularly when needed.

Suspected Resistant Strains:

Two suspected resistant strains were collected from fields. One was collected from peppers from Deir-Alla and the second strain from peppers in Madaba. These collected strains were reared and maintained on pepper plants at the Entomology laboratory at Faculty of Agriculture in University of Jordan for testing their resistance to four insecticides. Temperature ranged from 20-25 C°. Apterous aphids (adults) were tested only.

Mounting of the green peach aphid on the slides were prepared for identification according to [5]. Taxonomical confirmation was carried out by Dr. Tawfiq Al-Antary of the university of Jordan. In the green house a three wooden cages containing 25 pepper plants were infested with the isolated nymphs using camel brush and were monitored daily. The plants were irrigated regularly when necessary.

Aphid Culture:

Green House Aphid Culture:

In the green house at Jordan University a separated cabinet containing 50-75 plants were used for green peach aphid culturing. The temperature ranged from 25-35C. Infested leaves from the wooden cage were taken after 3 weeks distributed on the plants and then monitored daily. The plants and the aphid culture were renewed after 4-5 months from aphid infestation. The plants were irrigated regularly when needed.

Lab Aphid Culture:

In the lab at the Jordan University three wooden cages each containing five pepper plants were infested with aphid collected from the green house culture. The plants were renewed regularly and when necessary from time to time infested leaves from green house culture were distributed on the plants. This culture was kept during the whole period of the study and used for reinfestation of the newly established culture in the green house.

Lab Conditions:

Rearing of the aphid in this experiment were conducted under the following conditions:

Temperature was ranged between 25-30C°, R.H. 60-70% L:D 14:10 and light intensity from 4000-7000 Lux.
3.6 Laboratory assessments of pesticides toxicity to Myzus persicae:

Preliminary tests including the control were done for each pesticide to determine the concentrations that would be used in this study. Pepper plants, 2-3 months old. Five concentrations of each pesticides with three replicates for each strain were sprayed by a small hand sprayer on the pepper leaf disks in small Petri dishes as outlined by (Lowery and Simirle, 2003). Tap water was used as control for each pesticide. Twenty apterous aphids (third or fourth instars) were removed with a fine brush from a leaf of infested pepper plants on which they were reared and placed on the pepper leaf disks in small Petri dishes lined with moistened cotton under the pepper leaf for each concentration. The number of alive aphids were recorded 24 hours after the treatment.

To assess mortality aphids were touched lightly with a fine brush. If they responded normally by moving around their inserted stylets or by walking away they were classified as alive. They were classified as dead if their stylets were inserted into the leaf and they failed to move their legs or antennae when touched. If the stylets were not inserted and they were unable to move or walk when touched.

Results:

Toxicity of The Pesticides Against Myzus Persicae:

Data analysis for the toxicity experiments has been constructed in Tables (1,2,3,4) to facilitate comparison between different pesticides used in the experiment. Goodness of line fitting was checked by Chi-square test \( \chi^2 \). Referring to (Finney, 1971) the value of \( \chi^2 \) at 0.05 level of probability equals to 1.084, 0.433 and 1.28 at 3 degrees of freedom (df) for sensitive strain, Deir-Alla strain and Maddba strain, respectively, for Calypso 480 SC, 0.121, 1.72 and 1.23 at 3 df for sensitive strain, Deir–Alla strain and Maddba strain respectively for Karate and Maddba strain respectively for Calypso 480 SC, 0.121, 1.72 and 1.23 at 3 degrees of freedom (df) for sensitive strain, Deir-Alla strain and Maddba strain respectively for Karate 480 SC, 0.121, 1.72 and 1.23 at 3 df for sensitive strain, Deir–Alla strain and Maddba strain respectively for Karate 5%EC, 1.23, 3.29 and 1.21 at 3 df for sensitive strain, Dier-Alla strain and Maddba strain respectively for Karate Toxicity to Myzus Persicae:

Comparison between the LC50 of Calypso for three strains of Myzus persicae (Table 1) showed that the lowest LC50 is for sensitive strain (26.5), followed by Maddba strain (34.33) then Dier-alla strain (34.97). LC50 for Maddba strain and Dier-alla field strain were not significantly different (95% Cl did not overlap). While LC50 for the two strains when compared with LC50 for sensitive strain were found significantly different value for each line estimated by probit regression was equal zero when LC50 (x) was converted to log base 10.

Evisect toxicity to Myzus Persicae:

Comparison between the LC50 of Evisect for three strains of Myzus persicae: (Table2) showed that the lowest LC50 is for sensitive strain (0.42), followed by Maddba strain (1.37), then Deir-alla strain (2.13). LC50 for Maddba strain and Deir-alla strain were found not significantly different at (95% Cl did not overlap) while LC50 for Deir-alla strain with LC50 for sensitive strain was found significantly different. Y value for each line estimated by probit regression was equal to zero when LC50(x) was converted to log base 10.

Table 1: Calypso toxicity to three strains of Myzus persicae under lab conditions in Jordan.

<table>
<thead>
<tr>
<th>Strain</th>
<th>LC50 ppm</th>
<th>95% CL</th>
<th>LC90 ppm**</th>
<th>95% CL</th>
<th>L.E.P.R2</th>
<th>RATIO</th>
<th>R.F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitive</td>
<td>26.5c</td>
<td>21.9-30.1</td>
<td>68.13c</td>
<td>56.6-93.9</td>
<td>Y= -4.45 + 3.13(x)</td>
<td>3.13 + 0.49</td>
<td>121.13</td>
</tr>
<tr>
<td>Maddba</td>
<td>34.33a</td>
<td>30.9-37.7</td>
<td>73.23b</td>
<td>62.4-94.5</td>
<td>Y= -5.98 + 3.90(x)</td>
<td>3.90 + 0.51</td>
<td>121.13</td>
</tr>
<tr>
<td>Deir-alla</td>
<td>34.97a</td>
<td>30.3-39.6</td>
<td>100.14a</td>
<td>76.7-166.5</td>
<td>Y= -4.33 + 2.80(x)</td>
<td>2.80 + 0.47</td>
<td>121.13</td>
</tr>
</tbody>
</table>

1= 95% confidence limits for LC50 in ppm.
2= L.E.P.R. line estimated by probit regression.
3= R.F.R. recommended field rate in ppm.
*** = LC50 values in ppm in the same column having different letters are significantly different at 95% level did not over lap
**** = LC90 values in ppm in the same column having different letters are significantly different at 95% level did not over lap

*** = LC50 values in ppm divided by recommended field rate in ppm. lower ratio indicates that the pesticides are more toxic at LC50 value.
**** = LC50 value in ppm of field strain divided by LC50 value in ppm of sensitive strain. lower resistance factor indicates that pesticides are more toxic, the strain with lower resistance.
**Tabel 2:** Karate toxicity to three strains of *Myzus persicae* under lab conditions in Jordan.

<table>
<thead>
<tr>
<th>Strain</th>
<th>LC50 ppm*</th>
<th>95% CL1</th>
<th>LC90 ppm**</th>
<th>95% CL</th>
<th>L.E.P.R.2</th>
<th>Slope ± SE</th>
<th>R.F.R3 ppm</th>
<th>Ratio***</th>
<th>R.F.****</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitive</td>
<td>4.73c</td>
<td>3.9-5.7</td>
<td>19.89c</td>
<td>14.6-32.6</td>
<td>Y=-1.38+2.05(x)</td>
<td>2.05±-0.26</td>
<td>28.86</td>
<td>0.16</td>
<td>1.02</td>
</tr>
<tr>
<td>Maddba</td>
<td>6.26b</td>
<td>5.3-7.5</td>
<td>24.35b</td>
<td>17.7-40.3</td>
<td>Y=-1.73+2.17(x)</td>
<td>2.17±-0.27</td>
<td>28.86</td>
<td>0.22</td>
<td>1.32</td>
</tr>
<tr>
<td>Deir-alla</td>
<td>18.34a</td>
<td>16.6-20.3</td>
<td>40.17a</td>
<td>33.6-54.0</td>
<td>Y=-4.78+3.78(x)</td>
<td>3.78±-0.52</td>
<td>28.86</td>
<td>0.64</td>
<td>3.88</td>
</tr>
</tbody>
</table>

1=95% confidence limits for LC50 in ppm.  
2=L.E.P.R. line estimated by probit regression.  
3=R.F.R. recommended field rate in ppm.  
**=LC50 values in ppm in the same column having different letters are significantly different at 95% level did not overlap.  
***=LC90 values in ppm in the same column having different letters are significantly different at 95% level did not overlap.  
****= LC50 value in ppm of field strain divided by LC50 value in ppm of sensitive strain, lower resistance factor indicates that pesticides are more toxic, the strain with lower resistance.

**Tabel 3:** Evisect toxicity to three strains of *Myzus persicae* under lab conditions in Jordan.

<table>
<thead>
<tr>
<th>Strain</th>
<th>LC50 Ppm*</th>
<th>95% CL1</th>
<th>LC90 ppm**</th>
<th>95% CL</th>
<th>L.E.P.R.2</th>
<th>Slope ± SE</th>
<th>R.F.R3 ppm</th>
<th>Ratio***</th>
<th>R.F.****</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitive</td>
<td>0.42c</td>
<td>0.31-0.55</td>
<td>3.60c</td>
<td>2.24-7.72</td>
<td>Y=-0.52+1.37(x)</td>
<td>1.37±-0.18</td>
<td>521</td>
<td>0.0008</td>
<td>3.26</td>
</tr>
<tr>
<td>Maddba</td>
<td>1.37b</td>
<td>1.11-1.67</td>
<td>6.43b</td>
<td>4.60-10.86</td>
<td>Y=-2.26+1.91(x)</td>
<td>1.91±-0.24</td>
<td>521</td>
<td>0.003</td>
<td>5.07</td>
</tr>
<tr>
<td>Deir-alla</td>
<td>2.13b</td>
<td>1.79-2.49</td>
<td>7.45a</td>
<td>5.78-10.89</td>
<td>Y=-0.77+2.36(x)</td>
<td>2.36±-0.28</td>
<td>521</td>
<td>0.004</td>
<td>5.07</td>
</tr>
</tbody>
</table>

1=95% confidence limits for LC50 in ppm.  
2=L.E.P.R. line estimated by probit regression.  
3=R.F.R. recommended field rate in ppm.  
**=LC50 values in ppm in the same column having different letters are significantly different at 95% level did not overlap.  
***=LC90 values in ppm in the same column having different letters are significantly different at 95% level did not overlap.  
****= LC50 value in ppm of field strain divided by LC50 value in ppm of sensitive strain, lower resistance factor indicates that pesticides are more toxic, the strain with lower resistance.

**Tabel 4:** Dimethoate toxicity to three strains of *Myzus persicae* under lab conditions in Jordan.

<table>
<thead>
<tr>
<th>Strain</th>
<th>LC50 ppm*</th>
<th>95% CL1</th>
<th>LC90 ppm**</th>
<th>95% CL</th>
<th>L.E.P.R.2</th>
<th>Slope ± SE</th>
<th>R.F.R3 ppm</th>
<th>Ratio***</th>
<th>R.F.****</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitive</td>
<td>0.50c</td>
<td>0.37-0.68</td>
<td>5.98c</td>
<td>3.11-20.47</td>
<td>Y=-0.36+1.19(x)</td>
<td>1.19±-0.20</td>
<td>527</td>
<td>0.0009</td>
<td>35.9</td>
</tr>
<tr>
<td>Maddba</td>
<td>2.18b</td>
<td>1.93-2.54</td>
<td>6.13b</td>
<td>4.49-11.40</td>
<td>Y=0.97+2.86(x)</td>
<td>2.86±-0.50</td>
<td>527</td>
<td>0.004</td>
<td>4.36</td>
</tr>
<tr>
<td>Deir-alla</td>
<td>17.95a</td>
<td>16.2-19.70</td>
<td>37.97a</td>
<td>32.17-49.65</td>
<td>Y=4.94+3.94(x)</td>
<td>3.94±-0.53</td>
<td>527</td>
<td>0.03</td>
<td>35.9</td>
</tr>
</tbody>
</table>

1=95% confidence limits for LC50 in ppm.  
2=L.E.P.R. line estimated by probit regression.  
3=R.F.R. recommended field rate in ppm.  
**=LC50 values in ppm in the same column having different letters are significantly different at 95% level did not overlap.  
***=LC90 values in ppm in the same column having different letters are significantly different at 95% level did not overlap.  
****= LC50 value in ppm of field strain divided by LC50 value in ppm of sensitive strain, lower resistance factor indicates that pesticides are more toxic, the strain with lower resistance.

**Dimethoate Toxicity to *Myzus Persicae***:

Comparison between the LC50 of the Dimethoate for three strains of *Myzus-persicae* (Table 4) showed that lowest LC50 is for sensitive strain (0.5) followed by Maddba strain (2.18), then Deir-alla strain (17.95). LC50 for sensitive strain, Maddba strain, and Deir-alla strain were found significantly different. Y value for each line estimated by probit regression was equal to zero when LC50 LC 50 (x) was converted to log base 10.

**Discussion:**

The LC50 values and the 95% confidence limits were calculated from probit regressions using the SPSS 13.00 computer program [14]. The pesticide with the lowest LC50 did not indicate that it was the best one. The LC50 for Calypso was 34.97 ppm, Karate 18.34 ppm, Evisect 2.13 ppm and Dimethoate 17.95 ppm. Resistance factors (RF) were calculated by dividing the LC50 value in ppm of field strain by LC50 value in ppm of sensitive strain. This base line LC50 served as a reference for the calculation of resistance factors for Calypso, Karate, Evisect and Dimethoate in *Myzus persicae* strains. Lower resistance factor indicates that the pesticides was more toxic. Resistance factor for Calypso 1.32, Karate 3.88, Evisect 5.07 and Dimethoate 35.9. These results indicated that *Myzus persicae* field strains (Maddba and Deir-all) were relatively more resistance against Dimethoate when compared with...
the other pesticides (Calypso, Karate, Evisect). Generally speaking, Dimethoate was the least toxic against Myzus persicae than the other pesticides (Calypso, Karate, Evisect), in this study. [12] indicated that Myzus persicae shows extreme resistance to Pirimicarb from carbamates compared to Dimethoate from organophosphates, despite both insecticides acting on the same target site which is acetyl choline esterase enzyme in the synaps. This highlights the importance of knowing the pesticide group of resistance mechanisms are present in an aphid population on the crop prior to insecticide application, and in addition supports relatively the failure of Dimethoate and some of other insecticides noted by Jordanian farmers, to control green peach aphid. However, when a pesticide fails to provide control the aphid, at a concentration that formerly was effective, it is a case of suspected resistance [18]. In fact, during the past few years Jordanian farmers have noticed frequent failure of organophosphate (OP), pyrethroid insecticides and carbamates against infestation with the green peach aphid on many crops. It is evident that prolonged use of these insecticides did increase the degree of tolerance in aphids population although vegetable crops received frequent application of pesticides directed against white fly, thrips, leafminer and spider-mite [1]. The suspected resistance of Myzus persicae to (OP) was not surprising since it had been reported in different countries [3,6,12,22,25].

High levels of resistance to many insecticides, including pyrethroids, is wide spread in many populations of Myzus persicae throughout the world [11]. Field and lab toxicity evaluation of Pyrethroid insecticides against aphids populations revealed contradictory results [3,9,10,24]. The LC50 for Deltamethrin Cypermethrin, Fenvalerate and Permethrin to Myzus persicae colonies from Canada during 1972–1980 were in the range of 54–113, 65–412, 17–327 and 29–656 ppm, respectively, [18]. Whereas the LC50 for Esfenvalerate using two different clones of Myzus persicae were 19.6 and 40.8 ppm [24]. However in this study, Karate LC50 was 18.34 ppm and LC90 40.17 ppm.

References


