Population fluctuations of cabbage aphid, Brevicoryne brassicae (L.) (Hom.: Aphididae) and its natural parasitism rate on different canola cultivars

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Population fluctuations of cabbage aphid, *Brevicoryne brassicae* (L.) (Hom.: Aphididae) and its natural parasitism rate on different canola cultivars

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The cabbage aphid, *Brevicoryne brassicae* is one of the most destructive pests in Cruciferaceae or Brassicaceae plant family around the world. According to this pest rapid resistance to insecticide, using the resistant cultivars should be evaluated. In the present study, the different canola cultivars resistance against the cabbage aphid and the population fluctuations in canola fields and also the natural parasitism are evaluated in Shahre-rey region. To evaluate the population fluctuations and its natural parasitism on the RGS003, SLMOO46, Karag2, Licord, Sarigol, Opera, Ocap and Talaei canola cultivars were cultivated in four replications using the complete randomised block design. The population fluctuations studies showed that the pest is active during the canola growth period in studied region, but the peak of population and damage is found in 6 May month. The results showed that natural parasitism percentage of cabbage aphid on different canola cultivars has not significant difference, but the parasitism amount in different sampling dates was significantly different, so that the natural parasitism maximum observed in date 29 April. These results showed that the different canola cultivars have significant effects on cabbage aphid and parasitoids activity amount. Using the present results, the recognised cultivars in integrated pest management programmes can be used to grow the laboratory aphids as the parasitoids hosts.

**Keywords:** *Brevicoryne brassicae*; population fluctuations; parasitism rate; canola; resistant cultivars

**Introduction**

The canola, after the soy and oily palm, regards as the third and the most important oil source in the world. The winter cultivars are the main cultivars in Europe and many china region and the spring canola cultivars are important in Canada, east Europe and china (Srivastava & Singh 1996). During the recent years, because of more attention to canola cultivars and its development, its under cultivation area has increased accordingly. In 2001–2002, its under cultivation area has reached to 70,000 hectares. Among the most important canola pests and other pests in Cruciferaceae and Brassicaceae plant family in Tehran region are the *Plutella xylostella*, *Pieris rapae* and *Brevicoryne brassicae* (Hasanshahi et al. 2013a, 2013c; Jahan et al. 2013b). In Iran, cabbage aphid was recognised for the first time in 1938 as the pest in cabbage, radish, turnip and wild Brassicaceae plant family and in some region especially in North and central parts, Hamedan, Kermanshah are active on canola and damage the crops (Khanjani 2006). The cabbage aphids are

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active Brassicaceae plant family on plat such as usual cabbage, radish, turnip, cauliflower, canola, broccoli, cabbage and wild Cruciferaceae plant family (Farahbakhsh 1961; Rezvani 2001). The cabbage aphids cause direct feeding on plant soap and indirect damage by plant viruses transmission (Dubey et al. 1981; Costello & Altieri 1995; Blackman & Eastop 2000; Schliephake et al. 2000; Parker et al. 2003). This aphid can transfer the turnip mosaic viruses which are destructive pests in Cruciferaceae or Brassicaceae plant as the host plants. This aphid in addition to leave, root and stem damage causes the plant growth delay, fertilisation halting in some flowers in late season, delayed ripening, plant dryness and with making white cover causes the crop reduction. Also with feeding on juvenile plants causes the leaf spooning shape and leaf curling. This pest causes the highest damage in cabbage, canola, radish and turnip fields (Lamb 1989). Among the insects, aphids are regarded as the important pests in agricultural crops because of resistance, until now different control methods have used against them (Abramson et al. 2006). Some researchers have suggested the biological control methods for controlling the cabbage aphids and using the resistant cultivars which causes the pest long term biology and are effective to reduce the pest population which this method is cost effective, adaptable with the environment and enterable with other control methods (Maurya 1998; Kumar & Sharma 1999; Yue & Liu 2000). Because many parasitoids are active in Tehran southern parts on Cruciferaceae plant family, so evaluation the different parasitoids activity is too important (Hasanshahi et al. 2013b, 2013d; Jahan et al. 2013b). Since today, using the resistant cultivars regards as one important pest control methods, so this method has many advantages in integrated pest management programmes.

Materials and methods

Research site
This research was done in Tehran province and Shahre-rey region in a research and investigation field of Shahed University during the winter and spring in year 2013.

Canola cultivars cultivation
In this investigation, eight canola cultivars were cultivated. The seeds of canola cultivars were provided from the seed and plant breeding institute of Karaj. The used Canola cultivars were including the RGS003, SLMOO46, Karaj 2, Licord, Sarigol, Opera, Ocapi and Talaei cultivars. The experiment was done with four replications using the complete randomised block design in eight treatments. The experimental plots had 2 m × 2 m length and each plot was including three rows each with 1.5 m length.

Sampling programme
After plant cover formation, sampling was done weekly. For each sampling on eight different canola cultivars in each plot, 90 plants were selected randomly from different parts so that 30 plants were selected from each row.

Evaluation of cabbage aphids natural parasitism
Usually, the parasite aphids become waxy with brownish to copper and golden colour. With selecting the maximum population length in each of three rows in plots and
counting the waxy aphids numbers in it, parasitism and parasitism percentage in pollution unit in each bunch or plant were determined and this parameter compared on different canola cultivars. Also the cabbage aphids and parasitoid wasps were collected.

Parasitism percentage

The Parasitism percentage was determined using the following formula (Monfared et al. 2003):

\[
P\% = \frac{n}{N \times L} \times 100
\]

\(n\) = the number of waxy aphids, \(N\) = the number of waxy aphids in one centimetre (cm), \(L\) = the bunch pollution length (cm).

Statistical calculations

All graphs were drawn using the Excel software and data analysis was done using ANOVA method. The means comparison was done using Duncan test and all Statistical data analyses were done using SAS 9.1 and Minitab16 softwares.

Results

Cabbage aphids seasonal change based on the maximum of bunch pollution length

Comparison the different cultivars regarding the maximum of bunch pollution length to cabbage aphids is shown in Figure 1. In this evaluation, the Karaj 2 cultivar had the highest pollution length maximum in comparison to other cultivars, so that the mean of pollution length maximum for eight sampling data was equal to 8.88 cm. The maximum of bunch pollution length Opera cultivar was lower than other cultivars and the mean of pollution length for this cultivar was 1.66 cm. The maximum of bunch pollution length for all cultivar in first sampling in data 6 April was equal to 9.25 cm and in this date

![Figure 1. Cabbage aphids seasonal change based on the maximum of bunch pollution length.](image-url)
the maximum pollution observed on Karaj 2 and SLM0046 cultivars and the lowest pollution observed on Opera cultivar. In the beginning of sampling in data 6 April, the minimum pollution was equal zero. The first pollution peak time on studied cultivars observed in 6 April.

**Cabbage aphids seasonal change based on the mean of bunch pollution length**

Comparison the different cultivars regarding the mean of bunch pollution length to waxy aphids is shown in Figure 2. In this evaluation, the Karaj 2 cultivar had the highest mean of bunch pollution length to cabbage aphids, so that the mean of bunch pollution for the eight sampling data was equal to 1.18 cm. The mean of bunch pollution length on Opera cultivar was lower than other cultivars and the mean of pollution length for this cultivar was 0.22 cm. The maximum of bunch pollution length for all cultivar in five sampling in data 6 April was equal to 1.72 cm and in this date the highest mean of bunch pollution length to cabbage aphids observed on Karaj 2 cultivar and the lowest mean of bunch pollution length observed on Opera cultivar. In the beginning of sampling in data 6 April, the lowest pollution length was equal zero. In this date, the highest pollution observed on Karaj 2 cultivar and the lowest mean of bunch pollution length observed on Opera and RGS cultivars. The first pollution peak time on studied cultivars observed in date 6 April and in this date the highest and lowest pollution observed on Karaj 2 and Opera cultivars, respectively in Shahre-rey region.

**Parasitoid wasps identification**

In this evaluation, one parasitoid wasp with scientific name *Diaeretiella rapae* (Hym.: Braconidae) was identified.

**Evaluation the cabbage aphids natural parasitism percentage**

Comparison the different cultivars regarding the parasitism percentage is shown in Figure 3. In this evaluation, the Licord cultivar had the highest parasitism percentage in
comparision to other cultivars aphids, so that the mean of parasitism percentage for the eight sampling data was equal to 1.45%. The parasitism percentage on Opera cultivar was lower than other cultivars and the mean of parasitism percentage for this cultivar was equal to 0.53%. The maximum parasitism percentage for all cultivar was determined in forth sampling in data 6 April and was equal to 2.33%, and in this date the highest parasitism percentage observed on Licord and RGS cultivars and the lowest mean of parasitism percentage observed on Opera cultivar. In the beginning of sampling data in 6 April, the lowest parasitism percentage was equal zero. In this date, the highest parasitism percentage observed on Ocapi and SLM0046 cultivars and the lowest parasitism percentage observed on Opera, RGS-S003 cultivars.

_Comparision the studied parameters in different cultivars_

Comparision the different cultivars regarding the maximum of bunch pollution length, the maximum of parasitism percentage and pollution length, polluted bunch length in polluted bunch with cabbage aphids on different cultivars are showed in Tables 1–3. There was a significant difference between cultivars regarding the maximum of pollution length in level 5%. The maximum of pollution length with mean 8.88 ± 5.29 observed on Karaj 2 cultivar and the minimum of pollution length observed on Opera and Ocapi cultivar with mean 1.66 ± 1.44 and 3.88 ± 2.54, respectively. The effect of time was significant regarding the maximum of pollution length in level 5%, so that in different times the maximum of pollution length was different in different cultivars; this means that the maximum and minimum of pollution length observed, respectively in date 6 April and 27 May. Also the interaction effect of cultivar and time was significant in level 1% and this shows that the maximum of pollution length was different in different cultivars at different times. Among the studied cultivars regarding the mean of pollution length, there was a significant difference between cultivars in level 5%, so that the highest mean of pollution length observed on karaj 2 cultivar with mean 1.88 ± 0.89 cm and the lowest mean of pollution length observed on Opera and RGS003 cultivars with mean 0.22 ± 0.28 and 0.43 ± 0.40 cm, respectively. The effect of time was significant regarding the mean of pollution length in level 5%, so that in different times the mean of pollution length was different in different cultivars; this means that the maximum and
minimum of pollution length observed, respectively in date 6 April and 27 May. Also the interaction effect of cultivar and time was significant in level 1% and this shows that the maximum of pollution length was different in different cultivars at different times.

Table 1. The analysis of variance results of pollution to cabbage aphids in eight cultivars.

<table>
<thead>
<tr>
<th>Change source</th>
<th>Maximum of pollution length</th>
<th>Minimum of pollution length</th>
<th>Parasitism rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivar</td>
<td>3.60* (7)</td>
<td>2.87* (7)</td>
<td>2.06 ns (7)</td>
</tr>
<tr>
<td>Time</td>
<td>17.66** (7)</td>
<td>56.50** (7)</td>
<td>13.97** (7)</td>
</tr>
<tr>
<td>Cultivar*Time</td>
<td>2.15** (49)</td>
<td>2.12** (49)</td>
<td>2.09** (49)</td>
</tr>
<tr>
<td>C.V</td>
<td>31.15</td>
<td>24.98</td>
<td>38.44</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.75</td>
<td>0.85</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Note: *Significance per 5% level; **Significance per 1% level

Table 2. Comparison the means of cabbage aphids seasonal change based on canola cultivars.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Maximum of pollution length</th>
<th>Minimum of pollution length</th>
<th>Parasitism rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGS003</td>
<td>4.50 ± 2.63bc</td>
<td>0.43 ± 0.40bc</td>
<td>0.68 ± .37</td>
</tr>
<tr>
<td>SLM046</td>
<td>7.88 ± 5.28ab</td>
<td>0.65 ± 0.51ab</td>
<td>1.21 ± 1.15</td>
</tr>
<tr>
<td>Karaj2</td>
<td>8.88 ± 5.29a</td>
<td>1.81 ± 0.8a</td>
<td>1.10 ± 0.87</td>
</tr>
<tr>
<td>Talaei</td>
<td>6.47 ± 3.54ab</td>
<td>0.72 ± 0.73ab</td>
<td>1.33 ± 1.10</td>
</tr>
<tr>
<td>Ocapip</td>
<td>3.88 ± 2.54abc</td>
<td>0.50 ± 0.46abc</td>
<td>1.23 ± 1.33</td>
</tr>
<tr>
<td>Licord</td>
<td>6.22 ± 3.62ab</td>
<td>1.00 ± 0.67ab</td>
<td>1.45 ± 1.30</td>
</tr>
<tr>
<td>Sarigol</td>
<td>6.63 ± 4.01ab</td>
<td>0.71 ± 0.74ab</td>
<td>1.01 ± 0.77</td>
</tr>
<tr>
<td>Opera</td>
<td>1.66 ± 1.41c</td>
<td>0.22 ± 0.28c</td>
<td>0.53 ± 0.56</td>
</tr>
</tbody>
</table>

Note: Different lowercase letter represent significance per 5% level.

Table 3. Comparison the means of cabbage aphids seasonal change based on sampling time.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Maximum of pollution length</th>
<th>Minimum of pollution length</th>
<th>Parasitism rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 April</td>
<td>9.25 ± 4.77b</td>
<td>0.57 ± 0.48cd</td>
<td>1.96 ± 1.34b</td>
</tr>
<tr>
<td>15 April</td>
<td>6.84 ± 4.19b</td>
<td>0.52 ± 0.36c</td>
<td>1.12 ± 0.74bc</td>
</tr>
<tr>
<td>22 April</td>
<td>5.75 ± 3.80b</td>
<td>0.42 ± 0.24c</td>
<td>1.07 ± 0.73c</td>
</tr>
<tr>
<td>29 April</td>
<td>6.41 ± 4.07b</td>
<td>0.75 ± 0.43b</td>
<td>2.33 ± 1.05a</td>
</tr>
<tr>
<td>6 May</td>
<td>8.84 ± 4.09a</td>
<td>1.72 ± 0.75a</td>
<td>0.78 ± 0.36bc</td>
</tr>
<tr>
<td>13 May</td>
<td>5.50 ± 1.53b</td>
<td>1.19 ± 0.40a</td>
<td>0.58 ± 0.22bc</td>
</tr>
<tr>
<td>20 May</td>
<td>2.41 ± 0.03c</td>
<td>0.21 ± 0.20d</td>
<td>0.27 ± 0.22d</td>
</tr>
<tr>
<td>27 May</td>
<td>1.09 ± 0.57d</td>
<td>0.03 ± 0.02e</td>
<td>0.43 ± 0.36d</td>
</tr>
</tbody>
</table>

Note: Different lowercase letter represent significance per 5% level.
Among the studied cultivars regarding the number of polluted bunches, there was a significant difference between cultivars in level 5%, so that the highest number of polluted bunches was related to Licord cultivar with mean 33.47 ± 26.53 cm. The effect of time was significant regarding the number of polluted bunches in level 5%, so that in different times the was different in different cultivars; this means that the maximum number of polluted bunches observed in date 27 May. Also the interaction effect of cultivar and time was significant in level 1% and this shows that the number of polluted bunches was different in different cultivars in different times. Among the studied cultivars regarding the polluted bunches percentage, there was a significant difference between cultivars in level 5%, so that the highest polluted bunches percentage was related to Licord cultivar with mean 37.19 ± 29.47% and the lowest polluted bunches percentage was related to Opera and RGS003 cultivars. The effect of time was significant regarding the polluted bunches percentage in level 1%, so that in different times there was difference in different cultivars regarding the polluted bunches percentage. The maximum of polluted bunches percentage observed in 6 May and the lowest polluted bunches percentage observed in date 27 May. Also the interaction effect of cultivar and time was significant in level 1% and this shows that the polluted bunches percentage was different in different cultivars in different times. Among the studied cultivars regarding the pollution length, there was a significant difference between cultivars in level 5% so that the highest pollution length was related to Karaj 2 cultivar with mean 2.71 ± 1.49 cm and the lowest pollution length was related to Opera and RGS003 cultivars with mean 1.42 ± 1.03 and 1.59 ± 0.35 cm, respectively. The effect of time was significant regarding the pollution length in level 1%, so that in different times there was difference in different cultivars regarding the pollution length. The maximum of pollution length observed in date 6 April and the lowest pollution length observed in date 27 May. Also the interaction effect of cultivar and time was significant in level 1%, and this shows that there was difference in different cultivars in different times regarding the pollution length.

Discussion

With attention to this point that the host plant and its quality are the effective factors on growth and development, longevity, fertilisation and aphid population and many other pests (Askarianzadeh et al. 2013; Jahan et al. 2013a; Esmaeili-Vardanjani et al. 2013a, 2013b) in present study, the effect different cultivars was evaluated on cabbage aphids population seasonal change. The study based on the maximum of bunch pollution length and the minimum of bunch pollution length groped as sensitive and resistant cultivars. The Ocapi and Operai cultivars were resistant to cabbage aphids, so are the most appropriate cultivars for farmers in Shahre-rey region. Also the Karaj 2 was sensitive cabbage aphids, so it is necessary to reduce this pest in this region and its damage, the under cultivation area of this cultivar should evaluated accurately.

The studies on natural parasitism provide some information including the dominant natural parasitoid wasps varieties and the natural enemies activity peak which could be used to integrate the biological control with other control methods and to reduce the chemical pesticides. Regarding the resistant cultivar, many studies have done in Iran and some researchers reported resistance presence to New Zealand cabbage aphids population in some species of *Brassica* genus (Singh et al. 1994). In evaluation by Ellis et al. (1998) on 401 cabbage germplasm from different centres and counting the aphid clonies, a grading system have provided by researchers and using it, 11 cabbage cultivar
from *Brassica oleracea* have recognised as resistant cultivars. Singh et al. (1994) during an experiment observed that 90% of species of *Brassica* genus are polluted during the first attack, while the *Thaliana* (*Arabidopsis*) sp. and *Eruca sativa* were not polluted. In an evaluation by Monfared et al. (2003) on resistance of different canola cultivars (27 cultivars) to cabbage aphids, seven cultivars including the Hyola308, Hyola401, Hyola330, Eurol, Shiralee, Pfand Okapi cultivars and also the mustard (resistant cultivar) were identified which a little cabbage aphids attracted on them. Zandi-Sohani et al. (2004) evaluated the resistance of different canola cultivars to cabbage aphids and three cultivars determined as resistant cultivars. In a study in canola fields in Systan region, it was observed that the cabbage aphid population has the peak during the second half of March month until the late April month (Modares-Najafabadi et al. 2004). Farsi et al. (2009) evaluated the cabbage aphid population in Ahwaz region; according to their studies, this aphid presence peak is during the second half of March month until the late April month and ultimately, the population reduces with weather warming in late April month.

Different factors are effective on cabbage aphid population which the most important of them are weather condition, natural enemies, plant quality and the aphid species quality (Dixon 1998; Awmack & Leather 2002). With evaluations, the cabbage aphid population peak was in date 6 May month in Shahre-rey region but in following regions with attention to the conditions, the peak of waxy aphid population was different. Modares-Najafabadi et al. (2004) reported the peak of cabbage aphid population in Systan region in canola fields, during the second half of March month until the late April month. In studies by Khajehzadeh (2004) in Behbahan canola fields, the peak of cabbage aphid population in Systan region in canola fields is reported during the second half of March month. Khan and Rabbani (1992), in studies on cabbage aphid population changes in Pakistan region in canola fields, reported the peak of cabbage aphid population during the March month until April month and also during the October month until the December month. Farsi et al. (2009) reported the peak of cabbage aphid population during the March month. Karazemoodeh (2002) in studies on cabbage aphid population changes on four different canola cultivars observed that the canola cultivars were effective on cabbage aphid fertility and longevity. In present study, the results showed that with temperature increment the cabbage aphid population decreases and it can be said that the weather conditions are effective on this pest aphid population changes. With attention to the results that the aphid population fluctuations on Karag2 cultivar was higher than other cultivars, so it is recommended that to control this destructive pest, this cultivar under cultivation area should reduced.

References


