Seasonal abundance of aphid, *Rhopalosiphum maidis* (Fitch) and its natural enemies on barley (*Hordeum vulgare* Linn) and Predatory potential of major coccinellid predators on aphid (*Rhopalosiphum maidis*)

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Abstract

The aphid, *R. maidis* was found to be the major insect pest causing damage to the barley crop. The population of aphid started in the first week of January, increased and reached to peak (114.02 aphids/tiller) at 22.0 °C maximum temperature, 6.3 °C minimum temperature, 65 per cent relative humidity and 9.5 sunshine hours in the first week of February, thereafter, the population declined gradually and completely disappeared in the fourth week of February. The maximum temperature had significant negative correlation (r=-0.76) and relative humidity had significant positive correlation (r=0.80) with aphid population, other abiotic factors were no significant. The population of ladybird beetle, *Coccinella septempunctata* Linn. On barley crop reached to maximum (5.98 per five plants) in the third week of February at 31.1 °C maximum temperature, 12.7 °C minimum temperature, 55 per cent relative humidity, and 9.0 sunshine hours. The maximum temperature and sunshine hours had significant positive correlation (r=0.92, 0.91), and relative humidity and rainfall had significant negative correlation (r=-0.92,-0.93) with the population of *C. septempunctata*. The first instar larva of ladybird beetle, *C.septempunctata* consumed on an average 23.30±1.10; while second, third and fourth instar larva consumed on an average 34.60±1.91, 102.50±11.49 and 194.20±8.61 aphids, respectively. The total number of aphids consumed during whole larval period averaged 354.60±15.00 aphids. On an average, a male consumed 2409.50 aphids in 25 days with an average of 96.38±3.42; whereas, a female consumed 2936.90 aphids in 25 days with an average of 117.48±4.63 aphids per day.

Keywords: Aphid, barley, natural enemies, seasonal abundance, *C. septempunctata*

1. Introduction

Barley, *Hordeum vulgare* Linn. (family: Gramineae) is an important cereal crop of Rabi season grown in India. The *chapattis* made up of barley flour are very palatable and can be easily digested even by the persons suffering from stomach ailments. Besides an ideal feed and fodder for livestock, the crop has acquired the status of an industrial crop in malting and brewing. This crop could perform better under moisture stress and saline conditions than other cereal crops. The grains of barley contain 12.5 per cent moisture, 11.5 per cent albuminoids, 74.0 per cent carbohydrate, 1.3 per cent fat, 3.9 per cent crude fibre and 1.5 per cent ash. In Rajasthan, it is cultivated in about 307,936 ha area with an annual production to the tune of 957,896 tonnes (anonymous, 2013) [3].

The crop is infested by a number of insect pests, viz., armyworm, *Mythimna separata* (Haworth); ghujhia weevil, *Tanymecus indicus* (Faust); termite, *Odontotermes obesus* (Ramb.); cutworms, *Agrotis* spp.; shoot fly, *Atherigona naquii* (Styskal); pink borer, *Sesamia inferens* (Walker); jassids, *Amrasca basalis* (Baly); barley aphid, *Rhopalosiphum maidis* (Fitch) and *R. padi* (Linn.) (Singh, 1983) [17]. Among these insect pests, the aphid, *R. maidis* is most serious and regular insect pest of this crop (Sharma, 1990; Kumawat and Jheeba, 1999) [14, 9]. Both nymphs and adults cause damage by sucking the cell sap from the leaves, stems and earheads. Due to rapid multiplication of the aphid, usually the entire shoot is covered and with the result of continuous desaping by such a large population, yellowing, curling and subsequent drying of leaves takes place which ultimately lead to reduction in size of earheads (Bhatia and Singh, 1977) [9]. The aphid also acts as a vector of barley yellow dwarf virus. It is well known that the abundance of insect pests and natural enemies depends upon abiotic and
biotic factors at a particular space and time. Many workers (Verma, 1993; Barta and Cagan, 2005; Akhtar et al., 2004 and Salman and Ahmed, 2005) [21, 4, 1, 13] studied the abundance of aphids and their natural enemies but the information is fragmentary. In the present scenario of climate change, the insect pest situation is being changed with the variation in abiotic factors. The study was undertaken to find out the correlation of aphid population and their natural enemies with the weather parameters to know the hospitable conditions for insect development.

The insect predators have received much less attention as natural control agents. The use of predators may prove to be better choice among various groups of bio-agents. The important predators, viz., lady bird beetles, Coccinella septempunctata Linn., Menochilus sexmaculatus Fab., Adonia variegata Goeeze, Brunoiodes suturalis (Fab.); syrphid fly, Xanthogramma scutellare McIntosh and Syrphus balteatus (Degean) feed on aphids, whiteflies, mealy bugs, insect eggs and neonate larvae on different crops. The mass production of ladybird beetle, C. septempunctata has been studied by some workers but needs further investigations for commercial promotion in augmentative trials. The biotic and feeding potential and its effectiveness in the field have not been evaluated in full details. A perusal of available literature revealed that very little attention has been paid to quantify the response of predators against insect pests of barley.

2. Material and methods

The present evaluation of the Seasonal abundance of aphid, Rhopalosiphum maidis (Fitch) and its natural enemies on barley, Hordeum vulgare Linn. were carried out on the Agronomy farm, S.K.N. College of Agriculture, Jodhpur during rabi 2014-15. To record the seasonal abundance of the aphid, R. maidis and its natural enemies, the genotype RD-2052 was sown on 15th November during in Rabi, 2014-15 in five plots of size 3.0 x 2.25 m² keeping row to row distance of 25 cm. the observations of insect pests and their natural enemies were recorded at weekly interval soon after their appearance during the crop season till harvesting of the crop.

The data recorded on insect pests, natural enemies and meteorological parameters were used for statistical analysis. To record data on aphid population, five randomly selected tillers will be tagged in each plot. Timely visits of the experimental field will be made to observe the occurrence of aphid. As soon as the aphid population appeared, the numbers will be counted on each tagged tillers in each plot. The observations on aphid population will be recorded in early morning hours at weekly interval from appearance to harvesting of the crop. Weakly observations on natural enemies will also be recorded on the 10 randomly selected tillers in each plot. The correlation will be worked out between aphid population and abiotic factors of environment (maximum and minimum temperatures and average relative humidity). Correlation between aphid population and natural enemies will also be computed.

2.1. Interpretation of data

The simple correlation was computed for the population of aphid and their natural enemies with abiotic factors (maximum and minimum temperatures, relative humidity, sunshine hours and rainfall).

2.2 Predatory potential of coccinellid predators of aphid, R. maidis

The grubs, males and female coccinellid predators were collected from Agronomy Farm of the College and cultured by releasing them in glass jars (15x10 cm) at 28±2 °C temperature in BOD incubator to obtain eggs. Fresh leaves and shoots of barley plant harbouring aphids were kept in each glass jar to serve as food for predator. The jars were covered with muslin cloth and tied with rubber bands. A culture of aphid, R. maidis was maintained on barley plants grown in pots to ensure continuous supply of food for the predators. The newly hatched first instar grubs of coccinellid predator were released separately in each jar (one grub/ jar of size 6.4x4.5 cm). About hundred freshly collected apterous aphids were released in each jar along with fresh plant parts daily during morning hours. The coccinellid predators were allowed to feed for 24 hours and after feeding the left over aphids were counted. The process was continued till the adult emergence took place. The individual male and female adult was kept separately and provided with aphids till death and observations were recorded during experimental period to determine predatory potential. The average number of aphids consumed by every larval instar and adults was calculated.

3. Results and discussion

The aphid, R. maidis was found to be the major insect pest causing damage to the barley crop. The population of aphid started in the first week of January, increased and reached to peak (114.02 aphids/ tiller) at 22.0 °C maximum temperature, 6.3 °C minimum temperature, 65 per cent relative humidity and 9.5 sunshine hours in the first week of February, thereafter, the population declined gradually and completely disappeared in the fourth week of February. The maximum temperature had significant negative correlation ($r$=-0.76) and relative humidity had significant positive correlation ($r$=0.80) with aphid population, other abiotic factors were non significant.

The population of ladybird beetle, Coccinella septempunctata Linn. on barley crop appeared in last week of January, reached to maximum (5.98 per five plants) in the third week of February at 31.1 °C maximum temperature, 12.7 °C minimum temperature, 55 per cent relative humidity and 9.0 sunshine hours. The maximum temperature and sunshine hours had significant positive correlation ($r$=0.92, 0.91), and relative humidity and rainfall had significant negative correlation ($r$=-0.92,-0.93) with the population of C. septempunctata. The minimum temperature has non significant correlation with the population of ladybird beetle, C. septempunctata.

The aphid population reached to its peak in the first week of February (114.02 aphids/tiller) at 22.0 °C maximum, 6.3 °C minimum temperature, 65 per cent relative humidity and 9.5 sunshine hours. the present findings are in close approximation to those of Verma (1993) [21] who reported that infestation of R. maidis on barley crop started in the first week of January and reached to its peak during second week of February. Akhtar and Shahida (2002) [2] reported that aphid population appeared on 9th January and reached to its peak on 26th February. Similar results were also reported by Singh (2008) [16] which supports the present findings. Wang et al. (2002) [22] reported 25 °C to be the optimum temperature for development of R. maidis. Likewise, Richter and Balde (1993) [11] reported that optimum temperature for Acrystosaphis pisum (Harris) and R. maidis were 21-25 °C and 18-24 °C, respectively corroborate the present finding. The results indicated that maximum temperatures ($r$=-0.76) and relative humidity ($r$=0.80) played a pivotal role in multiplication of aphid as correlation of these abiotic factors with aphid population was found significant. It was concluded...
that the aphid population was not affected significantly by minimum temperature, rainfall and sunshine hours. The present findings partially corroborate with the findings of Roychoudhury and Jain (1993) [12] who reported that the incidence of alate aphids showed a positive correlation with relative humidity and negative with mean, maximum and minimum temperatures. The results are in full conformity with that of Sikandar (2011) [13] who reported that aphid count was low in January due to cold but started to increase in the month of February.

The coccinellid predator, *C. septempunctata* Linn. was first observed in the last week of January in Rabi, 2014-15. The findings corroborated with the results of Singh (2008) [14] who observed the peak of coccinellid beetles after one week of peak period of aphid infestation. The maximum population was recorded in the third week of February (5.98/ five plants) at 31.1°C maximum and 12.7°C minimum temperature, 55% relative humidity and 9.0 sunshine hours. The results are in conformity with the findings of Srivastava et al. (2003) [19] who reported that 30°C temperature was optimum for the development of ladybird beetle, *C. septempunctata*. The ladybird beetle population had significant positive correlation with maximum temperature (r=0.92) and sunshine hours (r=0.91), significant negative correlation with relative humidity (r=-0.92) and rainfall (r=-0.93). The present findings also corroborate with the findings of Tank and Korat (2007) [20] who reported that relative humidity was negatively correlated and sunshine hours was positively correlated with *C. sexmaculata* population on wheat crop. The results indicated that with the increase in maximum temperature and sunshine hours, the population of coccinellid predator, *C. septempunctata* was also increased, whereas, with the increase in relative humidity the population was decreased.

**Predatory potential of ladybird beetle, *C. septempunctata***

Both larvae and adults of *C. septempunctata* predate on aphids, hence to find out the predatory potential, counted numbers of aphids were provided as food each day. The data presented in table 2 showed that the rate of feeding among different larval instars varied greatly. The first instar larva on an average consumed 23.30±1.10 aphids ranging from 19-29 aphids; while second, third and fourth instar larva consumed on an average 34.60±1.91, 102.50±11.49 and 194.20±8.61 aphids (ranging from 27-45, 62-140, 166-237 aphids), respectively. The total number of aphids consumed during whole larval duration varied from 302-432 aphids with an average of 354.60±15.00 aphids.

Both male and female adults of *C. septempunctata* were evaluated to determine the rate of feeding. The result revealed that female beetles consumed more number of aphids than males. On an average, a male consumed 2409.50 aphids in 25 days with an average of 96.38±3.42 aphids per day. On the other hand, a female consumed 2936.90 aphids in 25 days with an average of 117.48±4.63 aphids per day.

A little work has been done in investigating the predatory potential of coccinellid beetles on R. maidis. Both larvae and adults of *C. septempunctata* feed on aphids, hence to find out the feeding potential, counted numbers of aphids were provided as food each day. The data presented in table and fig showed that the rate of feeding among different larval instars varied greatly. The first instar larva on an average 23.30±1.15 aphids ranging from 19-29 aphids; while second, third and fourth instar larva consumed on an average 34.60±1.91, 102.50±11.49 and 194.20±8.61 aphids (ranging from 27-45, 62-140, 166-237 aphids), respectively. The total number of aphids consumed during whole larval duration varied from 302-432 aphids with an average of 348.30±13.65 aphids.

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### Table 1: Seasonal abundance of aphid, *Rhopalosiphum maidis* (Fitch) and its predator, *Coccinella septempunctata* Linn. on barley

<table>
<thead>
<tr>
<th>SMW No.</th>
<th>Date of observations</th>
<th>Mean aphid population /tiller</th>
<th>Mean <em>C. septempunctata</em> population /five plants</th>
<th>Temperature (°C)</th>
<th>Mean Relative humidity (%)</th>
<th>Rainfall (mm)</th>
<th>Sunshine hours</th>
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<td>04.01.2015</td>
<td>14.15</td>
<td>0.00</td>
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<td>6.6</td>
<td>55</td>
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<td>2</td>
<td>11.01.2015</td>
<td>20.5</td>
<td>0.00</td>
<td>25.4</td>
<td>3.9</td>
<td>59</td>
<td>0.00</td>
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<td>3</td>
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<td>0.00</td>
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<td>4</td>
<td>25.01.2015</td>
<td>93.45</td>
<td>0.80</td>
<td>18.2</td>
<td>9.5</td>
<td>69</td>
<td>10.2</td>
</tr>
<tr>
<td>5</td>
<td>01.02.2015</td>
<td>114.02</td>
<td>3.90</td>
<td>22.0</td>
<td>6.3</td>
<td>65</td>
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<tr>
<td>6</td>
<td>08.02.2015</td>
<td>70.24</td>
<td>5.25</td>
<td>25.0</td>
<td>7.3</td>
<td>59</td>
<td>0.00</td>
</tr>
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<td>7</td>
<td>15.02.2015</td>
<td>52.65</td>
<td>5.15</td>
<td>27.0</td>
<td>10.0</td>
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</tr>
<tr>
<td>8</td>
<td>22.02.2015</td>
<td>18.98</td>
<td>5.98</td>
<td>31.1</td>
<td>12.7</td>
<td>55</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Correlation coefficient with mean aphid population (r) - - -0.76* NS 0.80* NS NS

Correlation coefficient with mean *C. septempunctata* population (r) - - 0.92* NS -0.92* -0.93* 0.91*

NS: Non significant
*Significant at 5 per cent level
AVerage of five replications
Table 2: Feeding potential of different stages of ladybird beetle, *Coccinella septempunctata* Linn

<table>
<thead>
<tr>
<th>S. No.</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Male Aphids consumed in 25 days</th>
<th>Female Aphids consumed/ day</th>
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<tr>
<td>1</td>
<td>20</td>
<td>35</td>
<td>62</td>
<td>185</td>
<td>302 2025</td>
<td>81 3165</td>
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<td>2</td>
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<td>29</td>
<td>105</td>
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<td>327 2640</td>
<td>105.6 3495</td>
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<td>28</td>
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<td>136</td>
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<td>4</td>
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<td>36</td>
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<td>334 2258</td>
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<td>8</td>
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<td>45</td>
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<td>178</td>
<td>408 2494</td>
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<tr>
<td>9</td>
<td>23</td>
<td>27</td>
<td>140</td>
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<td>402 2618</td>
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<td>10</td>
<td>22</td>
<td>29</td>
<td>106</td>
<td>198</td>
<td>355 2470</td>
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<td>23.30</td>
<td>34.60</td>
<td>102.50</td>
<td>194.20</td>
<td>354.60 2409.50</td>
<td>96.38 2936.90</td>
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<tr>
<td>± SE</td>
<td>1.10</td>
<td>1.91</td>
<td>11.49</td>
<td>8.61</td>
<td>15.00 85.53</td>
<td>3.42 115.84</td>
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4. Acknowledgement
The authors are thankful to the Dean, College of Agriculture, Sri Karan Narendra Agriculture University, Jobner- Jaipur for providing necessary facilities and permission to conduct the study.

5. References