Pakistan Entomologist

Journal homepage: www.pakentomol.com

COMPARATIVE INCIDENCE AND ABUNDANCE OF APHIDS AND THEIR ASSOCIATED PREDATORS ON CANOLA IN PAKISTAN

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ARTICLE INFORMATION

Received: July 19, 2018
Received in revised form: May 25, 2019
Accepted: August 30, 2019

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ABSTRACT

Aphids are the utmost common and predominant pest of oilseed brassica crops which caused 70-80% of losses in yield. So, a study was conducted to check the comparative incidence and abundance of canola aphids, *Brevicoryne brassicae*, *Lipaphis erysimi* and *Myzus persicae*. Results revealed that the incidence of all aphids appeared on the leaves and the inflorescences in 3rd week of January and 2nd week of February and continued till the harvesting of Faisal Canola variety. The per leaf peak population of *L. erysimi*, *B. brassicae* and *M. persicae* (17.66, 12.59 and 8.49, respectively) and per inflorescence (3.82, 2.93 and 2.19, respectively) was recorded. The highest mean population ranges 60.45-70.90/ leaf and 8.24-8.94/ inflorescence were observed from 08-February to 01-March and 08-February to 05-March, respectively. The temperature range of 17.67-23.33°C was suitable for the development of aphids. Predator species, *Chrysoperla carnea*, *Coccinella undecimpunctata*, and *Coccinella septempunctata* were recorded while the population of aphids was adequately established on the canola variety. The population of all predators increased as an increase in the population and decreased as the population of aphids decline. The present study will be helpful to take precautionary measures for the management of canola aphids when reached at economic injury level (5 aphids/ leaf) on canola crop.

Keywords: Population fluctuation, Mustard aphid, Cabbage aphid, Green peach aphid, Green lacewing, Ladybird beetles, Temperature, EIL

INTRODUCTION

Canola is achieving the prominent position as the dynamic basis of plant protein and oilseed crops in Pakistan. It does not only serve as a significant nutritive element for the individuals, however also utilized in food manufacturing (Mahmood *et al.,* 2012). A large number of oilseed crops are cultivated in several zones of Pakistan, however, the quantity of oil is not adequate to meet the requirements of the economy (Razaq *et al.,* 2014). The status of oilseed crops can be imagined from the statistic that the overall production of edible oil met merely 27.2% necessities of Pakistan, and the remaining quantity was imported with the value of 84 billion rupees (Hussain *et al.,* 2015). Oilseed brassicas including *Brassica napus*, *B. carinata,* and *B. juncea* retain the rank of minor crops in Pakistan and cultivated as fodders, vegetables and for edible oils (Razaq *et al.,* 2011).

The main reason of the reduction of the yield of oilseed brassica crops is the damage caused by different insect pests (Hussain *et al.,* 2015) including green peach aphid, *Myzus persicae* (Sulzer), cabbage aphid, *Brevicoryne brassicae* (Linnaeus), mustard aphid, *Lipaphis erysimi* (Kaltenbach), painted bug, *Bagrada hilaris* (Burmeister), cabbage butterfly, *Pieris brassicae* (Linnaeus), armyworm, *Agrotis ipsilon* (Hufnagel) and cabbage semilooper, *Tauroscopa notabilis* (Philpott) (Syed *et al.,* 1999; Saljoqi *et al.,* 2001). Among all these insect pests, aphids are the utmost common and predominant pest (Razaq *et al.,* 2014).

About 10-90% yield losses were observed in India due to *L. eyrsimi* depending upon the damage severity and stage of the crop (Rana, 2005). Different studies conducted in Pakistan also indicated that 70-80% of losses in yield due to *B. brassicae* and *L. eyrsimi* to various oilseed brassica crops (Rustamani *et al.,* 1988; Khattak *et al.,* 2002). Both aphids are

Cite this article as: Atta, B., M. Rizwan, A.M. Sabir, M.A. Ayub, M.F. Akhtar, M.B. Ayyub and S. Nadeem, 2019. Comparative incidence and abundance of aphids and their associated predators on canola in Pakistan. Pak. Entomol., 41(2):147-152.

also responsible for hindering the photosynthesis process in numerous oilseed crops (Hussain *et al.,* 2014; Razaq *et al.,* 2014). Severity infestation level of both aphids was observed in *B. napus* and *B. juncea* in Multan, Pakistan (Razaq *et al.,* 2011).

Several management tactics are adopted worldwide for the reduction of these aphids to brassica crops (Razaq *et al.,* 2011). In different parts of the world, farmers used various insecticides for the reduction of this notorious pest as a last option (Brown *et al.,* 1999; Bhowmik, 2003, Hainan *et al.,* 2007) which is not only helpful for achieving target mission but also have numerous negative impacts which includes resistance development and resurgence in target insect pests (Gogi *et al.,* 2006), causes mortality of beneficial arthropods, and environmental and health hazards (Desneux *et al.,* 2007). Non-chemical approaches are eco-friendly to minimize the population of aphids and subsequently reducing losses. Unfortunately, available cultivars of *B. juncea* and *B. napus* lack acceptable plant resistance to escape damage by aphids (Amer *et al.,* 2009; Aslam *et al.,* 2009). Predators like *Chrysoperla* spp. and *C. septempunctata* appear at the later phase of the crop while maximum injury has been produced by the aphids to brassica crops. Additionally, populations of predators are also low to manage aphids (Aslam and Razaq, 2007).

Population studies of insect pests are considered one of the utmost significant parts of the pest management approach (Abbas *et al.,* 2017). Keeping in view the status of population fluctuation of canola aphids and their predators, the present study was planned with the objective to conclude the population trends of canola aphids and their natural enemies in the ecological zone of Kala Shah Kaku, Punjab.

MATERIALS AND METHODS

The present experiment was conducted at Rice Research Institute (RRI), Kala Shah Kaku (KSK) (31.7213° N; 74.2700° E) during the year 2017-18. The seed of Faisal Canola variety was obtained from Oilseed Research Institute, Ayub Agriculture Research Institute, Faisalabad and was sown in well-saturated soil (tar wattar) condition on 20-October-2017 by using the broadcast method. The plot size was 100×100 sq. ft.

The experimental design used in this study was randomized complete block design which was replicated thrice. All cultural and agronomic practices which were recommended for this crop were implemented from sowing till harvesting. The spray of insecticide was restricted in and around the investigational site to offer natural environmental conditions for the attack of different aphids and their natural enemies, development, and reproduction on canola variety.

The observations on the occurrence and buildup of the population of turnip aphids (*M. persicae*), cabbage aphids (*B. brassicae*) and green peach aphids (*L. erysimi*) were started since the seedling stage till the maturity of the crop. Morning time (09-11 a.m.) was selected for recording the data twice a week. For this purpose, twenty-five plants were randomly selected. Five leaves per plant (one top, two mid and two bottom portion) were observed comprehensively for aphid counts through the vegetative growth stage. However, one inflorescence per plant was observed carefully from 25 plants during the flowering stage. Top 10cm of the inflorescence of the central shoot was slightly beaten five times with the help of a 15cm long stick having a thickness similar to the pencil. A white sheet was holding under the inflorescence during this activity for the collection of falling aphids on the sheet and then counted.

Incidence of predators (green lacewing, seven-spotted ladybird beetle, and eleven-spotted ladybird beetle) was also recorded on 25 plants selected randomly. Both immature and mature beetles were collected and brought to the laboratory for identification. The temperature of Kala Shah Kaku was recorded on a daily basis during this study.

Data obtained on the number of canola aphids and their associated predators were equated between treatments of study by a single factor ANOVA. The variance among means was parted with LSD test using the analysis by the Statistix-8.1 program package ($P \leq 0.05$). The means of aphid populations per leaf and inflorescence were also equated by using paired t-test.

RESULTS

The results of the present study are presented in Table 1 and Fig. 1-2. All aphids were observed on the leaves and inflorescences during the 2nd week of January and the 1st week of February on Faisal Canola variety and continued till the harvesting of the crop (Table 1, Fig. 1). The population of canola aphids on leaves was gradually increased from 22-January and extended to its peak (60.45 per leaf) on 08-February. The pest population on leaves showed another peak (70.90 per leaf) on 01-March. The population of canola aphids on inflorescence was gradually increased from 08-February and reached to its peak (8.94 per inflorescence) on 05-March (Fig. 1). Maximum per leaf population obtained by mustard aphid, *L. erysimi* (17.66), cabbage aphid, *B. brassicae* (12.59), and green peach aphid, *M. persicae* (8.49) was recorded on 01-March (Table 1), while maximum per inflorescence population obtained by mustard aphid, *L. erysimi* (3.82), cabbage aphid, *B. brassicae* (2.93), and green peach aphid, *M. persicae* (2.19) was recorded on 05-March (Table 1). The population of canola aphids on both leaves and inflorescences was gradually decreased during the first week of March due to the maturity of the crop. The result also showed that there were two peaks in the population of aphids from 08-February to 01-March indicated two overlapping generations (Table 1, Fig. 1). Results further indicated that the range between these two peaks with a temperature range of 17.67-23.33°C was suitable for the development of aphids (Fig. 1). A sudden decline was observed in the population of aphids on leaves and inflorescences on 05-March (57.46) and 08-March (7.26) respectively, because of crop maturity. This decline was observed till 29-March. During this phase, population of aphids was not affected by the temperature (Table 1, Fig. 1). The ANOVA of data indicated that the seasonal means population of *B. brassicae* (6.44±1.68) and *M. persicae* (8.13±1.53) on leaves were highly significant by using T-Value while seasonal means population of *L. erysimi* (3.98±1.99) on leaves was non-significant. The ANOVA of data also indicated that the seasonal means population of *L. erysimi* (9.58±1.26), *B. brassicae* (10.05±1.30) and *M. persicae* (10.54±1.35) on inflorescences were highly

significant by using T-Value (Table 2).

During this study, three different predator species were recorded i.e., *C. carnea*, *C. undecimpunctata*, and *C. septempunctata*. The maximum population of all predators (23.83 per 25 plants) was recorded on 01-March (Fig. 1). The highest population of *C. carnea* (9.49 per 25 plants) was recorded on this date as compared to *C. septempunctata* and *C. undecimpunctata* (7.83 and 6.51 per 25 plants, respectively) (Table 1). The reason for the highest population of all predators on 01-March maybe because of the maximum population of aphids on a similar date. The data in Figure 2 describe the weekly predator-prey curves. The population of all aphids was gradually increased (10.92 per plant) from 3rd week of January and reached their peak (153.39 per plant) during the 4th week of February. Therefore, the population of aphids was decreased up to 4th week of March. The population of predators was also gradually increased (14.49 per 25 plants) from 3rd week of January and reached their peak (46.22 per 25 plants) (Fig. 2). Results also indicated that population of predators was increased when the population of aphids was maximum on canola variety. Results further indicated that predators range between 20.75 and 23.83 per 25 plants with a temperature range of 17.67-23.33°C seems favorable for their development (Fig. 1). A sudden decline was also observed in case of predator population (16.69) on 08-March till 29-March. This decline was observed due to low population of aphids. The population of predators was also not affected by temperature during this declining phase (Table 1, Fig. 4). The ANOVA of data indicated that the seasonal means population of *C. carnea* (6.19±1.46), *C. septernpunctata* (7.03±1.42) and *C. undecimpunctata* (7.93±1.42) on inflorescences were highly significant by using T-Value (Table 2).

Table 1

Comparative means population of canola aphids, *Lipaphis erysimi*, *Brevicoryne brassicae*, and *Myzus persicae* (per leaf and inflorescences) and their associated predators, *Chrysoperla carnea*, *Coccinella septernpunctata*, and *Coccinella undecimpunctata* (per 25 plants) on Faisal Canola (*Brassica napus*) variety recorded from January-March 2018.

Observational Dates	On leaves			On inflorescences			Predators		
	L. erysimi	*B. brassicae*	*M. persicae*	*L. erysimi*	*B. brassicae*	*M. persicae*	*C. carnea*	*C. septernpunctata*	*C. undecimpunctata*
15-Jan	0.17^{l}	0.09^{mn}	0.05^{m}	-	-	-	1.18^{q}	0.07^{o}	0.44^{n}
18-Jan	0.49^{kl}	0.32^{mn}	0.22^{m}	-	-	-	1.91^{p}	1.53^{mn}	1.19^{l}
22-Jan	0.93^{k}	0.61^{kl}	0.57^{l}	-	-	-	2.44^{o}	2.39^{kl}	1.53^{k}
25-Jan	2.42^{j}	1.74^{j}	1.17^{k}	-	-	-	3.17^{m}	2.85^{jk}	2.11^{j}
29-Jan	4.02^{i}	3.48^{i}	2.01^{i}	-	-	-	4.13^{k}	3.74^{i}	2.53^{i}
01-Feb	6.61^{h}	4.42^{h}	3.33^{g}	-	-	-	4.85^{j}	4.18^{hi}	3.03^{gh}
05-Feb	10.04^{g}	7.79^{g}	4.76^{e}	-	-	-	6.12^{h}	5.33^{g}	4.29^{f}
08-Feb	15.55^{e}	9.82^{e}	6.20^{e}	3.51^{bc}	2.66^{bc}	2.07^{ab}	8.22^{d}	6.65^{cd}	5.88^{e}
12-Feb	13.72^{de}	8.84^{e}	5.88^{d}	3.23^{de}	2.57^{bcd}	1.95^{bcd}	7.43^{f}	6.27^{de}	5.19^{e}
15-Feb	12.04^{f}	7.53^{g}	5.86^{d}	3.11^{ef}	2.48^{cd}	1.82^{d}	7.18^{f}	6.07^{ef}	4.95^{e}
19-Feb	13.99^{d}	9.53^{d}	6.03^{cd}	3.35^{cd}	2.62^{bc}	2.01^{abc}	7.93^{e}	6.56^{de}	5.49^{d}
22-Feb	16.85^{b}	10.43^{b}	7.23^{b}	3.57^{b}	2.71^{b}	2.13^{ab}	8.54^{c}	7.09^{bc}	6.01^{bc}
26-Feb	16.97^{b}	10.65^{b}	7.25^{b}	3.63^{b}	2.74^{ab}	2.14^{a}	8.91^{b}	7.37^{ab}	6.11^{bc}
01-Mar	17.66^{a}	12.59^{a}	8.49^{a}	3.18^{def}	2.54^{bcd}	1.87^{cd}	9.49^{a}	7.83^{a}	6.51^{a}
05-Mar	13.34^{c}	8.48^{f}	5.92^{d}	3.82^{a}	2.93^{a}	2.19^{a}	9.16^{b}	7.46^{ab}	6.22^{b}
08-Mar	9.78^{g}	7.61^{g}	3.80^{f}	3.09^{ef}	2.38^{d}	1.79^{d}	6.52^{g}	5.61^{fg}	4.56^{f}
12-Mar	6.11^{h}	4.19^{h}	3.03^{h}	2.98^{fg}	2.11^{e}	1.34^{e}	5.12^{i}	4.44^{h}	3.19^{g}
15-Mar	2.88^{j}	1.93^{j}	1.50^{j}	2.86^{g}	2.09^{e}	0.63^{f}	4.66^{j}	4.10^{hi}	2.84^{h}
19-Mar	0.97^{k}	0.69^{k}	0.59^{l}	2.13^{h}	1.86^{f}	0.34^{g}	3.53^{l}	3.11^{j}	2.48^{i}
22-Mar	0.51^{kl}	0.35^{lm}	0.24^{m}	1.95^{h}	1.32^{g}	0.34^{g}	2.84^{n}	2.53^{k}	2.03^{j}
26-Mar	0.21^{l}	0.13^{mn}	0.08^{m}	1.10i	0.57^{h}	0.24^{g}	2.11^{p}	1.94^{lm}	1.28^{kl}
29-Mar	0.11^{l}	0.06^{n}	0.04^{m}	0.64^{j}	0.26^{i}	0.21^{g}	1.33^{q}	1.18^{n}	0.74^{m}
SE	0.17	0.08	0.06	0.05	0.06	0.05	0.07	0.13	0.07
CV	0.64	0.29	0.23	0.19	0.21	0.19	0.26	0.51	0.28

Mean with the same letter in the different rows of the column are not significantly different at P = 0.05.

Table 2

Relationship of mean population of aphids (per leaf and inflorescence) and their associated predators on Faisal canola (*Brassica napus*) variety

Parameters	Mean ± S.E (on leaves)	Mean ± S.E (on inflorescences)	Mean ± S.E (Predators)	T-Value
Lipaphis erysimi	3.98 ± 1.99	-	-	1.98^{NS}
Brevicoryne brassicae	6.44 ± 1.68	-	-	3.81^{HS}
Myzus persicae	8.13 ± 1.53	-	-	5.29^{HS}
Lipaphis erysimi	-	9.58 ± 1.26	-	7.56^{HS}
Brevicoryne brassicae	-	10.05 ± 1.30	-	7.72^{HS}
Myzus persicae	-	10.54 ± 1.35	-	7.77^{HS}
Chrysoperla carnea	-	-	6.19 ± 1.46	4.20^{HS}
Coccinella septernpunctata	-	-	7.03 ± 1.42	4.92^{HS}
Coccinella undecimpunctata	-	-	7.93 ± 1.42	5.56^{HS}

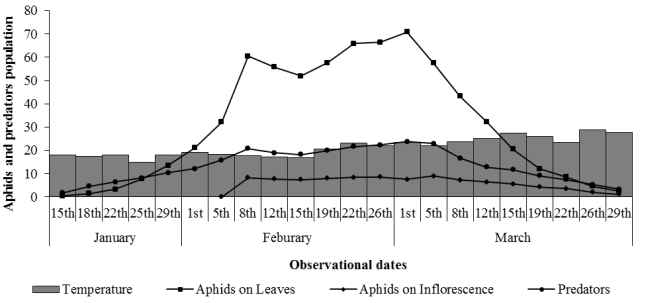

Fig. 1
Comparative means population of aphids (leaves and inflorescence) and their associated predators in relation to temperature on Faisal Canola (*Brassica napus*) variety recorded from January-March 2018.

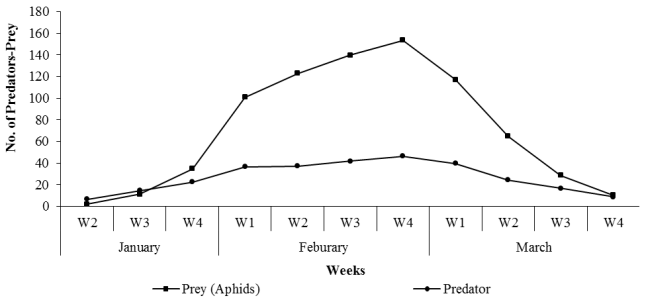

Fig. 2
Predator-prey ratio on Faisal Canola (*Brassica napus*) variety from January-March 2018. Predators are *Chrysoperla carnea*, *Coccinella undecimpunctata*, and *Coccinella septempunctata* and prey are *Brevicoryne brassicae*, *Lipaphis erysimi*, and *Myzus persicae* on leaves and inflorescences.

DISCUSSION

The population of *L. erysimi*, *B. brassicae*, and *M. persicae* was maximum with a range of 15.55-17.66, 9.82-12.59 and 6.20-8.49 per leaf, respectively and with a range of 3.51-3.82, 2.66-2.93 and 2.07-2.19 per inflorescence, respectively on Faisal Canola variety. The highest population of *L. erysimi* (207.53) was observed throughout the observational period on both leaves and inflorescences as compared to *B. brassicae* (143.12) and *M. persicae* (95.30). The results are in accordance with the study of Aslam *et al.* (2005) who investigated that in the environmental condition of Pakistan, winter oilseed brassica crops are attacked more by *L. erysimi* and to a lesser extent by *B. brassicae* and *M. persicae*. Aphids population showed peak after 75 days subsequently sowing of canola crop. These results are in the agreement with the study of Panda *et al.* (2000) and Talpur and Khuhro (2004) who reported the peak population of aphids was observed on 70 days old canola varieties in India and Sindh-Pakistan, respectively with extreme temperature ranged between 24.9-29.0°C and 16.5-27.5°C, respectively. While, during the present study the maximum weekly temperature was 17.67-23.33°C. The non-significant difference in temperature fluctuation could be because of agro-climatic variations in India, Sindh-Pakistan, and Punjab-Pakistan. This is the most critical time for the outbreak of aphids on canola crop which required consistent observation of the crop and control measures. The population decline of aphids on both leaves and inflorescences was observed from the 1st week to 4th week of March due to the maturity of the crop for harvesting. During this phase, population of aphids was not affected by the temperature. This declining trend in the population of aphids is in the agreement with the previous study of Talpur and Khuhro (2004) which also reported a sudden decline in the population of aphids started during the last month from maturity of the crop.

Predators appeared two months of post sowing of crop. The maximum population of *C. carnea*, *C. septempunctata*, and *C. undecimpunctata* was observed from 08-February up to 01-March with the range of 8.22-9.49, 6.65-7.83 and 5.88-6.51 per 25 plants, respectively. The highest population of *C. carnea* (116.77) was observed throughout the observational period on canola crop as compared to *C. septempunctata* (98.29) and *C. undecimpunctata* (78.61). Talpur and Khuhro (2004) also recorded the predators, *C. carnea*, *C. undecimpunctata*, and *C. septempunctata*, after the sufficient development of aphids population on Rainbow canola variety. They further reported that the number of predators was not able to take the population of aphids below control because of their low population on canola crop. The results of the present study were also showed that the population of all associated predators increased with an increase in the population of aphids and decreased as the population of aphids deceased. A decline in the population of predators was observed from the 2nd week of March with the reduction in their food source (aphids). A similar observation was documented by Singh and Kumar (2000) during their laboratory experiment that *C. cornea* has the potential in suppressing the population of *L. erysimi*.

The maximum population of all aphids was observed on leaves (350.88 aphids) as compared to inflorescences (95.06 aphids) of canola crop throughout the observational period. Results are in the agreement with Cibils-Stewart *et al.* (2015) who stated that both the vegetative and reproductive tissues of the host plant can offer altered resources to insects and these alterations in resource distribution can dissimilarly distress not only growth rates of insects but also their development. Malik *et al.* (2010) and Smallegange *et al.* (2007) reported that flowers comprise considerably advanced levels of glucosinolates as equated to the leaves in various brassica crops. Furthermore, accessibility and concentrations of nitrogen can vary through various organs of plant and transversely the stage of plant (Augustinussen, 1987; Malagoli *et al.,* 2005) by direct consequences on the growth and development of aphid (Walter and DiFonzo, 2007; Winde and Wittstock, 2011; Winder *et al.,* 2013). Plant-insect relations may be complex in canola and other brassica crops, as allelochemicals for example glucosinolates can have not only synergistic but also antagonistic impacts on both insects and natural enemies (Cibils-Stewart *et al.,* 2015). Earlier literature have reported toxic consequences of these secondary complexes on natural enemies, however the population of *B. brassicae* can flourish on a diet rich with glucosinolates (Pratt *et al.,* 2008; Ahuja *et al.,* 2009; Hopkins

et al., 2009; Chaplin-Kramer *et al.,* 2011; Kos *et al.,* 2011).

CONCLUSION

Three species of aphids (*B. brassicae*, *L. erysimi*, and *M. persicae*) attacked canola crop in the ecological zone of Kala Shah Kaku-Punjab. Canola crop is attacked by *L. erysimi* and to a lesser extent by *B. brassicae* and *M. persicae*. *C. carnea* and *Coccinella* spp. are effective natural enemies of these aphids. But the management of aphids is not only possible with these natural agents which are also affected by abiotic factors. The population of these agents is totally dependent on the availability of aphids which served as food resources. The population of natural enemies increased with an increase in the population of aphids and decreased as the population of aphids deceased. Therefore, natural enemies play a little effort to reduce the aphid population at some limit. This basic research will be helpful for the researchers and farmers for the development of an appropriate management approach for canola aphids.

ACKNOWLEDGMENTS

The authors would like to thank the Oilseed Research Institute, Ayub Agriculture Research Institute, Faisalabad, Pakistan for providing the seed of Faisal Canola for this study.

Authors' contributions

BA, MR and AMS designed the study and wrote the manuscript with input from all authors. SN and MAA analyzed the data. MFA and MBA gave their suggestions for improvement in the manuscript. All authors read and approved the final manuscript.

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