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POPULATION DYNAMICS OF WHEAT APHIDS AND THEIR NATURAL ENEMIES

Dixit, P.K Sharma, C.S. Jayaram and Abhishek Rana*

Department of Entomology, CSKHPKV, Palampur 176 062
*Email: abhir1392@gmail.com

ABSTRACT

The abundance of aphids infesting wheat and their natural enemies was studied at the CSKHPKV, Palampur. The aphids (*Rhopalosiphum padi* and *Sitobion avenae*) population commenced from first week of January and reached a peak (30.40 aphids/shoot) during third week of March. Seven species of coccinellid beetles were recorded as predators, of which *Coccinella septempunctata*, *Hippodamia variegata* and *Coccinella transversalis* were predominant. Peak population of their adults (8.10 beetles/m^2), grubs and pupae was observed during first week of April. As regards the syrphids, peak in population (13.00 adults/5 sweeps- *Episyrphus balteatus, E. viridaureus, Ischiodon scutellaris, Sphaerophoria* sp. and *Melanostoma* spp.) was during third week of April. Lacewing *Micromus* sp. started appearing from first week of March with its peak being during third week of March. The peak activity of *Diaeretiella* sp. was observed during first week of April with 16.6% parasitization. These natural enemies showed a significant positive correlation with aphid population, while with weather factors mixed results were observed. The predatory potential of coccinellids evaluated revealed that the adults as well as grubs have potential to suppress aphid population.

Key words: Wheat, aphids, parasitoids, predators, coccinellids, syrphids, green lacewing, Diaretiella, correlation, weather factors, predatory potential

Wheat (*Triticum aestivum* L.) is the world's second most important cereal crop after rice, and it is attacked by number of insect pests viz., aphids, termites, armyworm, shoot fly, brown wheat mite and cutworms. More than eleven aphid species infest wheat among which four species viz., *Sitobion avenae* (F.), *S. miscanthi* (Takahashi), *Rhopalosiphum padi* (L.) and *R. maidis* (Fitch) are important (Jarosik et al., 2003). Aphids attack wheat crop from seedling stage onwards; and also exude honey dew which encourages sooty mould growth (Kindler et al., 1995). In Himachal Pradesh, aphids are emerging as important pests. Their population in an agroecosystem is regulated by number of biotic and abiotic factors. Among biotic agents, coccinellids, syrphids and *Leucopis* spp. (Diptera: Chamaemyiidae) are generally known to prey on aphids (Shujing et al., 2004). Among coccinellids, seven spotted lady bird beetle, *Coccinella septempunctata* (L.) is a potential one (Soni et al., 2007). For utilising biological control as a component of IPM, complete information about such natural enemies' survival, relative abundance and their association with pests is required and the present study explores these

MATERIALS AND METHODS

Observations on seasonal incidence of aphids were made by employing quadrat method (Atwal and Singh, 1990) at weekly interval in wheat crop raised by following appropriate package of practices. Total 10 quadrats were selected randomly and observations on number of aphids/ shoot on ten plants in each quadrat (1m^2) were made and % infestation computed. Likewise, observations on number total and mummified aphids/ shoot on ten plants in each quadrat (1m^2) were made and % parasitisation The data on number of adults, grubs and pupae of coccinellids, and adult syrphids and lacewings were collected using sweep net method. Five sweeps at random places in the wheat field were made for these. The seasonal incidence of aphids and their natural enemies and their relationship with the weather parameters were worked out by correlation analysis.

For evaluating the predatory potential of grub and adults of *C. septempunctata*, stock culture of *R. padi* was maintained on potted plants. Third instar grubs and adult of *C. septempunctata*, the first instar grubs and pupae, were collected from the field and maintained separately. 1, 3, 5 and 7 number of grubs (3rd instar) as well as adult beetles (emerged from pupae) were provided with 150 aphids in each petriplates under laboratory conditions. Each treatment was replicated five times. Observations were made daily for number of aphids fed by grubs and adults of *C. septempunctata.* The population of aphids were again made up to its initial level by providing

number equal to aphids consumed by adult beetles of *C. septempunctata* in each replication. Influence of weather factors on the population of aphids and their natural enemies was evaluated with correlation analysis. The data were subjected to statistical analysis in completely randomized design (CRD) using CPCS1 software.

RESULTS AND DISCUSSION

Seasonal abundance

Two species of aphids viz., *R. padi* and *S. avenae* were found infesting wheat crop. Their activity commenced from first week of January (0.10 aphids/ shoot) (Table 1). Peak population (30.40 aphids/ shoot) and maximum infestation was observed during third week of March, which declined thereafter (0.10 aphids/ shoot) during third week of April. These results are in close proximity with the findings of Sharma et al. (2013), Soni et al. (2013), Ahmad et al. (2016), Ashfaq et al. (2007) and Wains et al. (2010). Almost similar observations ha also been reported by Slman and Ahmed (2005).

The results on the grubs and pupae of coccinellids are presented in Fig. 1, which revealed that their appearance commenced from last week of February. Their population increased gradually from 0.30 to 1.30 grubs and pupae/ m^2 during last week of March. Maximum population (2.00 grubs and pupae/ m^2) during first week of April, which declined thereafter (0.10 grubs and pupae/ m^2) during first week of May. Peak population of grubs of coccinellids had been earlier reported during third week of March by Soni et al. (2013).

Table 1. Seasonal abundance of aphids in wheat

Sampling date	Aphids (number/ shoot)	Plant infestation (%)
January 2	0.10±0.13	4.00
9	0.17±0.20	7.00
16	0.37±0.43	11.00
23	0.35±0.27	13.00
30	0.50±0.29	14.00
February 6	0.87±0.55	25.00
13	1.05±0.90	28.00
20	2.32±2.11	47.00
27	3.62±1.51	64.00
March 6	12.02±5.08	80.00
13	16.70±3.47	89.00
20	30.40±4.59	100.00
27	28.62±4.23	96.00
April 3	18.07±8.93	89.00
10	0.95±0.27	28.00
17	0.10±0.13	5.00
24	0.00±0.00	0.00
May 1	0.00±0.00	0.00

Values mean of 10 observations ± SD

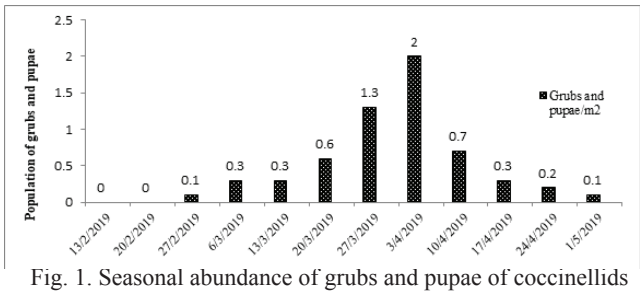

Fig. 1. Seasonal abundance of grubs and pupae of coccinellids

Amongst the seven coccinellids, *C. septempunctata, Hippodamia variegata* (Goeze) and *Coccinella transversalis* F. were observed in large proportion whereas, *Cheilomenes sexmaculata* (F.), *Oenopia sexareata* (Mulsant), *O. kirbyi* Mulsant and *Illeis indica* Timberlake were observed in less proportion. The peak population of adults of *C. septempunctata* (4.70 adults/ m^2) and *H. variegate* (2.30 adults/ m^2) was observed during first week of April (Table 2). The population of *C. transversalis* was comparatively low. The population started declining thereafter and minimum population of 0.50 beetles per m^2 was observed during first week of May. These findings are corroborated by those of Dhadwal et al. (2014) and Soni et al. (2013) who reported the peak population of coccinellids during second week of April and end of March, respectively. However, Singh (2008) reported this peak period as the third week of March in Punjab.

Six species of syrphids viz., *Episyrphus balteatus* (De Geer), *E. viridaureus* (Wiedemann), *Ischiodon scutellaris* (F.), *Sphaerophoria* sp. and *Melanostoma* spp. were observd (Fig. 2). Their appearance commenced from first week of March (0.65 adults/ five sweeps), with maximum (13.00 adults/ five sweeps) during third week

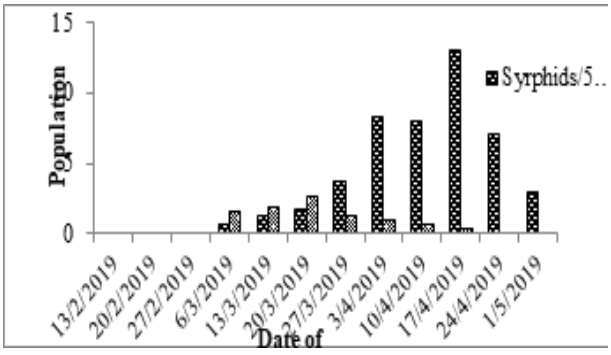

Fig. 2. Seasonal abundance of adult syrphids and lacewings

Table 2. Seasonal abundance of adult coccinellids

Sampling date	Adult coccinellids/m^2							Total
	C. septem-punctata	*H. varie-gata*	*C. transver-salis*	*C. sexmac-ulata*	*O. sex-areata*	*O. kirbyi*	*I. indica*	
Feb 13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.10	0.20	0.00	0.00	0.00	0.00	0.00	0.30
27	0.40	1.20	0.00	0.00	0.00	0.00	0.00	1.60
Mar 6	0.80	0.50	0.00	0.00	0.10	0.00	0.00	1.40
13	0.80	0.50	0.10	0.00	0.00	0.00	0.00	1.40
20	0.80	0.60	0.10	0.00	0.10	0.00	0.00	1.60
27	3.90	2.20	0.40	0.00	0.00	0.00	0.00	6.50
Apr 3	4.70	2.30	0.60	0.50	0.00	0.00	0.00	8.10
10	2.30	2.10	0.60	0.00	0.00	0.00	0.00	5.00
17	0.70	0.70	0.10	0.00	0.00	0.00	0.00	1.50
24	0.20	0.30	0.10	0.00	0.00	0.10	0.10	0.80
May 1	0.30	0.20	0.00	0.00	0.00	0.00	0.00	0.50

of April, and declining thereafter. The results of seasonal abundance of lacewings revealed that *Micromus* sp. started appearing from first week of March and its population found to be increased gradually and reached to maximum of 2.65 adults/ five sweeps during third week of March, which declined thereafter, with the least being 0.30 adults/ five sweeps during third week of April. The parasitisation by *Diaeretiella* sp. increased gradually from 1.23% during last week of February to 12.75% during last week of March (Fig. 3) with peak (16.60%) being during first week of April.

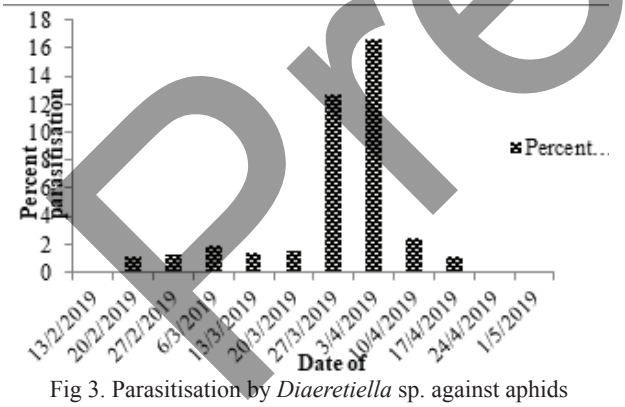

Fig 3. Parasitisation by *Diaeretiella* sp. against aphids

Predatory potential of *C. septempunctata*

Third instar grubs of *C. septempunctata* with 1, 3, 5 and 7 number of grubs consumed 78.54±0.59, 204.53±1.62, 307.03±1.80 and 406.64±1.60 aphids, respectively whereas, adult of *C. septempunctata* with 1, 3, 5 and 7 number of beetles fed 625.46±0.18, 1491.12±0.36, 2261.80±0.39 and 2853.21±0.99 aphids, respectively during their life span. Aphid consumption with one number of grub and beetle was significantly higher i.e. 15.76 and 17.87 aphids/ day, respectively as compared to with 3, 5 and 7 number of grubs and beetles (Table 3), which indicated that as the number of predators increased over the constant host population, the predatory potential of the *C. septempunctata* showed a decreasing trend.

The results of present study are in conformity with Rauf et al. (2013), who reported the third instar grub consumed 73.80±2.97 aphids during its developmental period which was in close proximity with our findings. Lakhanpal and Raj (1998) reported that the longevity of adult beetles of *C. septempunctata* varied from 30.2±2.46 to 34.58±1.16 days on different aphid species and consumed 628±3.42 aphids during their life period, which was in corroboration with the results of present study. However, Khursheed et al. (2006) reported that the adult of *C. septempunctata* consumed 1029±20.52 and 1042±52.89 aphids during entire life.

Population dynamics

Data on correlation analysis between the population of aphids and their associated natural enemies presented in Table 4 revealed that the coccinellids, lacewings and parasitoids population had positive and significant correlation with aphid population (r = 0.6057, 0.8979 and 0.6308, respectively), though syrphid population had positive but non-significant correlation with aphid population (r = 0.3640). The results of present study were identical to the findings of Soni et al. (2013), who also reported that the coccinellids showed a

Table 3. Predatory potential of *C. septempunctata* on *R.padi* infesting wheat

No. of 3rd instar grubs released	Duration (in days)	Total predatory potential	Aphids consumed/ day/grub	No. of adults released	Duration (in days)	Total predatory potential	Aphids consumed/day per beetle
1	4.40±0.16	78.54±0.59	15.76 (4.09)	1	30.30±1.05	625.46±0.18	17.87 (4.34)
3	4.60±0.18	204.53±1.62	13.64 (3.82)	3	30.90±1.00	1491.12±0.36	14.23 (3.90)
5	4.60±0.24	307.03±1.80	12.73 (3.70)	5	32.00±1.10	2261.80±0.39	13.48 (3.80)
7	4.67±0.33	406.64±1.60	12.15 (3.62)	7	30.30±1.47	2853.21±0.99	12.91 (3.73)
CD (p=0.05)			0.18	CD (p=0.05)			0.13

Figures in parentheses square root transformed values; mean of 5 replications

Table 4. Correlation coefficient (r) between aphids and population of their associated natural enemies

	Coccinellids	Syrphids	Lacewing	*Diaretiella* sp. #
Aphids	0.6057*	0.3640	0.8979*	0.6308*

* Significant at p= 0.05; # % parasitisation

strong positive correlation with the increase in aphid population.

Data on correlation analysis between weather factors and aphids and their associated natural enemies population depicted in Table 5 revealed that coccinellid and syrphid population had positive and significant correlation with maximum temperature (r= 0.5074 and 0.6741, respectively) and also with minimum temperature (r = 0.5375 and 0.7158, respectively). However, aphids, lacewings and parasitoids population had positive but non-significant correlation with maximum temperature (r = 0.3304, 0.3156 and 0.4131, respectively) and also with minimum temperature (r = 0.2783, 0.2688 and 0.4033, respectively).

Aphids, lacewings and parasitoid population had

Table 5. Correlation coefficient (r) between weather factors and population of aphids and their associated natural enemies

	Maximum temperature (ºC)	Minimum temperature (ºC)	Rainfall (mm)	RH (%)
Aphids	0.3304	0.2783	-0.0925	-0.3926
Coccinellids	0.5074*	0.5375*	0.0282	-0.1709
Syrphids	0.6741*	0.7158*	0.1811	-0.3656
Lacewings	0.3156	0.2688	-0.0793	-0.5877
Diaretiella sp. #	0.4131	0.4033	-0.0877	-0.1607

* Significant at p= 0.05; # % parasitisation

negative and non-significant correlation with rainfall (r = -0.0925, -0.0793 and -0.0877, respectively), whereas coccinellid and syrphid population had positive but non-significant correlation with rainfall (r = 0.0282 and 0.1811, respectively). Aphids, coccinellids, syrphids, lacewings and parasitoid population had negative and non-significant correlation with relative humidity (r = -0.3926, -0.1709, -0.3656, -0.5877 and -0.1607, respectively). Sharma et al. (2013), Ahmad et al. (2016), Ashfaq et al. (2007), Wains et al. (2010) reported that the aphid population had positive correlation with the maximum and minimum temperature whereas, negative with the rainfall and humidity, which was in corroboration with the results of present study.

The aphid population was maximum during third week of March and the activity of the coccinellids also showed the increasing trend from the third week of March till first week of April. It can be concluded that the coccinellids have the greater potential for suppression of aphids in wheat.

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