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Seasonal incidence of aphid, (*Rhopalosiphum padi* L.) and its natural enemies on forage oat (*Avena sativa* L.)

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Abstract

The field experiment was carried out at AICRP on Forage Crop and Utilization, M.P.K.V, Rahuri (M.S.) during *Rabi* 2019-2020. During the study of seasonal abundance, oat aphid noticed in middle of December 2019 (13.90 aphid/tiller). Thereafter, population of oat aphid showed increasing trend up to middle of February, 2020 (93.20 aphid/tiller). Population of oat aphid decreased thereafter and lowest population was noticed during first week of March, 2020 (12.50 aphid/ tiller). Oat aphid showed negative correlation with minimum temperature and positive correlation with coccinellid predators and Chrysoperla.

Lady bird beetles were active throughout the crop season; initial population was noticed during last week of December, 2019 (01 LBB/tiller). The population of grub of lady bird beetles started increasing simultaneously with aphid population and reached to its peak during first week of February, 2020 (3.40 LBB/tiller). The lady bird beetle population was negatively correlated with minimum temperature and chrysoperla and positively with oat aphids.

Keywords: Oat, seasonal abundance, oat aphid, lady bird beetle and *C. carnea*

Introduction

Oat (*Avena sativa* L.) belongs to gramineae family is one of the important cosmopolitan forage crops in the world agriculture ecosystem. Oat ranks sixth in the world cereal production following wheat, maize, rice, barley and sorghum. Oat is multipurpose cereal used primarily for animal feed, human food and industrial purpose. It is cultivated all over the world and major producing countries are Russia, Canada, Poland and USA. It has excellent growth habit, quick recovery after cutting and good quality herbage. It is palatable, succulent and nutritious forme crop. The protein quality of oat is excellent. Oat requires long and cool season for its growth; therefore, it is successfully grown in the plains and hilly areas of the country. Oat is a seasonal crop and can be sown either in autumn (for late summer harvest) or in the spring (for early autumn harvest). It is known locally as "jau".

In India it is grown in Punjab, Haryana, Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharashtra and West Bengal. According to Indian Grassland and Fodder Research Institute (IGFRI), Jhansi, the total area covered under oat cultivation in the country is about 500,000 ha. The crop occupies maximum area in Uttar Pradesh (34%), followed by Punjab (20%), Bihar (16%), Haryana (9%), and Madhya Pradesh (6%). Rest of the area is shared by other states *viz.*, Gujarat, Maharashtra, Orissa, Uttaranchal *etc.* Oats remain an important grain crop for people in marginal ecologies throughout the developing world and in developed economies for specialist uses. In many parts of the world oats are grown for use as grain as well as for forage and fodder, straw for bedding, hay, haylage, silage and chaff. Livestock grain feed is still the primary use of oat crops, accounting for an average of around 74% of the world's total usage in 1991 to 1992 (Welch,1995) [9].

Oat suffers qualitative and quantitative damage by various pests and diseases. However, Lone *et al.* (2009) [3] reported number of insect pest from Baramulla at different stages of crop growth and the status of the insect pests were recorded as either sporadic or minor in category; pests included *Mythimna seperata*, *Agrotis ipsilon*, *Stenothrips granium*, *Schizaphis graminum*, *Lecanium viridae*, *Heiroglyphus banian*, *Oscinella frit* *etc.* Indian Grassland and Fodder Research institute, IGFRI, Jhansi reported two insect-pests on oat namely: Bird cherry aphid, (*Rhapalosiphum* spp.) and Thrips (*Holothrips ganglbauen*).

Materials and Methods

The present investigation was carried out in *Rabi* season 2019-20. The experiments were conducted on the farm of All India Coordinated Research Project on Forage Crops and Utilization, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra. In order to study the population fluctuation of oat aphid and their natural enemies on forage oat, variety 'Kent' seeds were sown with line sowing method on the well cultivated soil in December, 2019. Ten tillers were selected randomly and marked with label on bamboo sticks for recording the observations of oat aphid and their natural enemies. The observations were recorded early in the morning at an interval of 7 days. Average population per tiller was calculated separately for aphid and their natural enemies. The data on weather parameters *viz.*, maximum temperature, minimum temperature, rainfall and relative humidity were obtained from the Department of Physics, Dr. Annasaheb Shinde College of Agricultural Engineering, MPKV, Rahuri for statistical analysis.

Result and Discussion

Seasonal Abundance of Oat Aphid and Their Natural Enemies on Forage Oat

Observations on average number of aphids and their natural enemies *viz.*, *chrysoperla* and predatory coccinellid were recorded at an interval of one week on forage oat starting from 1st week of October, 2019 to last week of March, 2020 as given in Table 1. The weekly data on seasonal abundance of aphids and predators in oat ecosystem are presented in Table 1. The correlation coefficient ('r' values) between the weekly data on aphids, natural enemies and meteorological parameters are indicated in Table 02. The fluctuation in the

aphid infestation, natural enemies and corresponding temperature, relative humidity and rainfall during crop period is shown graphically in Fig.1.

Oat Aphid

Periodic abundance of oat aphid (*Rhopalosiphum padi* L.) was observed during the investigation. The data on average number of aphids per tiller recorded from 1st week of October, 2019 to last week of March, 2020 is given in Table 1 and depicted in Fig. 1.

It is seen from the table that, population of oat aphid was noticed during 3rd week of December, 2019 i.e. 51 meteorological weeks (MW). It was 13.90 aphids/tiller. During this week, mean maximum and minimum temperatures, morning and evening relative humidity and rainfall recorded were 29.39 °C and 14.67 °C and 65.08 and 41.05 per cent and 0.0 mm, respectively. The population increased at faster rate and reached its peak (93.20 aphids /tiller) during the 2nd week of February, 2020 (7th MW). During this period, mean maximum and minimum temperatures, morning and evening relative humidity and rainfall recorded were 29.79 °C and 11.56 °C and 59.00 and 32.72 per cent and 0.0 mm, respectively. Thereafter it started declining in 3rd week of February, 2020 (8th MW). It was minimum in 1st week of March, 2020 (10th MW) with the population of 12.50 aphids/tiller. During this period, mean maximum and minimum temperatures, morning and evening relative humidity and rainfall recorded were 31.08 °C and 12.26 °C and 55.56 and 29.31 per cent and 0.0 mm, respectively. Thereafter, aphid population was not noticed to the end of season.

Table 1: Seasonal abundance of oat aphids its predators in oat ecosystem

Met. Week	Date	Aphids/ tiller	Coccinellid predators/tiller	<i>C. carnea</i> grubs /tiller	Abiotic factors				
					Temp Max	Temp Min	R.H. (%) Morn	R.H. (%) Even	Rainfall (mm)
40 (2019)	05.10.19	0.00	0.00	0.00	28.1	22.65	85.93	77.50	0
41	12.10.19	0.00	0.00	0.00	28.98	21.65	85.93	69.83	0
42	19.10.19	0.00	0.00	0.00	30.15	20.7	83.02	61.08	0
43	26.10.19	0.00	0.00	0.00	30.55	19.6	79.06	54.88	0
44	02.11.19	0.00	0.00	0.00	30.60	18.57	74.88	51.77	0
45	09.11.19	0.00	0.00	0.00	30.42	17.69	70.98	48.92	0
46	16.11.19	0.00	0.00	0.00	30.3	16.70	69.00	45.77	0
47	23.11.19	0.00	0.00	0.00	30.45	16.30	68.41	44.83	0
48	30.11.19	0.00	0.00	0.00	30.09	15.62	66.93	43.65	0
49	07.12.19	0.00	0.00	0.00	30.15	15.26	66.93	42.05	0
50	14.12.19	0.00	0.00	0.00	30.00	14.74	65.03	40.99	0
51	21.12.19	13.90	0.00	0.00	29.39	14.67	65.08	41.05	0
52	28.12.19	17.30	1.00	0.00	30.38	14.26	64.22	40.17	0
1 (2020)	04.01.20	22.40	1.00	0.00	30.8	10.90	67.00	31.00	0
2	11.01.20	28.80	2.00	0.00	29.10	9.38	65.87	32.62	0
3	18.01.20	30.10	2.50	0.00	27.94	9.42	56.72	34.50	0
4	25.01.20	42.80	2.70	0.50	28.51	10.34	60.39	34.73	0
5	01.02.20	69.30	3.10	1.00	28.88	10.85	59.89	34.37	0
6	08.02.20	88.70	3.40	1.00	28.66	11.26	59.41	33.00	0
7	15.02.20	93.20	3.00	1.40	29.79	11.56	59.00	32.72	0
8	22.02.20	58.60	3.00	1.60	30.19	11.88	58.10	30.53	0
9	29.02.20	25.30	2.40	2.00	30.64	12.00	56.00	30.53	0
10	08.03.20	12.50	1.00	1.00	31.08	12.26	55.56	29.31	0
11	15.03.20	0.00	0.00	0.00	31.18	12.33	52.82	28.61	0
12	22.03.20	0.00	0.00	0.00	31.43	12.55	52.82	27.73	0
13	29.03.20	0.00	0.00	0.00	31.80	12.92	51.88	27.77	0

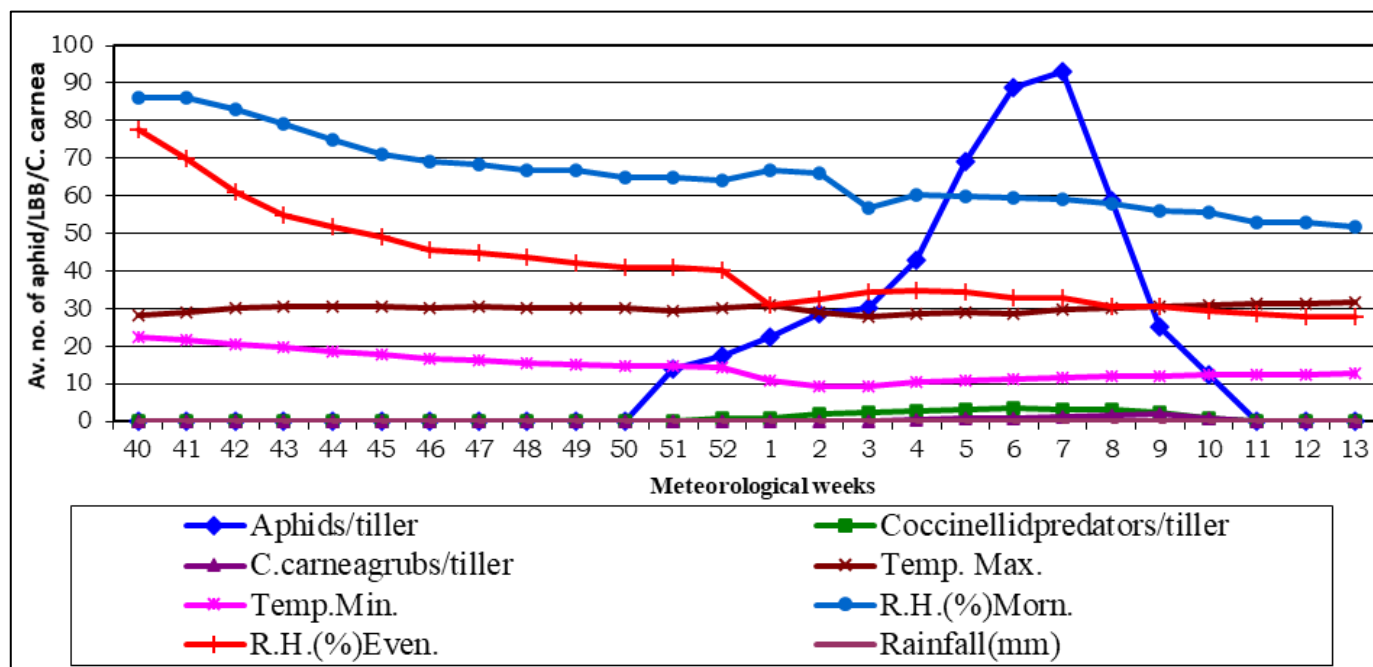


Fig 1: Seasonal abundance of oat aphids and predators in oat ecosystem

Table 2: Correlation coefficient (r) of oat aphid with their natural enemies and abiotic factor

Variable	Coccinellid predators	C. carnea grub	Metrological parameters				
			Temp max (°C)	Temp Min (°C)	Hum (%) Morn	Hum (%) Even	Rainfall (mm)
Oat aphid	0.924**	0.706**	-0.221	- 0.566**	-0.22	- 0.313	-
Coccinellid	-	-0.75**	0.273	0.638**	0.261	0.339	-
C. carnea Grub	-	-	-0.025	-0.357	-0.296	-0.33	-

* Significant at 5% level (p= 0.404)

** Significant at 1% level (p= 0.515)

Correlation studies

From Table 2, it was observed that the average number of oat aphids per plant showed highly significant negative correlation with minimum temperature (-0.566**). The average number of aphids per plant showed highly positive correlation with average number of coccinellid grubs (0.924**) and C. carnea grubs (0.706**)

Further, it was observed that with decrease in minimum temperature there was corresponding increase of aphid population while, increase in the minimum temperature there was decline in the population of oat aphid on forage oat.

Overall result indicated that the population of aphid varied from 13.90 to 93.20 per tiller throughout the crop season. The population of aphid was maximum during 2nd week of February, 2020 (7th MW). The minimum temperature and evening relative humidity started decreasing continuously, the aphid population showed increasing trend and reached at its peak during 2nd week of February (7th MW). Hence, decrease in minimum temperature resulted in enhanced population of aphids in forage oat.

Various research workers carried out the work on seasonal abundance of aphid A. craccivora. Sharma et al. (1994) [6] reported that population of aphid reacted sharply to changing weather factors like temperature and relative humidity. They also reported that the weather parameters collectively accounted for a wide fluctuation in aphid population from 31.55% to as high as 99.96%. Upadhyay et al. (1980) [8] stated that the increase in aphid population was negatively correlated with temperature. Tambe (2009) [7] observed that population of A. craccivora showed highly significant negative

correlation with minimum temperature. Nasir and Ahamad (2001) [4] found that temperature had a significant and positive role in fluctuating aphid density, and observed that most favorable conditions for the growth of aphid populations were 30.3 °C maximum temperatures, 13.7 °C minimum temperature and 45.3% relative humidity. On the other hand, relative humidity revealed negative and significant correlation with aphid population. Present results are in conformity with the findings of earlier workers with little variation in climatic fluctuation.

Natural Enemies

Coccinellid predators

During the study, observations on average number of lady bird beetle (LBB) grubs on oat from 1st week of October, 2019 to last week of March, 2020 are given in Table 1 and depicted in Fig. 1.

Population of coccinellid predators in 1st week of October (40th MW), was 0.0 per tiller and in last week of December, 2019 (52nd MW) with 1.00 grub/tiller. During this period, mean maximum and minimum temperatures, morning and evening relative humidity and rainfall recorded were 30.38 °C and 14.26 °C and 64.22 and 40.17 per cent and 0.0 mm, respectively. The population of the grubs increased very slowly up to the 1st week of February, 2020 (6th MW) with its maximum (3.40 grubs/tiller) level. The mean maximum and minimum temperatures, morning and evening relative humidity, during this period were 28.6 °C and 11.26 °C, 59.41 and 33.00 per cent, respectively. Thereafter, the population of the grubs started decreasing (3.00 grubs/tiller) from 2nd week

of February 2020 (7th MW). During this period, mean maximum and minimum temperatures, morning and evening relative humidity and rainfall recorded were 29.79 °C and 11.56 °C and 59.00 and 32.72 per cent and 0.0 mm, respectively. At the end of season population of coccinellid disappeared from 2nd week of March, 2020 (11th MW). During this period, mean maximum and minimum temperatures, morning and evening relative humidity and rainfall recorded were 31.18 °C and 12.33 °C and 52.82 and 28.61 per cent and 0.0 mm, respectively. The aphid population during the period showed decreasing trend.

Correlation studies

The influence of meteorological parameters and aphids on the abundance of coccinellid predators on forage oat was studied. The average number of grubs per plant was correlated with maximum and minimum temperature, morning and evening relative humidity, rainfall and average number of oat aphids per plant.

The correlation coefficient (r) of coccinellid predators on forage oat plants with meteorological parameters and average population of oat aphid is presented in Table 2. It is seen from the data, that the average number of coccinellid grubs per tiller showed highly significant positive correlation with minimum temperature (0.638**) and grubs of coccinellid predators showed highly positive correlation with oat aphids (0.924**). However *C. carnea* grubs showed highly negative correlation (-0.75**).

From Table 2 it is observed that, the population of lady bird beetle grub increased with decrease in minimum temperature. With increase in aphid population, the population of coccinellid predators also increased and with decline of aphid population the population of coccinellid predators also declined.

Various research workers carried out work on seasonal abundance of lady bird beetle. Ingwale and Tambe (2007) [2] observed that the infestation of aphid was positively correlated with lady bird beetles. With decrease in minimum temperature there was a corresponding increase in aphid population which resulted in increase of coccinellid predators. Sabaria (1980) [5] reported that the lady bird beetle was effective predator on aphids as compared to the other species of predators in cowpea field. Tambe (2009) [7] found that the average number of lady bird beetles showed highly significant positive correlation with cowpea aphid and showed highly significant negative correlation with maximum and minimum temperature. Alate (2012) [1] stated that the coccinellids and *C. carnea* showed highly significant positive correlation with aphid and highly significant negative correlation with minimum temperature.

Chrysoperla carnea

The data pertaining to the average number of *C. carnea* grubs per tiller are given in Table 1 and Fig. 1.

The population of *C. carnea* appeared (0.50 grub/tiller) at the 4th week of January, 2020 (4th MW). During this period, oat aphids were observed to be well established on oat. The mean maximum and minimum temperatures, morning and evening relative humidity during this period were 28.51 °C and 10.34 °C, 60.39 and 34.73 per cent, respectively. The highest population of *C. carnea* grub (2.00/tiller) was noticed in last

week of February 2020 (9th MW). It started decreasing (1.00 grub/tiller) from 1st week of March, 2020 (10 MW) and disappeared in 2nd week of March, 2020 (11th MW). During this period decreasing trend of aphid population was also noticed.

Correlation studies

The influence of meteorological parameters, coccinellid predators and aphids on the abundance of *C. carnea* on forage oat was studied. The average number of *C. carnea* grubs per plant was correlated with max and min temperature, morning and evening relative humidity, rainfall and average number of oat aphids per plant.

The correlation coefficient (r) of *C. carnea* grubs on forage oat plants with meteorological parameters and average population of oat aphid is presented in table 02. It is seen from the data, that the average number of *C. carnea* grubs per plant showed non significant negative correlation with maximum and minimum temperatures, morning, evening relative humidity, oat aphid and coccinellid predators. From table 02 it is observed that the population of *C. carnea* grubs was not much affected by abiotic and biotic factors.

Ingwale and Tambe (2007) [2] found that infestation of aphid was positively correlated with *chrysoperla* larval population. With decrease in minimum temperature there was a corresponding increase in aphid population. Present results are in conformity with the findings of earlier workers with little climatic fluctuation. Alate (2012) [1] observed that the coccinellids and *C. carnea* showed highly significant positive correlation with aphid and highly significant negative correlation with minimum temperature.



Plate 1: Abundance of oat aphid (*Rhopalosiphum padi* L.) on forage oat



Plate 2: Eggs of *C. carneaon* forage oat

Conclusions

Following conclusions were drawn from the investigation.

1. The infestation of aphids started from 3rd week of December, 2019 (51st MW) and reached peak in the middle of February, 2020 (7th MW).
2. Minimum temperature and relative humidity affected the aphid infestation.
3. The population of predatory lady bird beetles was coincided with the increase in aphid population. The predatory lady bird beetles had highly significant and positive correlation with aphid population and minimum temperature.

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