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RH Parmar
Department of Agricultural Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

MR Dabhi
Department of Agricultural Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

AD Kalola
Department of Agricultural Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

NV Thakor
Department of Agricultural Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

Corresponding Author:
RH Parmar
Department of Agricultural Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

Seasonal occurrence of the corn leaf aphid, *Rhopalosiphum maidis* (Fitch) (Hemiptera: Aphididae) and coccinellids on maize crop

RH Parmar, MR Dabhi, AD Kalola and NV Thakor

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Abstract
Field experiment on Seasonal occurrence of *Rhopalosiphum maidis* (Fitch) and coccinellids on maize crop was conducted during rabi season of 2021-22 at Entomology farm, BACA, AAU, Anand. During seasonal occurrence study, maize aphid species R. maidis was noticed from last week of December, 2021 to first week of March, 2022. The aphid infestation on the tassel began in the fourth week of December, progressively expanded and peaked (561. 8 aphids/tassel) in the fifth week of January (5th SMW). Similarly, an aphid infestation on cob began in the first week of January, 2022. Its population was initially low, but it gradually increased in numbers and peaked in the fifth week of January with 472.2 aphids/cob (5th SMW). The incidence of aphid declined from 1st week of February. Aphid infestation showed non-significantly negative correlation with maximum temperature. The minimum temperature had a very highly negative correlation (r=-0.81**). Aphids and relative humidity correlated positively in the morning and negatively in the evening. The activity of coccinellids was observed from 4th week of December to 1stweek of March. In January, the fifth standard meteorological week (for grubs) and the fourth standard meteorological week (for adults) both observed relatively higher population of coccinellids on tassels (2.24 grubs/tassel and 2.22 adults/tassel). Similarly on cob, activity of coccinellids observed during 1st week of January to 1st week of March. The higher population of coccinellids on cob was observed during 1th week of February for grubs (2.00 grubs/tassel) and 5th week of January for adults (2.22 adult/tassel). Decreasing trend of population of coccinellid grub was found from 1st week of February to 1st week of March and 5th week of January to 1st week of March for adults.

Keywords: Maize aphid, Seasonal Occurrence, *Rhopalosiphum maidis*, Coccinellids

Introduction
Maize (*Zea mays* L.), which originated in Mexico, is a member of the Poaceae family. It is a crop with a wide range of adaptability and a high potential output (Tali *et al*., 2018a) [10]. It is the most significant cereal crop, grown all over the world and has the biggest production of any grain. Due to its numerous uses, maize is frequently referred to as the "Queen of Cereals" (Tali *et al*., 2018b) [11]. Maize grain contains protein (10%), oil (4%), carbohydrates (70%), fat (5 to 7%), fibers (5 to 7%) and minerals (2%) (Tali *et al*., 2018a) [10]. Because the maize crop has lush growth, soft, succulent foliage, an endless supply of food, space, and shelters, it attracts a large number of insect pests. Among them, *R. maidis* is a significant agricultural polyphagous, multivoltine pest, also one of the most severe pests of maize. Although it has Asian origins, it may found in all tropics and temperate regions of the planet (Hill, 1987; Blackman and Eastop, 2000; Kuo *et al*., 2006) [6, 2, 7]. It is found in barley, oats, maize and occasionally in wheat. It's most common wild host is Jhonson grass. Both are connected to orchards and fields of cereal. Two weeds, *Chromolaena odorata* and *Cynodon dactylon*, served as alternate food sources and maintained the population alive from October to March. The main food plants are wheat, barley and sorghum (Ganguli and Raychaudhary, 1985) [4]. It produces a large amount of honeydew, which causes inflorescences to be sterilized and leaves to become malformed (Hill, 1987; Bing *et al*., 1991; Blackman and Eastop, 2000) [6, 1, 2]. The sucking cell sap by sharp needle like stylet into cell that result into stunted growth of plant and secreting honeydew like sweet sugary substance by nymphs and adults gives the plant its sticky appearance, while also luring black ants. 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.

Materials and Methods

The present evaluation of the Seasonal occurrence of aphid, *Rhopalosiphum maidis* (Fitch) and coccinellids on maize, were carried out on the Entomology farm, BACA, AAU, Anand during *rabi* 2021-22. To record the seasonal occurrence of the aphid, *R. maidis* and its natural enemies like coccinellids, the maize crop was sown in area of 120 sq.m. It was grown using all conventional agronomic practices, with the exception of using pesticides. The plot was divided into six equal quadrates. Observations of each quadrate (4×5m) were recorded at weekly interval starting from the commencement of the pest incidence till the harvest of the crop. For this 30 randomly selected plants were tagged and observations on aphid were recorded from the plant by visual count during morning hours. The observations on population of aphid were recorded on randomly selected shoot, tassel and cob from each tagged plant and mean population of aphid per shoot, tassel and cob was worked out. Weekly meteorological data recorded at the meteorological observatory, AAU, Anand were collected and correlation coefficient values were calculated in order to determine the impact of weather parameters.

Results and Discussion

The aphid, *R. maidis* was found to be the major insect pest causing damage to the maize crop started in the fourth week of December, 2021 and continued until the crop was harvested. The data on the *R. maidis* population observed on maize plants are provided in Table 1 and Fig. 1. Aphid activity started in December and continued upto March. The aphid infestation on the tassel began in the fourth week of December, 2021 (52nd SMW). Aphid population increased gradually in small counts (54.7 aphids/tassel), progressively expanded and peaked (561. 8 aphids/tassel) in the fifth week of January (5th SMW). Once the crop reached maturity, the population gradually reduced until the last week of March (1st SMW). Between the second to fifth weeks of January, there was higher infestation of aphid (2nd SMW to 5th SMW). The maximum aphid population on maize tassel reached during January, 2022. Similar to above, an aphid infestation on cob began in the first week of January, 2022 (1st SMW). Its population was initially low (47.3 aphids/cob), but it gradually increased in numbers and peaked in the fifth week of January with 472.2 aphids/cob (5th SMW). Once the crop reached maturity, the population gradually decreased until the first week of March (1st SMW). Between the second to fifth weeks of January, there was maximum infestation of aphid (2nd SMW to 5th SMW). Ghortale (2015) [5] from Rahuri also observed aphid incidence in December, 2014 to February, 2015. According to the report of Varadharasu *et al*. (2019) [12], the incidence of *R. maidis* began to develop in December (0.57/leaf) and persisted through March. However, Aphid population increased in the second and third weeks of February after increasing in the second and third weeks of January as reported by Singh (2011) [9]. According to Choudhary *et al*. (2017) [3], the aphid, *R. maidis* population peaked in the first week of February after first emerging in the first week of January. As per the report of Patel (2021) [8] came to the conclusion that the aphid first occurred in the second week of January and gradually increased and goes down up to March, 2021. The aforementioned reports thus slightly differ from the current findings. The variance could result from many environmental factors at various sites. The correlation coefficient value indicated that bright sunshine hour exhibited a non-significant positive correlation with aphid population on tassel. The maximum temperature was determined to be non-significantly negative correlation. The minimum temperature had a very strong negative correlation (r=-0.83**). Aphids and relative humidity correlated positively in the morning and negatively in the evening. Significant negative association was established between the morning vapour pressure (r=-0.58*) and evening vapour pressure (r=0.55*). Aphid population and wind speed showed a weakly positive correlation. Bright sunshine hour had a non-significant positive correlation in the aphid on cob study. A non-significant negative correlation was noticed at the maximum temperature. The lowest temperature had a very strong negative correlation (r=-0.83**). Aphids and relative humidity correlated positively in the morning and negatively in the evening. Significantly negative correlations established between the vapour pressure in the morning (r=-0.61*) and evening (r=-0.60*). Aphid population and wind speed showed a weakly positive correlation. Similar to the current findings, Ghortale (2015) [5] also noted a highly significant negative correlation between aphid infestation and the minimum temperature and non-significantly positive correlation with humidity.

Table 1: Seasonal occurrence of corn leaf aphid, *R. maidis* and its natural enemies on maize during *Rabi*, 2021-22

Month	Week	SMW	No. of aphids Per		No. of Lady bird beetle			
					Grub per		Adult per	
			Tassel	Cob	Tassel	Cob	Tassel	Cob
December, 2021	I	49	0.00	0.00	0.00	0.00	0.00	0.00
	II	50	27.89	0.0	0.24	0.00	0.42	0.00
	III	51	86.54	0.0	0.42	0.00	0.84	0.00
	IV	52	174.7	35.08	0.68	0.42	1.22	0.42
January, 2022	I	1	262.6	107.3	1.24	0.60	1.48	0.84
	II	2	386.3	294.9	1.62	0.82	1.86	1.42
	III	3	460.7	358.4	1.86	1.44	2.00	1.86
	IV	4	522.4	415.2	2.00	1.62	2.22	2.00
	V	5	561.8	472.2	2.24	1.84	1.86	2.22
February, 2022	I	6	433.8	360.7	1.82	2.00	1.62	1.84
	II	7	365.6	243.3	1.44	0.84	1.24	1.46
	III	8	170.2	164.1	0.82	0.68	0.68	0.82
	IV	9	44.8	71.7	0.64	0.46	0.42	0.66
March, 2022	I	10	14.8	32.5	0.26	0.22	0.22	0.24

Note: SMW = Standard Meteorological Week

According to Chaudhary *et al.* (2017) [4] likewise came to the conclusion that the maximum temperature showed a significant negative association (r=-0.76) and relative humidity showed a significant positive correlation (r=0.80). However, Varadharasu *et al.* (2019) [12] found a positive correlation between the occurrence of aphids and the minimum and maximum relative humidity.

Table 2: Correlation coefficient (r) between weather parameters and population of aphid, *R. maidis* on maize (*Rabi*, 2021-22)

Weather parameters	Correlation co-efficient (r)	
	Tassel	Cob
Bright sunshine hours, hr/day (BSS)	0.073	0.268
Maximum Temperature, ℃ (Max T)	-0.386	-0.252
Minimum Temperature, ℃ (Min T)	-0.838**	-0.832**
Morning Relative Humidity,% (RH_1)	0.381	0.290
Evening Relative Humidity,% (RH_2)	-0.271	-0.375
Morning Vapour pressure, mm of Hg (VP_1)	-0.588*	-0.619*
Evening Vapour pressure, mm of Hg (VP_2)	-0.554*	-0.600*
Wind Speed, km/hr (WS)	0.251	0.149

The population of ladybird beetle, *Menochilus sexmaculata* (Fab.) on maize crop appeared on tassel was observed from the fourth week of December to the first week of March during the 52nd SMW to 10th SMW. In January, the fifth standard meteorological week (for grubs) and the fourth standard meteorological week (for adults) both observed relatively higher population of coccinellids on tassels (2.24 and 2.22 adults/tassel). From the fifth week of January to the first week of March, the population of coccinellid grubs and adults noticed decreasing (4th SMW to 10th SMW). The aphid population continued to decline downward during these months. Similarly on cob, activity of coccinellids observed during 52nd standard meteorological week (4th week of December) to 10th standard meteorological week (1st week of March (Table 4.2). The higher (2.00 and 2.22 adult/tassel) population of coccinellids on cob was observed during 6th standard meteorological week (1th week of February) for grubs and 5th standard meteorological week (5th week of January) for adults. Population of coccinellid grub declined in trend from 1st week of February to 1st week of March (6th SMW to 10th SMW) and 5th week of January to 1st week of March (5th SMW to 10th SMW) for adults. On the tassel, there was an extremely significantly positive association between the coccinellid grubs and adults and aphids (r= 0.98 and 0.94, respectively). Population of coccinellid grub (r=0.95**) and adult (r=0.98**) have a significantly positive correlation with aphid on cob (Table 4.4). Present findings are confirmation with Waghmare *et al.* (1995) where in *R. maidis* population was negatively correlated with temperature and it was positively correlated with relative humidity. Aphid infestation had a non-significantly positive correlation with humidity and a highly significant negative correlation with lowest temperature (Ghortale, 2015) [5]. According to Choudhary *et al.* (2017b) [4] the highest temperature showed a significant negative association (r=-0.76) and the relative humidity showed a considerable positive correlation (r=0.80) with the aphid population.

Table 3: Correlation coefficient (r) between population of coccinellid and aphid, *R. maidis* on maize during *Rabi*, 2021-22

Stages of Coccinellids	Correlation co-efficient (r)	
	Tassel	Cob
Grub	0.987**	0.953**
Adult	0.944**	0.986**

Conclusion

The present study revealed that the first incidence of aphid on maize tassel was observed during 2nd week of December and on cob during 4th week of December. Aphid population were dynamically fluctuated on maize during the crop period. Apparently, prevailing weather parameters were found to be exclusively responsible factors to oscillate the pest population. The maximum and minimum temperature were found negative correlation with aphid population while, aphids and relative humidity correlated positively in the morning and negatively in the evening.

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