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Population dynamics of aphid, *Aphis craccivora* Koch and their natural enemies in Indian bean

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Abstract

A field experiment was conducted during *kharif-rabi*, 2023-2024 to study the population dynamics of aphid, *Aphis craccivora* infesting Indian bean at Anand Agricultural University, Anand, Gujarat. The incidence of aphids commenced in the third week of September (39th SMW) and it persisted up to the termination of the crop in the second week of January (2nd SMW). The population of aphid ranged from 5.90 to 41.80 aphids/twig. The highest population was observed during the first week of November (45th SMW). The population of *A. craccivora* exhibited a highly significant negative correlation with minimum temperature and morning and evening vapour pressures. It also showed significant negative correlation with relative humidity, evening relative humidity and rainfall. The highest population of coccinellids was observed in the second week of December (50th SMW), whereas the highest population of chrysopids was observed in the first week of November (45th SMW). In the case of natural enemies, Coccinellid population exhibited a significant negative correlation with morning vapour pressure and evening vapour pressure. The Chrysopid population had a significant negative correlation with evening vapour pressure.

Keywords: Population dynamics, Indian bean, aphid, coccinellids, chrysopids

Introduction

Indian bean, *Lablab purpureus* (L.) Sweet, belongs to the *Fabaceae* family of pulse crops (Deka & Sarker, 1990) [4]. The cultivation of Indian beans originated in India and subsequently spread to other regions of South Asia, Southeast Asia, Africa and various tropical countries (Raghu *et al.*, 2018) [8]. It is a twining plant with trifoliate, alternating leaves and widely variable pods and seeds in size and colour (Guretzki & Papenbrock, 2014) [5]. Indian beans are mostly grown for their delicate pods but are also grown as fodder or green manure crops (Morris, 1999) [7]. The crop offers a dense green cover which serves a dual purpose it protects the soil against desiccation and acts as a source of natural manure (Kimani *et al.*, 2012) [6]. In Gujarat, the crop is invaded by several insect pests *viz.*, pod borer,

Ettiella zinckenella (Treitschke), Bihar hairy caterpillar, *Spilosoma oblique* Walker, *Maruca vitrata* (Fabricius) and *Helicoverpa armigera* (Hubner), aphid, *Aphis craccivora* Koch, jassids, *Empoasca fabae* (Harris) and *Empoasca kerri* Singh-Pruthi, whitefly, *Bemisia tabaci* (Gennadius) (Vaidik *et al.*, 2021) [11]. Aphid, *A. craccivora* causes 20 to 40 per cent yield loss in cowpea (Singh & Allen, 1980) [9]. Due to their fast multiplication, within a few days, aphids usually cover the entire surface of apical shoots and with the result of continuous feeding by such a large population yellowing, curling and subsequent drying of leaves take place, which ultimately leads to the formation of weak pods and undersized grain in the pods and decreased yield (David & Kumaraswami, 1982) [3]. Hence, the present investigation of population dynamics in Indian bean is crucial for predicting outbreaks and assessing the impact of environmental factors, natural predators, and human interventions on pest behavior and reproduction. Through this analysis, researchers can develop targeted pest control IPM strategies that minimize crop losses, reduce reliance on chemical pesticides, and promote ecological balance and sustainable farming practices.

Materials and Methods

The present experiment was conducted at the research farm of the Anand Agricultural University, Anand, Gujarat during *kharif-rabi* 2023–24.

The Indian bean variety Gujarat Navsari Indian Bean 22 (GNIB 22) was sown at 60 × 30 cm spacing. The crop was sown on September 05, 2023. The experimental plot was kept free from the application of any insecticides. The entire plot was divided into four equal size (6.0 × 6.0 m) sectors. To record observations on population of aphid, five plants were randomly selected from each sector. From each selected plant, three 10 cm long twigs were selected and the number of aphids were counted. Based on this, number of aphids/10 cm long twig were worked out. The observations on aphid population were recorded at weekly intervals starting from one week after the germination of the crop and continued up to the termination of the crop. While recording observations of aphids, observation on the population of natural enemies Coccinellids and chrysopids were also recorded. Based on this, the mean population of natural enemies per plant was worked out. A simple correlation was worked out between population of aphid as well as natural enemies and weather parameters. The data on weather parameters were obtained from the meteorological observatory located at Anand Agricultural University, Anand, Gujarat.

Results and Discussion

Population Dynamics of Aphid

The data on the aphid population are presented in Table 1, which indicate that the infestation initiated in the second week after sowing *i.e.*, the third week of September (39th SMW) and continued up to the termination of the crop in the second week of January *i.e.*, 17th week after sowing (2nd SMW). Overall, the population ranged from 5.9 to 26.8 aphids per 10 cm twig. The population exhibited an increasing trend from the second week after sowing *i.e.*, the third week of September (39th SMW) to the eighth week after sowing *i.e.*, the first week of November (45th SMW). The highest population of aphid (41.8 aphids/twig) was recorded during the eighth week after sowing *i.e.*, the first week of November (45th SMW). Thereafter, the population declined to 29.5 aphids/twig in the ninth week after sowing *i.e.*, the second week of November (46th SMW). During the

third week of November (47th SMW), the aphid population increased to 34.90 aphids/twig. During the fourth week of November (48th SMW), the population declined to 13.39 aphids/twig. Thereafter, there was a gradual increase in the population till the 13th week after sowing *i.e.*, the second week of December (50th SMW) *i.e.*, 22.80 aphids/twig. In the subsequent week (51st SMW) there was slight decline in the population (20.67 aphids/twig). After this week, the aphid population again increased in the 15th week after sowing *i.e.*, the 4th week of December (52nd SMW) and reached 31.60 aphids per twig. In the following two weeks, the aphid population exhibited a declining trend. The aphid population showed four distinct peaks *i.e.*, 45th SMW (41.80 aphids/twig), 47th SMW (34.90 aphids/twig), 50th SMW (22.80 aphids/twig) and 52nd SMW (31.60 aphids/twig).

The above results are in agreement with Dalwadi *et al.* (2007) [2], who reported that *A. craccivora* remained active from mid-November to the end of March. Bhagora (2019) [1] also reported that the population of aphid was at its peak during the first week of November. Thus, the present findings are more or less in agreement with the reports of above workers.

Correlation with weather parameters

The correlation coefficient values between the population of *A. craccivora* and weather parameters were computed to ascertain their influence on the population build-up. The correlation coefficient values are presented in Table 2, which indicated that the aphid population had a highly significant negative correlation with minimum temperature ($r = -0.667$), morning vapour pressure ($r = -0.693$) and evening vapour pressure ($r = -0.820$). Morning relative humidity ($r = -0.561$), evening relative humidity ($r = -0.605$) and rainfall ($r = -0.560$) showed a significant negative correlation, whereas maximum temperature ($r = -0.068$) and wind speed ($r = -0.226$) showed a non-significant negative correlation with aphid population. Bright sunshine hours ($r = 0.455$) exhibited a non-significant positive correlation with the aphid population in Indian bean.

Table 1: Population dynamics of pest complex and their natural enemies in Indian bean

Month and weeks		SMW	WAS	No. of aphids/twig	No. of natural enemies/plant	
					Coccinellids	Chrysopid
September, 2023	II	38	1	0.00	0.00	0.00
	III	39	2	5.90	0.00	0.00
	IV	40	3	9.15	0.05	0.00
October	I	41	4	13.75	0.10	0.10
	II	42	5	21.20	0.15	0.15
	III	43	6	23.90	0.30	0.30
	IV	44	7	25.60	0.65	0.50
November	I	45	8	41.80	1.50	0.80
	II	46	9	29.50	1.20	0.65
	III	47	10	34.90	1.50	0.75
	IV	48	11	13.39	0.85	0.40
December	I	49	12	15.20	1.20	0.30
	II	50	13	22.80	1.70	0.50
	III	51	14	20.67	0.85	0.75
	IV	52	15	31.60	1.10	0.25
January, 2024	I	1	16	28.40	0.45	0.15
	II	2	17	26.80	0.35	0.30

Earlier, Dalwadi *et al.* (2007) [2] reported that minimum temperature and vapour pressure showed a significant negative association with the aphid population, whereas

sunshine hours exhibited positive correlation with the aphid population. Bhagora (2019) [1] also reported negative correlation between aphid population and maximum

temperature, minimum temperature, morning vapour pressure and evening vapour pressure, while the bright sunshine had a non-significant positive correlation with aphid population. Vaidik and Patel (2022) [10] found that minimum temperature, morning and evening vapour

pressure had a highly significant negative correlation with aphid population, whereas maximum temperature, morning and evening relative humidity had a negative correlation with aphid population. Thus, the above reports are in conformity with the present findings.

Table 2: Correlation coefficient (r) between weather parameters and aphid population as well as their natural enemies in Indian bean

Weather parameters	Correlation coefficient (r)		
	Aphid	Coccinellids	Chrysopids
Maximum temperature (°C) (Max. T)	-0.068	-0.198	0.248
Minimum temperature (°C) (Min. T)	-0.667**	-0.442	-0.157
Morning relative humidity (%) (RH ₁)	-0.561*	-0.336	-0.190
Evening relative humidity (%) (RH ₂)	-0.605*	-0.195	-0.405
Morning vapour pressure (mm) (VP ₁)	-0.693**	-0.572*	-0.304
Evening vapour pressure (mm) (VP ₂)	-0.820**	-0.563*	-0.540*
Bright Sunshine (hrs/day)	0.455	-0.125	0.274
Wind speed (kmph)	-0.226	0.375	-0.147
Rainfall (mm)	-0.560*	-0.096	-0.021
Note: **Correlation is significant at the 0.01 level.			
*Correlation is significant at the 0.05 level.			

Activity of Natural Enemies in Indian bean Coccinellids

The weekly data on the population of Coccinellids (grub + adult) are presented

Table 1. Coccinellids, comprising of both grubs and adults, first appeared in the third week after sowing *i.e.*, the fourth week of September (40th SMW) and persisted till the termination of crop. Their population fluctuated from 0.05 to 1.70 Coccinellids/plant and the highest population (1.70 Coccinellids/plant) was observed in the 13th week after sowing *i.e.*, the second week of December (50th SMW). Initially, in the fourth week of September (40th SMW) the population was very low (0.05 Coccinellid/plant), which gradually increased and reached the first peak (1.50 Coccinellids/ plant) in the first week of November (45th SMW). In the following week, *i.e.*, 46th SMW the population decreased (1.20 Coccinellids/plant). Thereafter, in the next week *i.e.*, 47th SMW the population increased and reached the second peak (1.50 Coccinellids/plant). The coccinellids population was in an increasing trend from the 4th week of November to the 2nd week of January (48th to 50th SMW). The population attained the third peak in the 50th SMW (1.70 Coccinellids/plant). In the 51st SMW, there was a decline in the population (0.85 Coccinellids/plant), thereafter the population again increased in the 4th week of December (52nd SMW) and reached the fourth peak with a population of 1.10 Coccinellids/plant. In the following weeks (1st and 2nd SMW) the population of Coccinellids exhibited in decreasing trend. The above results are in agreement with Bhagora (2019) [1] who reported that the peak population of Coccinellids was observed during month of December (51st SMW) with 2.20 Coccinellids (grubs and adults) per plant.

Correlation with weather parameters

The correlation coefficient values are given in Table 2 which indicate that a significant negative correlation existed between the population of coccinellids and morning vapour pressure ($r = -0.572$) as well as evening vapour pressure ($r = -0.563$). On the other hand, maximum temperature ($r = -0.198$), minimum temperature ($r = -0.442$), morning relative humidity ($r = -0.336$), evening relative humidity ($r = -0.195$), rainfall ($r = -0.096$) and bright sunshine ($r = -0.125$) exhibited a non-significant negative correlation with the

population of Coccinellids. Only wind speed ($r = 0.375$) showed a positive correlation with the Coccinellids population, but it was non-significant. Bhagora (2019) [1] reported that maximum temperature, morning relative humidity, evening relative humidity and evening vapour pressure showed negative correlations while bright sunshine hours and wind velocity exhibited positive correlations with the population of coccinellids. Therefore, the results of the present investigation are in line with earlier findings.

Chrysopids

The weekly data on the population of Chrysopids recorded in Indian bean crop are presented in Table 1. The chrysopids population initiated in the fourth week after sowing *i.e.*, the first week of October (41st SMW) and persisted till the termination of crop in the second week of January (2nd SMW). The maximum population of Chrysopids was recorded during the eighth week after sowing *i.e.*, the first week of November (45th SMW). Overall, the population fluctuated from 0.10 to 0.80 Chrysopids per plant. Initially, the population was very low (0.10 Chrysopids/plant) and in the following weeks the population exhibited an increasing trend and reached the first peak (0.80 Chrysopids/plant) in the first week of November (45th SMW). In the very next week, the population declined (0.65 Chrysopids/plant). Thereafter, the population increased and reached the second peak in the third week of November (47th SMW) with a population of 0.75 Chrysopids/plant. In the following weeks (48th to 51st SMW) the population fluctuated and reached the third peak in the third week of December *i.e.*, 51st SMW (0.75 Chrysopids/plant). In the last three weeks of crop period (52nd to 2nd SMW) the population of Chrysopids was low.

Correlation with weather parameters

The correlation coefficient data presented in Table 2, revealed that there was a significant negative correlation between the population of Chrysopids and evening vapour pressure ($r = -0.540$). Furthermore, the Chrysopids population showed a non-significant negative correlation with minimum temperature ($r = -0.157$), morning relative humidity ($r = -0.190$), evening relative humidity ($r = -0.405$), morning vapour pressure ($r = -0.304$), wind speed ($r = -0.147$) and

rainfall ($r = -0.021$). Additionally, there existed a non-significant positive correlation between Chrysopids population and bright sunshine ($r = 0.274$) as well as maximum temperature ($r = 0.248$). According to Bhagora (2019) [1], minimum temperature, morning vapour pressure, morning relative humidity and evening vapour pressure exhibited negative correlation with the population of chrysopids.

Correlation between Population of Aphids and Natural Enemies

The aphid population showed positive correlation with the population of Coccinellids ($r = 0.533$) and Chrysopids ($r = 0.515$), as indicated by the values given in Table 3. Very few workers have studied the correlation between population of aphids and natural enemies in Indian bean. Bhagora (2019) [1] reported a positive correlation between the aphid population and the population of coccinellids and chrysopids.

Table 3: Correlation between aphid and their natural enemies in Indian bean

Natural enemies	Correlation coefficient (r)
Coccinellids	0.533*
Chrysopids	0.515*
Note: *Correlation is significant at the 0.05 level.	

Conclusion

The infestation of aphid, *A. craccivora* commenced in the third week of September (39th SMW) and persisted up to the termination of the crop in the second week of January (2nd SMW). The population fluctuated from 5.90 to 41.80 aphids/twig with four distinct peaks. The highest population was observed i.e., 41.80 aphids per twig during the first week of November (45th SMW). The aphid population showed a highly significant negative correlation with minimum temperature and morning and evening vapour pressures. It also had a significant negative correlation with morning relative humidity, evening relative humidity and rainfall. Coccinellid population was observed from the fourth week of September (40th SMW) to the termination crop. The highest population was observed during the second week of December (50th SMW). The Coccinellid population exhibited a significant negative correlation with morning vapour pressure and evening vapour pressure. The Chrysopids population emerged in the first week of October (41st SMW) and persisted till the second week of January (2nd SMW). The Chrysopids population was highest during the first week of November (45th SMW). There was significant negative correlation between the population of Chrysopids and evening vapour pressure.

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