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Seasonal Incidence of Pulse Aphid (*Aphis craccivora* Koch.) and its Natural Enemies on Field Pea (*Pisum sativum* L.) in Relation to Some Abiotic Factors in Alluvial Zone of West Bengal

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ABSTRACT

Background: Field pea, *Pisum sativum* L. is an important winter-season pulse crop. It is subjected to damage by both field and storage insect pests and approximately 10-15 per cent reduction in yield was reported due to the infestation of different insect pests. Among these, pulse aphid (*Aphis craccivora* Koch.) affects plant physiology directly by removal of nutrients or indirectly by dispersal of various viral diseases. The present investigation has been aimed to study the seasonal fluctuations of aphids and their natural enemies as well as their correlation. Another objective was to know the effect of various weather parameters on pulse aphids and their natural enemies which ultimately would be helpful to develop a forewarning model.

Methods: The field experiment was conducted at the A-B Block Farm of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal using two varieties of field pea (KPMR 935 and IFPD 122) during *rabi* seasons of two consecutive years of 2017-18 and 2018-19 following a randomized block design with three replications. After recording the total population of both pests (nymphs and adults) and their natural enemies across the season, the mean population was worked out and used for correlation and regression studies along with the weather parameters.

Result: Maximum aphid population was noticed during the peak pod formation stage of the crop irrespective of the varieties. The pest population was very strongly correlated with the incidence of coccinellid and ant population in both test varieties. Among the weather parameters, both maximum and minimum temperature and sunshine hour showed a positive correlation with the pest population and their natural enemies but relative humidity and rainfall showed a negative correlation. Regression studies indicated that temperature and relative humidity were the most influencing factors over the incidence of aphid in both the seasons.

Key words: *Aphis craccivora,* Field pea, Natural enemy, *Pisum sativum,* Pulse aphid, Weather parameters.

INTRODUCTION

Field pea, *Pisum sativum* L. (Family: Fabaceae, Subfamily: Papilionaceae) is an important source of protein for animal feed (Khan and Croser, 2004). The crop is cultivated for its tender and immature pods for use as a vegetable and mature dry pods for use as a pulse. India is the third-largest producer of the pea in the world and accounts for 21 per cent of the world's production (Anonymous, 2015). Due to its high nutritional value mainly the high protein content (22.5%) it is subjected to damage by both field and storage insect pests (Sharma *et al*., 2010). Approximately 10-15 per cent reduction in yield of field pea was reported due to the infestation of different insect pests (Anonymous, 2015a). Among these pests, pulse aphid, *Aphis craccivora* Koch., is one of the most important biotic constraints for pea production worldwide. Both nymph and adult aphids suck sap from plant parts and cause serious damage from the seedling to pod maturity stage of the plant. If a severe infestation occurs, young seedlings become dried and ultimately lead to death whereas, the older plants show symptoms such as stunting, curling of leaves, delayed flowering, shriveling of pods and finally resulting in yield reduction by qualitatively and quantitatively (Saranya *et al*., 2010). It is a polyphagous pest which can attack more than 15 different crops, mostly belong to the family Leguminosae (Gomez Souza *et al*., 2007). Due to a large number of host range, this aphid seems to be present in the field throughout the year. Therefore, to know about their population dynamics

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is very crucial for integrated pest management practices. Nowadays, wide use of synthetic insecticides for controlling the insect pests has resulted in development of resistance and resurgence capacity of the pest against insecticides, the minor pest becomes major ones and the pest defender ratio increased (Thomas and Waage, 1996). These harmful effects of chemical insecticides prompted us to create interest in various cultural practices for reducing the pest population below the economic threshold level. The first aim of this study was to know about the seasonal fluctuations of pea aphids and their natural enemies and how they are correlated with each other. The second aim was to know about the effect of various weather parameters on pulse aphids and their natural enemies.

MATERIALS AND METHODS

The field experiment was conducted at the A-B Block Farm of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal using two varieties of field pea (KPMR 935 and IFPD 122) during the *rabi* season of two consecutive years of 2017-18 and 2018-19. The seeds were sown maintaining a seed rate of 60 k g/ha following a Randomized Block Design with three replications. The row to row and plant to plant spacing was 30 cm and 20 cm, respectively. Weekly visual observations were taken in the morning time. The data collection was started three weeks after sowing (WAS) and continued till the harvest of the crop. For taking observations six plants were tagged randomly from each replication. Nymph and adult population of aphid occurred on 30 cm shoot tip of the sampled plants were separated with the help of a very fine camel hair brush and kept on a white paper and then counted manually. The number of adult coccinellid beetles as well as ants present on the tagged plants was also counted. For counting the coccinellids consolidated population of different coccinellid species was recorded. A similar method was followed for ants also. Weekly weather data of the experimental location were collected from AICRP on Agrometeorology (Kalyani Centre), Directorate of Research, BCKV. After recording the total population of both pest and its natural enemies from three replications across the season, the mean population was worked out and used for statistical analysis. Correlation studies between the mean population of pests and natural enemies and also with the weather parameters were done by using Microsoft Excel 2010. For different weather parameters *viz*. maximum temperature (Tmax), minimum temperature (Tmin), maximum relative humidity (RHmax), minimum relative humidity (RHmin), sunshine hour (SSH) and wind speed (WS) weekly mean values of previous seven days were used except rainfall (RF) where the sum of previous seven days was used. Afterwards, backward regression models of the aphid population in each variety of pea with the weather parameters were worked out by using the software SPSS 20.0.

RESULTS AND DISCUSSION

Seasonal incidence of pulse aphid and its natural enemies on pea

Aphid infestation started in the field from the third and second standard meteorological week (SMW) during the first and second year, respectively as presented in Table 1 and 2. In 2017-18 initial aphid population was 1.15 and 0.17 per 30 cm apical shoot of the plant in variety KPMR 935 and IFPD 122, respectively at the flower bud initiation stage of the crop. The pest population increased progressively up to 7th SMW thereafter decreased. The pest population was 65.97 per 30 cm apical shoot in the first week of February but thereafter increased suddenly to reach 98.34 per 30 cm apical shoot in the 2nd week of February (11 WAS) at the peak pod formation stage of the variety KPMR 935. At that time aphid population was 76.89 per 30 cm apical shoot in variety IFPD 122. Later on, the pest population decreased gradually and ultimately reached 3.08 and 2.35 per 30 cm apical shoot on variety KPMR 935 and IFPD 122, respectively at the pod maturity stage of the crop in the 10th SMW. In the year 2018-19, the aphid population started during 1st SMW in variety KPMR 935 and the initial population was 0.12 per 30 cm apical shoot per plant however, in variety IFPD 122, the population started from 2nd SMW and the pest population was 0.02 per 30 cm apical shoot per plant. The peak aphid population was noticed during the 6th SMW at the podding stage of the crop thereafter the pest population declined suddenly. The pest population was very low at the time of crop harvesting during 8th SMW and these were 9.38 and 4.26 per 30 cm apical shoot per plant in variety KPMR 935 and IFPD 122, respectively. The results are in partial agreement with Kataria and Kumar (2016), who found that maximum infestation of *A. craccivora* occurred in February to March on cowpea in Gujarat. The results are also more or less in agreement with Srikanth and Lakkundi (2014), who stated that the population of *A. craccivora* on cowpea increased rapidly with crop growth and their peak coincided with peak pod formation which may be due to higher availability of quality proteins in the plant and is very essential for aphid multiplication. Kumar *et al*. (2018) reported that on vegetable pea another aphid species *Acyrthosiphon pisum* (Harris) first appeared during the third week of November (47th SMW) and gradually reached up to the maximum level in the first week of February.

During the investigation, three different species of coccinellid beetles *viz*. *Coccinella septempunctata* L., *C. transversalis* F., *Menochilus sexmaculatus* Fab. and two different species of ants *viz*. *Monomorium destructor* (Jerdon) and *Camponotus compresus* (Fab.) were noticed in the field. During the first year, the coccinellid population started to build up from the second or third week of January but the ant population first noticed during the last week of January. Then their population increased slowly up to 3rd week of February thereafter declined. The maximum population of coccinellids and ants were 4.68 and 8.97 per plant, respectively in KPMR 935, however, in the case of IFPD 122 these populations were 2.85 and 5.64 per plant, respectively during 2nd week of February when the aphid population was also maximum. During the second year, an increasing trend of population of natural enemies was noticed from the first week of January at the flowering stage

of the crop and reached maximum in the first week of February at the podding stage of the crop and thereafter the population declined. The maximum population of coccinellids and ants was 2.84 and 8.38 per plant, respectively in variety KPMR 935 during 6th SMW when the aphid population was 75.52 per 30 cm apical shoot per plant. At that time in variety IFPD 122 both coccinellid and ant population were 2.18 per plant. The results are inpartial agreement with Srikanth and Lakkundi (2014) who reported that the activity of predatory coccinellids started 2 weeks after the appearance of aphids and peak predator population more or less coincided with the peak aphid population.

Correlation between the pest and natural enemies

Table 1 and 2 reveals that the population of natural enemies was positively and significantly correlated with the pest population during both the years of the experiment. During the first year, the correlation analysis of the aphid population with coccinellid showed a positive and highly significant correlation (r = 0.922 and r = 0.912) in both the varieties. Similarly, the ant population also showed a positive and significant correlation (r = 0.817 and r = 0.840) with the pest population. During the second year also, the correlation analysis of the aphid population with coccinellid showed that the pest population had a highly significant positive correlation (r = 0.839 and 0.962) with this predator. Here, the ant population also showed a positive and significant correlation (r = 0.947 and r = 0.844) with the aphid population in two varieties of pea. Similarly, correlation analysis between the aphid population along with coccinellid and ant population over the years also showed a highly strong and positive relationship for both the varieties. The present findings are in agreement with Karane *et al*. (2019) and Gauns *et al*. (2014) who found a highly significant and positive correlation between coccinellid and cowpea aphid population. The present findings are in accordance with the findings of Kataria and Kumar (2013) who reported a strong correlation between aphid and ant population in various host plants.

Influence of abiotic factors on the aphid population and their natural enemies

Different weather parameters are taken into consideration during two years of experimentation. The correlations between the pest population and weather parameters are presented in Table 3. In first year, it was observed that mean aphid population showed positive correlation with maximum temperature (r = 0.367 and r = 0. 404), minimum temperature (r = 0.309 and r = 0. 342), wind speed (r = 0.367 and r = 0.404) and sunshine hours (r = 0.251 and r = 0. 205) but negative correlation with maximum relative humidity (r = -0.588 and r = -0. 613) and rainfall (r = 0.367 and r = 0. 404). However, the pest population showed negative correlation (r = -0.426) with minimum relative humidity in variety KPMR 935 but positive correlation (r = 0. 215) in case of variety IFPD 122. During second year, the pest population showed positive correlation with maximum temperature (r = 0.414 and r = 0.433), minimum temperature (r = 0.512 and r = 0. 468), wind speed (r = 0.370 and r = 0. 381) and sunshine hours (r = 0.060 and r = 0. 168) but negative correlation with maximum relative humidity (r = -0.436 and r = -0.442), minimum relative humidity (r = -0.286 and r = -0.527) and rainfall (r = -0.148 and r = -0. 183). Similarly, over the years, the pest population showed positive correlation with maximum temperature (r = 0.376 and r = 0.410), minimum temperature (r = 0.373 and r = 0. 382), wind speed (r = 0.284 and r = 0. 251) and sunshine hours (r = 0.181 and r = 0. 205) but negative correlation with maximum relative humidity (r = -0.513 and r = -0.567), minimum relative humidity (r = -0.309 and r = -0.346) and rainfall (r = -0.111 and r = -0.129). Except for a few instances the weather parameters showed

Table 1: Population dynamics of aphid and their natural enemies during 2017-18.

SMW	Date	KPMR 935			IFPD 122		
		Aphids*/30 cm apical twig/plant	Coccinellids* / plant	Ants*/ plant	Aphids*/30 cm apical twig/plant	Coccinellids */plant	Ants*/ plant
51	18.12.17	0.00	0.00	0.00	0.00	0.00	0.00
52	25.12.17	0.00	0.00	0.00	0.00	0.00	0.00
1	02.01.18	0.00	0.00	0.00	0.00	0.00	0.00
2	09.01.18	0.00	0.00	0.00	0.00	0.00	0.00
3	16.01.18	1.15	0.01	0.00	0.17	0.00	0.00
4	23.01.18	5.58	0.38	0.00	3.16	0.69	0.00
5	30.01.18	18.76	1.24	0.06	10.34	0.92	0.00
6	06.02.18	65.97	1.54	2.46	45.97	1.37	0.79
7	13.02.18	98.34	4.68	8.97	76.89	2.85	5.64
8	20.02.18	37.26	2.79	6.79	21.34	1.86	3.27
9	27.02.18	13.86	0.93	3.84	9.34	0.42	1.63
10	06.03.18	3.08	0.05	1.83	2.35	0.00	0.16
Correlation between aphid population with their natural enemies (2017-18)		-	0.922**	0.817**	-	0.912**	0.840**

**Significant at 1% level in two tail, *Mean values of three replication.

a very weak association with the seasonal incidence of aphid population. The present findings resembled with results of Wains *et al*. (2010) who reported that aphid density was positively associated with maximum as well as minimum temperature while it showed a negative correlation with relative humidity. Similarly, Hasen *et al*. (2009) reported that among the different environmental factors maximum temperature and sunshine hours were positively correlated with aphid population. Contrary to the present findings, Gami *et al*. (2002) observed that aphid

Table 2: Population dynamics of aphid and their natural enemies during 2018-19.

SMW	Date	KPMR 935			IFPD 122		
		Aphids*/30 cm apical twig/plant	Coccinellids* /plant	Ants* /plant	Aphids*/30 cm apical twig/plant	Coccinellids* /Plant	Ants* /plant
49	03.12.18	0.00	0.00	0.00	0.00	0.00	0.00
50	10.12.18	0.00	0.00	0.00	0.00	0.00	0.00
51	16.12.18	0.00	0.00	0.00	0.00	0.00	0.00
52	22.12.18	0.00	0.00	0.00	0.00	0.00	0.00
1	01.01.19	0.12	0.00	0.02	0.00	0.00	0.00
2	08.01.19	1.58	0.08	0.46	0.02	0.05	0.01
3	15.01.19	6.76	0.14	1.13	1.18	0.02	0.16
4	22.01.19	24.48	0.23	0.86	8.43	0.16	1.13
5	29.01.19	49.76	1.26	3.16	24.68	1.24	2.03
6	05.02.19	75.52	2.84	8.38	62.16	2.18	2.18
7	12.02.19	18.23	2.21	1.35	20.15	1.05	0.18
8	18.02.19	9.38	0.24	0.26	4.26	0.63	0.03
Correlation between aphid population with their natural enemies (2018-19)		-	0.839**	0.947**	-	0.962**	0.844**
Correlation between aphid population with their natural enemies (Over Years)			0.891**	0.866**		0.931**	0.820**

**Significant at 1% level in two tail, *Mean values of three replication.

Table 3: Correlation coefficient of aphid population and their natural enemies with different weather parameters during two years of experimentation.

Year	Varieties	Pests and predators	Max Temp (^{0}C)	Min Temp (^{0}C)	Max RH (%)	Min RH (%)	Sun Shine Hour (hour)	Wind Speed (km/h)	Rain Fall (mm)
2017-18	IFPD 122	Aphids	0.367	0.309	-0.588	-0.426	0.251	0.312	-0.204
		Coccinellids	0.473	0.341	-0.629*	0.479	0.298	0.315	0.187
		Ants	0.507	0.420	-0.328	-0.369	0.383	0.301	-0.242
	KPMR 935	Aphids	0.404	0.342	-0.613*	0.215	0.205	0.282	-0.204
		Coccinellids	0.490	0.380	-0.494	-0.418	0.324	0.296	-0.178
		Ants	0.658*	0.585*	-0.265	-0.466	0.239	0.236	-0.291
2018-19	IFPD 122	Aphids	0.414	0.512	-0.436	-0.286	0.060	0.370	-0.148
		Coccinellids	0.486	0.449	-0.492	-0.329	0.164	0.429	-0.169
		Ants	0.270	0.452	-0.502	-0.263	0.026	0.230	-0.145
	KPMR 935	Aphids	0.433	0.468	-0.442	-0.527	0.168	0.381	-0.183
		Coccinellids	0.520	0.504	-0.477	-0.374	0.225	0.418	-0.179
		Ants	0.319	0.372	-0.423	-0.305	0.198	0.107	-0.166
Over years	IFPD 122	Aphids	0.376	0.373	-0.513	-0.309	0.181	0.284	-0.111
		Coccinellids	0.499	0.403	-0.512	-0.355	0.283	0.338	-0.138
		Ants	0.481	0.437	-0.287	-0.248	0.327	0.209	-0.108
	KPMR 935	Aphids	0.410	0.382	-0.567	-0.346	0.205	0.251	-0.129
		Coccinellids	0.504	0.419	-0.435	-0.298	0.276	0.324	-0.127
		Ants	0.539	0.548	-0.324	-0.309	0.164	0.219	-0.118

*Significant at 5% level in two tail.

population showed significant negative correlation with maximum and minimum temperatures, though their test crop as well as aphid species were different.

The coccinellid population was positively correlated with maximum temperature, minimum temperature, wind speed and sunshine hours but negatively correlated with maximum relative humidity and rainfall during both the years. But minimum relative humidity showed a positive correlation with this predator on variety IFPD 122 (r = 0.479) and a negative correlation on variety KPMR 935 (r = -0.494) during the first season. However, during the second season, there was a negative correlation (r = -0.329 and r = -0.374) between the minimum relative humidity and coccinellid population in both varieties. Over the years the coccinellid population showed a positive correlation with maximum temperature, minimum temperature, wind speed and sunshine hours but a negative correlation with maximum relative humidity and rainfall. Similarly, the ant population also showed a positive correlation with maximum temperature, minimum temperature wind speed and sunshine hours but negative correlation with maximum relative humidity, minimum relative humidity and rainfall during 2017-18, 2018-19 and over the years of study in two varieties of field pea. The present findings are in partial agreement with Tank (2006) who reported that the grub and adult population of coccinellid on cowpea showed a negative correlation with minimum

Table 4: Backward regression models for forewarning of pulse aphid in relation to different weather parameters.

Year: 2017-18	
$Y_1 = 461.44 - 0.81X_1 + 5.03X_2 - 6.40X_3 + 0.81X_4 + 122.85X_5 + 3.79X_6 - 57.81X_7$	(R^2= 0.73, P = 0.34)
$= 454.98 + 4.48X_2 - 6.66X_3 + 1.15X_4 + 114.60X_5 + 4.04X_6 - 57.81X_7$	(R^2= 0.73, P = 0.19)
$= 462.19 + 4.22X_2 - 6.\ 26X_3 + 0.66X_4 + 143.86X_5 - 52.44X_7$	(R^2= 0.71, P = 0.10)
$= 505.08 + 4.07X_2 - 6.\ 54X_3 + 0.47X_4 + 117.50X_5$	(R^2= 0.69, P = 0.05)
$= 465.99 + 3.63X_2 - 5.\ 80X_3 + 116.60X_5$	(R^2= 0.68, P = 0.02)
$= 558.27 + 2.82X_2 - 6.\ 33X_3$	(R^2= 0.58, P = 0.02)
$Y_2 = 669.44 - 0.31X_1 + 6.22X_2 - 9.16X_3 + 1.16X_4 + 140.70X_5 + 3.89X_6 - 55.16X_7$	(R^2= 0.76, P = 0.27)
$= 666.92 + 6.00X_2 - 9.27X_3 + 1.30X_4 + 137.70X_5 + 3.99X_6 - 54.01X_7$	(R^2= 0.76, P = 0.14)
$= 674.03 + 5.75X_2 - 8.\ 87X_3 + 0.81X_4 + 166.57X_5 - 51.62X_7$	(R^2= 0.75, P = 0.06)
$= 716.25 + 5.61X_2 - 9.\ 14X_3 + 0.62X_4 + 140.65X_5$	(R^2= 0.74, P = 0.02)
$= 664.63 + 5.02X_2 - 8.\ 17X_3 + 139.50X_5$	(R^2= 0.73, P = 0.01)
$= 774.98 + 4.05X_2 - 8.\ 80X_3$	(R^2= 0.65, P = 0.008)
Year: 2018-19	
$Y_1 = 370.65 - 5.59X_1 + 9.53X_2 - 7.06X_3 - 0.64X_4 + 95.44X_5 + 8.52X_6 - 0.40X_7$	(R^2= 0.77, P = 0.26)
$= 389.85 - 6.07X_1 + 9.29X_2 - 6.36X_3 + 0.53X_4 + 90.77X_5 + 10.0X_6$	(R^2= 0.76, P = 0.14)
$= 459.88 - 6.24X_1 + 8.\ 68X_2 - 5.36X_3 + 97.44X_5 + 11.10X_6$	(R^2= 0.75, P = 0.07)
$= 232.05 - 4.43X_1 + 8.42X_2 - 5.14X_3 + 12.36X_6$	(R^2= 0.68, P = 0.05)
$= 94.27 - 2.84X_1 + 8.45X_2 - 5.27X_3$	(R^2= 0.56, P = 0.02)
$= 107.81 + 5.60X_2 - 5.32X_3$	(R^2= 0.48, P = 0.01)
$Y_2 = 530.02 - 6.50X_1 + 1.08X_2 - 5.26X_3 - 1.33X_4 + 194.50X_5 + 2.58X_6 - 1.39X_7$	(R^2= 0.78, P = 0.39)
$= 523.33 - 6.11X_1 + 10.52X_2 - 5.02X_3 - 1.94X_4 + 201.32X_5 - 1.63X_7$	(R^2= 0.77, P = 0.29)
$= 45.75 - 3.73X_1 + 11.58X_2 - 2.16X_4 + 115.23X_5 - 1.85X_7$	(R^2= 0.66, P = 0.16)
$= -21.52 + 7.81X_2 - 1.56X_4 + 66.9X_5 - 1.43X_7$	(R^2= 0.58, P = 0.04)
$= - 4.74 + 7.76X_2 - 1.54X_4 - 1.37X_7$	(R^2= 0.54, P = 0.02)
$= 13.68 + 6.77X_2 - 1.76X_4$	(R^2= 0.46, P = 0.01)
Over Years	
$Y_1 = 455.21 - 4.15X_1 + 7.25X_2 - 4.95X_3 - 0.59X_4 + 117.49X_5 + 3.95X_6 - 0.67X_7$	(R^2= 0.68, P = 0.08)
$= 443.52 - 3.97X_1 + 7.05X_2 - 4.97X_3 - 0.48X_4 + 106.73X_5 + 5.20X_6$	(R^2= 0.67, P = 0.06)
$= 437.27 - 3.32X_1 + 6.52X_2 - 5.29X_3 + 91.38X_5 + 6.28X_6$	(R^2= 0.65, P = 0.04)
$= 405.16 - 3.43X_1 + 6.34X_2 - 6.07X_3 + 8.56X_6$	(R^2= 0.61, P = 0.02)
$= 103.63 - 2.63X_1 + 5.36X_2 - 6.37X_3$	(R^2= 0.56, P = 0.01)
$Y_2 = 614.35 - 4.97X_1 + 9.08X_2 - 6.36X_3 - 1.17X_4 + 186.60X_5 + 1.21X_6 - 1.34X_7$	(R^2= 0.60, P = 0.02)
$= 620.50 - 4.89X_1 + 8.96X_2 - 6.32X_3 - 1.25X_4 + 193.52X_5 - 1.44X_7$	(R^2= 0.58, P = 0.01)
$= 606.74 - 4.21X_1 + 8.15X_2 - 6.27X_3 - 1.20X_4 + 184.02X_5$	(R^2= 0.55, P = 0.007)
$= 601.71 - 1.92X_1 + 6.14X_2 - 7.12X_3 - 1.13X_4$	(R^2= 0.53, P = 0.005)
$= 512.13 + 4.26X_2 - 6.39X_3 - 1.28X_4$	(R^2= 0.51, P = 0.002)

Where, Y_1= Aphid population IFPD 122, Y_2= Aphid population KPMR 935, X_1= Maximum temp, X_2= Minimum temp, X_3= Maximum RH, X_4= Minimum RH, X_5= SSH, X_6= Wind Speed, X_7= Rainfall.

temperature, relative humidity and rainfall. Similarly, Bajia and Singh (2014) found that the coccinellid population was greatly influenced by different weather parameters and reported that the maximum and minimum temperature showed a positive correlation with the coccinellids population, whereas relative humidity had a negative correlation. The present findings are in partial accordance with the findings of Kataria and Kumar (2016) who reported that the ant population on cowpea showed a negative correlation with maximum and minimum temperature.

Backward multiple regression model for forewarning pulse aphid in pea

From the backward multiple regression analysis, it was observed that the combined effect of weather parameters had less influence on aphid population during the first season as compared to the second season which may be due to the different dates of sowing in two years. During the first season, the coefficient of determination values in varieties IFPD 122 and KPMR 935 were 0.73 and 0.76, respectively but, during the second season, the combined effect of the weather parameters slightly increased with R^2 value of 0.77 and 0.78 in IFPD 122 and KPMR 935, respectively (Table 4). Over the years, the coefficient of determination values in varieties IFPD 122 and KPMR 935 were 0.68 and 0.60, respectively. It was observed that minimum temperature and maximum relative humidity had the most influence on aphid multiplication in both the varieties during the first season but, during the second season in IFPD 122 only, minimum temperature and maximum relative humidity had the profound influence on aphid population however, in KPMR 935 minimum temperature and minimum relative humidity were the most influencing factors over the incidence of aphid population. While over the years maximum temperature, minimum temperature and maximum relative humidity had a profound influence on the aphid population of IFPD 122 but in KPMR 935 minimum temperature, maximum relative humidity and minimum relative humidity were the most influencing parameters for fluctuating pest population. From the above findings, it can be said that minimum temperature, maximum and minimum relative humidity could explain 73-78 per cent variation in aphid population occurring on field pea irrespective of varieties and seasons.

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Conflict of interest

All authors declare that they have no conflicts of interest.

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