Plant Archives Vol. 26, Supplement 2, 2026 pp. 2452-2458 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.308

SEASONAL INCIDENCE OF *Helicoverpa armigera* (Hübner) AND ITS LARVAL PARASITOID *Campoletis chlorideae* UCHIDA IN CHICKPEA

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(Date of Receiving : 16-04-2026; Date of Revision : 05-06-2026; Date of Acceptance : 29-06-2026)

ABSTRACT

The investigation on "Seasonal Incidence of *Helicoverpa armigera* (Hübner) and Its Larval Parasitoid *Campoletis chlorideae* Uchida in Chickpea" was conducted during *Rabi*, 2021-22 at Rajasthan College of Agriculture. Udaipur. The major insect pest recorded was *Helicoverpa armigera*, whereas *Campoletis chlorideae* was recorded as its prominent natural enemy. The incidence of *H.armigera* on chickpea crop was initiated in the 50th standard meteorological week (1.32 larvae/plant) with its peak in the 9th standard meteorological week with 3.92 larvae/plant. The population showed a significant positive correlation with the maximum and minimum temperature (r = 0.598* and r = 0.507*) while a negative non-significant correlation with maximum and minimum RH (r = -0.27, r = -0.136) and rainfall (r = -0.138) was observed. The incidence of *Campoletis chlorideae* commenced in the third week of December with a mean population of 0.80 adults/plant and continued up to the last week of March (12th SMW) during *rabi*, 2021-22. The population of *Campoletis chlorideae* touched its peak (1.90 adult/plant) during the 8th standard meteorological week. The population showed a significant positive correlation with the maximum temperature (r = 0.512*) and positive correlation with minimum temperature (r = 0.365) respectively whereas negative non-significant correlation with maximum and minimum relative humidity (r = -0.171, r = -0.066) and rainfall (r = -0.346), respectively. The parasitization by *C. chlorideae* ranged from 8.00 to 43.60 per cent. Highest parasitization of 43.60 per cent was observed in the 8th SMW.
Keywords **:** Seasonal incidence, *Helicoverpa armigera*, *Campoletis chlorideae*, Parasitization.

Introduction

Chickpea (*Cicer arietinum* L.), a member of the Fabaceae family, subfamily Fabiodeae is predominantly self-pollinated in nature with a chromosomal number of 2n =14. Chickpea (*Cicer arietinum* L.) is the 3rd most important pulse crop and an economically beneficial protein-rich food legume. India is the largest chickpea-producing country, with a 75 per cent share of global production (Gaur *et al*., 2019). Nutritionally, it contains 24 per cent protein, 59 per cent carbohydrates and 3.2 per cent minerals. Henceforth, Indian Council of Medical Research (ICMR) has recommended a pulse intake of 80 g/capita/day. Besides all this, it is suitable for various crop rotations and bears nodules on its roots, which use to fix the atmospheric nitrogen into the soil and make it more fertile (Cumming *et al*., 2011). Many factors aid in contributing to the low productivity of chickpea, the major constraint in chickpea cultivation in recent years was found to be the attack of the insect pest. Among the insect pests, the chickpea pod borer (*Helicoverpa armigera*) is the most destructive pest of chickpea. The young larvae feed upon the tender portion of foliage before attacking the fruiting bodies, causing heavy losses to chickpea. Even sometimes the crop faces failure due to an attack of pod borer. Its larvae appeared on the chickpea crop after 15 days of germination (Kambrekar, 2005) and the larvae were found active throughout the chickpea crop. A single larva can consume 30-40 pods in its lifetime (Taggar and Singh, 2012). It has been reported as a prolific pest of chickpea and caused yield losses mainly due to pod damage which ranges from 14-38 per cent, whereas if the environmental conditions are congenial to *H. armigera*, then pod damage goes up to 90-95 per cent. In the light of the above facts this experiment was

carried out to determine the seasonal incidence of chickpea pod borer and impact of weather parameters on them in order to formulate effective management strategy of the pest. It is a preliminary survey that is carried out to investigate the sensitivity of the occurrence of the pest to the different meteorological parameters. The correlation of pest population with different weather parameters provides valuable information, based on that predictive model can be developed which can be utilized in the forecasting of pest population build up. Ultimately by it, farmers can plan for plant protection strategies.

Materials and Methods

Location and Sowing: The field experiments on "Seasonal Incidence of *Helicoverpa armigera* (Hübner) and Its Larval Parasitoid *Campoletis chlorideae* Uchida in Chickpea" were laid out at the Instructional farm, Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur during *Rabi*, 2021-22. Seeds of chickpea variety 'GNG-2144' were sown with 30 cm row to row and 10 cm plant to plant distance in uniformly sized plots measuring 3 m x 3 m (9 m^2) which were replicated thrice. The plots were maintained pesticide-free to allow natural infestation and seasonal incidence of major insect pests and their associated natural enemies was recorded on 10 randomly selected and tagged plants from each plot by adopting the sampling method and observations according to the insect pest.

Sampling and observations

The observations for the population of *Helicoverpa armigera* larvae infesting the crop were taken along the one-meter row length from ten plants selected at random. Observations are recorded during the last activity of the pest i.e., during the early hours of the day (7:30-9:30 h). Observations were taken for the associated natural enemies in chickpea from the same rows observed for the pest. The field-collected larvae were brought to the laboratory and maintained in jars. The larvae were reared on fresh leaves and pods of gram until pupation or emergence of the parasitoid. The parasitoids collected were identified using standard references and internet sources (NBAIR, Bangalore). The entire collection of parasitoids happened to be males and females of *Campoletis chlorideae* Uchida (Hymenoptera: Ichneumonidae).

Parasitization of *Helicoverpa armigera* (Hübner) by *Campoletis chlorideae* Uchida: The larval parasitization of *H. armigera* was studied by collecting 50 larvae at weekly intervals and brought to the laboratory from the chickpea field and kept in jars. Collected larvae were kept in separate jars to avoid cannibalism. The larvae were reared on fresh leaves and pods of a gram to check the emergence of the adult parasitoid. The jars were covered with a muslin cloth secured with rubber bands and placed at ambient conditions of temperature and humidity. The effective parasitization percentge was computed using the methodology adopted by Tian *et al.* (2008) and Hugar *et al*. (2014).

Parasitization percentage =

$$\frac{No.of\ parasitoid\ emerged}{No.of\ Larave\ collected} x100$$

Statistical analysis:

The following statistical analysis were performed:

Formula for simple correlation (Pearson, 1895):

$$r_{xy} = \frac{\sum XY - \frac{(\sum X)(\sum Y)}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

Where,

r_{xy} = Simple correlation coefficient

X = Variable i.e., abiotic component (Maximum, Minimum temperature and relative humidity, Total rainfall)

Y = Variable i.e., mean number of insect pests

n= Number of paired observations

The correlation coefficient (r) values were subjected to the test of significance by Using t-test:

$$t = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n-2} \sim t_{n-2}\ d.f$$

The calculated t- value obtained was compared with tabulated t- value at 5 per cent level of significance.

Results and Discussion

Seasonal incidence of *Helicoverpa armigera* (Hübner) (Nocutidae: Lepidoptera)

The data recorded during the experimental period on the incidence of *Helicoverpa armigera* (Hübner) have been presented in Table 1. The data reveal that the infestation of *H. armigera* in the chickpea crop was initiated in the 50th standard meteorological week (third week of December) with a mean population of 1.32 larvae/plant which continued throughout the crop duration from the vegetative growth stage till the maturity of the crop. Then a decrease in the larval population was recorded till the 4th standard meteorological week gradually for two weeks but a sudden decrease in the population has been seen in the 52nd and 1st standard meteorological week. After the 4th

standard meteorological the larval population of *H. armigera* again start increasing gradually with a slight decrease in some week and reaches its peak in the 9th standard meteorological week with 3.92 larvae/plant, thereafter starts declining with the maturity of the crop and reaches 1.16 larvae/plant at the time of harvesting of the crop. The minimum population of larvae was recorded in the 52nd meteorological week. Minimum and maximum temperature (°C) during the lowest population recorded were 7.86 °C and 23.58 °C respectively and a maximum and minimum relative humidity of 94.38 per cent and 59.38 per cent were recorded with rainfall of 18.00 mm. The highest infestation of the pod borer larvae was recorded in the 9th standard meteorological week with maximum and minimum temperature (°C) of 23.58 °C and 7.86 °C, respectively and a maximum and minimum relative humidity of 90.43 per cent and 70.57 per cent were recorded with no rainfall during the period. The findings of the present investigation are almost similar to the findings of Yadav, (2016), who also reported that the incidence of *H.armigera* initiated in the 50th standard meteorological week and reached its peak of 1.80 larvae/plant in the 7th standard meteorological week and then the larval population starts declining with the drying of pods and last recorded in the 10th standard meteorological week with a mean population of 0.60 larvae/plant. Also, the present experimental results are closely aligned to the findings of Kachhawa *et al*. (2016), Bahadur *et al*. (2018), Gautam *et al*. (2018), Roshan *et al*. (2018) and Singh *et al*. (2018). The population of *H. armigera* was recorded from its first appearance in the 48th standard meteorological week (1.12 and 1.00 larva per meter row length) to the 10th SMW (0.74 and 0.46 larva per meter row length) in two consecutive years, respectively. The sixth and seventh standard meteorological weeks saw the greatest mean larval populations of *H. armigera*, measuring 1.48 and 1.68 larvae per meter row length during two consecutive years as reported by Kachhawa *et al*. (2016). Bahadur *et al*. (2018) recorded the pest activity from the 2nd standard week with a population of 1.21 larvae per plant and until the 11th standard week with 3.67 larvae per plant. The maximum mean population of 5.67 larvae/plant of *H. armigera* larvae was observed in the 8th standard meteorological week by Gautam *et al*. (2018). Whereas, Roshan *et al*. (2018) observed the peak larval population in the 9th standard week (9.31 larvae per 10 hills). Singh *et al*. (2018) first observed the pest in 51th SMW with its peak in the 9th standard meteorological week. Contrary to this Kumar *et al*. (2018) recorded the initiation of the incidence of *H.armigera* in the 7th standard week (2.33 larva/plant) with a peak in the 13th standard week (5.33 larva/plant).

Correlation studies between the various weather parameters and the larval population of *H. armigera* show that the population is positively and significantly related to the maximum and minimum temperature (r = 0.598* and r = 0.507*), respectively whereas negatively but non-significantly correlated related to maximum and minimum relative humidity (r = -0.27, r =-0.136) and rainfall (r = -0.138) respectively. The findings of the present investigation are in close conformity with the findings of the earlier work of Shinde *et al*. (2013), Kumar *et al*. (2015), Spoorthi *et al*. (2017) and Bahadur *et al*. (2018). Shinde *et al*. (2013) reported that the minimum and maximum temperatures both are positively and significantly correlated with the larval population. Rainfall is considered the most important factor regulating the insect population. The insect population was found to be negatively correlated with the rainfall. The larval population of *H. armigera* was found to be positively correlated with both the maximum (r = 0.858) and minimum (r = 0.886) temperature. Relative humidity and larval population were found to be negatively correlated (r = -0.569) as reported by Kumar *et al* (2015). Similarly, Spoorthi *et al*. (2017) reported a positive correlation with maximum (r = 0.5133) and minimum (r = 0.5946) temperature while negative correlation between larval population with relative humidity (r = -0.3016) and rainfall (r = -0.0041) were observed. Present findings are also in line with the findings of Bahadur *et al*. (2018) during the year 2016-17 who reported that the maximum temperature (r = 0.636) and minimum temperature (r = 0.580) were positively correlated, while the morning relative humidity (r =-0.706), evening relative humidity (r = -0.320), and rainfall (r = -0148) were all negatively correlated during the year 2016-17. In partial confirmation with the present findings, Kumar *et al*. (2018) reported that the larval population was positively correlated with maximum temperature, whereas negative non-significantly related to the minimum temperature. Roshan *et al*. (2018) also observed that the maximum and minimum temperature was positively correlated with the larval population but found to be non-significant.

Seasonal incidence of *Campoletis chlorideae* Uchida

The data recorded on the adult population of *Campoletis chlorideae* have been presented in Table 2. *Campoletis chlorideae* is the major parasitoid of *H.armigera*. A perusal of the data presented in the Table 2, revealed that the population of *C. chlorideae* initiated in the third week of December (50th SWM)

with a mean population of 0.80 adults/plant and continued up to the last week of March (12th SMW) during *rabi*, 2021-22. The population of *C. chlorideae* touched its peak (1.90 adult/plant) during the 8th standard meteorological week (4th week of February) when the *H. armigera* population was near to its peak (3.12 larvae/plant) and then declined gradually with a slight increase in 10th standard meteorological week. The activity of the pest is observed from its initiation till the harvest of the crop. The maximum and minimum temperature recorded during the peak period was 30.0 ^{o}C and 7.59 ^{o}C, respectively and the maximum and minimum humidity recorded was 86.14 per cent and 57.86 per cent with no rainfall. The least population of *C. chlorideae* was recorded during the 52nd meteorological week (last week of December). The maximum and minimum temperature recorded during the least incidence was 23.58 ºC and 7.86 ºC and maximum and minimum relative humidity of 94.38 and 59.38 per cent, respectively with 18.00 mm rainfall. The present findings are in partial conformity with the findings of Pillai *et al*. (2016) who also observed that the larval parasitoid *C. chlorideae* attained its peak population in the 7th and 8th standard meteorological week while it makes its first appearance in the 3rd standard meteorological week. Kankale *et al.* (2018) recorded the incidence of *C. chlorideae* from 1st standard meteorological week to the 11th standard meteorological week and the results are almost similar to the findings of the present investigation. Jaba *et al.* (2018) reported that *Campoletis chlorideae* Uchida was the single most prominent parasitoid in chickpea for major pest *Helicoverpa armigera* (Hübner) under the natural ecosystem with its highest occurrence in the 11th standard meteorological week. In partial confirmation to the present findings, Kankale *et al*. (2018) observed the initiation of the parasitoid in 1st standard meteorological week that lasts up to the 11th standard meteorological week.

Correlation studies between the various weather parameters and the adult population of *C. chlorideae* show a significant positive correlation with the maximum temperature (r = 0.512*) and a positive correlation with minimum temperature (r = 0.365), respectively. Whereas it showed a negative non-significant correlation with maximum and minimum relative humidity (r =-0.171, r = -0.066) and rainfall (r =-0.346), respectively. In confirmation of the above findings, Jaba *et al.* (2018) also observed that the parasitoid population was positively related to maximum temperature and negatively correlated to minimum temperature. Whereas, contrary to the above finding evening relative humidity and rainfall were found to be positively correlated with the parasitoid population. Pillai *et al*. (2016) reported a significant negative correlation between maximum and minimum temperature and a significant positive correlation between maximum relative humidity and minimum relative humidity, these findings are in contrast to the findings of the present investigation.

Parasitization of *Campoletis chlorideae* Uchida on *Helicoverpa armigera* (Hübner) in chickpea

In the present investigation to understand the parasitization of *Helicoverpa armigera* (Hübner) by *Campoletis chlorideae* Uchida per cent parasitization was worked out. A perusal of the data depicted in Table 2, revealed that the per cent parasitization of *H. armigera* larvae by its parasitoid; *C. chlorideae during rabi*, 2021-22 reveals that the parasitization ranges from 8.00 to 43.60 per cent. The highest per cent parasitization of 43.60 per cent was observed in the 8th standard meteorological week (4th week of February) whereas the lowest per cent parasitization of 8 per cent was observed in the 50th standard meteorological week (third week of December). The findings of the present investigation are in close confirmation with the findings of Devi *et al*. (2002), Gupta and Raj (2003), Jaba *et al*. (2018), Kankale *et al*. (2018) and Meena *et al*. (2011). According to Devi *et al*. (2002) the parasitism of *H. armigera* larvae in chickpea by *C. chlorideae* ranged from 0.18 to 23.81 per cent. Gupta and Raj (2003) reported parasitism from 8.33 to 28.00 per cent. Jaba *et al*. (2018) reported a higher per cent parasitization of 60.67 per cent on the 1st collection of 11th SMW of March. Meena *et al*. (2011) reported the peak period of the parasitoid activity during the 6th standard meteorological week. Ojha *et al*. (2017) reported a higher parasitization of 56.67 per cent during December month.

Conclusion

The present investigation revealed that major insect pest infesting chickpea was *Helicoverpa armigera* and its activity started from 50th standard meteorological week and was highest during 9th SMW (3.92 larvae/plant). It was evident from this study that larval population of *H. armigera* had significant positive association with maximum and minimum temperature whereas relative humidity and rainfall exhibited negative influence on pest incidence. *Campoletis chlorideae* was the only larval parasitoid of *H. armigera* in chickpea. The parasitization by *C. chlorideae* ranged from 8.00 to 43.60 per cent with the maximum parasitization being observed during 8th SMW indicating its significant role in the natural suppression of the population of *H. armigera* .It was evident from the study that weather parameters have a

significant effect on the seasonal incidence of both the pest and its natural enemy in chickpea. The information obtained from the present investigation will be useful for developing weather based forecasting models and eco-friendly pest management strategies by conserving and utilizing natural biological control agents in chickpea cultivation.

Table 1: Seasonal incidence of gram pod borer, *Helicoverpa armigera* (Hubner) during *rabi*, 2021-22

SMW	Mean abiotic factors					Mean population/plant
	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	
	Max.	Min.	Max.	Min.		
50	25.04	6.46	95.86	55.29	0.00	1.32
51	23.64	3.34	92.29	51.14	0.00	0.80
52	**23.58**	**7.86**	**94.38**	**59.38**	**18.00**	**0.30**
1	23.31	8.91	94.43	69.00	4.80	0.50
2	20.89	3.86	95.71	53.14	0.00	0.40
3	23.56	3.87	96.00	61.86	0.00	0.62
4	21.59	3.26	92.57	64.00	0.00	0.92
5	27.00	4.21	89.29	59.71	0.00	1.96
6	25.87	5.07	92.00	69.14	0.00	1.50
7	26.69	5.11	95.29	66.71	0.00	2.21
8	30.00	7.59	86.14	57.86	0.00	3.12
9	**30.07**	**8.93**	**90.43**	**70.57**	**0.00**	**3.92**
10	31.40	12.36	82.71	48.00	3.50	3.72
11	36.26	12.31	59.29	17.14	0.00	2.90
12	37.71	13.14	48.83	19.86	0.00	2.26
13	38.01	11.96	45.57	14.86	0.00	1.16
Seasonal Mean	27.79	7.39	84.42	52.35	1.64	
Correlation coefficient between population of *H.armigera* and abiotic factors						
Max. Temperature (°C)						0.598*
Min. Temperature (°C)						0.507*
Max. Relative Humidity (%)						-0.27
Min. Relative Humidity (%)						-0.136
Rainfall (mm)						-0.138

SMW = Standard meteorological week *significant at 5% level

Table 2: Seasonal incidence of *Campoletis chlorideae* (Uchida) during *rabi*, 2021-22

SMW	Mean abiotic factors					Mean population/plant	Percent parasitization (%)
	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)		
	Max.	Min.	Max.	Min.			
50	25.04	6.46	95.86	55.29	0.00	0.80	8.00
51	23.64	3.34	92.29	51.14	0.00	0.60	10.00
52	**23.58**	**7.86**	**94.38**	**59.38**	**18.00**	**0.20**	**9.00**
1	23.31	8.91	94.43	69.00	4.80	0.30	14.50
2	20.89	3.86	95.71	53.14	0.00	0.22	19.20
3	23.56	3.87	96.00	61.86	0.00	0.60	27.0
4	21.59	3.26	92.57	64.00	0.00	0.50	25.00
5	27.00	4.21	89.29	59.71	0.00	1.00	29.00
6	25.87	5.07	92.00	69.14	0.00	1.10	34.90
7	26.69	5.11	95.29	66.71	0.00	1.32	37.60
8	**30.00**	**7.59**	**86.14**	**57.86**	**0.00**	**1.90**	**43.60**
9	30.07	8.93	90.43	70.57	0.00	1.50	35.00
10	31.40	12.36	82.71	48.00	3.50	1.80	39.00
11	36.26	12.31	59.29	17.14	0.00	1.50	23.00
12	37.71	13.14	48.83	19.86	0.00	0.90	13.00
13	38.01	11.96	45.57	14.86	0.00	0.60	11.00
Seasonal Mean	27.79	7.39	84.42	52.35	1.64		

Correlation coefficient between population of *C.chlorideae* and abiotic factors		
Max. Temperature (^{o}C)	0.512*	
Min. Temperature (^{o}C)	0.365	
Max. Relative Humidity (%)	-0.171	
Min. Relative Humidity (%)	-0.066	
Rainfall (mm)	-0.346	
Correlation coefficient between population of *H.armigera* and *Campoletis chlorideae*	0.938	

SMW = Standard meteorological week *significant at 5% level

Acknowledgments

Authors express sincere thanks to the Head, Department of Entomology; Dean, Rajasthan College of Agriculture and Director of Research, MPUAT, Udaipur for providing necessary facilities and encouragement for research.

Conflict of Interest

The authors declare no conflict of interest.

Declaration of Generative AI and AI-assisted technologies in the writing process

The authors declare that no AI tools have been used in the writing process.

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