

## Seasonal Incidence and Natural Parasitization of Leaf Webber, *Pammene critica* Meyrick (Lepidoptera: Tortricidae) on Pigeonpea

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**Abstract** An experiment was conducted to study the seasonal incidence and parasitization of leaf webber, *Pammene critica* Meyrick on pigeonpea crop during the year 2013-2014 at Pantnagar, Uttarakhand (India). The activity of *P. critica* commenced during 37<sup>th</sup> standard week and it attained peak during 41<sup>st</sup> standard week. During the course of investigation one larval solitary endoparasitoid, *Apanteles* sp. (Braconidae: Hymenoptera) was recorded on *P. critica*. The peak activity of this parasitoid coincided with peak activity of the insect pest. Correlation studies with different weather variables indicated that the population build-up of *P. critica* and its larval parasitoid exhibited a significant positive correlation with

temperature and average relative humidity. Multiple regression analysis indicated that various abiotic factors contributed 91.2 and 89.2% variation in *P. critica* population and per cent parasitization, respectively.

**Keywords** Pigeonpea, *Pammene critica* Meyrick, Parasitization, Braconidae.

### Introduction

Pigeonpea, *Cajanus cajan* (L.), is an important legume crop grown in the tropics and subtropics, mostly in Asia, Africa, Latin America and the Caribbean region occupying 6.5% of the world's total pulse area and contributing 5.7% to the total pulse production. In Asia, pigeonpea is grown on 4.1 million ha and India alone accounts for 86% of Asia's total pigeonpea area and contributes 82% to the total production and is the single largest producer of pigeonpea in the world [1]. Though, India is largest producer of pigeonpea, its productivity has always been cause of concern. Pigeonpea yields have remained stagnant for the past 3 to 4 decades, largely due to damage inflicted by insect pests [2]. More than 250 species of insect pests are known to infest pigeonpea crop at its various growth stages in India [3].

Amongst many insect pests attacking pigeonpea, the leaf webber, *Pammene critica* Meyrick (Lepidoptera: Tortricidae), is one of the major limiting factors affecting its production [4]. *Pammene critica* is the new name for *Grapholita (Cydia) critica* (Lepi-

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**Table 1.** Seasonal incidence of *P. critica* and its larval parasitoid, *Apanteles* sp. on pigeonpea crop during *kharif*, 2013-14.

Standard week	Total no. of larvae collected	No. of <i>Apanteles</i> sp. emerged	No. of <i>P. critica</i> larvae parasitized by <i>Apanteles</i> sp.	Percent parasitization by <i>Apanteles</i> sp.
37	6	1	1	16.67
38	14	3	3	21.43
39	27	7	7	25.92
40	38	13	13	34.21
41	54	21	21	38.89
42	25	5	5	20.00
43	21	6	6	28.57
44	15	1	1	6.67
45	4	0	0	0.00
46	2	0	0	0.00
Total	206	57	57	27.66

doptera: Tortricidae) [5]. The caterpillar of *P. critica* feeds on foliage, buds, flowers and sometimes even on pods. In the vegetative stage, larvae web the leaves together and feed inside the web. Although damage by the larva is greater during the vegetative stage, sometimes its attack extends up to the reproductive stage injuring the flowers and pods.

Diverse array of natural enemy complex of pod borers of pigeonpea has been reported from different countries [6]. Several hymenopteran parasitoids and hyperparasitoids like *A. taragamae* Viereck, *Dolichogenidea molgandasi* and *Protapanteles obliquae* (Wilkinson) (Braconidae), *Goniozus* sp.

**Table 2.** Correlation coefficients of *P. critica* population and its parasitization with abiotic factors. \*Correlation is significant at the 0.05 level (two-tailed), \*\*Correlation is significant at 0.01 level (two-tailed).

Abiotic factors	<i>P. critica</i> population	<i>P. critica</i> parasitization
Maximum temperature (°C)	0.801**	0.919**
Minimum temperature (°C)	0.544	0.782**
Average relative humidity (%)	0.718*	0.879**
Rainfall (mm)	0.020	0.237
Sunshine hours	0.216	0.503
Wind velocity (km/ha)	-0.463	-0.597

(Bethyridae), *Pristomerus microdon* Cushman (Ichneumonidae), *Copidosoma (Paralitomastix)* sp. (Encyrtidae), *Elasmus albopictus* Crawford, *E. anticles* Walker and *Pediobius cydiae* Khan (Eulophidae), have been reported from different areas of India attacking *P. critica* [7, 8].

The aforementioned studies clearly indicate that there is a high potential for utilizing such bio-control agents for the management of this insect pest. For this, it is important to ascertain natural parasitization of *P. critica* on pigeonpea, especially in the northern parts of India where it is a major problem. The present study was therefore conducted to access the influence of weather parameters on *P. critica* and its

**Table 3.** Multiple regressions of *P. critica* population with abiotic factors.  $Y_1$ =*P. critica* population,  $X_1$ =Maximum temperature (°C),  $X_2$ =Minimum temperature (°C),  $X_3$ =Average relative humidity (%),  $X_4$ =Rainfall (mm),  $X_5$ =Sunshine (hours),  $X_6$ =Wind velocity (km/hr).

Multiple regression	Temperature (°C)		Average Relative humidity (%) ( $X_3$ )	Rainfall (mm) ( $X_4$ )	Sunshine hours ( $X_5$ )	Wind velocity (km/hr) ( $X_6$ )
	Maximum ( $X_1$ )	Minimum ( $X_2$ )				
Coefficient	8.491	-2.505	1.048	0.104	-5.055	-5.601
Standard Error	1.679	0.934	0.703	0.179	1.611	1.888
T value	5.057	-2.681	1.492	0.582	-3.138	-2.967
F value	17.702					
R <sup>2</sup>	0.912					
Regression equation	$Y_1 = -215.492 + 8.491 (X_1) - 2.505 (X_2) + 1.048 (X_3) + 0.104 (X_4) - 5.055 (X_5) - 5.601 (X_6)$					

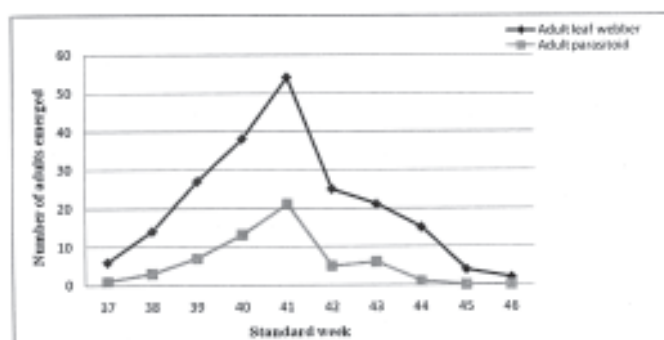


Fig. 1. Weekly population of the leaf webber, *P. critica* and its parasitoid, *Apanteles* sp. on pigeonpea crop.

parasitoids on pigeonpea at Pantnagar, Uttarakhand (India).

#### Materials and Methods

To study the seasonal abundance and natural per cent parasitization of *P. critica* on pigeonpea, a field experiment was conducted at Norman E. Borlaug Crop Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar, during *kharif* season of 2013-14. Short duration pigeonpea cultivar Manak was used for the study and the crop field was kept free from pesticide sprays. One hundred pigeonpea inflorescences or apical twigs were randomly collected at weekly intervals from the field. These shoots were brought to the laboratory and total numbers of larvae of *P. critica* present in these

shoots were collected and reared up to adult stage to study the per cent parasitization. For rearing, the larvae of *P. critica* were placed separately in plastic jars of one liter capacity along with pigeonpea flowers and pods and the jars were covered with muslin cloth. Samples were maintained at room temperature (25–30°C) and checked daily for either parasitoid or adult moth population. All parasitic wasps emerged from parasitized larvae were kept separately in small vials containing 70% ethanol for identification. The per cent parasitism was calculated weekly by the following formula [9, 10].

$$\text{Percent parasitization} = \frac{\text{No. of adults parasitoid emerged}}{\text{no. of host adult insects} + \text{no. of parasitoid adults}} \times 100$$

**Table 4.** Multiple regressions of *P. critica* population with abiotic factors.  $Y_1$ =*P. critica* population,  $X_1$ =Maximum temperature (°C),  $X_2$ =Minimum temperature (°C),  $X_3$ =Average relative humidity (%),  $X_4$ =Rainfall (mm),  $X_5$ =Sunshine (hours),  $X_6$ =Wind velocity (km/hr).

Multiple regression	Temperature (°C)		Average Relative humidity (%) ( $X_3$ )	Rainfall (mm) ( $X_4$ )	Sunshine hours ( $X_5$ )	Wind velocity (km/hr) ( $X_6$ )
	Maximum ( $X_1$ )	Minimum ( $X_2$ )				
Coefficient	5.145	-0.533	0.371	-0.027	-1.004	-1.944
Standard Error	2.775	1.544	1.161	0.295	2.662	3.120
<i>T</i> value	1.854	-0.345	0.319	-0.092	-0.377	-0.623
<i>F</i> value	4.112					
<i>R</i> <sup>2</sup>	0.892					
Regression equation	$Y_1 = -140.879 + 5.145 (X_1) - 0.533 (X_2) + 0.371 (X_3) - 0.027 (X_4) - 1.004 (X_5) - 1.944 (X_6)$					

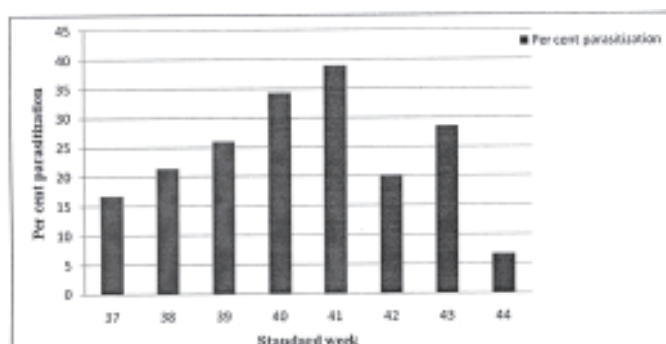


Fig. 2. Weekly per cent field parasitization on leaf webber, *P. critica* by *Apanteles* sp. on pigeonpea crop.

Influence of weather parameters on population build up of *P. critica* and its weekly per cent parasitization was also worked out. For this, mean larval population of *P. critica* and its weekly per cent parasitization data were subjected to correlation and regression analysis with weather parameters viz., maximum and minimum temperatures, average relative humidity, rainfall, sunshine hours and wind velocity in respect of the corresponding standard week. The meteorological data for the above analysis were obtained from the meteorological observatory of G. B. Pant University of Agriculture and Technology, Pantnagar.

## Results and Discussion

### Abundance and parasitization of *P. critica*

The activity of *P. critica* commenced during 37<sup>th</sup> standard week at late vegetative stage of the crop and it persisted up to 46<sup>th</sup> standard week. The population of *P. critica* was found to be maximum (54 larvae/100 shoots) at 41<sup>st</sup> standard week when the crop was in its flowering stage (Table 1). Similar trend of leaf webber population on pigeonpea was also observed by Sujithra and Chander [11]. The periodic mean incidence of *P. critica* and extent of its parasitization is presented in Fig. 1 and 2 respectively.

During the course of investigation one larval solitary endoparasitoid, *Apanteles* sp. (Braconidae: Hymenoptera) was recorded on *P. critica*. The peak

level of weekly per cent parasitization by *Apanteles* sp. (38.89%) was observed during 41<sup>st</sup> standard week. There was a significant positive correlation ( $r = 0.972^{**}$ ) of *P. critica* population with its larval parasitoid, *Apanteles* sp. (Table 5). One hyperparasitoid insect, *Elasmus* sp. (Elasmidae: Hymenoptera) was also recovered from *Apanteles* sp. Hyperparasitism by *Elasmus* sp. was found to be higher towards the end of the pest season. There also has been a report of parasitization of *P. critica* by *Apanteles mohandasi* (Hymenoptera: Braconidae), a solitary endo-parasitoid, from Kanpur, Uttar Pradesh [12]. Yu [13] also reported three Eulophidae species viz., *Elasmus albopictus* Crawford, *E. anticles* Walker and *Pediobius cydiae* Khan as hymenopteran hyperparasitoids of *Cydia critica*.

### Influence of weather parameters on population of *P. critica*

Simple correlation was worked out between *P. critica* population and the weather parameters. It revealed that there was a positive significant association with maximum temperature ( $r = 0.801^{**}$ ) and average relative humidity ( $r = 0.776^{**}$ ) whereas a non significant negative relationship was maintained with wind velocity ( $r = -0.463$ ). A non-significant positive association was also maintained with minimum temperature ( $r = 0.544$ ), rainfall ( $r = 0.020$ ) and sunshine hours ( $r = 0.216$ ) (Table 2). The results are in accordance with Saxena and Ujagir [14] who studied that the larval populations of *M. vitrata* and *G. critica* were not sig-

**Table 5.** Correlation coefficient of incidence of leaf webber, *P. critica* with its larval parasitoid, *Apanteles* sp. \*\*Correlation is significant at 0.01 level (two-tailed).

Biotic factor	<i>P. critica</i> population
Mean population of <i>Apanteles</i> sp.	0.972**

nificantly associated with temperature and relative humidity in 2003-04, but showed a significant positive association with both parameters in 2004-05 at Pantnagar. Kumar and Nath [15] also revealed that *P. critica* showed a positive correlation with minimum, maximum and average temperature that further supported the present findings.

The regression revealed that the various abiotic factors were found to be most influencing factor, which contributed ( $R^2 = 0.912$ ) 91.2% variation in population of *P. critica* (Table 3). The regression equation was fitted to study the effectiveness of weather parameters indicated that for every 1°C increase in maximum temperature, every one per cent increase in average relative humidity and one mm increase in rainfall there would be an increase of 8.491, 1.048 and 0.014 numbers of *P. critica* larval population respectively, while for every 1°C increase in minimum temperature, every one hour increase in sunshine hour and for every one km/hr increase in wind velocity there would be a decrease of 2.505, 5.055 and 5.601 numbers of *P. critica* larval population respectively.

#### Influence of weather parameters on per cent parasitization in *P. critica*

Simple correlation was worked out between per cent parasitization and the weather parameters. It revealed that there was a positive significant association with maximum temperature ( $r = 0.919^{**}$ ), minimum temperature ( $r = 0.782^{**}$ ) and average relative humidity ( $r = 0.808^{**}$ ) whereas a non significant negative relationship was maintained with wind velocity ( $r = -0.597$ ). A non-significant positive association was also maintained with rainfall ( $r = 0.237$ ) and sunshine hours ( $r = 0.503$ ) (Table 2).

The regression revealed that the various abiotic

factors were found to be most influencing factor, which contributed ( $R^2 = 0.892$ ) 89.2% variation in per cent parasitization of *P. critica* (Table 4). The regression equation was fitted to study the effectiveness of weather parameters indicated that for every 1°C increase in maximum temperature and every one per cent increase in average relative humidity there would be an increase of 5.145 and 0.371% parasitization respectively, while for every 1°C increase in minimum temperature, every one mm increase in rainfall, every one hour increase in sunshine hour and for every one km/hr increase in wind velocity there would be a decrease of 0.533, 0.027, 1.0004 and 1.944% parasitization respectively.

This study indicates that *Apanteles* sp. (Hymenoptera: Braconidae) is a potential larval parasitoid of *P. critica*. The peak activity of this parasitoid coincided with peak activity of the insect pest. High humidity and moderate temperature during September–October proved congenial for the population build up of the parasitoid. This information will be useful for understanding the influence of different weather parameters on the activity and abundance of natural enemies, which will have great bearing on insect-pest population dynamics, insect damage and crop production.

#### References

1. ICRISAT (2012) <http://www.icrisat.org> (Accessed 26 May, 2014).
2. Basandrai AK, Basandrai D, Duraimurugan P, Srinivasan T (2011) Breeding for biotic stresses. In: Biology and breeding of food legumes. Pratap A, Kumar J (eds.) CAB International, Oxfordshire, UK, pp 220–240.
3. Gopali JB, Teggelli RD, Mannur M, Yelshetty S (2010) Web-forming lepidopteran, *Maruca vitrata* (Geyer): An emerging and destructive pest in pigeonpea. Karnataka J Agric Sci 23 : 35–38.
4. Singh KB, Cheema HK (2006) Evaluation of pigeonpea genotypes for resistance to pod borer complex. Ind J Crop Sci 1 : 194–196.
5. Beccaloni B, Scoble M, Kitching I, Simonsen T, Robinson G, Pitkin B, Hine A, Lyal C. (eds.) (2003) The global Lepidoptera Names Index (LepIndex). World Wide Web electronic publication. <http://www.nhm.ac.uk/entomology/lepindex> (Accessed 27 May, 2014).
6. Shanower TG, Kelly TG, Cowgill SE (1997) Development of effective and environmentally sound strategies to control *Helicoverpa armigera* in pigeonpea and

- chickpea production system. In: Proc 3<sup>rd</sup> Int Conf Trop Entomology. Saini RK (ed.) ICEPE, Nairobi, Kenya, pp 235—276.
7. Lateef SS, Reddy YVR (1984) Parasitoids of some pigeonpea pests at ICRISAT. Int Pigeonpea Newslett 3 : 46—47
  8. Mohapatra LN, Sahu BB (2003) Natural parasitization of pigeonpea leaf webber *Cydia critica* in the eastern ghat highland zone of Orissa. Ind J Entomol 65 : 465—467.
  9. Mills N (1997) Technique to evaluate the efficiency of natural enemies. In: Methods in ecological and agricultural entomology. Dent DR, Watton MP (eds.) CAB International, Oxfordshire, UK, pp 271—291.
  10. Van Driesche RGV (1983) Meaning of percent parasitism in studies of insect parasitoids. Environ Entomol 12 : 1611—1622.
  11. Sujithra M, Chander S (2014) Seasonal incidence and damage of major insect pests of pigeonpea, *Cajanus cajan* (L.). Ind J Entomol 76 : 202—206.
  12. Gupta A, Ghosh A, Baby NL, Jalali SK (2011) Morphological and molecular characterization of *Apanteles mohandasi* Sumodan and Narendran (Hymenoptera: Braconidae), a solitary endoparasitoid of *Pammene critica* Meyrick (Lepidoptera: Tortricidae), with notes of biology from India. Entomol News 122 : 354—365.
  13. Yu DSK (2012) Home of Ichneumonoidea <http://www.taxapad.com> (Accessed 27 May, 2014).
  14. Saxena K, Ujagir R (2007) Effect of temperature and relative humidity on pod borer in pigeonpea. J Food Leg 20 : 121—123.
  15. Kumar A, Nath P (2005) Insect pests of early pigeonpea in relation to weather parameters. Ann Pl Protec Sci 13 : 23—26.