



Seasonal abundance of invasive leaf miner, *Phthorimaea absoluta* (Meyrick) on tomato under mid hill conditions of Himachal Pradesh

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Abstract

The South American tomato leaf miner, *Phthorimaea absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is an invasive pest which has been causing havoc both in greenhouse and open field. The study was conducted in mid-hill region of Himachal Pradesh during summer of 2022 and 2023 to record the seasonal abundance of the pest under field conditions. The per cent leaf and fruit infestation varied from 2.38 to 32.68 and 1.49 to 12.33 during 2022 and 3.70 to 29.71 and 1.30 to 9.09 during 2023, respectively. The number of mines, leaf infestation (%) and fruit infestation (%) had a significant positive correlation with relative humidity and minimum temperature. Adult trap catch showed a negative non-significant correlation with rainfall. Based on the results it is inferred that, monitoring and pest management interventions should be initiated in the early growth period of the crop to avoid build-up of the pest.

Key words: Tomato, leaf miner, abundance, correlation, temperature, rainfall

Invasive pest species are a major threat in agricultural landscapes. Increased globalization and international trade facilitate the spread and establishment of invasive species (Hulme 2009; Paini *et al.* 2016). The South American tomato leaf miner, *Phthorimaea absoluta* (Meyrick) (Lepidoptera: Gelechiidae), native to South America (Barrientos *et al.* 1998), is a potentially invasive and key pest of tomato, *Solanum lycopersicum* L. in different parts of the world (Biondi *et al.* 2018). Outside its native home, it was detected for the first time in Spain in 2006 (Urbaneja *et al.* 2007), and since then, it has invaded many countries including India (CABI 2019). At present, the pest has spread to almost all the tomato growing parts of India (Sridhar *et al.* 2014; Ballal *et al.* 2016, Sankarganesh *et al.* 2017). In Himachal Pradesh, the first case of *P. absoluta* infestation on tomato was reported in the mid-hills of Solan in 2015 (Sharma and Gavkare 2017). Later, the pest was found in an epidemic form under protected conditions in Mandi district (Sood and Yadav 2017). It has become one of the most devastating pests of tomato crop all over the world both in greenhouse and open fields (Sapkal *et al.* 2018). Tomato is known to be the main host of *P.*

absoluta, but it also feeds, develops and reproduces on other solanaceous plants and related weeds (Pereyra and Sanchez 2006). The larvae cause damage by mining into the leaves, producing large galleries that later become necrotic. The larvae also burrow inside stalks and consume apical buds and fruits. The pest cause damage during all growth stages and has a potential of causing a yield loss of 50 to 100 per cent (Medeiros *et al.* 2009; Desneux *et al.* 2010). It has a high reproductive potential (Gebremariam 2015), with 10–12 generations per year, depending on the favourable environmental conditions. It can overwinter in the egg, pupa, or adult stage (EPPO 2005). Considering the damage potential and threat of this invasive pest, the study was carried out to know the seasonal abundance and damage level of *P. absoluta* under mid hill conditions of Himachal Pradesh.

Materials and Methods

Investigations on the seasonal abundance of tomato leaf miner were carried out at Experimental Farm of Department of Entomology, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya, Palampur (H.P.) during the summer of 2022 and 2023.

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The extent of damage caused by the pest was studied by transplanting tomato variety Avatar on 13th April in 2022 and 29th March in 2023 in an area of 150 m². The crop was raised following recommended package of practices except the use of insecticides (Anonymous 2018).

P. absoluta moth population was monitored on tomato crop starting from transplanting until final harvest at weekly intervals by using sex pheromone traps (WOTA open pan water traps). Sex pheromone dispensers were renewed every 15 days and the numbers of moths captured in the trap were recorded weekly during the cropping seasons of 2022 and 2023. The observations on number of eggs, larvae and mines per 3 leaves (top, middle and bottom) per plant were recorded on 30 number of randomly selected plants at weekly intervals starting from the appearance of the pest on the crop till harvest of the crop. Data on leaf and fruit infestation were also recorded to work out per cent leaf/fruit infestation. The population build up data were correlated with weather parameters to establish relationship with abiotic factors (max temp, min temp, rainfall, humidity) through simple correlation analysis (Chandel 1993). The weather data were collected from the Agro-meteorological observatory of the Department of Agronomy, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur.

$$\text{Leaf infestation (\%)} = \frac{\text{Number of mined leaves}}{\text{Total number of leaves}} \times 100$$

$$\text{Fruit infestation (\%)} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

Results and Discussion

Seasonal incidence of *P. absoluta* during summer 2022

The tomato leaf miner started appearing during 21st standard meteorological week (SMW) in the year 2022. Number of eggs per plant varied from 0.27 to 5.87 with highest density during the 27th standard week (5.87) (Table 1). *P. absoluta* larvae appeared during 21st SMW i.e., 3rd week of May with maximum number of mines made during 27th SMW (19.59). With the advancement of the season, the larval density increased to reach a peak of 12.67 larvae per plant during the 28th standard week (2nd week of July). Leaf infestation was recorded from 21st SMW, which increased with the crop maturity, to reach a maximum of 32.68 per cent during 31st SMW. The mean per cent leaf damage and mean number of larvae recorded were 17.84±2.73 and 4.73±1.23, respectively. The per cent fruit infestation was observed from 26th SMW to 31st SMW with mean infestation of 3.75±1.38 per cent during 2022. The moth catch began from 21st SMW and continued throughout the season (Fig. 1). Highest moth catch was noticed during 26th SMW (25.00) while the least number of moths trapped were 2.00 during 31st SMW. The mean moth catch per week was 10.73±2.09.

Seasonal incidence of *P. absoluta* during summer 2023

The incidence of the pest was recorded during 19th SMW in the year 2023. The eggs were first noticed on

Table 1. Incidence of *Phthorimaea absoluta* during summer 2022

SMW	No. of eggs*	No. of larvae*	No. of mines*	Leaf infestation (%)	Fruit infestation (%)
21	0.00	0.33	3.72	2.38	0.00
22	0.27	0.60	5.39	7.08	0.00
23	0.87	1.53	6.81	10.43	0.00
24	1.20	1.80	8.28	14.52	0.00
25	3.13	5.60	9.13	15.32	0.00
26	5.27	8.07	15.63	18.00	1.49
27	5.87	9.60	19.59	20.84	3.70
28	3.73	12.67	14.56	23.19	7.50
29	1.67	6.47	14.81	24.46	6.25
30	1.33	3.67	15.45	27.40	10
31	0.13	1.73	17.16	32.68	12.33
Mean±SE	2.13±0.62	4.73±1.23	11.87±1.61	17.84±2.73	3.75±1.38

*Average per 3 leaves per plant

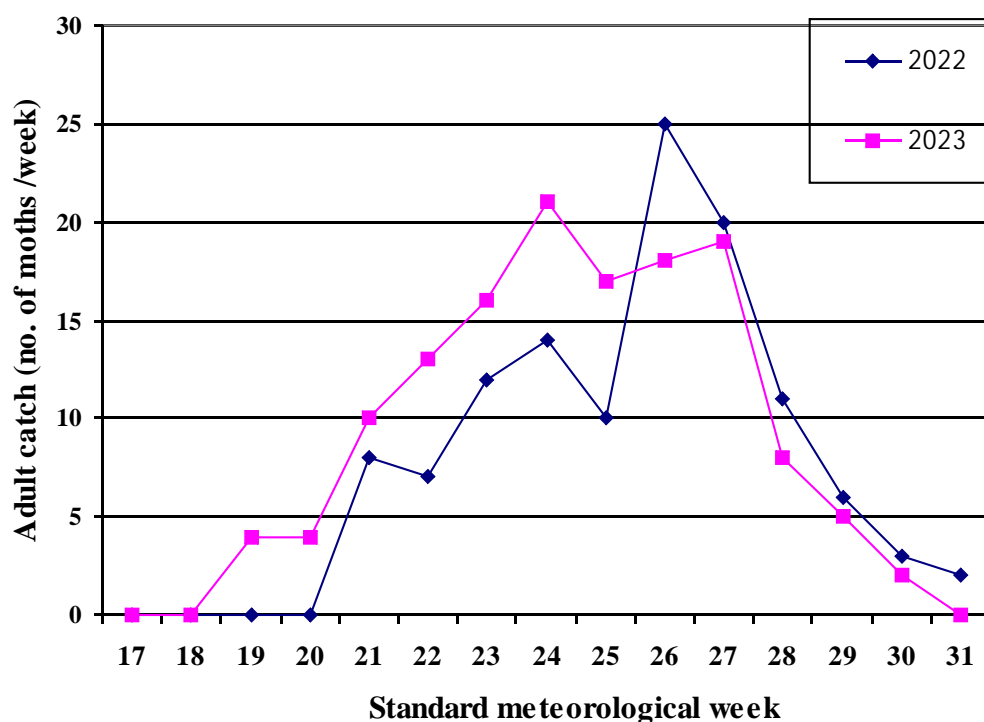


Fig. 1 Pheromone trap catch of *P. absoluta* during summer 2022 and 2023

the crop during 21st SMW and attained a peak of 6.07 eggs per plant during 27th SMW (Table 2). The larvae, mines and per cent leaf damage on the crop started appearing from 19th SMW. Highest numbers of larvae recorded per plant were 9.13 during 26th SMW. The number of mines per plant varied from 0.47 to 14.07 and the highest mine count was observed during 28th SMW. The mean number of eggs and mines per plant

were 2.61 ± 0.65 and 9.21 ± 1.45 , respectively. Per cent leaf infestation progressed with the crop maturity, with slight fluctuations, and recorded highest during 30th SMW (29.71). Fruiting started from 24th SMW and fruit infestation was noticed right from the first week of fruiting stage which ranged from 1.30 to 9.09 per cent. The mean per cent leaf and fruit infestation was 17.13 ± 2.36 and 2.78 ± 0.94 , respectively. Pheromone

Table 2. Incidence of *Phthorimaea absoluta* during summer 2023

SMW	No. of eggs*	No. of larvae*	No. of mines*	Leaf infestation (%)	Fruit infestation (%)
19	0.00	0.13	0.47	3.70	0.00
20	0.00	0.53	1.80	6.67	0.00
21	0.60	1.07	3.53	8.68	0.00
22	1.00	3.47	5.93	11.96	0.00
23	1.53	4.73	8.27	15.32	0.00
24	2.47	7.00	11.07	18.04	1.30
25	3.73	6.00	14.00	17.49	1.85
26	5.73	9.13	12.47	19.96	2.78
27	6.07	8.40	12.40	22.42	5.00
28	5.47	5.20	14.07	25.15	7.14
29	3.40	2.13	13.00	26.42	6.25
30	1.27	1.33	13.53	29.71	9.09
Mean \pm SE	2.61 ± 0.65	4.09 ± 0.90	9.21 ± 1.45	17.13 ± 2.36	2.78 ± 0.94

*Average per 3 leaves per plant

trap catch reveal that the highest number of moths were trapped during 24th SMW (21.00) (Fig. 1). Adult trap catch continued throughout the season. The mean number of moths trapped were 11.42±1.95.

The present findings are in agreement with the earlier workers (Lietti *et al.* 2005; Karut *et al.* 2011; Portakaldali *et al.* 2013; Ata and Megahed 2014) who have reported relatively low pest density in the early stage, increasing towards middle of the crop cycle and then declining thereafter. The incidence of *P. absoluta* increased with the crop growth stage and the results are in accordance with the findings of earlier workers (Ramesh 2016; Nayana *et al.* 2018, Shiberu and Getu 2018; Negi 2019). The current finding is supported by Leite *et al.* (2001) who have reported comparatively lesser number of eggs and larvae towards the end of season. The damage on fruits was lesser compared to that on leaves during both the years which find support from the studies conducted by Kumari *et al.* (2018). Higher number of mines per leaf than the corresponding larval population was reported in the present study which is in accordance with the findings of Lee *et al.* (2014) and Nitin *et al.* (2017). The adult catch in pheromone traps also varied (2-25 adults) during both the years of study; being higher towards the middle of the season and lower towards the beginning and the end of the cropping season.

Correlation between incidence of *P. absoluta* and various abiotic factors during 2022-23

Data on the the incidence of *P. absoluta* were correlated with different weather parameters

prevailing at Palampur during 2022 and 2023 (Table 3). Maximum temperature showed negative correlation with eggs, larvae, mines, per cent leaf and per cent fruit infestation. Minimum temperature revealed positive correlation during both the seasons with number of eggs ($r=0.67$), number of mines ($r=0.85$), per cent leaf infestation ($r=0.79$) and per cent fruit infestation ($r=0.68$) during 2023. Present studies drew support from the findings of Negi (2019) and Chaudhary *et al.* (2022) and who have also reported negative correlation of maximum temperature with the pest incidence and a positive and significant correlation of minimum temperature with the number of mines and per cent leaf infestation. Rainfall had significant influence on the number of mines, per cent leaf and fruit infestation with $r=0.67$, $r=0.72$ and 0.84 during 2022, respectively. Adult catch was negatively influenced by rainfall during both the cropping years with $r=-0.22$ and $r=-0.34$, respectively. A positive and non-significant correlation of adult catch with minimum and maximum temperature was observed, which was also reported by Venkataramanaiah *et al.* (2021). Relative humidity had a positive significant correlation with the number of larvae ($r=0.65$), number of mines ($r=0.91$), per cent leaf ($r=0.91$) and per cent fruit ($r=0.79$) infestation during 2022.

Conclusion

Minimum temperature and relative humidity had a significant positive influence on the pest population which led to increase in infestation level. The pest density was initially low during the early stages of crop

Table 3. Correlation between incidence of *Phthorimaea absoluta* and various abiotic factors during 2022-23

Weather Factor	Year	Correlation coefficient (r)					
		No. of eggs	No. of larvae	No. of mines	Leaf infestation (%)	Fruit infestation (%)	Pheromone trap catch per week
Max. Temperature (°C)	2022	-0.24	-0.39	-0.50	-0.53	-0.57*	0.30
	2023	-0.09	0.02	-0.01	-0.15	-0.25	0.20
Min. Temperature (°C)	2022	0.08	0.15	0.30	0.27	0.20	0.17
	2023	0.67*	0.45	0.85**	0.79**	0.68*	0.18
Rainfall (mm)	2022	0.14	0.27	0.67*	0.72*	0.84**	-0.22
	2023	-0.01	-0.29	0.00	0.11	0.19	-0.34
Relative Humidity (%)	2022	0.47	0.65*	0.91**	0.91**	0.79**	-0.02
	2023	0.76**	0.47	0.90**	0.93**	0.87**	0.09

*Significant at P=0.05

**Significant at P=0.01

growth which progressed with the advancement of the crop and thereafter declined. Based on these results, pest monitoring should be initiated right from the transplanting of crop in the field and thereafter management practices should be followed to avoid build-up of the pest.

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