



First record of tomato leaf miner (*Tuta absoluta*) from Jammu, India

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Received: 01 September 2023; Accepted: 24 June 2024

Keywords: Invasive pest, Leaf miner, Trap catches, *Tuta absoluta*, Tomato

Tomato (*Solanum lycopersicum* L.) holds 2nd position in worldwide vegetable cultivation, after potato (Costa and Heuvelink 2018). India is the second largest tomato producer (20 million tonnes), after China (62.8 million tonnes) (FAO 2021) with 79.95 thousand tonnes of production contributed by Jammu and Kashmir (NHB 2022). However, insect-pests have emerged as a pivotal factor contributing to tomato quality deterioration and diminished yields. Within the tomato ecosystem, a myriad of insect-pests pose challenges, and in 2014, the alarming presence of another such pest, viz. *Tuta absoluta* (Meyrick 1917) (Lepidoptera: Gelechiidae), was introduced from South America to India (Shashank *et al.* 2015). During its initial year of introduction, damage levels ranged from 0.5–60% across different locations, which intensified in subsequent years (Shashank *et al.* 2015). The lack of effective inter-quarantine measures facilitated the interstate movement of *T. absoluta*, leading to its detection in northern India two years later, with no prior records of its presence in Jammu and Kashmir. This article serves as a momentous document, heralding the first-ever occurrence of *T. absoluta* in Jammu region.

The study was carried out during 2022 and 2023 at different tomato growing belts of the Jammu region to determine the status of *T. absoluta* invasion in the Jammu region. Nine different locations in four districts were assessed to estimate the incidence and infestation of *Tuta absoluta*, viz. Chenani (33.0355°N, 75.2852°E; 1139 m amsl), Basht (33.0439°N, 75.3094°E; 1342 m amsl) and Sudhmahadev (33.0208°N, 75.3603°E; 1225 m amsl) in district Udhampur; Sangaldan (33.2420°N, 75.0903°E; 1383 m amsl) and Gool (33.2662°N, 75.0045°E; 2228 m amsl) in district Ramban; Assar-Baggar (33.2234°N, 75.2753°E; 1150 m amsl) in district Doda; Bathindi (32.4237°N, 74.5422°E; 327 m amsl), R S Pura (32.6806°N, 74.8436°E;

270 m amsl) and Sher-e-Kashmir University of Agricultural Sciences and Technology (32.3910°N, 74.4825°E; 281 m amsl) in district Jammu.

Monitoring of *Tuta absoluta*: Light traps and pheromone traps (@10/ha) were strategically placed in farmers' fields to monitor the adult population. The survey was conducted monthly during the tomato cropping period (March–June). The data on larval and adult populations, and leaf and fruit infestations were diligently recorded. To gain a comprehensive understanding of *T. absoluta* incidence across the Jammu region, the monthly data were pooled and subjected to statistical analysis. The pest identification was carried out at the Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu based on its external morphology, following established guidelines outlined by Shashank *et al.* (2015). Furthermore, the samples were curated at the Museum of Entomological Science Academy, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu.

Studies on biology and morphometrics of *Tuta absoluta*: *T. absoluta* larvae were meticulously collected from the surveyed fields and brought to laboratory of Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu for further examination. These larvae were confined within metal wire screen cages (30 cm × 30 cm × 30 cm) and were provided with fresh tomato plants cultivated in mid-sized pots. The emerging male and female pairs were placed in separate cages for mating and subsequent oviposition. To cater to the nutritional needs of adult moths, small petri dishes containing cotton swabs soaked in 5% sugar solution were included in cages. Various crucial biological parameters, viz. incubation period, larval duration, pupal period, adult longevity, oviposition period, and fecundity were carefully recorded. Magnus MS13 inverted microscope was employed to measure different developmental stages, and observations were conducted under laboratory conditions, with controlled temperature and humidity.

Statistical analysis: The data collected over two years were subjected to statistical analysis. The critical difference

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Table 1 Incidence of tomato leaf miner, *Tuta absoluta* in different tomato growing belts of Jammu region during 2022 and 2023

District	Survey areas	Coordinates	Altitude (amsl)	Variety	Parameters				Fruit infestation (%)**	
					Light trap catches*	Pheromone trap catches*	Number of larvae/plant**	Leaf infestation (%)**		Fruiting stage
Udhampur	Chenani	33.0355°N,	1139 m	Nunheems	2022	23.30±0.05 ^c	14.41±0.08 ^c	39.25±0.01 ^c	57.17±0.01 ^c	52.73±0.13 ^c
		75.2852°E		28-53						
	Basht	33.0439°N,	1342 m	Tofa		29.27±0.07 ^a	17.67±0.06 ^a	41.06±0.09 ^a	70.45±0.03 ^a	71.92±0.16 ^a
		75.3094°E								
	Sudh Mahadev	33.0208°N,	1225 m	Tofa; 7711		25.81±0.01 ^b	16.25±0.05 ^b	46.04±0.01 ^b	60.47±0.04 ^b	63.82±0.03 ^b
Ramban	Sangaldan	75.3603°E	1383 m	Manisha Plus		0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e
		33.2420°N,	2228 m	Abilasha		0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e
	75.0903°E									
	Gool	33.2662°N,	1150 m	Tofa		17.20±0.07 ^d	10.55±0.07 ^d	20.69±0.07 ^d	45.67±0.05 ^d	25.78±0.17 ^d
	75.0045°E									
Doda	Assar Baggar	33.2234°N,	327 m	Tofa		0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e
Jammu	Bathindi	75.2753°E	270 m	Avtar Hybrid		0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e
		32.4237°N,	281 m	Pusa Ruby		0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e	0.00±0.00 ^e
	74.5422°E									
	R S Pura	32.6806°N,								
	74.8436°E									
SKUAST-Jammu	32.3910°N,									
74.4825°E										
Udhampur	Chenani	33.0355°N,	1139 m	Nunheems	2023	14.60±0.05 ^c	6.38±0.08 ^c	30.55±0.01 ^c	48.47±0.01 ^c	44.03±0.13 ^c
		75.2852 °E		28-53						
	Basht	33.0439°N,	1342 m	Tofa		20.57±0.07 ^a	9.14±0.06 ^a	37.34±0.01 ^a	61.75±0.03 ^a	63.22±0.16 ^a
		75.3094°E								
	Sudh Mahadev	33.0208°N,	1225 m	Tofa; 7711		17.11±0.01 ^b	7.12±0.05 ^b	32.36±0.09 ^b	51.77±0.04 ^b	55.12±0.03 ^b
Ramban	Sangaldan	75.3603°E	1383 m	Manisha Plus		0.00±0.00 ^g	0.00±0.00 ^h	0.00±0.00 ^h	0.00±0.00 ^h	0.00±0.00 ^g
		33.2420°N,	2228 m	Abilasha		0.00±0.00 ^g	0.00±0.00 ^h	0.00±0.00 ^h	0.00±0.00 ^h	0.00±0.00 ^g
	75.0903°E									
	Gool	33.2662°N,	1150 m	Tofa		10.13±0.07 ^d	4.95±0.07 ^d	19.48±0.07 ^d	36.97±0.05 ^d	17.08±0.17 ^d
	75.0045°E									
Doda	Assar Baggar	33.2234°N,	327 m	Tofa		8.48±0.00 ^e	4.07±0.00 ^e	14.82±0.00 ^e	19.20±0.00 ^e	15.93±0.00 ^d
Jammu	Bathindi	75.2753°E	270 m	Avtar Hybrid		1.90±0.00 ^g	3.10±0.00 ^g	8.72±0.00 ^g	12.88±0.00 ^g	8.58±0.00 ^f
		32.4237°N,	281 m	Pusa Ruby		3.05±0.00 ^f	3.60±0.00 ^f	11.62±0.00 ^f	16.89±0.00 ^f	11.84±0.00 ^e
	74.5422°E									
	RS Pura	32.6806°N,								
	74.8436°E									
SKUAST-Jammu	32.3910°N,									
74.4825°E										

Survey period, March–June. SKUAST-Jammu, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir; *, Mean number of moths/trap/week; **, Mean of 3 replications; Means with the same letters have significant differences between them ($P \leq 0.05$; Tukey HSD).

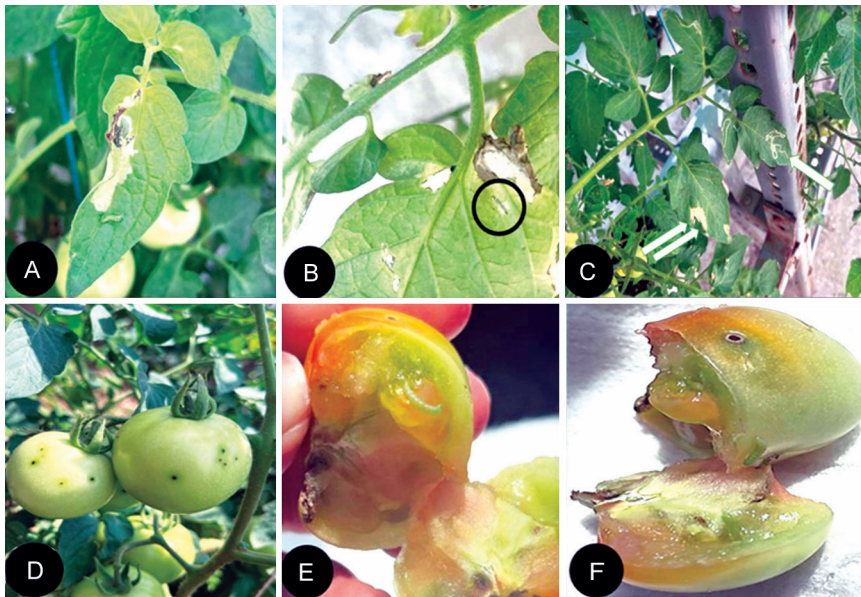


Fig. 1 Infestation of *Tuta absoluta* on tomato plants. (A) Foliar damage; (B) Larva inside the leaf mine (encircled area); (C) Difference between the foliar infestation of *Liriomyza trifolii* and *Tuta absoluta*; (D) Pinhole-sized damage on the fruit; (E, F) Larva inside the fruit. The single arrow depicts the leaf mine of *L. trifolii* and the dual arrow depicts the leaf mine of *T. absoluta*.

absoluta was conspicuously evident on the infested plants which exhibited characteristic blotch mines on leaves (Fig. 1A) with fully grown larvae easily noticeable within the mines (Fig. 1B). The mines made by *T. absoluta* were notably wider than those made by the serpentine leaf miner, *Liriomyza trifolii* (Burgess) (Fig. 1C). Furthermore, larval damage extended to tomato fruit during the reproductive stage of the plant. Small pinhole-sized damage marks were randomly distributed on the fruit's surface (Fig. 1D), and upon splitting the fruit from the middle, the larva could be observed feeding on the fruit pulp (Fig. 1 E, F). Comprehensive research on the biology of *T. absoluta* revealed four distinct stages in its life cycle: egg, larva, pupa, and adult (Fig. 2).

between infestation at various locations was computed at a 5% significance level using one-way variance analysis (ANOVA) and a post-hoc Tukey HSD test was done using SPSS 20.0 software.

The assessment of *Tuta absoluta* distribution over two years revealed a worrisome pattern, indicating the spread of this insect across various districts in the Jammu region. During 2022 and 2023, the pest was found between an altitude range of 281–1342 m amsl, with no observed presence beyond this range. In 2022, *T. absoluta* was detected in four of these locations, while in the subsequent year (2023), the pest invaded seven out of the nine surveyed locations, depicting the increasing invasion over time. The insect incidence and infestation were highest in district Udhampur followed by Doda and Jammu, respectively (Table 1). Remarkably, there were no recorded instances of this pest in the Jammu district in 2022, but the subsequent year witnessed a significant infestation. Interestingly, district Ramban did not show any pest presence during the entire survey duration. The damage caused by *Tuta*

absoluta was conspicuously evident on the infested plants which exhibited characteristic blotch mines on leaves (Fig. 1A) with fully grown larvae easily noticeable within the mines (Fig. 1B). The mines made by *T. absoluta* were notably wider than those made by the serpentine leaf miner, *Liriomyza trifolii* (Burgess) (Fig. 1C). Furthermore, larval damage extended to tomato fruit during the reproductive stage of the plant. Small pinhole-sized damage marks were randomly distributed on the fruit's surface (Fig. 1D), and upon splitting the fruit from the middle, the larva could be observed feeding on the fruit pulp (Fig. 1 E, F). Comprehensive research on the biology of *T. absoluta* revealed four distinct stages in its life cycle: egg, larva, pupa, and adult (Fig. 2). The adult female deposited individual creamy white eggs on both upper and lower leaf surfaces, which later took on a yellow hue. These eggs hatched after four days, and the newly emerged larvae underwent three moults, progressing through four larval stages. The mature larvae then entered the pupation stage, during which they transformed into a cylindrical, dark brown pupa. The emerging adult insects were silver-greyish and possessed fringed wings. Both adult male and female moths showed a lifespan of approximately 7–15 days. The entire life cycle of *T. absoluta* was completed in around 29 days for males and 37 days for females. Detailed information on the biological characteristics and morphometric measurements

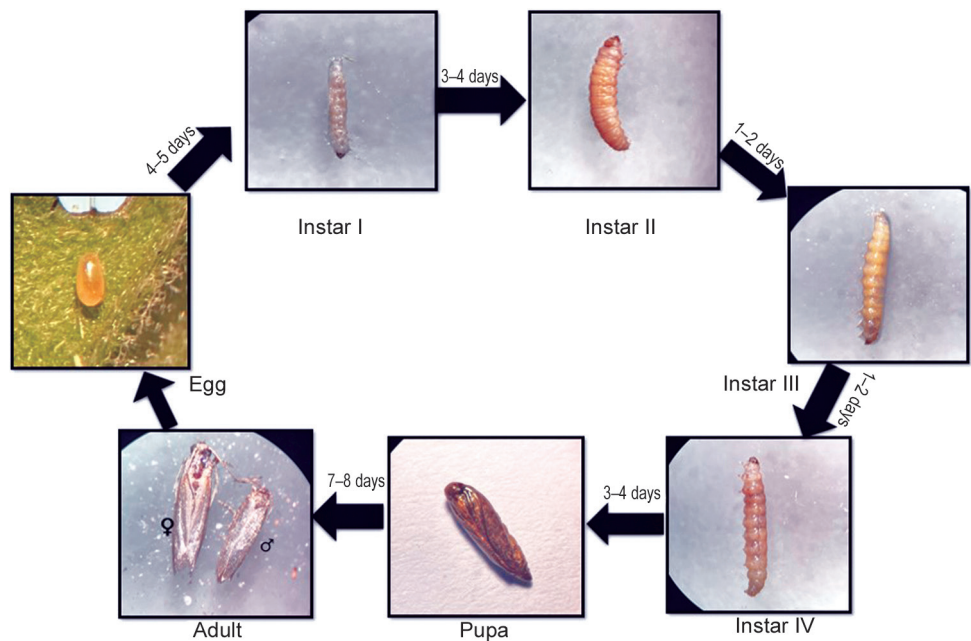


Fig. 2 The life cycle of *Tuta absoluta* depicting different development stages.

Table 2 Biological parameters and morphometry of tomato leaf miner, *Tuta absoluta* under laboratory conditions during 2022 and 2023

Parameter		Life cycle		Morphometry	
		Duration (days)	Length (mm)	Breadth (mm)	Head capsule (mm)
Egg**		4.01±0.01	0.29±0.05	0.22±0.01	-
Larva *	I st Instar	3.49±0.01	1.26±0.03	0.23±0.01	0.14±0.03
	II nd Instar	1.79±0.02	2.37±0.01	0.24±0.06	0.21±0.02
	III rd Instar	1.86±0.01	3.64±0.03	0.55±0.07	0.35±0.04
	IV th Instar	3.47±0.08	6.49±0.06	1.10±0.05	0.58±0.01
Total larval duration		10.61±0.09	-	-	-
Pupa*		7.66±0.05	4.38±0.05	1.12±0.08	-
Total development period		22.28±0.09	-	-	-
Mating time (hours)		4.42±0.37	-	-	-
Pre-oviposition period		1.21±0.10	-	-	-
Oviposition period		10.99±0.08	-	-	-
Post-oviposition period		2.01±0.04	-	-	-
Adult*	Male	7.58±0.01	3.03±0.05	2.14±0.01	-
	Female	15.04±0.07	4.48±0.04	1.23±0.07	-
Total Life cycle	Male	29.87±0.04	-	-	-
	Female	37.33±0.01	-	-	-
Fecundity (No. of eggs/female)		135.81±0.13	-	-	-
Fore wing	Male	-	4.06±0.08	0.82±0.09	-
	Female	-	4.35±0.01	0.93±0.01	-
Hind wing	Male	-	3.15±0.01	0.67±0.03	-
	Female	-	3.10±0.06	0.74±0.01	-

*, Mean±SE of 20 observations; **, Mean±SE of 60 eggs.

are presented in Table 2.

T. absoluta invaded India in 2014 (Shashank *et al.* 2015) which can be attributed to tomato and packaging material imports from infested countries, thus underscoring the potential risks associated with global trade in relation to invasive species material (Potting *et al.* 2013). Regrettably, the lack of robust quarantine measures within the country facilitated the rapid dissemination of this pest to numerous Indian states, leaving the nation susceptible to further invasions in the foreseeable future (Gupta *et al.* 2019). *T. absoluta* has been a notorious tomato pest in South America since the 1960s (Desneux *et al.* 2010). Its inclusion in the A2 quarantine list of EPPO in 2009 signified its alarming threat to plant health in Europe and the Mediterranean region (EPPO 2010, Biondi *et al.* 2018). Given that India stands as the second-largest global producer of tomatoes, the consequences of *T. absoluta* infestation can be far-reaching, posing potential risks to food security. This pest exhibits a pronounced affinity for tomato crops, setting it apart from other solanaceous crops (Karadjova *et al.* 2013, Tumuhaise *et al.* 2016), thereby exacerbating concerns for the tomato industry in Jammu and Kashmir—an economic hub reliant on horticulture. Tamatar Morh, a prominent area in the Udhampur district renowned for its extensive tomato

cultivation, would face an imminent risk along with other areas of the region, if the infestation of *T. absoluta* escalates. Disturbingly, the present survey documented a range of foliar infestations from 39–70% and fruit infestations from 52–71% in Udhampur district, highlighting the severity of the situation. Alarming agricultural practices, such as the indiscriminate application of high-dose insecticides and repetitive use of insecticides with identical modes of action, may inadvertently foster insecticide resistance, further complicating pest management efforts (Sharma *et al.* 2015). The remarkable adaptability of *T. absoluta* allows it to rapidly acclimatize, establish, and disperse, making both local and long-distance spread plausible (Stol *et al.* 2009, Desneux *et al.* 2010). Thus, it becomes imperative to conduct regular surveys of tomato-growing areas in the Jammu region to monitor pest populations closely. The active involvement of quarantine departments in formulating effective management strategies is paramount to curtail the invasive pest's relentless expansion. In response, diligent monitoring through trap installations in fields and heightened awareness among farmers have become indispensable. Furthermore, effective collaboration among stakeholders, researchers, and extension officers is essential to tackle this pressing challenge. Considering the potential risks posed by

this emerging pest in the Jammu region, urgent and proactive measures must be taken to thwart its epidemic potential. It is hoped that the information presented in this article will provide pertinent and essential insights to stakeholders, empowering them to effectively tackle the looming menace of *T. absoluta* in the Jammu region.

The presence of *Tuta absoluta*, an invasive insect pest, has been documented for the first time in Jammu, India, with alarming implications for tomato growers in the region. This article serves as a pivotal source to assess the pest's damage potential across diverse locations in the Jammu region and provides essential characteristics for its accurate identification. As this study highlights the pest's impact across various regions in Jammu, it underscores the urgency to address the issue proactively. To effectively combat this emerging menace, decisive and location-specific Integrated Pest Management (IPM) strategies must be devised. Tailored approaches are imperative, as the challenges posed by *T. absoluta* vary across different areas in the Jammu region. By implementing a targeted and timely response, the adverse consequences on tomato cultivation can be curtailed and the region can effectively navigate this emerging pest threat and protect its crucial agricultural sector.

SUMMARY

Tomato leaf miner, *Tuta absoluta* is an invasive insect pest that was introduced to India from South America wherein its initial occurrence in India was recorded in tomato fields of Pune, Maharashtra in October 2014. However, it was first observed in northern India in 2016, with no prior reports from the Jammu region until 2022. This article documents the first recorded instance of *T. absoluta* infestation on tomato in Jammu region. The survey was conducted for two consecutive years (2022 and 2023) during the tomato cropping period (March–June), encompassing four different districts of Jammu regions, viz. Udhampur, Doda, Ramban, and Jammu with nine locations. This research provides valuable insights into the spread and impact of *T. absoluta* in the Jammu region. The two-year data revealed the highest leaf and fruit infestation in district Udhampur, followed by Doda and Jammu districts. Curiously, there were no records of *T. absoluta* infestations in Ramban district. To gain a better understanding of biology and morphometrics of this pest, larvae were collected and reared in the laboratory of Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu. The crucial data on biological and morphometric attributes are

documented which can facilitate further investigations and development of potential management strategies.

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