
**ISSN Print:** 2664-844X
**ISSN Online:** 2664-8458
NAAS Rating (2025): 4.97
IJAFS 2025; 7(9): 670-673
www.agriculturaljournals.com
Received: 21-06-2025
Accepted: 25-07-2025

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# Ecological Succession of Insect Pests complex and Beneficials in Tomato (*Solanum lycopersicum* L.) crop at Raisen District of Madhya Pradesh

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**DOI:** https://www.doi.org/10.33545/2664844X.2025.v7.i9i.811

**Abstract**
Tomato (*Solanum lycopersicum* L.) is an economically important vegetable crop, widely cultivated across India, with Madhya Pradesh being one of the leading producers. Despite its significance, tomato production faces severe yield constraints due to a complex of insect pests and fluctuating environmental conditions. The present study was conducted in Raisen district of Madhya Pradesh during 2022-23 and 2023-24 to document the ecological succession of insect pests and beneficial arthropods associated with tomato under field conditions. Observations were recorded twice weekly on a randomly selected sample of 25 plants from untreated plots of variety Arka Vishesh. Results indicated that sucking pests such as jassids (*Amrasca biguttula biguttula*), whiteflies (*Bemisia tabaci*), and aphids (*Aphis gossypii*) appeared early in the vegetative stage and persisted until the late reproductive stage. Thrips (*Thrips tabaci*) and leaf miners (*Liriomyza trifolii*) were active from vegetative to reproductive phases, while the invasive pinworm (Tuta absoluta) remained prevalent throughout the crop cycle. The fruit borer (Helicoverpa armigera) caused severe damage during fruiting, whereas red spider mites (*Tetranychus spp*.) appeared under warm, dry conditions in 2023-24. Among beneficials, ladybird beetles (*Menochilus sexmaculatus*) were consistently recorded across all stages, while lacewings (*Chrysoperla sp*.) appeared during the vegetative phase, highlighting their role in natural regulation. The findings emphasize a clear pattern of pest succession, validating earlier reports, and underscore the importance of integrating ecological knowledge into pest management strategies. Conservation of natural enemies and timely interventions can support sustainable tomato production.

**Keywords:** *Solanum lycopersicum*, Insect pests, ecological succession & natural enemies

## Introduction
Tomato (*Solanum lycopersicum* L.) is one of the most widely cultivated vegetable crops globally, belonging to the family Solanaceae. It is an important source of vitamins (A, C, and E), minerals, antioxidants such as lycopene, and contributes significantly to human nutrition. In addition to its nutritional value, tomato also plays a vital role in the agroeconomy, serving as a major cash crop for millions of small and marginal farmers. Globally, tomato occupies an area of about 5.05 million hectares with a production of 189.34 million metric tonnes and an average productivity of 37.5 tonnes per hectare (FAOSTAT, 2022). India ranks second in global tomato production after China, with a cultivated area of 0.80 million hectares, production of 21.18 million tonnes, and productivity of 26.4 tonnes per hectare (NHB, 2023). Within India, Madhya Pradesh is one of the leading tomato-producing states, contributing substantially to national acreage and output. The state has a cultivated area of 0.14 million hectares under tomato, producing 2.94 million tonnes with a productivity of 21.5 tonnes per hectare (NHB, 2023). The Raisen district, situated in the central part of Madhya Pradesh, is a significant tomato belt owing to its favorable agro-climatic conditions, fertile soils, and availability of irrigation. Tomato cultivation in this region plays a crucial role in supporting the livelihoods of farmers, but its productivity often fluctuates due to abiotic stresses and biotic constraints, particularly insect pest infestations. Tomato crops are vulnerable to a wide range of insect pests, which together form a complex pest community that varies with the crop growth stage and season. The major insect pests reported on tomato include the fruit borer (*Helicoverpa armigera)*, whitefly (*Bemisia tabaci*), aphids (*Aphis gossypii*), leafminer (*Liriomyza trifolii*), thrips (*Thrips tabaci*), and jassids (*Amrasca biguttula biguttula*).

These pests cause significant yield losses either directly by feeding or indirectly by transmitting plant viruses, particularly Tomato leaf curl virus (ToLCV) vectored by whiteflies. Studies have estimated yield losses due to insect pests in tomato ranging between 30-70% depending on pest intensity and management practices (Sharma *et al*., 2020; Reddy *et al*., 2021) [3, 4].

The occurrence and dominance of insect pests in tomato fields follow a pattern of ecological succession influenced by crop phenology, local weather conditions, and interspecific competition. Early in the crop season, sap-feeding pests such as aphids and whiteflies generally colonize the crop, followed by foliage feeders and later by fruit borers during the reproductive stage. Alongside pests, beneficial insects including predators (ladybird beetles, lacewings, spiders), parasitoids (Trichogrammatids, Braconids), and pollinators play an important role in natural pest regulation and maintaining ecological balance. The dynamics between pests and natural enemies are crucial for ecological sustainability and form the basis for integrated pest management (IPM). Despite tomato's economic significance in Madhya Pradesh, detailed and systematic studies on the ecological succession of insect pests and associated beneficials are limited, particularly in Raisen district. Such studies are essential to identify key pests and natural enemies, understand their seasonal patterns, and develop location-specific IPM strategies.

Hence, the present investigation was undertaken to document the ecological succession of insect pest complexes and beneficial arthropods associated with tomato (*Solanum lycopersicum* L.) in Raisen district of Madhya Pradesh. The findings of this study will provide insights into pest-beneficial interactions, help forecast pest outbreaks, and support the development of sustainable management practices for enhancing tomato productivity in the region.

## Material & Methods

The present study was conducted on tomato (*Solanum lycopersicum* L.) variety Arka Vishesh under field conditions at Raisen district of Madhya Pradesh. The experimental plot measured 10 m × 15 m, comprising 10 rows, each with a row length of 4.4 m. The spacing between rows was maintained at 60 cm, while 40 cm spacing was kept between adjacent plots to ensure proper crop growth, field management, and to avoid overlapping of observations. Field observations were initiated immediately after sowing and continued throughout the crop growth period. Data were recorded twice every standard week to monitor the insect pest complex and associated natural enemies. For each observation, 25 plants were randomly selected from the field to obtain representative and unbiased samples. The field was maintained without the application of any chemical insecticides or protective treatments, thereby allowing a natural build-up of insect populations. During each observation, insect pests and beneficial arthropods were carefully recorded. Particular attention was given to the order of appearance, duration of presence, and population status of different insect groups. Both harmful pests (such as fruit borers, sap-sucking insects, leaf miners, etc.) and beneficial insects (predators, parasitoids, and pollinators) were systematically documented.

This methodological approach enabled the assessment of ecological succession of insect pests and natural enemies, providing valuable insights into population dynamics, seasonal incidence, and pest-beneficial interactions in tomato crops. The data generated from this study serve as a basis for developing effective integrated pest management (IPM) strategies suited to local agro-ecological conditions.

**Crop:** Tomato
**Variety:** Arka Vishesh
**Plot size:** 10×15
**No. of row/plot:** 10
**Row length:** 4.4
**Spacing row to row:** 60 cm
**Spacing plot to plot:** 40 cm

## Result & Discussion

### Year 2022-23

Sucking pests such as jassids (*Amrasca biguttula biguttula*), whiteflies (*Bemisia tabaci*), and aphids (*Aphis gossypii*) were the earliest to colonize the crop, appearing from the vegetative phase (24 DAT) and persisting until the late reproductive stage (up to 145 DAT). These pests caused characteristic symptoms including leaf curling, chlorosis, and reduced vigour. Whiteflies were particularly important due to their role as vectors of Tomato Yellow Leaf Curl Virus (TYLCV). Thrips (*Thrips tabaci*) and leaf miners (*Liriomyza trifolii*) were also active from vegetative to reproductive stages, with thrips causing silvering and deformation of floral structures, and leaf miners producing serpentine mines that reduced photosynthetic efficiency. Their continuous activity highlights their adaptability and pest status. Similar persistence of jassids and whiteflies during tomato growth was reported by Patel *et al*. (2012) and Das and Ray (2010) [5, 12], who emphasized their early-season establishment and prolonged damage potential. Whiteflies, in particular, are critical due to their role in transmitting Tomato Yellow Leaf Curl Virus (TYLCV), a finding supported by Kumar *et al*. (2011) [8], who stressed the yield losses linked to virus outbreaks. The invasive tomato pinworm (*Tuta absoluta*) was present from the vegetative phase and continued throughout the crop cycle, infesting leaves, stems, and fruits. Its prolonged activity and cryptic feeding habit made it a major challenge. The fruit borer (*Helicoverpa armigera*) was recorded during the reproductive stage (from 112 DAT), coinciding with fruit development. It caused direct fruit damage and economic losses. Among beneficial insects, the ladybird beetle (*Menochilus sexmaculatus*) was consistently observed throughout the crop period, preying on aphids, whiteflies, and thrips, indicating natural biological control potential.

### Year 2023-24

Similar succession pattern was recorded with certain additional observations. Jassids, whiteflies, and aphids once again appeared early (24 DAT) and persisted until late stages, remaining major sucking pests. Aphid populations peaked during cooler conditions, while whiteflies-maintained dominance due to favourable climate and their virus-transmitting role. Thrips and leaf miners were observed from vegetative to reproductive stages, with heavy activity during warmer periods. Thrips caused floral deformities and served as vectors of Tomato Spotted Wilt Virus (TSWV), while leaf miners reduced leaf vigour through internal feeding. The invasive pinworm (*Tuta absoluta*) persisted throughout the crop cycle, causing extensive damage to all aerial plant parts. Similarly, fruit

borer (H. armigera) was prominent during fruiting (from 112 DAT), inflicting severe fruit damage. A new addition to the pest complex was the red spider mite (*Tetranychus spp*.), recorded from 63-111 DAT during reproductive stages, thriving under warm and dry conditions and causing bronzing and defoliation. Among beneficials, lacewings (*Chrysoperla sp*.) were recorded during the vegetative stage, actively feeding on aphids and whiteflies, while ladybird beetles remained consistent predators throughout the season, further highlighting the role of natural enemies in regulating pest populations. The study revealed a clear ecological succession of insect pests and beneficials in tomato. Jassids, whiteflies, and aphids were dominant from the vegetative to reproductive stages, consistent with earlier reports highlighting their persistence and adaptability. Thrips and leaf miners peaked during flowering, causing significant damage and transmitting viral diseases, in agreement with observations by Jamuna (2019) and Yadav *et al*. (2014) [6, 16]. The invasive *Tuta absoluta* emerged as a major threat, infesting all crop stages, while *Helicoverpa armigera* was prominent during fruiting, corroborating findings of Lal *et al*. (2007) [8]. Red spider mites appeared during warm, dry conditions, reflecting climate-driven outbreaks. Beneficial insects such as ladybird beetles and lacewings were consistently observed, indicating their potential in regulating pest populations and supporting sustainable pest management. These findings emphasize the need for integrated pest management (IPM) strategies that combine timely interventions, conservation of natural enemies, and ecological approaches to minimize yield losses.

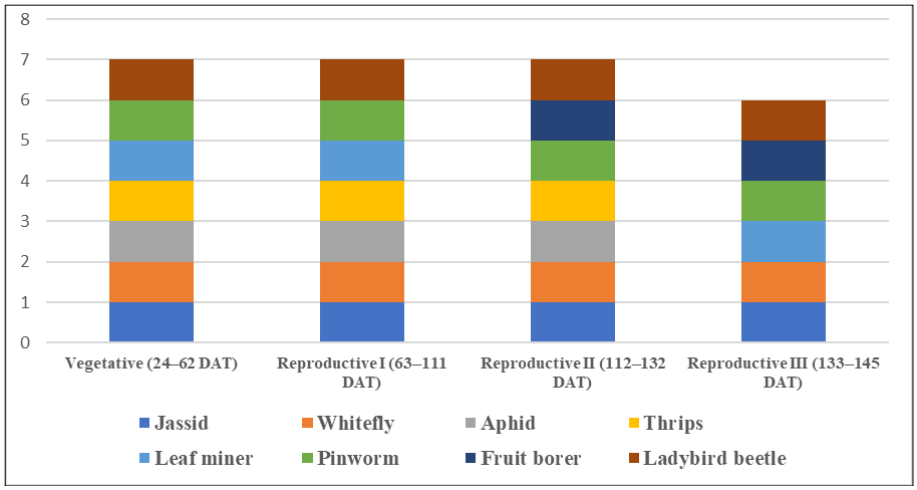


**Fig 1:** Succession of Insect Complex in Tomato (Rabi 2022-23)

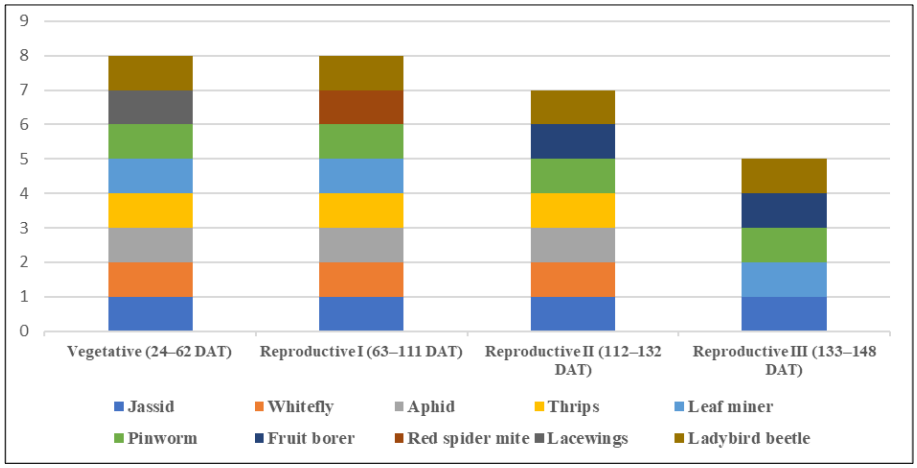


**Fig 2:** Succession of Insect Complex in Tomato (Rabi 2023-24)

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