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INVASIVE THRIPS, *THRIPS PARVISPINUS* (KARNY, 1992), AND ITS THREAT TO AGRICULTURE: A COMPREHENSIVE REVIEW

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ABSTRACT

The invasive pest, *Thrips parvispinus* (karny) (Thysanoptera: Terebrantia: Thripidae) is a polyphagous species that significantly impacts a wide range of agricultural crops and ornamental plants. Initially reported in India on papaya plantations, its presence has now been confirmed on various other hosts, including mulberry, mung bean, cotton, and onion. Adaptability on diverse hosts, small size, short life cycle, cryptic behaviour and capacity for species replacement contributes expanding geographical range within the country. Major damage caused by direct feeding of larvae and adults on leaves, growing buds, fruits, causes leaf distortion, silvery appearance on older leaves and leading to flower drop and malformed fruit setting. Effective pest management of *T. parvispinus* requires thorough understanding of pest biology, life cycle and accurate identification of species utilizing both morphological characters and molecular methods. Implementing an Integrated Pest Management (IPM) strategies that combines Mulching, biorationals, blue sticky traps and need based chemical insecticides, is critical to mitigate the impact of *T. parvispinus* and ensure sustainable agricultural practices. This review emphasizes the essential components for effective pest management.
Keywords **:** *Thrips parvispinus*, Invasive thrips, Integrated Pest Management, Sustainable agriculture, black thrips, South east Asian thrips and Tobacco thrips.

Introduction

Thrips parvispinus (Karny), a pest species native to Southeast Asia, has been observed reproducing in Europe for the first time, notably causing damage to Gardenia plants in Greece. The increasing distribution of this species emphasize its quarantine significance (Mound *et al*., 2000). Classified under the "Thrips orientalis" group, *T. parvispinus* is a prevalent pest species with quarantine importance, documented across regions from Thailand to Australia (Mound, 2005; Mound and Collins, 2000).

Expansion of host range, noting its occurrence on papaya in Hawaii, Gardenia species in Greece, and on various vegetable crops such as capsicum, green beans, potato, and brinjal across multiple countries (Murai *et al.,* 2010). In India, *T. parvispinus* was first reported on papaya plantations based on an integrated approach combining morphological characteristics and DNA barcoding, haplotyping data suggested that Indonesia is a potential source of this pest introduction to India (Tyagi *et al*., 2015).

Further reports highlighted the emergence of *T. parvispinus* on ornamental *Dahlia rosea* cav., a newly identified host, which raised concerns about the spread of this invasive species within India and enhanced quarantine measures are needed to prevent its movement from Karnataka to other regions (Rachana *et al.,* 2018). Later documentation of severe infestations on bell pepper crops in Andhra Pradesh, Chhattisgarh, and Karnataka, as well as damage to *Mangifera indica* in Tamil Nadu, further solidifying the pest's threat to agricultural productivity in India (Rachana *et al.,* 2022).

In Gujarat, *T. parvispinus* infestations on non-pungent chilli varieties are recorded higher than high pungent chillies during a roving survey, while high populations of thrips (14-16 per flower) in chilli fields across the Anand district. (Lodaya *et al.,* 2022; Patel *et al.,* 2022). Similarly, in Karnataka, infestations reached alarming levels, with over 75% of chilli crops affected, resulting in an 85% loss of yield and the thrips were mostly seen on flowers, flower buds, and foliage in the surveyed areas (Prasanna Kumar *et al.,* 2021). Hulagappa *et al.* (2022) recommended using the MaxEnt model to forecast thrips incidence in chilli and mitigate further damage.

Hosts

Thrips parvispinus is a highly polyphagous pest, infesting a broad range of fruits, vegetables, and ornamental plants. It was first identified as a serious agricultural pest when it caused significant damage to chilli peppers (Talekar 1991). Its host range has since expanded to include economically important crops such as coffee, gardenia, papaya, sweet peppers, potatoes, tobacco, Vigna, green beans, strawberries, shallots, watermelons, cucumbers, and several ornamental species (EPPO 2001; Azidah 2011; Moritz 2013; Hutasoit 2017). Murai *et al.* (2009) further documented infestations of *T. parvispinus* on papaya in Hawaii, Gardenia sp. in Greece, and vegetable crops such as capsicum, green beans, potatoes, and brinjal across different countries. The pest's adaptability to diverse climates and hosts has contributed significantly to its global distribution.

In Europe, *T. parvispinus* is primarily found in greenhouse environments, particularly on ornamental plants like Citrus, Dipladenia, and *Ficus benjamina*, with additional records on Gardenia, Gerbera, and Schefflera species (Lacasa *et al.* 2019). In areas where it is well-established, it regularly infests crops like papaya, peppers, potatoes, eggplants, beans, shallots, Crotalaria, Vigna, coffee, cucumbers, and tobacco (Hutasoit *et al.*, 2017).

In India, *T. parvispinus* was first identified by Tyagi *et al.* (2015) on papaya in Bengaluru, signifying its spread to important agricultural regions. Later, ornamental plants like *Dahlia rosea* were recognized as new hosts, elevating the pest's quarantine significance (Rachana *et al.* 2018). Ranjith *et al.* (2022) further documented its invasion and infestation on guava, marking the first report of its impact on guava cultivation and its potential implications for export markets in India (Fig 2.).

Table 1: Host range of *Thrips parvispinus*

Black Jack (Bidens Pilosa), coffee, Gardenia sp., papaya, chilli pepper, paprika, potato, tobacco, Vigna sp., green bean, strawberry, eggplant, watermelon and other cucurbit	(Factsheet-*Thrips parvispinus* (uni-halle.de))
Pepper, anthurium and hoya	Johari *et al.,* 2014
Papaya	Tyagi *et al.,* 2015
Papaya, peppers, potatoes, eggplants, beans, shallots, crotalaria, vigna, coffee, cucumber, tobacco	Hutasoit *et al.,* 2017
Anthurium, chrysanthemum, dahlia, dipladenia, gardenia and ficus	NPPO, 2019
Chilli, weed species like Parthenium, *Amaranthus* sp., *Axonopus* sp., *Ageratum* sp. *Alternanthera* sp. *Thunbergia* sp, foliage of neem and pongamia	Nagaraju *et al.,* 2021
Guava	Ranjith *et al.,* 2022
coriander	Verghese *et al.,* 2022
Ridge gourd	Fening *et al.,* 2022
Onion	Saini *et al.,* 2023
cotton	Amutha and Rachana (2023)
Mungbean	Gothi *et al.,* 2024
Mulberry	Kumar *et al.,* 2024

Damage Symptoms

The damage caused by *T. parvispinus* is both extensive and severe, primarily due to its feeding activity, which involves sucking and rasping plant tissues. Signs of infestation include deep punctures and scratches on the underside of leaves, which turn reddish-brown, while the upper surface exhibits yellowing. Leaf blades become distorted, showing necrotic regions and yellow staining. Damage to the floral parts is characterized by scrapes on petals, resulting in brownish stripes. Infested fruit sets dry out and wither, and in heavily infected fields, there is a significant drop in flowers, affecting overall plant productivity (Siresha *et al.,* 2021).

The highest flight activity of adult *T. parvispinus* was observed during the morning hours, with nymphs residing on the leaf surfaces while adults preferred to inhabit the flowers (Pratiwi *et al.* 2018). Additionally, *T. parvispinus* was identified as the most prevalent species infesting flowers (71%) and leaves (56%) of both chilli and cayenne peppers (Hutasoit *et al.* 2019). The infestation of this pest on fruit leads to improper and malformed fruit development, resulting in a button-like shape for bell peppers, while the fruit surfaces exhibit a rough, scratchy appearance. This infestation can cause the fruits to take on abnormal shapes (Maharijaya *et al.* 2011). Both nymphs and adult thrips cause damage by feeding on leaves, buds, and flowers, with feeding damage creating an entry point for secondary infections, such as saprophytic fungal species like Cladosporium, particularly in papaya crops (Lim, 1989).

In addition to agricultural crops, *T. parvispinus* poses a threat to ornamental plants such as dahlias, chrysanthemums, gardenias, dipladenias, and Ficus species, where feeding can result in significant aesthetic and commercial losses. In Florida, *T. parvispinus* has been observed on Anthurium and Hoya grown in greenhouses, further highlighting its broad host range and adaptability to different environments. The impact of this pest across multiple plant species emphasizes the need for rigorous management and quarantine measures to prevent further spread and economic damage.

Development and Biology

The life cycle is influenced by temperature, duration from egg to adult ranges approximately 15 days (Lewis 1973). After four to five days of incubation, the female inserts eggs into leaves. The nymphs hatch and feed on leaves and flowers until adulthood, characterized by two moults lasting two to three days, followed by pupation. Sexual reproduction is the primary reproduction process, with an average of 15 eggs laid by females and live for nine days. The lifespan of adult males is six days, with an average lifespan of thirteen to fourteen days. The pre-adult phase lasts an average of 12.97 days in both males and females and 13.57 days in females. A female *Adult* has a lifespan of approximately nine days and lays around 15 eggs during her lifetime. In contrast, male adults live for an average of six days (Ahmed *et al*., 2023) (Fig 1).

Based on the biological and demographic data Hutasoit *et al.* (2017) recorded five distinct stages of immature *T. parvispinus*, including eggs, nymphs, prepupa, and pupas, with their stadia respectively 1.11 days preoviposition, 13.68 days life cycle, 8.55 days longevity (male), 6.00 days longevity (female), and 15.33 eggs per female.

The type III of the survivorship curve was found to be followed, with an intrinsic rate of increase of 0.15 per day per female and a net reproduction rate of 5.71 per female in each generation. A generation averaged 11.49 days, and the doubling period for males and females was 4.57 days. Borror *et al.* (2005) observed a transition between paurometabolism and holometabolism of the species, while Murai *et al.* (2010) observed average fecundity and average generation.

Establishment and spread

T. parvispinus has been found in various regions including Thailand, Malaya, New Guinea, Northern Australia, Hawaii, Micronesia, and Greece. Over time, it has expanded its distribution into Southeast Asia, including northern Australia and the Solomon Islands (Palmer, 1992), as well as spreading to Yunnan in China (Zhang *et al.,* 2011), the Philippines (Reyes, 1994), Taiwan (Mound and Masumoto, 2005), and India (Tyagi *et al.,* 2015; Rachana *et al.,* 2018). In 2006, it was first observed in Hawaii (Sugano *et al.,* 2013). Additionally, it has been identified in African locations such as La Reunion (Bournier, 2000) (a French overseas department), Mauritius, Tanzania (specifically Dar-es-Salaam), and Uganda (in Kampala) (Moritz *et al.,* 2013). In Europe, it was documented in Greece in 1998 (Mound and Collins, 2000), Spain in 2017 (Lacasa *et al.,* 2019), and France in 2018 (EFSA, 2019).

Sartiami *et al.* (2011) collected data on the morphological characteristics of *T. parvispinus* at three different elevations, Cirebon (at 30 meters above sea level), Bogor (ranging from 300 to 400 meters above sea level), and Cianjur (exceeding 1200 meters in elevation). They observed that the highland thrips exhibited larger body length, thoracic width, and wing length compared to their counterparts in the mid and lowland regions. In the Cianjur population, the prevalent colors observed were dark brown (resembling chocolate) for the head, olive brown (similar to olive green chocolate) for the thorax, and dark brown for the abdomen. On the other hand, in lower elevations like Bogor and Cirebon, the dominant colors for the head and thorax were olive-brown, while the abdomen appeared dark.

Outbreak of *T. parvispinus* in India

During 2021, an outbreak of this species was observed in Andhra Pradesh, Telangana, and Karnataka, inflicting 70-100 per cent damage. The presence of thrips on chilli flowers was first observed in Chilakaluripeta and Pratipadu mandals of Andhra Pradesh's Guntur district in January 2021, and their outbreak was afterward observed in all chilli cultivation areas in the state (Sireesha *et al.,* 2021). It also infested the red chilli crop in Telangana and Andhra Pradesh. The infestation was noticed throughout the flowering period, impacting the yield. The infestation was also recorded in weed species, such as *Parthenium*, *Amaranthus* sp., *Axonopus* sp., *Ageratum* sp., *Alternanthera* sp., and *Thunbergia* sp., (Nagaraju *et al.,* 2021).

The invasion of *T. parvispinus* reached a lag phase, during which its population remained relatively stable, but after this period, it increased significantly over the course of four years. Its ability to adapt to various plant hosts and extend its geographic range makes it a more vulnerable pest (Rachana *et al.,* 2021).

T. parvispinus has taken over the well-entrenched chilli thrips, *Scirtothrips dorsalis*, in chilli ecosystems in Andhra Pradesh, Karnataka, and Telangana (Sridhar *et al.,* 2021). They emphasized the need for systematic *T. parvispinus* monitoring. On capsicum and chilli *T. parvispinus* and *S. dorsalis* coexisted. *Thrips palmi*, *Thrips tabaci*, *Frankliniella schultzei,* and *M. abdominalis* co-occur alongside *T. parvispinus* on allied crops (Palanisamy *et al.,* 2023)

Economic importance

Thrips parvispinus poses a significant threat to agriculture in India, particularly affecting crops, leading to substantial yield losses. Farmers in Andhra Pradesh have reported losses of Rs 1 lakh per acre in chilli cultivation due to large-scale flower shedding, malformation, and fruit drop (Anon 2021b). Damage from *T. parvispinus* in chilli crops has ranged from 40% to 80% across various fields in Andhra Pradesh and Telangana (Anon 2022b). *T. parvispinus* infestation levels were reported to be highest on chilli, melon, cucumber, brinjal, and squash in Indonesia (Johari *et al*., 2014; Johari and Desfaur 2018). Comparatively, in Indonesia, yield losses attributed to *T. parvispinus* range from 10% to 46% under field conditions (Johari *et al.,* 2014). In addition to its economic impact, this pest has also been linked to damage in mungbean and mulberry crops, with reports indicating drastic yield losses in these plants (Gothi *et al.,* 2024; Sreeramakumar *et al.,* 2024). Despite its harmful effects, *T. parvispinus* serves an important role as a pollinator for several tropical and subtropical crops (Varatharajan *et al.,* 2016). Thus, while the economic implications are alarming, the ecological significance of *T. parvispinus* must also be considered in developing integrated pest management strategies.

Morphology

Adult *T. parvispinus* was brown to dark brown, and its head and thorax were lighter than the abdomen. The head was strong, with reticulation patterns and pigmented large eyes. Its Compound eyes were not elongated. The antenna had seven segments, whereas the second and third segments had forked sense organs. It did not have the 1st ocellar setae; the 2nd ocellar setae are shorter than the 3rd ocellar setae. The pronotum had two pairs of long posteroangular setae and three pairs of shorter posteromarginal setae. Campaniform sensillae were absent in the metanotum. Tergite VIII contained comb microtrichia. The V-VIII tergite had ctenidia at part of the lateral and tergite VIII ctenidia located behind the spiracles. The length of the wing was more than half that of the abdomen. It was dark or shaded, with a pale base, and at the first and second wing vein fronts, there was a full line of setae. The size and color of the body varied with long, medium, and short criteria (Johari *et al.,* 2014).

Rachana *et al*. (2022) described the morphological characteristics of *T parvispinus*; the female antennae had seven segments, and Ocellar pair III is small, located on the anterior margin of the Ocellar Triangle. Campaniform Sensilla absent. The body is brown with yellow legs, brown forewings, and a pale base. The first and second forewing veins and setae rows were complete. The abdomen had two marginal pair setae and three pairs of sternites II and VII. The first and second forewing veins and setae rows were complete. The posteromarginal comb of the female is absent, but there are a few microtrichia present laterally. The pleurotergites are not discal but are approximately 6-12 irregularly arranged.

Adult female *T. parvispinus* were characterised by a dark brown complexion with a lighter head and thorax than their abdomen, as well as yellowish legs (Hulagappa *et al.,* 2022). They were smaller in size than adult male thrips. Scanning electron microscopy revealed that adult female thrips possessed seven segmented antennae and forked sensory organs on segments III and IV. The head was broader and consisted of three pairs of ocellar setae, with segment III being small and situated outside the ocellar triangle. The first and third pair of postocular setae are longer than the third ocelllar setae, and additionally, three pairs of posteromarginal setae are present on the pronotum. In the forewing, the first and second veins have full rows of setae and the clavus region consists of five marginal setae. An irregular line of Discal setae (ranging from 6 to 12) was found on sternites III, VI, and absent on Tergite II and VII. Male thrips have a yellowish-coloured body and do not possess aposteromarginal comb on Tergite VIII; the sternal segments of Tergite III to VII include small transverse pore plates and discal setae, which are situated laterally.

Molecular identification of *T. parvispinus*

Tyagi *et al*. (2015) reported that a homology search using BLAST showed a high similarity between *T. parvispinus* sequences from Indonesia. The dataset of *T. parvispinus* sequences had 89 variation sites, with 10 being parsimony informative. Four haplotypes were identified without specific haplotyping based on the host plant or geographical locality. Molecular evidence suggests transfer of genetic material between Indonesia and India, indicating Indonesia as a probable source of invasion of *T. parvispinus* to India.

The mitochondrial genome of *T. parvispinus* is 15,067 bp long, containing 37 genes, with notable low nucleotide diversity indicating evolutionary patterns within the Thysanoptera suborders and phylogenetic analyses suggest a close relationship with other thrips species, enhancing our understanding of its genetic lineage (Pakrashi *et al.,* 2023).

Thrips parvispinus has rapidly expanded in the North Western, Western, and Cauvery delta regions of Tamil Nadu, while being sparse in the Southern region and absent in hilly and high rainfall areas. Additionally, fifteen allied crops were identified as host plants, with *Buxus microphylla* noted as a new host for the first time (Palanisamy *et al.,* 2023). In Andhra Pradesh and Telangana, mean populations of *T. parvispinus* ranged from 18.46 to 37.16 per five terminal leaves. Genetic analysis revealed that Indian populations exhibited greater haplotype diversity (Hd = 0.856) and nucleotide diversity (π = 0.00585) compared to those from Indonesia (Hd = 0.580; π = 0.00396), suggesting that Indonesia may be a source of *T. parvispinus* invasion into India (Raghavendra *et al.,* 2023).

Integrated Management of *Thrips parvispinus*

Cultural Control

Adopting practices that ensure the use of healthy, pest-free seedlings, along with the removal of infected plants, can help minimize the spread of *T. parvispinus*. Severely infested areas should be razed to reduce further infestation (Sridhar *et al.,* 2021). Cultivating crops away from infested plants and removing weed hosts will also help mitigate damage. Interestingly, *T. parvispinus* populations were found to be more abundant in coriander flowers, suggesting that coriander can be used as a trap crop to divert thrips away from heavily affected crops (Prasannakumar *et al.,* 2021). Various pepper accessions, including *Capsicum annuum* AC 1979, *C. annuum Bisbas*, *C. annuum Keystone* Resistant Giant, C. *annuum* CM 331, *C. baccatum* no. 1553, and *C. baccatum* Aji Blanco Christal, have been identified as resistant to *T. parvispinus* and *Frankliniella occidentalis*, and are recommended for use in resistant breeding programs (Maharijaya *et al.,* 2011). The chilli planting system utilizing plastic mulch, without crop intercropping and with pesticide application, exhibited the lowest average population of *T. parvispinus* during the vegetative stage of chilli plants (Haerul *et al*. 2020). Furthermore, the mayang ratih genotype of chrysanthemum demonstrated resistance to *T. parvispinus*, making it a strong prospect for future resistance breeding programs (Musalamah *et al*. 2021). Minimizing the excess use of nitrogenous fertilizers and following recommended balanced fertilizer practices can also help reduce thrips infestation (Sireesha *et al.,* 2021).

Botanicals

Neem oil, pongamia oil, or soap solution can be applied in areas with severe infestations (Anon 2021a). The fish poison bean (*Tephrosia vogelii*) at 2.5% and 3.0%, Indonesian mahogany (Toona sureni) at 3.0%, and eucalyptus oil at 2.0% showed over 30% effectiveness during the vegetative stage. These treatments resulted in minimal *T. parvispinus* infestation up to 75 days after planting (DAP) and produced the highest yield of marketable chrysanthemum flowers (Rahardjo *et al.,* 2022).

Physical and Mechanical Control

Thrips parvispinus is attracted to certain colors, and white traps have been found to attract more thrips compared to blue or yellow traps (Murai *et al.,* 2010). However, blue and yellow sticky traps can still be effectively used for monitoring and reducing adult populations when installed at a rate of 30 traps per acre in chilli fields (Sireesha *et al.,* 2021). Laboratory studies showed that *T. parvispinus* is susceptible to spinosad but not to acetamiprid (Murai *et al.,* 2010). Additionally, mechanical removal of crop debris and weeds, along with proper sanitation practices, can prevent thrips populations from building up in the field. Exposure to a 60% CO2 atmosphere at 30°C leads to complete mortality of five thrips species: *Frankliniella occidentalis* (Pergande), *F. intonsa*, *T. tabaci*, *T. palmi*, and *T. parvispinus* (Seki and Murai 2012).

Chemical Control

Chemical control remains an important aspect of managing *T. parvispinus*, especially when combined with cultural and biological controls. Sequential spraying of chemicals like fipronil 80WG at 0.2 g/litre, cyantraniliprole at 1.25 ml/litre, acetamiprid at 0.2 g/litre, or spinosad at 0.3 ml/litre of water at weekly intervals has been shown to effectively manage *T. parvispinus* populations (Anitha Kumari *et al.,* 2021). For maximum efficacy and to avoid the development of resistance, rotating insecticides with different modes of action is crucial (Sugano *et al.,* 2013). Utilizing insecticides such as fipronil, cyantraniliprole, acetamiprid, and spirotetramat in rotation at recommended rates can help manage infestations more effectively (Sireesha *et al.,* 2021). In studies evaluating the cost-effectiveness of various treatments, spinosad 45% SC was found to be both the most effective and economical option (Neelofor and Kumar, 2022). However, excessive insecticide use may lead to the resurgence of *T. parvispinus* populations, particularly in chilli crops (Sireesha *et al.,* 2021).

Biological Control

Biological control is gaining recognition as a sustainable approach to managing *T. parvispinus*. Natural predators like ladybird beetles (*Menochilus sexmaculatus*) and entomopathogenic fungi like *Lecanicillium lecanii* have been proven effective (Prabaningrum *et al.,* 2008). Additionally, bio-pesticides such as *Pseudomonas fluorescens* and *Bacillus albus* show promise in reducing thrips populations when applied to flowers and fruits of crops (Anon 2021a). Among bio-pesticides, azadirachtin and *Pseudomonas fluorescens* were particularly effective in controlling thrips populations in chilli fields (Anon 2022a).

IPM Modules

A study evaluated integrated management strategies against *Thrips parvispinus* in chilli. Seven modules, including a control, were tested, with Module-IV proving most effective. This module (mulching + blue sticky traps with sequential insecticide applications viz., fipronil 80WG @ 0.2 g/L, spinetoram 11.7SC @ 1 ml/L, spirotetramat 240SC @ 0.8ml/L, acetamapride 20%SP @ 0.2g/L, thiamethoxam 25%WG @ 0.2g/L, dimethoate 30%EC @ 2ml/L sprayed sequentially at 10 days interval)) resulted in the highest chilli yield of 32.22 q/ha, an 87.08% increase over control (Priya *et al*., 2022).

The adoption of IPM practices resulted in a 40-85% reduction in black thrips infestation compared to farmers' practices, with an average yield of 57 q/ha. IPM fields achieved net returns of Rs. 4,96,000 per hectare, with a cost-benefit ratio of 3.29. The IPM components included seed treatment, marigold as a trap crop, blue sticky traps, *Beauveria bassiana* spray, Neem oil and Fipronil 5 SC spray at 30 DAT, and Imidacloprid + Fipronil 40% WG spray at 50 DAT. The most effective was the Imidacloprid + Fipronil 40% WG spray at 50 DAT in reducing black thrips infestation (Anusha *et al*.m 2024).

Pongamia soap and Spinosad significantly reduced thrips populations on chrysanthemum, with Spinosad achieving an 80.2% reduction, indicating the effectiveness of integrating biorationals and chemical insecticides (Manideep *et al.,* 2023). In 2020, *T. parvispinus* was detected in Florida, prompting laboratory tests on 32 insecticides. Chlorfenapyr, sulfoxaflor-spinetoram, and spinosad were the most effective, while mineral oil and sesame oil were the top biorational options. Implementing a rotation strategy with these products is advised to manage resistance effectively (Ataide *et al*. 2024). A controlled field study conducted in plastic houses compared IPM and farmer's standard practices in chrysanthemum cultivation, finding no significant difference in controlling *T. parvispinus.* While IPM effectively managed thrips populations, it reduced synthetic insecticide use and maintained crop quality and yield. The IPM approach offered competitive costs and successfully minimized environmental impact without compromising productivity (Hutapea *et al*. 2024).

Conclusion

Regular monitoring of *T. parvispinus* is essential for timely interventions to prevent its spread. As an invasive and polyphagous, understanding its bioecology is crucial for developing effective IPM strategies. Community-based management is important during large-scale outbreaks, while studies on baseline toxicology data will support insecticide resistance management. An integrated pest management approach using host plant resistance, biological control, and eco-friendly insecticides is recommended to effectively manage *T. parvispinus*, which poses a serious threat to various crops and ornamental plants.

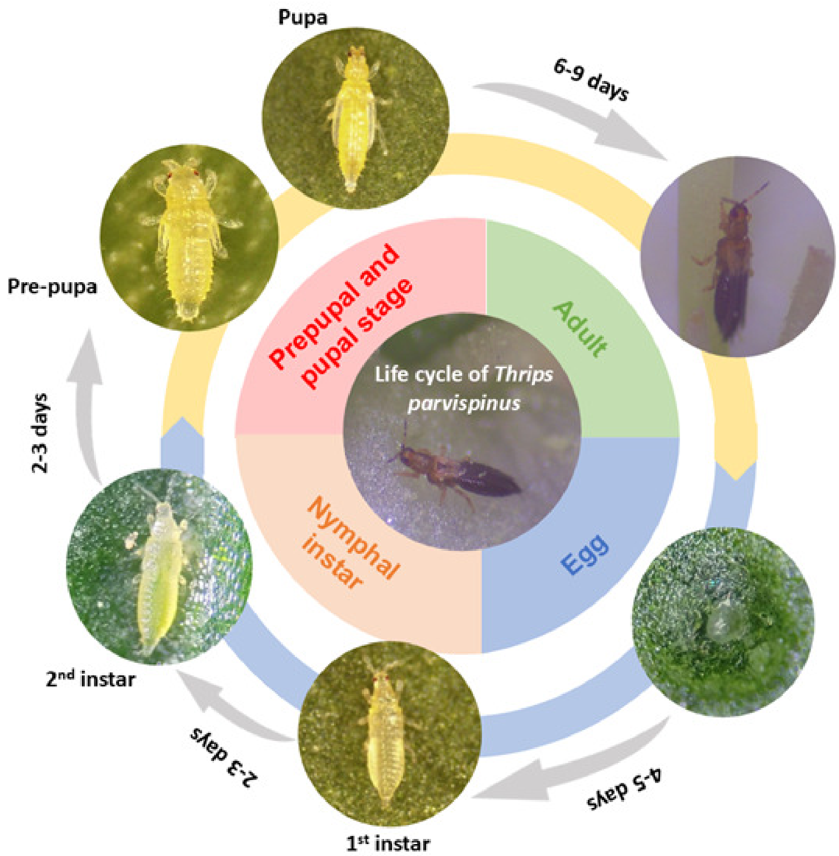

Fig 1 : Life cycle of *T. parvispinus* (Ahmed *et al*., 2023) (i) Egg (ii) Nymphal instar (1st & 2nd instars) (iii) Pre-pupa and Pupal stage (iv) Adult. (https://www.koppert.com/plant-pests/thrips/tobacco-thrips/#life-cycle)

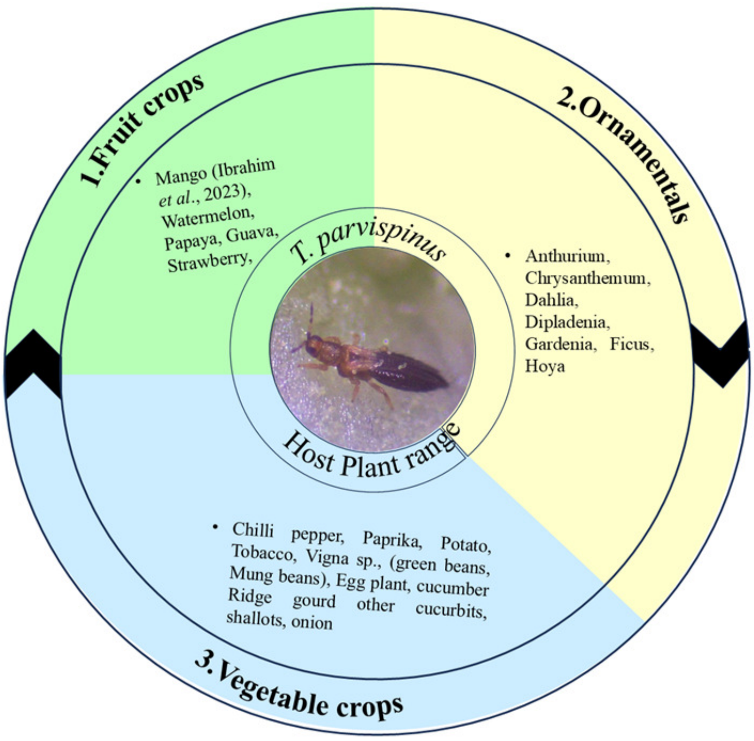

Fig. 2: Host Plant Range of *T. parvispinus* across major crop categories

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