Litchi stink bug, *Tessarotoma javanica* (Thunberg) (Hemiptera: Tessaratomidae) - present status, regional risk, and next-generation management strategies

Ipsita Samal, Jaipal Singh Choudhary, Sunil Kumar, Amit Kumar, Bikash Das, Sanjan Kumar Bharti

India, the world's second-largest producer of litchi harvests approximately 746,000 metric tonnes annually from ~98,180 ha, yet mean productivity (~7.6 t ha^{-1}) remains well below attainable yields. Among diverse biotic stressors, the litchi stink bug, *Tessarotoma javanica* (Thunberg) (Hemiptera: Tessaratomidae), has transitioned from a historically inconsequential pest to a regionally significant constraint across eastern India (Bihar, Jharkhand, West Bengal) and adjacent South Asian landscapes. Since 2011, documented outbreaks have precipitated orchard-level fruit losses of 70-100%, with concomitant reports from Bangladesh highlighting transboundary risk and the necessity of coordinated surveillance. This chapter consolidates current evidence on pest distribution, status, and host range; elucidates adult and nymphal biology (oviposition approximately 13 days post-mating; egg clusters of ~14 with ~97% hatch; five nymphal instars; laboratory egg-to-adult development ~142 days); and delineates diagnostic advances, including a 658-bp COI barcode facilitating species-level confirmation. We interrogate hypothesized drivers of proliferation interactions among host phenology, climatic permissivity, and prevailing pesticide regimes and identify phenophase-specific windows of vulnerability from vegetative flushing and anthesis through fruit set.

Keywords: *Litchi stink bug, Tessarotoma javanica, host phenology, monitoring, surveillance, next generation strategies, traditional control methods*

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Building on this synthesis, we articulate a next-generation, regionally adaptable management framework: phenology-aligned monitoring and action thresholds; cultural and canopy sanitation; habitat manipulation to conserve and augment natural enemies; judicious, time-specific deployment of selective chemistries to mitigate resistance evolution and non-target impacts; and decision support underpinned by surveillance networks and risk forecasting tools. The chapter concludes with research–extension agenda prioritizing cross-border data harmonization, biological control pipelines, resistance management schemes and rapid molecular diagnostics to contain *T. javanica*, safeguard smallholder livelihoods and narrow India's litchi yield gap.

Introduction

India is the world's second-largest producer of litchi (*Litchi chinensis* Sonn.), which often referred to as the "queen of subtropical fruits." India produces approximately 746,000 metric tonnes of litchi fruit annually from a total area of 98,180 hectares (GOI, 2024). The average productivity of litchi in the country is around 7.6 tonnes per hectare, which remains substantially lower than the potential productivity of the crop. Over 85% of Indian litchi is farmed in the eastern states of India i.e., Bihar, Jharkhand, and West Bengal (Nath et al., 2016). The hitherto insignificant pest, the litchi stink bug *Tessarotoma javanica* (Thunberg) (Hemiptera: Tessaratomidae), has proliferated in these regions in recent years (Banjade et al., 2024). Outbreaks in the region were observed in Jharkhand (2011) (Choudhary et al., 2013), Bihar (Kumar et al., 2022), and initially in the Sylhet district of Bangladesh (2020) (Tahmiduzzaman et al., 2025). In 2018, the *T. javanica* was initially documented in Bihar, with infestations observed in litchi orchards across the state, marking the first recognition of the pest's substantial impact in the region (Kumari et al., 2024). The devastation from these outbreaks reached up to 100% crop loss on the impacted farms. *T. javanica* had previously been documented in certain regions of India as a minor pest or as a low-level occurrence in Jharkhand, Uttar Pradesh, Punjab, Himachal Pradesh, and Jammu & Kashmir (Parveen et al., 2015). The outbreaks in Jharkhand in 2011 and 2012 highlighted that the country was emerging as a pesticide powerhouse. These infestations are associated with severe devastation: losses of 70-90 percent of fruit set have been observed in orchards with a significant prevalence of infestations. *T. javanica* is a significant pest affecting litchi in India and adjacent countries, with rapid dissemination (Mondal et al., 2021). This chapter reviews the biology, consequences, and next-generation management strategies of the pest, with an emphasis on India and Southeast Asia.

Pest Biology and Ecology

Litchi stink bug, *T. javanica*, is a large reddish brown stink bug, measuring approximately 20-25 mm in length, characterized by the broad body shape typical of the Tessarotomidae family (Banjade et al., 2024). Body morphology and genitalia can be utilized to distinguish between males and females (Figure 1). Like other Tessarotomids, it has well-developed metathoracic stink glands that generate defensive fluid. Oviposition occurs 13 days after mating, and eggs are usually laid in clusters of 14 eggs, arranged in 3-4 rows on leaf, flower, fruit surfaces, with hatching occurring in about 12.8 days and a hatch rate of 97%. The mean fecundity per female is observed 13.4 egg clusters. The nymphs undergo five instar stages before attaining adulthood, with development accelerating during instars II and III (Figure 1). The average lifespan from egg to adult in a laboratory condition is approximately 142 days. The durations of each instar have been determined as follows: egg 12.8 ± 1.4 days; 1st instar 11.7 ± 0.6 days; 2nd instar 7.2 ± 0.2 days; 3rd instar 8.6 ± 0.6 days; 4th instar 13.0 ± 0.6 days; 5th instar 26.3 ± 1.0 days. Diagnostics at the species level Molecular markers, such as the 658-bp COI barcode, have been developed (Kumari et al., 2024).

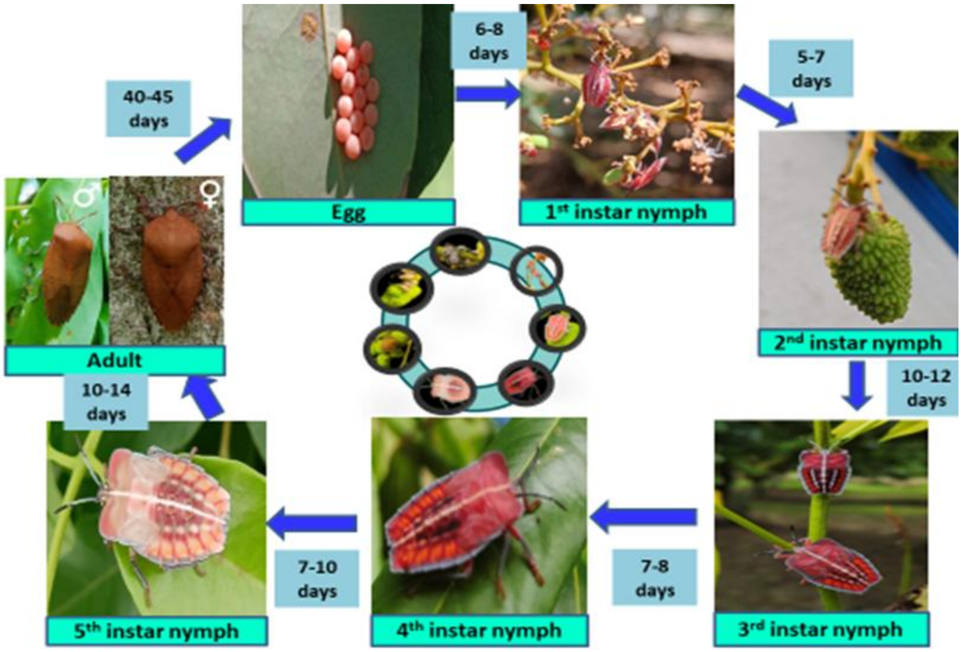

Figure 1. Different developmental stages of litchi stink bug, *Tessarotoma javanica*

Host range and ecology

T. javanica exhibits oligophagous feeding behaviour on Sapindaceae and allied arboreal species. It aggressively targets litchi, attacking blossoms, young shoots, and fruit peduncles (Samal et al., 2025a). It is also recognized on longan (*Dimocarpus longan*), rambutan, pomegranate, Kusum, champak and even non-fruit-bearing trees such as Mahua and Eucalyptus (Wu et al., 2020) (Table 1). In India and Bangladesh, *T. javanica* typically infests litchi inflorescences towards the conclusion of winter. From February to March, nymphs and adults consume growing panicles and shoots, leading to gregarious infestations that inhibit or terminate blossoms and delicate fruit. Adults likely overwinter beneath bark and debris (possibly inferred from related species) following fruiting (July to August) (Choudhary et al., 2021).

Table 1. List of host plants of litchi stink bug, *Terssarotoma javanica*

Sl. no	Host Plant	Scientific Name	Plant Type / Notes	Reference(s)
1	Litchi	*Litchi chinensis*	Primary economic fruit host - causes severe yield loss	Choudhary et al., 2013
2	Longan	*Dimocarpus longan*	Alternate host	Wu et al., 2020
3	Rambutan	*Nephelium lappaceum*	Alternate host	Kumari et al., 2024
4	Pomegranate	*Punica granatum*	Alternate host	Samal et al., 2025a,b
5	Pummelo	*Citrus maxima*	Alternate host	
6	Kusum	*Schleichera oleosa*	Alternate host; lac host plant	
7	Champak	*Michelia champaca*	Alternate host	
8	Castor	*Ricinus communis*	Alternate host	
9	Mulberry	*Morus* spp.	Alternate host	
10	Rose	*Rosa* spp.	Alternate host	
11	Eucalyptus	*Eucalyptus* spp.	Alternate host	
12	Loquat	*Eriobotrya japonica*	Alternate host	
13	Mahua	*Madhuca longifolia*	Alternate host	

Pheno-phase associated occurrence and incidence of litchi stink bug

Field research in India indicates that the activity of *T. javanica* correlates with litchi flowering. Females lay eggs in February (after fruit initiation) and predominantly in March-April (Malhotra et al., 2018). In unsprayed orchard research conducted in Jharkhand, the prevalence of egg masses and nymphal duration peaked in March and declined by late April. Consequently, the essential scouting periods span from late winter to mid-summer (Samal et al., 2025a). The overwintered adults become active as temperatures rise, feeding on the emerging inflorescences and engaging in mating. However, field observations at ICAR-NRCL indicate that litchi stink bug populations persist year-round, exhibiting two distinct peaks: one during the vegetative phase, coinciding with the rainy season, and a second during the flowering stage in summer. These bimodal dynamics underscore the need for phenology-targeted monitoring, with intensified surveillance and interventions aligned to the post-hatch nymphal window after the rainy-season peak and to pre- and peri-flowering periods when adults aggregate and oviposit. Such timing improves detection sensitivity, supports precise threshold setting, and increases the efficacy of cultural, biological, and chemical control methods.

Damage Assessment and Economic Importance

Extent of damage

Both nymphs and adults extract sap, causing significant damage. They penetrate flower buds and immature fruits, injecting saliva that induces wilting, necrotic lesions, and the abortion of fruitlets (Figure 2). Defective panicles are typically discarded, resulting in the remaining fruits being diminutive or malformed. In affected orchards, yield loss may reach 70 to 90 percent at its most severe (Samal et al., 2025b). Chlorosis of leaves may also be noted during heavy infestations. Damage of *T. javanica* has been documented on Kusum (lac production) and non-orchard hosts, indicating a broader agro-ecosystem impact (Choudhary et al., 2021). *T. javanica* not only presents a significant risk to litchi orchards but also endangers human health due to its secretion of a malodorous fluid. This substance, typically secreted when the insect is agitated or threatened, causes skin irritation and a burning sensation upon contact. The harvesting procedure can become an unpleasant and hazardous experience, even when handling the fruits or pests themselves. The pronounced odour of the fluid complicates harvesting processes, as it may adhere to the fruit, rendering it unappealing to harvesters and thus indirectly diminishing its marketability (Mondal et al., 2021) (Table 2).

Table 2. Present status of litchi stink bug in different parts of India

Sl No.	State / Region	Presence Status	Noted Host Plants	Reference
1	Jharkhand	Major outbreak recorded in 2011–2012; severe crop damage (~80%)	Litchi; possible migration from wild *Schleichera oleosa* (Kusum)	Choudhary et al., 2013
2	Bihar	First recorded in 2018; recent widespread infestation causing significant threats to litchi production	Litchi (emerging pest in orchards)	Kumar et al., 2022
3	Mizoram	*T. papillosa* (related litchi stink bug species) recorded as a major pest of litchi.	Litchi (crop affected); likely shares similar host range as *T. javanica*.	Boopathi et al., 2017

4	Meghalaya	Severe infestations reported around 2014 in the Dauki region, causing ~90% litchi crop loss; located in border area near Sylhet (Bangladesh), indicating transboundary spread potential.	Litchi; likely similar alternative hosts as elsewhere (e.g., Kusum, Pomegranate).	https://thefinancialexpress.com.bd/national/country/researchers-detect-sporadic-pest-attacks-on-litchi-trees-1525358922
5	Other NE States	No specific northeast-wide reports for *T. javanica*, but given its spread in nearby regions and outbreak patterns, presence in adjacent states (e.g., Assam, Tripura) is plausible though unconfirmed in published literature.	Litchi, and possibly other common hosts documented elsewhere (e.g., Kusum, Longan, Pomegranate, Mahua, Rambutan, etc.).	Choudhary et al., 2013

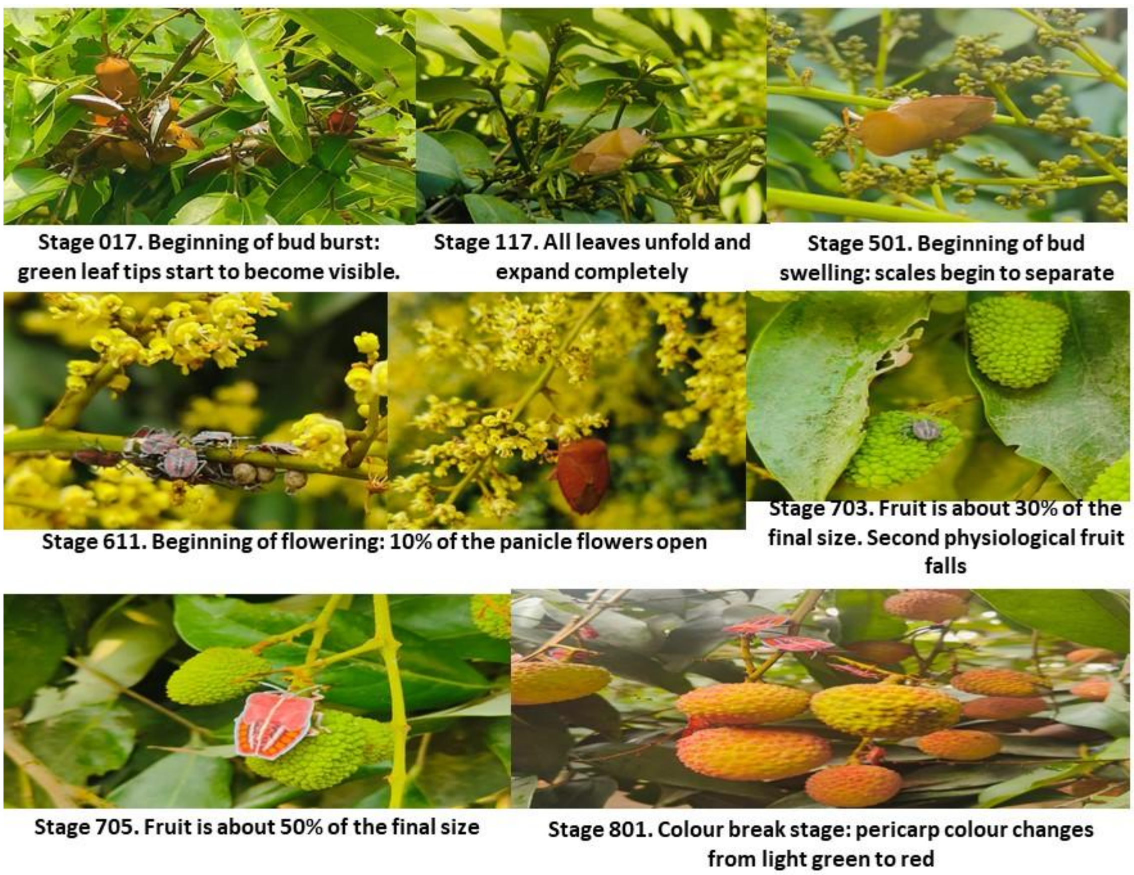

Figure 2. Occurrence of litchi stink bug in different pheno-phases of litchi

Economic impact

Quantitative economic data is scarce; however, given the high value of litchi, even slight damage incurs significant costs. Outbreaks were documented in several places, resulting in near-total crop devastation. In 2019, Jharkhand and Bihar incurred substantial financial losses amounting to millions of dollars due to damage caused by the stink bug to fruit crops. In 2020-21, the initial severe infestations were documented in Bangladesh, which evidently led to a substantial decline in productivity (Mondal et al., 2021). Litchi constitutes a significant livelihood crop in these regions, making uncontrolled *T. javanica* a substantial threat to smallholder incomes and export profits (Schoeman, 2012).

Traditional method of stink bug management in litchi

Monitoring and Detection Techniques

The regular monitoring of orchards is essential for future forecasting of litchi stink bugs. Growers are urged to examine inflorescences and stems for the presence of egg masses (distinctly 14-15 grouped eggs on the undersides of leaves) and nymph aggregations. Adults may be captured at night using light traps. A characteristic aggregation pattern is observed in *T. javanica*: adults preferentially occupy trees receiving ample sunlight and good aeration, typically along the outer margins of orchards. Early recognition of these edge-focused clusters enables targeted, spot applications of insecticides, thereby suppressing localized populations and reducing overall pesticide use. If unmanaged, infestations intensify as the non-flight, weakly migratory nymphs spread locally within blocks, after which later-stage, fully winged adults disperse to distant host trees and oviposit on suitable plant parts, amplifying regional spread. Integrating edge-oriented scouting with spot treatments, sanitation, and timely interventions at early nymphal stages can therefore curb proliferation and limit long-range dispersal.

No specific aggregation pheromone has yet been identified in *T. javanica* for pheromone traps. Nonetheless, pheromone-based traps are effective against similar stink bugs (e.g., *Halyomorpha halys*) and may be adapted upon the identification of potential compounds (e.g., sesquiterpenes or aldehydes). The research of multi-attractant lures, such as host volatiles, is also justified (Rondoni et al., 2022). In extensive plantations, drones or thermal/multispectral satellite photography will be employed to identify canopy feeding stress (Duarte et al., 2022). NDVI mapping with UAVs has proven effective in detecting defoliating pests in orchards; similar techniques could be employed to identify stink-bug infested trees in real time for targeted treatments (Zhang et al., 2021).

Current Management Strategies

- **Chemical control (Table 3)**

During the epidemics, conventional pesticides have dominated. Significant knockdown is noted with organophosphates (e.g., acephate) and carbamates (e.g., thiodicarb). Choudhary et al. (2015) found that Dichlorvos 76/EC achieved complete mortality of 1st instar nymphs within 24 hours in laboratory conditions. Acephate (75% SP), quinalphos (25% EC), and thiodicarb (75% WP) each achieved an average mortality rate of approximately 86%-93% in 1st instar nymphs. Recent Mode of action insecticides are also efficacious: the anthranilic diamide, chlorantraniliprole (18.5% SC), and the neonicotinoid, thiacloprid (21.7% SC) eliminated over 86% of first instar stages. Laboratory LC_{50} studies confirm that chlorantraniliprole and thiacloprid exhibit toxicity levels 28-37 times greater than the benzoylurea IGR novaluron (Srivastava and Choudhary, 2022). Choudhary et al. (2015) note that even highly effective chemicals “in general kill natural enemies and so need to be used cautiously”. Thus, sprays should target peak phenology (e.g. early nymphal stages in March) and avoid post-spray resurgence of pest.

Table 3. The list of insecticides used for management of litchi stink bug, *Tessarotoma javanica*

Insecticide (Active Ingredient)	Formulation & Recommended Dose	Remarks / Efficacy	Source
Chlorantraniliprole (18.5% SC)	Field-recommended dose typical for litchi is ~ 40 ml/acre (≈ 100 g a.i./ha)	Among the most efficacious- 36.8× more toxic than novaluron	Choudhary et al., 2015
Dichlorvos (76 EC)	Field dosage (typically ~1.0 l/ha, assumed standard)	Caused 100% mortality in 1st instar nymphs within 24 h	Choudhary et al., 2015
Acephate (75 SP)	Field dosage (~1.0 kg/ha typical)	Caused 86.7% mortality in 1st instar nymphs within 24 h	
Quinalphos (25 EC)	Field dosage (~1 l/ha typical)	86.7% mortality in 1st instar nymphs within 24 h	
Thiodicarb (75 WP)	Field dosage (~250 g/acre or ~600 g/ha typical)	86.7% mortality in 1st instars; 22.1× more toxic than novaluron	
Mixture: Chlorpyrifos + Cypermethrin (10:1 ratio)	138 ppm (≈ 138 mg/L) - effective concentration for knockdown	Achieved 100% mortality in adults in 7 days; residual effect at 550 ppm	Zeng et al., 2000
Thiacloprid 21.7% SC + Fipronil 5% SC	Thiacloprid 21.7% SC (0.5 ml/l) + Fipronil 5% SC (1.5 ml/l) per litre of water	ICAR-NRCL recommendation	ICAR-NRCL Annual Report, 2024
Thiacloprid 21.7% SC + Profenphos 50% SC	Thiacloprid 21.7% SC (0.5 ml/l) + Profenphos 50% SC (1.5 ml/l) per litre of water		
Lambda Cyhalothrin 5% EC + Chlorfenapyr 10% EC	Lambda Cyhalothrin 5% EC (1.5 ml/l) + Chlorfenapyr 10% EC (1.0 ml/l) per litre of water		

Although single active ingredients may provide acceptable knockdown early in an infestation, ICAR-NRCL advisories frequently recommend combination products or tank mixes for *Tessaratoma* spp. because the insects' thick, well-sclerotized cuticle reduces penetration and reduces field efficacy of individual insecticides.

- **Cultural and mechanical controls**

Pest populations can be reduced by maintaining cleanliness in orchards. This is accomplished through measures such as cutting the most severely damaged bushes, destroying egg clusters, and eradicating other host plants (e.g., untreated Kusum or Mahua trees in the vicinity). Shaded or dense canopies may shelter overwintering adults, making canopy thinning beneficial (Choudhary et al., 2021). Predators may encounter overwintering adults when trash or soil is disturbed beneath trees. In addition to employing insecticides, manual removal of pests is also an essential component of stink bug control. Insecticides should be applied, and the fallen insects should be swept away with a broom. The infested insects must be transported to a hole and interred beneath soil to prevent their return to the orchard (Samal et al., 2025a). The manual removal of survivor's post-spray ensures their physical elimination (Figure 3), significantly diminishing the pest population and reducing the likelihood of crop infestation or reproduction. Nymphs are the primary targets for insecticidal intervention because they are less mobile and remain concentrated on host trees, which increases spray contact and improves control. To prevent recolonization, coordinated, community-based applications are recommended for litchi-growing clusters.

Peak incidence of litchi stik bug, *Tessarotoma javanica* in litchi at ICAR-NRCL, Muzaffarpur, Bihar

Manual collection of litchi stink bugs after insecticide spray

Figure 3. Peak incidence of litchi stink bug and adoption of manual collection of litchi stink bugs after insecticide spray

- **Biological control (classical/augmentative)**

Choudhary et al. (2015) identified three parasitic wasps of *T. javanica* eggs in India: *Anastatus bangalorensis*, *A. acherontiae* (Eupelmidae), and an *Ooencyrtus* species (Encyrtidae). *A. bangalorensis* affected around 46 percent of eggs in March in unsprayed orchards. It is recommended that such benefits (reducing insecticide usage) be promoted. *Anastatus* spp. grown in laboratory conditions could be released for augmentation; however, mass-rearing protocols have yet to be established. General predators, including as lacewings, ants, and assassin bugs, are reported to potentially prey on nymphs and eggs; however, their impacts require quantification (Zhao et al., 2024). The use of *Anastatus* spp. as egg parasitoids for stink bug management warrants caution in Bihar and Jharkhand, where sericulture is actively promoted, because potential non-target impacts on silkworms pose a biosafety concern. Before any augmentative releases, programs should require host-specificity testing against locally reared silkworm species, semi-field confinement assays, and a formal risk assessment. If releases proceed, they should be limited to defined buffer zones away from sericulture units, deployed at conservative doses, and accompanied by pre- and post-release monitoring using sentinel egg cards and standardized non-target surveys. Clear rotation or prioritization of alternative agents (e.g., *Telenomus* spp. where appropriate), along with grower training, documentation of recoveries, and regulatory oversight, can further reduce risk. In short, while *Anastatus* can contribute to integrated management, its mass release should be conditional on demonstrated safety for sericulture and on a precautionary deployment plan.

Next-generation approaches for management of litchi stink bug
Life table studies across diverse litchi varieties and different agro-ecologies

Life table studies of the litchi stink bug (*Tessaratoma javanica*) across litchi cultivars and contrasting agroclimatic zones provide the demographic basis for evidence-driven management by quantifying stage-specific survivorship, development time, fecundity, net reproductive rate (R_0), intrinsic and finite rates of increase (r and λ), and generation time (T). Comparative estimates across varieties reveal host suitability, including cultivars that slow nymphal development or depress fecundity, which supports informed cultivar selection to reduce baseline pest pressure. Geographic analyses clarify how temperature and humidity shape voltinism and seasonal peaks, allowing phenology models and degree-day forecasts that anticipate rather than react to outbreaks.

Molecular Approaches

Emerging genomic techniques open up new opportunities (Table 4). Despite the availability of COI barcodes, the nuclear genome and transcriptome of *T. javanica* have not yet been completely sequenced. Finding olfactory receptors and pheromone binding proteins (as in *T. papillosa*) could lead to the development of pheromone-based attractants or repellants (Cheng et al., 2022). The use of double-stranded RNA (dsRNA) for gene silencing has great potential for Hemiptera. One study found that dsRNA targeting critical genes (vATPase, chitin synthase) was responsible for the mortality of 35-80% of stink insect relatives (e.g., *Halyomorpha halys*, *Euschistus heros*). These results suggest that by developing dsRNA that is specific to *T. javanica*, it may be possible to create bio-insecticides that are selective for this species. Delivery (by feeding or nanoparticle carriers) and the possibility of RNA-degrading enzymes in stink insect guts are practical concerns. CRISPR gene editing: Several Hemiptera have been edited using CRISPR/Cas9, enabling gene drives and knockouts. This could pave the way for future efforts to create sterile lines or to break the reproductive genes in *T. javanica*.

Table 4. Different studies focused on molecular approaches in the management of litchi stink bugs

Sl No	Study (year), Journal	Species	Molecular focus	Key outcomes	Management relevance
1	Wu et al., 2017, Scientific Reports	*T. papillosa*	Antennal transcriptome (olfaction genes)	Identified 59 ORs, 14 IRs, 33 OBPs with sex-biased expression in antennae.	Targets for semiochemicals; enables lure/repellent design & disruption of mate/host finding.
2	Cheng et al., 2022, Frontiers in Physiology	*T. papillosa*	Whole-body/tissue & stage RNA-seq	Assembled 67,597 unigenes; 462 growth/development, 1,851 digestion/detox (incl. many P450s), 70	Prioritizes gene targets (e.g., detox & olfaction) for RNAi/SIGS; informs

				olfaction genes; tissue/stage-specific expression verified by qPCR.	resistance-management strategies.
3	Zhang et al., 2009, J. Chromatographic Sci.	*T. papillosa*	Volatile/pheromonal profiling (SPME-GC-MS)	16 volatiles pre-disturbance; 22 post-disturbances; key alarming volatiles reported.	Basis for alarm-mediated repellents/push–pull and monitoring baits.
4	Wang et al., 2015, Chemistry of Natural Compounds	*T. papillosa*	Nymph volatile chemistry (GC-MS)	17 volatiles across instars; composition varies with stage/treatment.	Stage-tailored semiochemical tools and trap optimization.
5	Parveen et al., 2015, Zootaxa	*T. javanica*	mtCOI DNA barcoding (+ morphology)	Produced barcodes for all life stages; clarified separation from *T. papillosa.*	Fast molecular diagnostics for surveillance, quarantine, and clean colony sourcing.
6	Wu et al., 2020, Insects	*T. papillosa*	Population genetics (mtDNA) + parasitoids	Two genetic clades suggest multiple invasions; documented dominant egg parasitoids (*Anastatus dexingensis*, *A. fulloi*).	Guides biocontrol releases & area-wide management using genetic structure and natural enemy data.
7	Liu et al., 2021/2022, Antonie van Leeuwenhoek	*T. papillosa*	Microbiome across life stages	Proteobacteria dominant; Pantoea prevalent; three microbiome “phases” (egg → early nymph → late nymph/adult).	Symbiont-targeted control/paratransgenesis concepts; stage-specific microbial manipulation.
8	Kumari et al., 2024, Heliyon	*T. javanica*	Microbiome (16S amplicon)	Developmental shifts in bacterial diversity; predicted functions in metabolism, signaling, transport.	Identifies candidate symbionts/pathways to disrupt for biological control.
9	Samal et al., 2025b, Scientific Reports	*T. javanica*	Microbiome across stages	Stage-specific community shifts (e.g., Gammaproteobacteria vs. Bacilli dominance); highlights taxa like *Ligilactobacillus/Pseudomonas*; suggests biological-control avenues.	Pinpoints life-stage windows/taxa for microbiome-based interventions.

Biocontrol Strategies

Classical biological control aims to preserve native predators while also introducing new, foreign species of natural enemies. Various egg parasitoid species, including Scelionids and Eupelmids, feed on *T. javanica* in its native Asia. It is recommended to conduct surveys in Southeast Asia to screen potential species (such as *Anastatus japonicus* and *Ooencyrtus submetallicus*) before they are released (Meng et al., 2017). Among the potential biocontrol agents are entomopathogenic fungi. *Beauveria bassiana* (LC_{50}=1.9 x 10^7 conidia/mL, LT_{50}=4.3 d) and *Paecilomyces lilacinus* (LT_{50}=4.3 d) were found on cadavers during investigations on the lychee gigantic stink bug (*T. papillosa*) (Giovannini et al., 2022). The death rate of 2nd instar nymphs reached 89%. This data points to the possibility that field applications of *B. bassiana* formulations could kill, *Tessarotoma* spp.

Semiochemical-based control

Stink bugs are frequently influenced by aggregation pheromones, which are sesquiterpenes that are released by males. If *T. javanica* secretes volatile attractants, synthetic analogues could be used in traps for mass monitoring, similar to alarm pheromones found in many Pentatomids (Pal et al., 2023). But these chemicals might also be deployed as push techniques, or repellents, to protect orchard borders. For instance, odor-baited traps have the potential to greatly enhance early detection in situations where honeydew or host-volatile cues are detected.

Role of extension functionaries in litchi stink bug management

Extension functionaries are pivotal to litchi stink bug (*Tessaratoma* spp.) management because they translate research into coordinated action at orchard and landscape scales (Chowdary et al., 2024). Their core roles include: organizing community-level surveillance and harmonized spray windows to prevent refuge effects between treated and untreated orchards; training growers to recognize phenology cues, edge-based aggregation, egg masses, and early nymphal cohorts; standardizing scouting, damage rating, and record-keeping so thresholds and interventions are evidence-based; issuing timely advisories (SMS/WhatsApp/IVR) on monitoring dates, degree-day/phenology forecasts, and safe, resistance-aware insecticide rotations; promoting IPM tactics such as sanitation, pruning, and conservation of natural enemies; coordinating area-wide actions (spot treatments on outer rows, synchronized sprays targeting nymphs, and border management across farm boundaries); ensuring residue compliance, PPE use, and pre-harvest intervals; supporting rapid diagnostics (field clinics, voucher submission) and data feedback loops to researchers; and managing biosafety in biological control.

Challenges and Knowledge Gaps

The ecological dynamics of *T. javanica* and its associated natural enemy complexes remain insufficiently delineated across various localities. Investigation is required on the dispersal between *T. javanica* orchards and survival on alternate hosts during the off-season. Insecticide resistance: the recurrent use of a restricted selection of pesticides poses a risk of resistance; foundational monitoring of susceptibility is inadequate. Further, no effective rearing techniques have been established for *T. javanica* or its parasitoids in biocontrol (parasitoid or SIT). The chemical attractants (pheromones, volatile hosts) remain uncharacterized. The investigation of its olfactory receptors (antennal transcriptome) remains in its nascent stages, with certain genes identified in *T. papillosa*. The context of smallholders may impede the adoption of advanced technological solutions (e.g., UAVs, dsRNA). The pest exhibits mobility across national borders, necessitating coordination among India, Bangladesh, and Nepal.

Conclusion and Future Research Directions

T. javanica has rapidly expanded from first detection in Jharkhand (2011) to the major litchi belts of Bihar, West Bengal, and the Northeast, causing severe fruit injury and yield loss. Its polyphagy and probable movement via plant material create a clear transboundary threat. Mitigation demands coordinated surveillance and reporting, regionally synchronized biosecurity, and IPM that prioritizes cultural and mechanical sanitation, conservation of natural enemies, and resistance-aware, judicious insecticide use. Near-term priorities include multi-year field trials to define degree-day requirements, population peaks, and economic thresholds; optimization of pheromone traps; and targeted exploration for native and exotic parasitoids and other biocontrols. Parallel efforts should advance chemical ecology (semiochemical identification and field validation) and molecular tools (genome/transcriptome resources, RNAi, and paratransgenesis). Strong extension programs are essential to translate these tools into practice and protect productivity and market access.

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