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Insect-pests Complex Associated With Basmati Rice in Basmati Growing Region of India

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Abstract

The present study was conducted during the *Kharif* seasons of 2023 and 2024 at the Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, to assess the insect-pest complex associated with Basmati rice (variety PB-1509) under non-insecticidal conditions. Eleven insect pest species belonging to five taxonomic orders and eight families were recorded at various phenological stages of the crop. These were categorized based on their incidence, damage potential, and economic importance. *Scirpophaga incertulas* (rice yellow stem borer) and *Cnaphalocrocis medinalis* (rice leaf folder) were identified as the major pests, causing substantial yield losses due to dead hearts and whiteheads, and leaf damage, respectively. Secondary pests included *Nilaparvata lugens*, *Nephotettix virescens*, *Sogatella furcifera*, *Leptocorisa acuta*, and *Dicladispa armigera*, while *Hieroglyphus banian*, *Mythimna separata*, *Nymphula depunctalis*, and *Odontotermes obesus* were identified as incidental or occasional pests. Temporal occurrence patterns revealed intermittent pest activity throughout the crop growth stages. The findings underscore the need for continuous monitoring and the implementation of biointensive pest management strategies to mitigate losses while minimizing environmental impacts. This study contributes valuable insights into the pest dynamics of Basmati rice and serves as a foundation for developing region-specific integrated pest management approaches.

1. INTRODUCTION

Rice (*Oryza sativa* Linn.) is a self-pollinated crop belonging to the Gramineae family, with a chromosome number of 2n = 24. It is the second most widely cultivated cereal crop worldwide and serves as the staple food for over half of the global population, particularly in Asia and Africa. More than 60% of the world's population depends on rice as their primary food source. India ranks as the second-largest producer and the leading global exporter of rice. In the 2023-24 agricultural year, India achieved a record rice production of 137.8 million tonnes, surpassing the previous year's output of 135.7 million tonnes **(**Press Information Bureau, Government of India, 2024**)**. The area under rice cultivation increased to 47.6 million hectares during the fiscal year 2024 **(**Statista, 2024**)**. This rise in production is attributed to favourable monsoon conditions, government initiatives, and the adoption of modern agricultural techniques. The top rice-producing states in 2023-24 included Telangana, which recorded 16.87 million tonnes, followed by Uttar Pradesh with 15.99 million tonnes, West Bengal with 15.69 million tonnes, Punjab with 14.36 million tonnes, Chhattisgarh with 9.70 million tonnes, and Odisha with 8.47 million tonnes **(Ministry of Agriculture & Farmers Welfare, 2024)**. India's rice exports also witnessed substantial growth, with key destinations including the Middle East, Africa, and Southeast Asia. In 2023-24, India exported approximately 22 million tonnes of rice, maintaining its status as the world’s largest rice exporter **(**Ministry of Commerce and Industry, 2024**)**.

Government schemes such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and the National Food Security Mission (NFSM) have significantly contributed to enhancing rice productivity by encouraging efficient irrigation systems, subsidized fertilizers, and high-yielding seed varieties **(Ministry of Agriculture & Farmers Welfare, 2024)**. However, rice cultivation faces several challenges, including water scarcity, pest infestations, and the impacts of climate change. In response, the government and agricultural research institutions are developing drought-resistant and pest-resistant rice varieties to address these concerns. Overall, India’s rice sector continues to expand, playing a vital role in ensuring national food security and economic growth while maintaining its strong presence in the global rice market. Basmati rice is a premium rice variety known for its distinctive aroma and flavour upon cooking. The key characteristics of Indian basmati rice include extra-long, superfine, and slender grains with a length-to-breadth ratio exceeding 3.5, a naturally sweet flavour, soft texture, delicate curvature, and significant elongation with minimal width-wise expansion during boiling. Basmati rice is also referred to as the "Pearl of Rice" **(**Bashyal et al., 2016).

The rice crop is susceptible to over 100 species of insect pests, with approximately 20 causing severe economic losses. The estimated yield loss due to insect pests in rice is around 30–40%. Among these pests, yellow stem borer (*Scirpophaga incertulas*, Walker), brown planthopper (*Nilaparvata lugens*, Stal), green leafhopper (*Nephotettix* spp.), ear head bug (*Leptocorisa oratorius*, Fabricius), leaf folder (*Cnaphalocrocis medinalis*, Guenée), and case worm (*Nymphula depunctalis*, Guenée) are the most prevalent in Karnataka. These pests attack rice at various growth stages, causing damage such as tissue boring, sap sucking, defoliation, and leaf scraping. The rice ecosystem consists of numerous pests and their natural enemies, leading to complex pest dynamics. On average, yield losses in rice have been reported as 30% due to stem borers, 20% from plant hoppers, 15% from gall midges, 10% from leaf folders, and 25% from other pests (Parasappa, 2017).

Among different stem borer species, the yellow stem borer is the most prevalent, accounting for nearly 70% of borers. It is also a major pest in other parts of Asia. After hatching from eggs, the larvae bore into the stems of rice plants, disrupting the supply of photosynthates and nutrients to the upper plant parts. Infestation at the vegetative stage results in ‘dead hearts’ (DHs), whereas an attack at the reproductive stage (during panicle development) leads to ‘whiteheads’ (WHs). While rice plants can recover from low levels of dead hearts, yield losses of 1–3% occur for every percentage increase in whiteheads. Due to the overlapping life stages of larvae and pupae in the field, stem borers remain concealed inside the stem, making them difficult to control with insecticide sprays. Proper timing of insecticide application is essential for effective management of stem borers **(**Rahaman and Stout, 2019**)**. Abiotic factors such as temperature, humidity, and rainfall significantly influence insect pest population dynamics. Rainfall plays a crucial role in the survival and dispersal of insect populations. Keeping these aspects in mind, various studies have focused on understanding the impact of abiotic factors on the population buildup of lepidopteran pests **(**Sharma et al., 2018).

Synthetic chemical insecticides are commonly used for managing the yellow stem borer, *Scirpophaga incertulas* (Walker). However, excessive and indiscriminate use of chemical insecticides has led to several adverse effects, including insect resistance, residual toxicity, pest resurgence,

secondary pest outbreaks, environmental pollution, ecological imbalances, and risks to human health. These concerns have driven interest in biointensive pest management approaches, including the use of microbial insecticides, biopesticides, botanicals, and biological control agents.

2. MATERIALS AND METHODS

The field experiment was carried out at the Crop Research Centre (CRC) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, during two consecutive *Kharif* seasons of 2023 and 2024. The experiment aimed to study the insect pest complex associated with Basmati rice without the use of insecticidal applications. Seeds of Basmati rice (**variety - 'PB-1509'**) were sown on July 17th in a designated plot measuring 100 m², maintaining a row to row spacing of 20 cm and a plant to plant spacing of 15 cm. Standard agronomic practices were followed throughout the crop cycle to ensure optimal growth conditions.

The experimental field was closely monitored daily to observe pest infestation and insect activity. However, systematic data collection was conducted at 7-day intervals, starting from the seedling stage and continuing until harvest. Observations were recorded from five randomly selected hills within the designated incidence plot to ensure representative sampling. Insect pests were collected using various methods depending on their type and behavior, including light trapping, netting, sweeping, and manual handpicking. Immature stages of insect pests were carefully collected and transported to the laboratory for rearing, facilitating species identification and further study of their life cycles. Meanwhile, adult insects were collected and preserved using appropriate entomological techniques. Depending on their size, the adult specimens were either killed in specialized killing bottles, mounted on insect pins, or placed on paper points for proper documentation. Each specimen was properly labelled for accurate identification.

For species-level identification, a combination of contemporary resources was utilized. The identification process involved referencing the latest taxonomic keys, consulting recent photographic records, and seeking guidance from subject matter experts. All collected specimens were systematically identified in the Department of Entomology at Sardar Vallabhbhai Patel University of Agriculture and Technology (SVPUA&T), Meerut.

3. RESULTS

Investigations on the Multifarious Insect-Pest Complex Infesting Basmati Rice (Kharif 2023 and 2024)

The research delving into the variegated insect-pest assemblage afflicting Basmati rice was conducted over two consecutive *Kharif* seasons, spanning 2023 and 2024. Empirical findings underscored the vulnerability of Basmati rice to a plethora of insect-pests, each exhibiting infestation at disparate phenological phases. A systematic classification was undertaken, wherein the insect-pests were delineated based on their taxonomical hierarchy, incorporating aspects such as vernacular nomenclature, binomial designation, taxonomic order, familial affiliation, developmental stages of infestation, and economic repercussions. Data tabulated in Table 1 and graphical representations in Fig. 1 elucidate that the observed insect-pests were encompassed within five orders and eight families. Insect-pests demonstrating perpetual prevalence and causing substantial detriment were categorized as **primary pests**, whereas those manifesting ephemeral occurrences or inhabiting fields in scant populations were designated as **secondary pests**. Sporadically occurring insects in negligible densities were further categorized as **incidental pests**.

Table 1
Insect-pests complex associated with basmati rice during Kharif, 2023 and 2024.

S. No.	Common Name	Scientific Name	Family	Order	Damaging Stage	Plant Parts Affected	Activity Period	Severity of Pests	Economic Status
1	*Kharif* Grasshopper	*Hieroglyphus banian*	Acrididae	Orthoptera	Nymphs, Adults	Leaves	Kharif season	Sporadic	Incidental
2	Rice Yellow Stem Borer	*Scirpophaga incertulas*	Crambidae	Lepidoptera	Larvae	Stem, Tillers	Transplantation to Harvest	High	Primary
3	Rice Leaf Folder	*Cnaphalocrocis medinalis*	Crambidae	Lepidoptera	Larvae	Leaves	Throughout crop cycle	High	Primary
4	Caseworm	*Nymphula depunctalis*	Crambidae	Lepidoptera	Larvae	Leaves	August-September	Moderate	Secondary
5	Armyworm	*Mythimna separata*	Noctuidae	Lepidoptera	Larvae	Leaves, Panicles	Sporadic	Moderate	Secondary
6	Brown Planthopper	*Nilaparvata lugens*	Delphacidae	Hemiptera	Nymphs, Adults	Stem, Leaves	August-September	High	Primary
7	Green Leafhopper	*Nephotettix virescens*	Cicadellidae	Hemiptera	Nymphs, Adults	Leaves	Throughout crop cycle	Moderate	Secondary
8	White-Backed Planthopper	*Sogatella furcifera*	Delphacidae	Hemiptera	Nymphs, Adults	Leaves, Stem	Throughout crop cycle	High	Primary
9	Earhead Bug	*Leptocorisa acuta*	Alydidae	Hemiptera	Nymphs, Adults	Grains, Panicles	Post-panicle emergence	Moderate	Secondary
10	Rice Hispa	*Dicladispa armigera*	Chrysomelidae	Coleoptera	Larvae, Adults	Leaves	July-September	Moderate	Secondary
11	Termites	*Odontotermes obesus*	Termitidae	Isoptera	Workers, Soldiers	Roots, Basal Stem	Throughout crop cycle	Low	Secondary

Among the eleven documented insect-pests, **Scirpophaga incertulas** (Rice Yellow Stem Borer) and **Cnaphalocrocis medinalis** (Rice Leaf Folder) emerged as the principal pests exerting pronounced adversity upon Basmati rice. Conversely, **Nilaparvata lugens** (Brown Planthopper), **Nephotettix virescens** (Green Leafhopper), **Sogatella furcifera** (White-Backed Planthopper), **Leptocorisa acuta** (Earhead Bug), and **Dicladispa armigera** (Rice Hispa) were relegated to the category of **secondary pests**. Additionally, **Hieroglyphus banian** (*Kharif* Grasshopper), **Mythimna separata** (Armyworm), **Odontotermes obesus** (Termites), and **Nymphula depunctalis** (Caseworm) were identified as **incidental pests**. The sequential emergence of these pests exhibited a consistent trend across both years, with most species displaying intermittent appearances throughout the observational tenure.

1. Orthopteran Insect Pests

1.1 *Kharif* Grasshopper (*Hieroglyphus banian* Fabr.)

The sporadic manifestation of *Hieroglyphus banian* was discerned during the *Kharif* seasons of 2023 and 2024, wherein it inflicted foliar damage upon Basmati rice. This Acrididae family pest, in both its nymphal and adult stages, exhibited defoliatory behavior, characterized by the emergence of irregular perforations and notching along the foliar margins. Severe infestations resulted in chaffy grains due to diminished photosynthetic efficiency. Despite its transient presence, its potential to contribute to localized crop depredation necessitated its classification as an **incidental pest**. Corroborative accounts of its infestation have been documented by Sachan et al., (2006), Singh and Singh (2014), Saini et al., (2015), Gangwar et al., (2015), Deshwal et al., (2019), and Singh et al., (2020).

2. Lepidopteran Insect Pests

2.1 Rice Yellow Stem Borer (*Scirpophaga incertulas* Walker)

This insidious lepidopteran pest pervaded Basmati rice fields from the transplantation stage to harvest during both *Kharif* seasons under study. The larval instars exhibited endophytic boring behavior, leading to the formation of *dead hearts* in vegetative stages and *white earheads* in reproductive stages, culminating in substantial yield attrition. Infested tillers, rendered structurally fragile, were effortlessly detachable. The severity of its impact

warranted its classification as a **primary pest**. This pest has been extensively documented in previous studies [Sachan et al., (2006), Singh and Singh (2014), Saini et al., (2015), Gangwar et al., (2015), Deshwal et al., (2019), Singh et al., (2020)].

2.2 Rice Leaf Folder (*Cnaphalocrocis medinalis* Guenee)

Infestation by *C. medinalis* was recurrently observed, manifesting as characteristic longitudinal foliar folding, followed by chlorophyll depletion. Extensive damage conferred a scorched field appearance, diminishing the photosynthetic capacity and vigor of the crop. Given its substantial impact, it was categorized as a **primary pest**. Previous accounts corroborate these findings [Saini et al., (2015), Gangwar et al., (2015), Deshwal et al., (2019), Singh et al., (2020)].

2.3 Caseworm (*Nymphula depunctalis* Guenee)

Caseworm larvae were active in August and September, fashioning protective foliar casings within which they consumed leaf tissue, resulting in withered, papery foliage. Despite its presence, its impact was restricted, meriting classification as a **secondary pest**. Similar findings have been reported by Singh and Singh (2014), Dumra et al., (2020).

2.4 Armyworm (*Mythimna separata* Walker)

This nocturnal defoliator exhibited voracious feeding, particularly during late-stage larval development, inducing severe defoliation and panicle severance. Owing to its sporadic appearance, it was deemed a **secondary pest** [Singh and Singh (2014)].

3. Hemipteran Insect Pests

3.1 Brown Planthopper (*Nilaparvata lugens* Stal.)

This sap-sucking delphacid pest exhibited peak activity in August and September, culminating in *hopper burn*, a condition characterized by plant desiccation and necrosis. Given its economic significance, it was classified as a **primary pest**.

3.2 Green Leafhopper (*Nephotettix virescens* Distant)

The nymphs and adults of this cicadellid pest engendered foliar chlorosis and desiccation, thereby predisposing plants to viral afflictions. It was designated as a **secondary pest**.

3.3 White-Backed Planthopper (*Sogatella furcifera* Hovarth)

Analogous to *N. lugens*, this pest debilitated rice plants by sap extraction, inducing widespread chlorosis and stunted growth, earning its classification as a **primary pest**. Prior reports validate these findings [Sachan et al., (2006), Singh and Singh (2014), Saini et al., (2015), Gangwar et al., (2015), Deshwal et al., (2019), Singh et al., (2020)].

3.4 Earhead Bug (*Leptocorisa acuta* Thunberg)

Feeding on developing grains, this alydid pest incited panicle deformities and discoloured grains. Owing to its ephemeral activity post-panicle emergence, it was labelled as a **secondary pest** [Deshwal et al. (2019)].

4. Coleopteran Insect Pests

4.1 Rice Hispa (*Dicladispa armigera* Oliver)

This chrysomelid beetle, active from July to September, incised *windowpane* foliar damage, albeit without substantive economic repercussions, warranting its **secondary pest** classification [Singh and Singh (2014) [16], Gangwar et al. (2015)].

5. Isopteran Insect Pests

5.1 Termites (*Odontotermes obesus* Rhomb.)

Feeding primarily on subterranean plant structures, termites debilitated rice plants, though their impact was confined, justifying their classification as **secondary pests** [Singh and Singh (2014), Saini et al., (2015), Deshwal et al., (2019)].

4. DISCUSSION

Between July and October of both 2023 and 2024, an extensive field investigation documented the presence of eleven distinct insect-pest species infesting Basmati rice crops. These included *Scirpophaga incertulas* (rice yellow stem borer), *Cnaphalocrocis medinalis* (rice leaf folder), *Nilaparvata lugens* (brown plant hopper), *Nephotettix virescens* (green leaf hopper), *Sogatella furcifera* (white-backed plant hopper), *Leptocorisa acuta* (earhead

bug), *Dicladispa armigera* (rice hispa), *Hieroglyphus banian* (*Kharif* grasshopper), *Mythimna separata* (armyworm), and *Nymphula depunctalis* (caseworm). Prior scholarly endeavours have catalogued an array of insect pests afflicting rice crops across India. Singh *et al.*, delineated twelve pest species impacting rice from the seedling phase through to harvest, while Patel and Verma enumerated fifteen species, emphasising *Scirpophaga incertulas* and *Cnaphalocrocis medinalis* as principal menaces. The findings of Sachan *et al.*, were notably more expansive, chronicling twenty-eight distinct insect species associated with rice crop infestation. Sharma *et al.*, recorded the presence of eight insect pests spanning the vegetative stage, whereas their observations in the western region of Uttar Pradesh identified twelve species, distributed across six taxonomic orders. Desai *et al.*, registered fourteen rice pest species, corresponding to five orders and eight families. The scholarly contributions of Kumar and Rathi underscored the prevalence of twenty rice pest species, with *Scirpophaga incertulas*, *Cnaphalocrocis medinalis*, and *Nilaparvata lugens* demonstrating dominance. Verma *et al.*, documented six insect species persistently present throughout all phenological phases of rice growth. Meanwhile, Joshi and Patel observed seven recurrently overlapping pest species across distinct developmental stages of the crop. These findings align with those of Nair, whose prior research corroborates similar patterns of infestation.

5. CONCLUSION

Eleven insect pest species were identified infesting Basmati rice crops. *Scirpophaga incertulas* (rice yellow stem borer) and *Cnaphalocrocis medinalis* (rice leaf folder) were the most damaging, significantly threatening yields. Seven others—*Nilaparvata lugens* (brown plant hopper), *Nephotettix virescens* (green leaf hopper), *Sogatella furcifera* (white-backed plant hopper), *Leptocorisa acuta* (earhead bug), *Dicladispa armigera* (rice hispa), *Hieroglyphus banian* (Kharif grasshopper), and *Mythimna separata* (armyworm)—were classified as minor pests. *Nymphula depunctalis* (caseworm), termites, and *Dicladispa armigera* were occasional pests, appearing sporadically.

Given the severe impact of major pests, continuous multi-year regional surveys are essential to monitor pest populations and refine control strategies, ensuring effective pest management and sustainable rice production.

Declarations

Author Contribution

A.S. designed the study, performed field data collection, and conducted data analysis. A.S. drafted the manuscript. Dr. H.S. supervised the research, provided critical revisions, and approved the final manuscript. Both authors have read and approved the submitted version of the manuscript.

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Figures

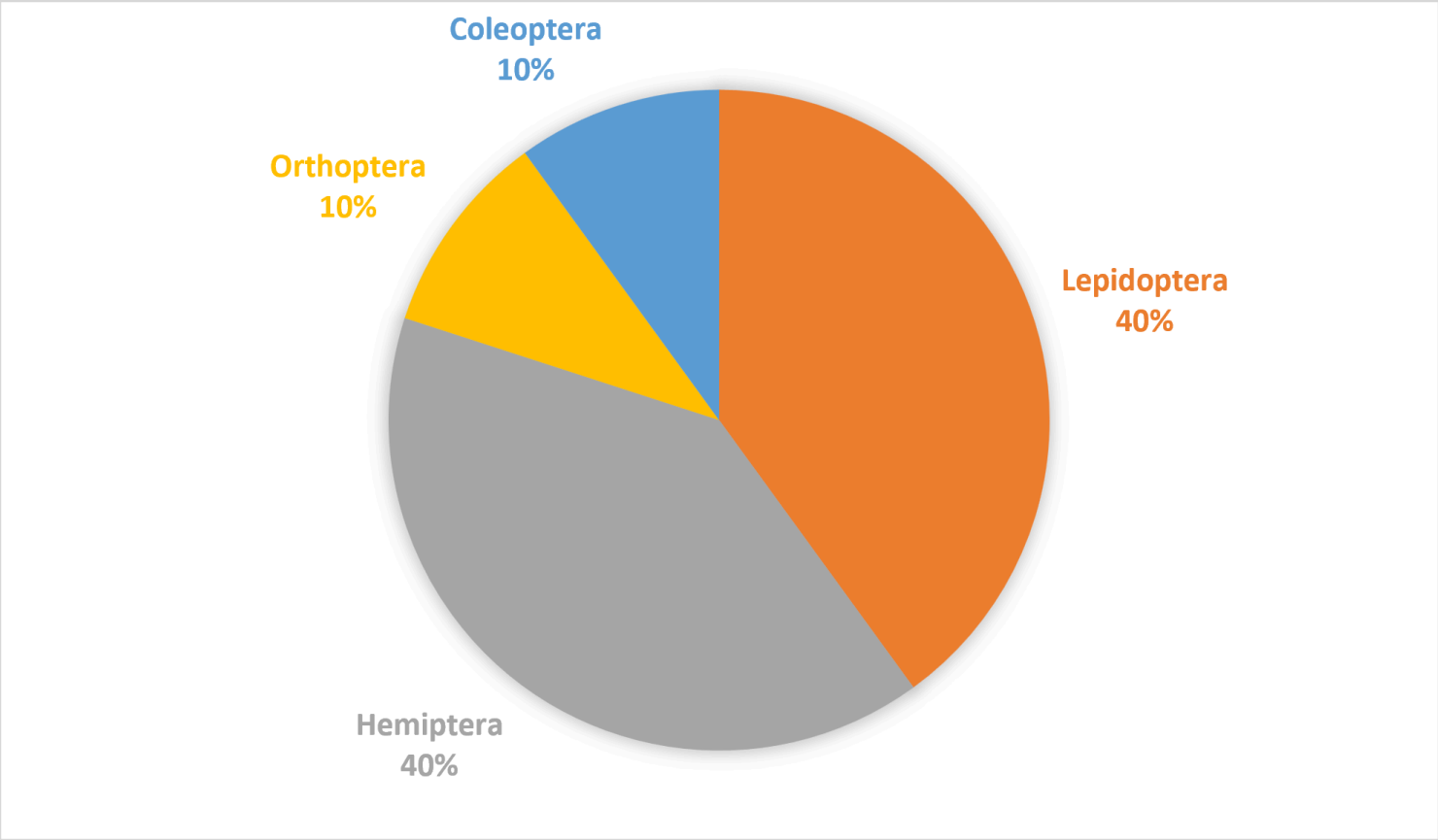


Figure 1

Insect-pest complex in Basmati rice belonging to different orders at CRC, SVPUA&T, Meerut during Kharif 2023 and 2024.