

## Pest management in coffee: A global perspective on challenges and integrated solutions

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### Abstract

Coffee (*Coffea arabica* and *Coffea canephora*) is a globally significant cash crop cultivated in over 60 countries. However, its production is constantly challenged by a diverse range of insect pests that cause severe yield losses, reduce bean quality, and increase production costs. This review explores the global status of coffee pests, including major pests like the coffee berry borer (*Hypothenemus hampei*), coffee leaf miner (*Leucoptera coffeella*), and coffee stem borer (*Xylotrechus quadripes*). It highlights recent trends in pest outbreaks, climate change influences, and the role of monoculture practices. Integrated Pest Management (IPM) strategies including biological control, host plant resistance, cultural practices, and botanical and microbial pesticides are examined. This review underscores the necessity of location-specific and ecologically sustainable pest management practices to maintain productivity and ecological balance in coffee ecosystems.

**Keywords:** Coffee pests, IPM, biological control, climate change, arabica, robusta, sustainable pest management

### Introduction

Coffee is one of the most valuable traded commodities in the global agricultural market, with over 10 million hectares under cultivation worldwide, predominantly in tropical regions. However, the productivity and profitability of coffee are significantly hindered by the damage caused by insect pests. Among these, the coffee berry borer (*Hypothenemus hampei*) alone is responsible for over \$500 million in annual crop losses globally.

In addition to economic implications, pest outbreaks threaten the sustainability of coffee agroecosystems, especially as monoculture plantations and changing climates alter pest dynamics. As conventional chemical control faces limitations due to resistance development and ecological side effects, Integrated Pest Management (IPM) has emerged as a sustainable approach.

This review consolidates recent findings and global experiences in coffee pest management, addressing pest

biology, infestation patterns, monitoring techniques, and integrated control strategies suited for varying agro-climatic zones.

### Materials and Methods

This review is based on a comprehensive literature survey of peer-reviewed articles, research reports, and institutional publications from 2000 to 2024. Key databases such as ScienceDirect, PubMed, SpringerLink, and Scopus were used. Search terms included “coffee pests,” “IPM in coffee,” “coffee berry borer,” “coffee stem borer,” “biological control in coffee,” and “climate change and pests in coffee.” Emphasis was placed on globally distributed pest species, sustainable management practices, and regional control strategies. Expert interviews and extension bulletins were also consulted.

### Results

Major Global Pests of Coffee

Pest	Scientific Name	Distribution	Key Damage
Coffee Berry Borer	<i>Hypothenemus hampei</i>	Africa, Latin America, Asia	Bore into berries, affecting yield and quality
Coffee Leaf Miner	<i>Leucoptera coffeella</i>	Latin America	Mines leaves, reduces photosynthesis
Coffee Stem Borer	<i>Xylotrechus quadripes</i>	Asia (India, Vietnam)	Girdling of stems, death of branches
Coffee Mealybugs	<i>Planococcus citri</i>	Worldwide	Sap sucking, sooty mold formation
White Stem Borer	<i>Monochamus leuconotus</i>	Africa	Tunneling in main stem, plant death
Coffee Green Scales	<i>Coccus viridis</i>	Asia and Africa	Weakens plants, promotes fungal infection

### Factors Affecting Pest Outbreaks

- **Monoculture Practices:** Favor pest colonization due to lack of biodiversity.
- **Climate Change:** Warmer temperatures expand pest ranges, especially for *H. hampei*.
- **Pesticide Resistance:** Overreliance on synthetic insecticides accelerates resistance.
- **Crop Seasonality:** Perennial nature of coffee allows year-round pest survival.

### Control Methods Reported Worldwide

- **Chemical Controls:** Use of chlorpyrifos, bifenthrin, imidacloprid—limited due to resistance.
- **Biological Controls:** Use of parasitoids (*Phymastichus coffea*), entomopathogenic fungi (*Beauveria bassiana*).
- **Botanicals:** Neem-based products, essential oils.
- **Cultural Practices:** Sanitation, pruning, shade management.
- **Mechanical Traps:** Alcohol-based attractants for *H. hampei*.

## Discussion

### Efficacy of Current IPM Strategies

Integrated approaches combining cultural, mechanical, and biological methods have shown promise globally. In Latin America, mass trapping of *H. hampei* combined with fungal biocontrol has reduced infestations by over 70%. Similarly, shade regulation in Indian plantations has reduced coffee stem borer attacks.

### Biological Control – A Key Strategy

Biological control is central to sustainable coffee pest management. *B. bassiana* and *Metarhizium anisopliae* are widely used entomopathogens. In Kenya, *P. coffea* has proven highly effective in reducing berry borer populations. However, success depends on correct timing, formulation, and environmental compatibility.

### Climate Change and Pest Dynamics

Climate change is expanding the altitudinal and latitudinal distribution of several pests. For example, *H. hampei* has been reported at elevations above 1500 m, previously unsuitable for its development. Predictive models are needed to adapt strategies accordingly.

### Pest Surveillance and Forecasting

Advancements in remote sensing, pheromone traps, and digital apps allow for better pest surveillance. Projects like Colombia's Coffee Cloud integrate farmer inputs with real-time weather to predict borer infestations.

### Challenges and Knowledge Gaps

- Lack of location-specific pest thresholds.
- Limited availability of affordable biopesticides.
- Regulatory restrictions on novel IPM agents.
- Poor adoption of IPM due to lack of farmer training.

## Conclusion

Pest management in coffee is a complex but critical aspect of global coffee sustainability. As the industry faces challenges from climate change, resistance development, and ecological concerns, integrated pest management offers a way forward. Sustainable strategies that prioritize ecological balance, use of biological agents, and adaptive surveillance tools are essential for long-term productivity. Collaborative research, farmer education, and policy support must align to ensure global coffee remains profitable and environmentally viable.

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