Integrated Management of Coffee Berry Borer (*Hypothenemus hampei* Ferrari) in Coffee Plantations of Alluri Sitarama Raju District, Andhra Pradesh

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Received:- 04 April 2024/ Revised:- 14 April 2024/ Accepted:- 21 April 2024/ Published: 30-04-2024

Abstract— *The coffee berry borer (CBB), Hypothenemus hampei Ferrari (Coleoptera: Curculionidae: Scolytinae), is one of the most destructive insect pests of coffee worldwide. The pest damages coffee berries by boring through the fruit and developing within the coffee bean, where larvae and adults feed on the endosperm. Because most of its developmental stages remain concealed inside the berry, effective management depends strongly on preventive sanitation, timely monitoring, trapping, and interventions directed against adults before they penetrate the bean. The pest was first reported in India in 1990 and subsequently became established in the major coffee-growing regions of southern India (Kumar et al., 1990). In 2025, H. hampei was reported for the first time in Alluri Sitarama Raju (ASR) district of Andhra Pradesh, creating an important phytosanitary concern for the region's coffee-based farming systems. Current Coffee Board recommendations emphasize clean and complete harvesting, collection and destruction of leftover berries and gleanings, installation of Broca traps, drying of coffee to prescribed moisture levels, and application of Beauveria bassiana at the initial stage of infestation. The present article summarizes the biology, symptoms, damage, monitoring and integrated management of coffee berry borer, with particular emphasis on sustainable and environmentally compatible management strategies suitable for the coffee-growing areas of Andhra Pradesh.*

Keywords— Coffee berry borer, Hypothenemus hampei, coffee, Beauveria bassiana, Broca trap, integrated pest management, Araku coffee, Andhra Pradesh.

I. INTRODUCTION

Coffee is an important plantation crop in the Eastern Ghats of Andhra Pradesh and provides an important source of livelihood for tribal farming communities in Alluri Sitarama Raju district. The coffee-growing landscape of the district is characterized by smallholder and tribal production systems, often under mixed shade conditions. The ecological conditions of the Eastern Ghats are favourable for coffee production but can also support the development and persistence of several insect pests.

The coffee berry borer (CBB), *Hypothenemus hampei* Ferrari, is regarded as one of the most economically important insect pests of coffee worldwide. The pest is particularly difficult to manage because the female beetle enters the coffee berry and subsequently develops inside the bean. Consequently, conventional contact insecticide applications have limited effectiveness after the insect has penetrated deeply into the berry (Johnson et al., 2020; Moreno-Ramirez et al., 2024).

In India, coffee berry borer was first reported from Gudalur in the Nilgiris, Tamil Nadu, in 1990 and subsequently spread to the principal coffee-growing regions of southern India (Kumar et al., 1990). The pest was subsequently detected in Alluri Sitarama Raju district in 2025, representing the first confirmed occurrence reported from Andhra Pradesh. Field reports during September 2025 documented infestation in coffee plantations in the Araku region and subsequently at the Horticultural Research Station, Chintapalli, highlighting the importance of rapid surveillance and containment measures in the district.

The Coffee Board of India currently recommends an integrated approach involving sanitation, complete harvesting, removal of leftover berries and gleanings, Broca trapping, proper drying, and timely application of biological control agents such as *Beauveria bassiana* (Coffee Board of India, n.d.).

Novelty and Contribution of this Review: While coffee berry borer is among the most extensively studied coffee pests globally, with comprehensive reviews available (e.g., Johnson et al., 2020; Moreno-Ramirez et al., 2024), most syntheses focus on global or Latin American contexts. This review makes three specific contributions. First, it documents and contextualizes the first confirmed occurrence of *H. hampei* in Alluri Sitarama Raju district, Andhra Pradesh, in 2025—a new phytosanitary record of regional and national significance. Second, it synthesizes the biology, damage, and integrated management options specifically for the tribal, smallholder, mixed-shade coffee systems of the Eastern Ghats, a context under-represented in the international literature. Third, it proposes a district-level surveillance and containment strategy tailored to ASR district, with practical actions for growers, the Coffee Board, the Department of Horticulture, and research institutions. By distinguishing between established recommendations and locally proposed pathways, the review aims to support rapid, evidence-informed decision-making in a newly affected region.

II. REVIEW METHODOLOGY

This article is a narrative review and does not present a new field experiment or a new statistical survey. The supplied article on coffee berry borer in ASR district was used as the baseline source for the original structure, local context, and proposed management recommendations. The review was expanded using published and authoritative sources on CBB biology, ecology, monitoring, and management.

Search strategy: Literature was identified through targeted searches of Google Scholar, Scopus, Web of Science, and official institutional sources (Coffee Board of India, ICAR, Dr. Y.S.R. Horticultural University) using combinations of the following terms: "coffee berry borer," "*Hypothenemus hampei*," "coffee pest management," "*Beauveria bassiana*," "Broca trap," "integrated pest management coffee," and "coffee Andhra Pradesh." The search covered English-language sources published between 1980 and 2026, with priority given to foundational CBB literature, recent international reviews, Indian CBB research, and current Coffee Board advisories.

Inclusion and exclusion criteria: Sources were included if they addressed CBB biology, ecology, monitoring, or management, or coffee production in India and comparable contexts. Sources were excluded if they focused exclusively on non-coffee crops or were not available in English. Grey literature was included where issued by recognized institutions (e.g., Coffee Board of India).

Synthesis approach: The synthesis is organized around the pest's biology and identification, symptoms and damage, and integrated management components (sanitation, destruction of infested berries, trapping, processing and drying, biological control, timing, and chemical management). Where a recommendation is drawn directly from a cited source, it is presented as such; where it is a synthesis or inference, it is presented as a proposed management pathway. Quantitative values are retained only when traceable to a cited source.

III. BIOLOGY AND IDENTIFICATION

The adult coffee berry borer is a very small, dark brown to black beetle, approximately 1.5–1.8 mm long. The female is larger than the male and is responsible for dispersal and infestation of new berries. The female typically enters the coffee berry through the region surrounding the tip or navel of the fruit. After entering a suitable berry, she constructs tunnels and lays eggs within the coffee bean.

Published accounts indicate that the female may lay up to approximately 30–70 eggs (commonly cited as around 50 under favourable conditions), with eggs hatching in approximately 5–9 days and development from egg to adult occurring in about 25–35 days, depending on temperature (Baker, 1984; Damon, 2000; Jaramillo et al., 2009; Vega et al., 2015). The strongly female-biased sex ratio, together with the flightless nature of males, contributes to the pest's ability to persist and multiply within coffee berries (Coffee Board of India, 2019). The species is multivoltine and can complete several overlapping generations per season where berries remain available.

The pest's cryptic biology is the major difficulty in its management. Adults are most vulnerable before they enter the berry or while they remain at the entrance tunnel. Once the female has penetrated the bean, contact-based management becomes considerably less effective. Therefore, monitoring and timely intervention are critical components of an integrated pest-management programme.

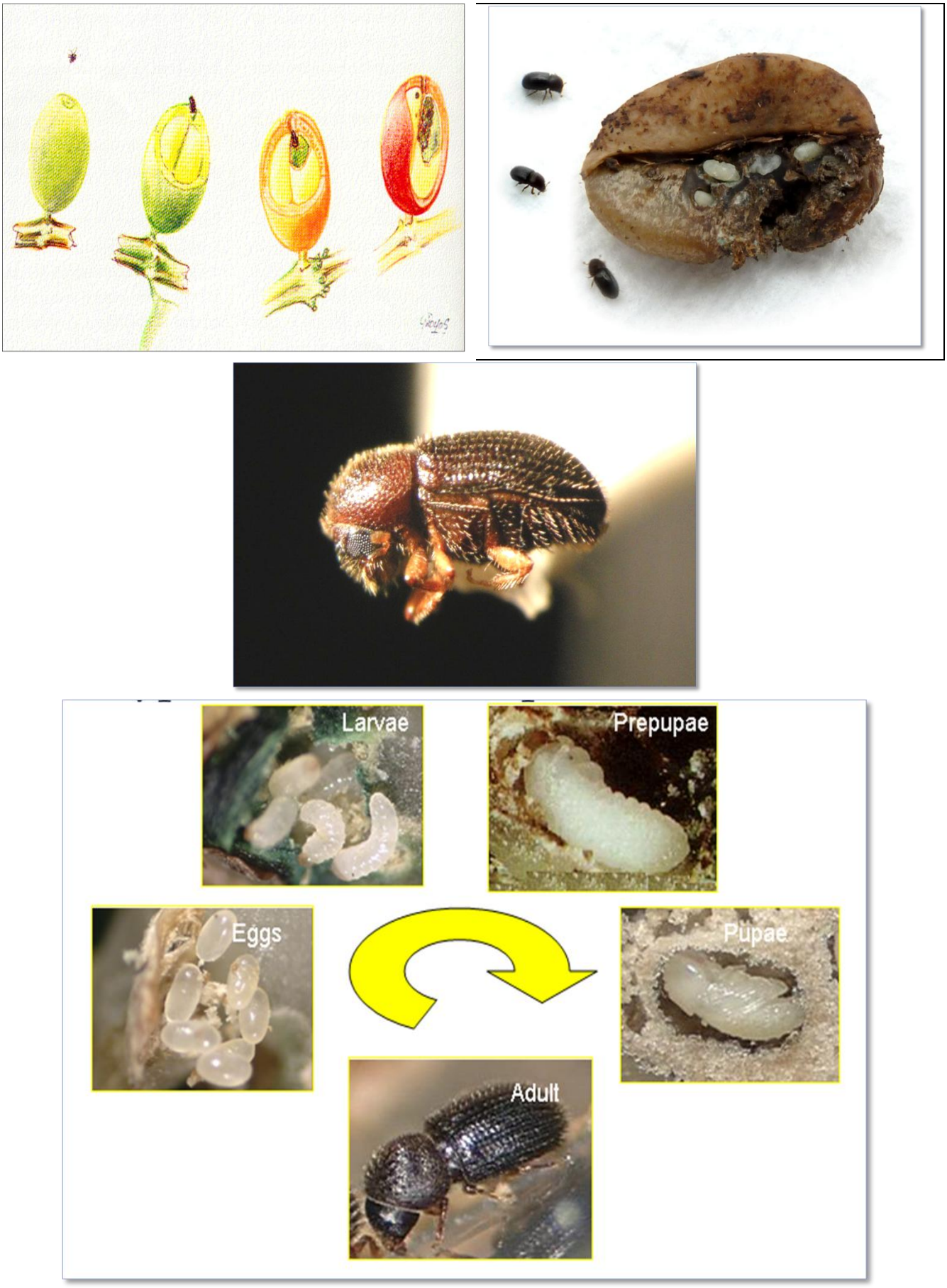

FIGURE 1: Life cycle of Coffee Berry Borer

IV. SYMPTOMS AND NATURE OF DAMAGE

Coffee berry borer attacks both developing and mature coffee berries. The most characteristic field symptom is a small circular pinhole near the tip or navel region of the berry. In heavily infested berries, more than one entry hole may be observed.

The female beetle bores through the berry and eventually reaches the endosperm. The larvae and adults feed within the bean and construct tunnels, resulting in loss of bean weight, deterioration in quality, premature fruit drop in some cases, and reduced marketable yield. Usually, one bean in a berry may be attacked initially, although both beans can be damaged under severe infestation. Because the pest completes much of its life cycle inside the coffee berry, infestation may remain unnoticed until considerable damage has occurred. Delayed harvesting and the presence of leftover berries on plants and on the ground provide suitable reservoirs for continued multiplication and carry-over of the pest (Johnson et al., 2020). Damage severity and loss have been reported to vary widely across regions and seasons, with quality downgrading often being as economically important as direct weight loss (Vega et al., 2015; Johnson et al., 2020).

V. INTEGRATED MANAGEMENT OF COFFEE BERRY BORER

Effective management of coffee berry borer requires integration of preventive, cultural, mechanical, biological and monitoring-based measures. No single method is sufficient under all situations.

5.1 Field Sanitation and Cultural Management

Field sanitation is the most important component of CBB management. Coffee berries remaining on the plants after harvest, fallen berries, gleanings and off-season berries can serve as reservoirs for the pest and permit continuous generation of beetles. This principle is consistently supported across the international CBB literature (Baker, 1984; Damon, 2000; Johnson et al., 2020).

The following practices should therefore be adopted:

- Complete and timely harvesting of coffee berries.
- Collection and destruction of leftover berries on coffee bushes.
- Thorough collection of fallen berries and gleanings from the ground.
- Use of picking mats or polythene sheets during harvesting to minimize berries falling to the ground.
- Removal of off-season berries that can maintain the pest population.
- Avoidance of unnecessary retention of ripe and overripe berries on plants.
- Maintenance of plantations in a condition that permits efficient harvesting, scouting and plant-protection operations.
- Coffee Board guidance similarly emphasizes clean harvest, removal of leftover berries and gleanings, and the use of picking mats as important measures for reducing CBB inoculum (Coffee Board of India, n.d.).

5.2 Destruction of Infested Berries

Collected infested berries should not be discarded indiscriminately because they may contain eggs, larvae, pupae or adult beetles. Infested berries and gleanings can be immersed in hot or boiling water for approximately 2–3 minutes to kill the different developmental stages. Heavily infested material should be destroyed or safely disposed of so that surviving beetles cannot emerge and reinfest healthy coffee plantations. This measure is particularly important during the harvest and post-harvest period, when large quantities of infested berries may accumulate. Deep burial and solarization have also been used in other producing regions as alternative destruction methods (Johnson et al., 2020).

5.3 Monitoring Using Broca Traps

Broca traps are an important component of CBB monitoring and management. They can be installed in coffee plantations and around drying yards to detect adult beetle activity and reduce the number of dispersing adults. The Coffee Board currently recommends the installation of Broca traps in the field and drying yards. Trap density should follow the current Coffee Board/Department of Horticulture recommendation for the specific coffee-growing region, as advisory densities have been revised over time and may vary with infestation pressure and landscape context. As a general guide, commonly cited densities in Indian advisories range from approximately 10 to 30 traps per acre depending on the source and year; growers should confirm

the current official recommendation before large-scale installation. Trap catches should be recorded periodically to identify increasing pest activity and to guide timely management decisions.

5.4 Management during Coffee Processing and Drying

Coffee processing is an important stage in preventing carry-over and dissemination of the pest. Infested coffee should not be transported from infested to pest-free areas without appropriate treatment. Processing and transport containers should be managed carefully to prevent movement of live beetles. Coffee should be dried to the prescribed moisture level. Proper drying reduces the possibility of survival and continued development of CBB associated with stored or processed coffee.

The original article specifies approximately 10.5% moisture for Arabica/Robusta parchment and approximately 11.5% for coffee cherries. These values are broadly consistent with typical Coffee Board guidance for safe storage and processing, and current Coffee Board information should be consulted for the applicable moisture specification before field dissemination.

5.5 Biological Control Using *Beauveria bassiana*

The entomopathogenic fungus *Beauveria bassiana* is an important biological-control agent against coffee berry borer. The fungus infects the insect through contact with the cuticle, followed by fungal growth and eventual death of the insect. The effectiveness of *B. bassiana* depends strongly on environmental conditions, formulation quality, spore viability, adequate coverage of the target berries and contact between the fungal spores and exposed beetles.

Since CBB spends most of its life inside the berry, applications are most useful when adults are exposed before or during entry into the berry. Coffee Board recommendations currently emphasize spraying *B. bassiana* at the initial stage of infestation (Coffee Board of India, n.d.). Earlier Indian research also demonstrated the potential of indigenous *B. bassiana* isolates for management of CBB, with field efficacy depending on environmental conditions such as temperature and relative humidity (Uma et al., 2019; Kumar et al., 1994). Applications should be made using a formulation and dose approved or recommended by the competent agricultural authority. The spray should be directed towards coffee berries and bearing branches to maximize contact with exposed beetles. Where conditions are hot, dry, or highly exposed to ultraviolet radiation, application timing (preferably late evening) and formulation choice can influence field performance (Moreno-Ramirez et al., 2024).

FIGURE 2: Fungal pathogen *Beauveria bassiana* infecting coffee berry borer

5.6 Timing of Intervention

Timing is one of the most important factors determining the success of CBB management. The female beetle is comparatively accessible before it penetrates deeply into the bean. Once the insect has entered the bean, it is protected from many externally applied control measures. Therefore, monitoring should begin before the period of maximum berry susceptibility, and interventions should be timed according to pest activity, berry development, and local Coffee Board advisories. The original article indicates an important management window approximately 120–150 days after flowering, when the endosperm begins to harden. This window is consistent with the period during which berries become increasingly suitable for CBB attack and when exposed adults are still accessible. However, the exact timing varies with coffee type, flowering date, elevation, weather, and berry development. Consequently, calendar-based spraying alone should not replace field monitoring.

5.7 Chemical Management

Chemical insecticides, where legally registered and officially recommended for coffee berry borer, should be used strictly according to the current label and the latest recommendations of the Coffee Board/Department of Horticulture. In India, the range of insecticides registered for CBB is limited, and growers must confirm current registration status with the competent authority. Indiscriminate chemical use should be avoided, particularly where coffee is produced under organic or low-input production systems. The cryptic biology of CBB also means that insecticide application after the beetle has entered the bean is generally less effective than timely intervention against exposed adults. Therefore, chemical control, where permitted, should form only one component of an integrated pest-management programme rather than being relied upon as the sole control method. Compatibility with biological control agents should be considered when planning spray programmes.

VI. INTEGRATED MANAGEMENT STRATEGY FOR ASR DISTRICT

The emergence of coffee berry borer in ASR District highlights the need for a district-level surveillance and containment programme. The following strategy is recommended:

1) **Regular surveillance:** Conduct systematic surveys of coffee plantations, particularly around known infested locations and areas adjoining affected plantations.
2) **Early detection:** Train growers and field personnel to identify the characteristic pinhole at the navel region of the berry.
3) **Clean harvesting:** Ensure complete harvesting and avoid leaving ripe, overripe or infested berries on plants.
4) **Gleaning:** Collect fallen berries immediately after harvesting.
5) **Destruction of infested material:** Treat infested berries with hot water and dispose of them safely.
6) **Broca traps:** Install and monitor Broca traps according to current Coffee Board recommendations.
7) **Biological control:** Use quality *B. bassiana* formulations at the initial stage of infestation under suitable environmental conditions.
8) **Movement restriction:** Avoid movement of infested berries, planting material or contaminated coffee-processing materials from infested to pest-free areas.
9) **Processing hygiene:** Maintain strict sanitation around pulping, drying and storage facilities.
10) **Farmer awareness:** Conduct village-level training programmes on pest identification, sanitation, trap monitoring and biological control.
11) **Institutional coordination:** Coordinate surveillance and management activities among the Coffee Board, Department of Horticulture, tribal development agencies, agricultural universities and research stations.
12) **Record keeping:** Maintain village-wise and plantation-wise records of infestation, trap catches and management interventions.

TABLE 1

ROLES AND INDICATIVE TIMELINES FOR IMPLEMENTATION OF THE ASR DISTRICT CONTAINMENT STRATEGY

Activity	Lead agency	Supporting agencies	Indicative timeline
Surveillance and scouting	Coffee Board / Dept. of Horticulture	KVKs, research stations	Continuous; intensified pre- and post-harvest
Farmer training and awareness	Dept. of Horticulture / KVKs	Coffee Board, tribal development agencies	Pre-harvest and harvest season
Sanitation and gleaning	Growers	Cooperatives, extension staff	During and immediately after harvest
Trap installation and monitoring	Growers	Coffee Board, extension staff	From berry development to harvest
Biological control application	Growers	Extension staff, research stations	At initial infestation stage
Infested berry destruction	Growers / cooperatives	Extension staff	Immediately after collection
Processing hygiene	Growers / pulping units	Dept. of Horticulture	Throughout processing and drying
Movement regulation	Coffee Board / Dept. of Horticulture	Transport and trade stakeholders	Throughout the season
Record keeping and reporting	Coffee Board / Dept. of Horticulture	Extension staff, growers	Monthly reporting
Coordination and review	Coffee Board / Dept. of Horticulture	All partner agencies	Quarterly review meetings

Recent reports from ASR district indicate that the pest was initially detected in the Araku region in 2025 and was subsequently detected in other coffee-growing locations, emphasizing the need for continued surveillance and containment.

VII. IMPORTANCE OF INTEGRATED PEST MANAGEMENT

Integrated pest management is particularly important for coffee berry borer because of its concealed feeding habit. Cultural practices reduce the number of suitable breeding sites, trapping helps monitor and suppress dispersing adults, biological control provides an environmentally compatible intervention, and timely chemical intervention where officially permitted can provide additional suppression.

The Coffee Board of India presently lists *B. bassiana*, clean harvesting, removal of gleanings and leftover berries, proper coffee drying, and Broca traps among the important management measures for coffee berry borer. Research also indicates that biological control using entomopathogenic fungi and parasitoids has considerable potential, although field performance can vary with environmental conditions, pest behaviour and compatibility with other crop-protection practices (Johnson et al., 2020; Moreno-Ramirez et al., 2024). Classical biological control agents used in other producing regions—including the parasitoids *Cephalonomia stephanoderis*, *Prorops nasuta*, and *Phymastichus coffea*—have shown variable establishment and efficacy and are not currently part of mainstream recommendations in India (Infante et al., 2012; Vega et al., 2015). The relative emphasis on sanitation, traps, and *B. bassiana* in the Indian context reflects both practical feasibility and compatibility with smallholder and organic production systems.

VIII. CONCLUSION

Coffee berry borer is a serious threat to coffee production because it directly damages the coffee bean and remains concealed inside the berry for most of its developmental period. Its recent occurrence in Alluri Sitarama Raju district of Andhra Pradesh necessitates continuous surveillance and rapid implementation of integrated management measures. The most practical strategy for the region is based on clean and complete harvesting, removal of gleanings and leftover berries, destruction of infested

material, installation and monitoring of Broca traps, timely application of *Beauveria bassiana*, proper post-harvest drying and strict prevention of pest movement through infested coffee and contaminated materials.

For sustainable management in the tribal coffee ecosystems of ASR district, emphasis should be placed on early detection, community-level sanitation and biological control rather than dependence on repeated insecticide applications. Continued collaboration among growers, Coffee Board personnel, research institutions and extension agencies will be essential for preventing further spread and protecting the productivity and quality of Andhra Pradesh coffee.

Limitations of the Review: This is a narrative review based on Coffee Board advisories, the supplied baseline article, and selected peer-reviewed literature. A formal systematic search was not employed, and the evidence base for some management recommendations—particularly trap densities, optimal *B. bassiana* application conditions, and chemical options—is context-dependent and evolving. Longitudinal data on the newly reported ASR district infestation are limited. The recommendations presented here should therefore be adapted to local conditions and confirmed against the latest Coffee Board/Department of Horticulture advisories.

Future Research Directions: Priority research should include: (1) district-level surveillance and mapping of CBB incidence and spread; (2) field evaluation of *B. bassiana* formulations under Eastern Ghats conditions; (3) assessment of optimal trap densities and monitoring protocols; (4) evaluation of locally available biological control agents, including parasitoids; (5) quantification of yield and quality losses in ASR district coffee; and (6) integration of IPM with organic and tribal coffee production systems.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this study.

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