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Insecticide Resistance in Brinjal Shoot and Fruit Borer (BSFB), *Leucinodes orbonalis* Guenée: Status, Mechanisms and Resistance Management Strategies

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Brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenée (Lepidoptera: Crambidae), is one of the most destructive insect pests affecting brinjal (*Solanum melongena* L.) production in India and other Asian countries. The larvae bore into tender shoots, flower buds and developing fruits, resulting in considerable quantitative and qualitative yield losses. Chemical insecticides remain an important component of its management; however, their repeated and indiscriminate application has increased the risk of insecticide resistance in field populations. Resistance development reduces the effectiveness of commonly used insecticides, increases production costs and encourages excessive pesticide application. Studies conducted in India have reported considerable variation in insecticide susceptibility among geographical populations of *L. orbonalis*, including resistance to several conventional and newer insecticide molecules. The major factors contributing to resistance include continuous exposure to the same mode of action, improper pesticide application, inadequate field sanitation and insufficient integration of non-chemical management practices. This article discusses the status, possible mechanisms and contributing factors of insecticide resistance in BSFB, along with appropriate resistance management strategies. Emphasis is placed on insecticide rotation based on mode of action, field monitoring, biological control, pheromone-based approaches, removal of infested plant parts and integrated pest management (IPM). Sustainable management through scientifically planned pesticide use is essential for maintaining insecticide effectiveness, protecting beneficial organisms and ensuring long-term brinjal productivity.

Introduction

Brinjal (*Solanum melongena* L.) is an economically important vegetable crop cultivated extensively in India because of its nutritional value, adaptability and year-round market demand. However, its production is seriously affected by several insect pests, among which brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenée, is considered particularly destructive. The pest causes damage during both vegetative and reproductive stages of crop growth. Newly hatched larvae initially feed on tender plant tissues and subsequently bore into shoots, flower buds and fruits, where they remain concealed and protected from direct contact with insecticide sprays. The characteristic symptoms include drooping and drying of terminal shoots, wilting of affected branches and the presence of boreholes with frass on infested fruits. Larval feeding makes fruits unmarketable and significantly reduces their commercial quality. Because the larvae remain inside plant tissues, effective management becomes difficult once infestation is established. Farmers frequently depend on chemical insecticides to control this pest. Different insecticide groups, including organophosphates, pyrethroids, carbamates, diamides, spinosyns and avermectins, have been used for its management. However, repeated application of insecticides with similar modes of action creates strong

selection pressure, favouring the survival and multiplication of resistant individuals. Consequently, insecticide resistance has emerged as an important challenge in the sustainable management of BSFB (Shirale et al., 2017).

Concept and Development of Insecticide Resistance

Insecticide resistance refers to the inherited ability of a population of insects to survive exposure to a dose of insecticide that would normally control a susceptible population of the same species. Resistance develops through natural selection, in which individuals possessing genetic characteristics that provide greater tolerance to a pesticide survive and reproduce. In the case of *L. orbonalis*, repeated exposure to the same insecticide or insecticides having similar modes of action can gradually increase the frequency of resistant individuals within a population. Initially, the insecticide may provide satisfactory control; however, its effectiveness may decline after several generations of continuous selection. Resistance does not necessarily develop equally against all insecticides. A population may show reduced susceptibility to one insecticide group while remaining relatively susceptible to another. Cross-resistance may also occur when a single resistance mechanism provides protection against multiple insecticides, particularly those with related chemical properties or modes of action.

Status of Insecticide Resistance in BSFB

Several investigations have documented changes in insecticide susceptibility among field populations of *L. orbonalis* in India. Shirale et al. (2017) reported widespread resistance in field populations against conventional insecticides, including carbaryl, chlorpyrifos, deltamethrin, endosulfan, fenvalerate and profenofos. The reported resistance ratios varied considerably among insecticides and geographical populations, indicating the influence of differences in pesticide exposure and selection pressure. Similarly, Shirale et al. (2020) evaluated the susceptibility of Indian populations to newer insecticides, including chlorantraniliprole, flubendiamide, chlorfenapyr, indoxacarb and spinosad. The study demonstrated geographical variation in susceptibility, providing useful baseline information for insecticide resistance monitoring. More recent evidence from Odisha is particularly relevant. Pasayat and Tripathy (2026) investigated insecticide application patterns and resistance development in field populations of *L. orbonalis*. Their bioassay results indicated resistance ratios of 31.46–38.34-fold against thiodicarb, 14.21–17.01-fold against indoxacarb and 11.00–19.82-fold against spinosad compared with a susceptible laboratory population. These findings highlight the importance of regular susceptibility monitoring and scientifically planned insecticide application in brinjal-growing regions. Such observations indicate that the effectiveness of insecticides should not be assumed to remain constant across locations and cropping seasons. Resistance monitoring is therefore necessary to identify changes in susceptibility and guide appropriate pest management decisions.

Major Mechanisms of Insecticide Resistance

Insecticide resistance in insect pests generally develops through several physiological, biochemical and genetic mechanisms. These mechanisms may operate individually or simultaneously within a population.

Metabolic Resistance

Metabolic resistance occurs when insects develop an enhanced capacity to detoxify or metabolize insecticides before these chemicals can reach their target sites. Important enzyme systems involved in this process include cytochrome P450 monooxygenases, glutathione-S-transferases (GSTs) and carboxylesterases. Increased activity or expression of these enzymes may reduce the toxic effects of insecticides and contribute to resistance development.

Target-Site Resistance

Target-site resistance occurs when genetic changes alter the insecticide's specific binding site within the insect body. Such modifications may reduce insecticide binding and decrease its effectiveness. Mutations affecting sodium channels, acetylcholinesterase and other insecticide

target proteins are established resistance mechanisms in insects. However, the contribution of individual target-site mutations in particular BSFB populations requires specific molecular investigation.

Reduced Penetration

Changes in the insect cuticle may reduce the rate at which insecticides enter the insect body. This mechanism can delay the absorption of toxic compounds and may contribute to resistance, particularly when it operates together with metabolic detoxification.

Behavioural Resistance

Behavioural resistance involves changes in insect behaviour that reduce contact with insecticide-treated surfaces. Insects may avoid treated plant parts or alter their feeding and resting behaviour, thereby reducing pesticide exposure. Such avoidance can contribute to reduced field-level control.

Factors Responsible for Resistance Development

Several agricultural and biological factors contribute to the development of insecticide resistance in BSFB. Continuous use of the same insecticide or repeated application of products belonging to the same mode-of-action group is a major contributing factor. Excessive spraying, inappropriate concentrations, unnecessary tank mixtures and applications without considering pest population levels can increase selection pressure. The concealed feeding habit of BSFB larvae also complicates management. Once larvae enter shoots and fruits, they are less exposed to insecticide deposits. Inadequate spray coverage and applications at inappropriate crop stages may therefore result in poor control and repeated pesticide use. Furthermore, the availability of continuous host plants, overlapping crop cultivation and inadequate removal of infested plant materials can support pest survival and population multiplication. These factors, together with insufficient monitoring and poor awareness of insecticide mode-of-action groups, can accelerate resistance development.

Strategies for Insecticide Resistance Management

Rotation of Insecticides Based on Mode of Action

Rotation of insecticides with different modes of action is one of the most important approaches for delaying resistance development. Insecticides should be selected according to their mode-of-action classification rather than merely changing their commercial brand names. Repeated application of different products belonging to the same mode-of-action group may continue to exert similar selection pressure. The Insecticide Resistance Action Committee (IRAC) classification can help farmers and agricultural professionals identify appropriate insecticide groups for resistance management. Rotation should follow approved product labels, recommended application intervals and local agricultural advisories.

Judicious and Need-Based Application

Insecticides should be applied only when monitoring indicates that intervention is necessary. Regular field inspection, identification of early infestation and assessment of pest incidence can help avoid unnecessary spraying. Application timing, recommended dosage, spray coverage and weather conditions should be considered carefully.

Field Sanitation and Mechanical Management

Regular removal and destruction of infested shoots and fruits is an important non-chemical management practice. Such plant materials should be collected frequently and disposed of safely to prevent larvae from completing their development. Field sanitation reduces the carry-over population and helps decrease dependence on insecticides.

Biological Control

Conservation and utilization of natural enemies can strengthen sustainable BSFB management. Egg parasitoids such as *Trichogramma* species and suitable microbial biopesticides based on *Bacillus thuringiensis* may contribute to pest suppression when used appropriately. Conservation of predators and parasitoids through selective pesticide use is also essential for maintaining ecological balance.

Pheromone-Based Management

Sex pheromone traps can be used for monitoring adult male populations and supporting mass-trapping strategies. Pheromone-based approaches help assess pest activity and provide information for timely management decisions. Their integration with field sanitation and other IPM practices can reduce reliance on repeated chemical applications.

Integrated Pest Management

Integrated pest management combines cultural, mechanical, biological and chemical methods to maintain pest populations below economically damaging levels. For BSFB, an effective IPM programme should include regular field monitoring, removal of infested plant parts, pheromone trapping, conservation of natural enemies and need-based insecticide application. This integrated approach can reduce selection pressure and improve the long-term sustainability of pest management.

Future Perspectives and Research Priorities

Future research on insecticide resistance in *L. orbonalis* should focus on regular monitoring of field populations across major brinjal-growing regions. Laboratory bioassays, biochemical investigations and molecular characterization can help identify the mechanisms responsible for reduced insecticide susceptibility. The development of geographically representative baseline susceptibility data is particularly important for detecting early changes in resistance. Further investigations should evaluate the role of detoxification enzymes, target-site mutations and possible cross-resistance among insecticide groups. In addition, greater emphasis should be placed on farmer awareness programmes, scientific pesticide-use practices and the adoption of IPM technologies. Digital pest surveillance, decision-support systems and improved pheromone-based monitoring may also contribute to timely and sustainable management.

Conclusion

Insecticide resistance in brinjal shoot and fruit borer, *Leucinodes orbonalis*, is an important challenge affecting the effectiveness and sustainability of brinjal pest management. Repeated and indiscriminate use of insecticides, particularly those with similar modes of action, can accelerate the selection of resistant individuals and reduce field-level control. Research findings from different parts of India, including recent observations from Odisha, emphasize the need for continuous insecticide susceptibility monitoring. Sustainable management requires a shift from routine pesticide application towards scientifically planned and integrated pest management. Rotation of insecticides based on their modes of action, need-based spraying, field sanitation, pheromone monitoring and conservation of natural enemies should be prioritized. Combining these approaches with biochemical and molecular resistance studies will help develop more effective management strategies. Ultimately, responsible insecticide use and coordinated IPM practices are essential for delaying resistance development, maintaining pesticide effectiveness and ensuring sustainable brinjal production.

References

1. Pasayat, B., and Tripathy, M. K. (2026). Insecticide application trends and resistance development in *Leucinodes orbonalis* Guenée in brinjal shoot and fruit borer. *Indian Journal of Entomology*, 88(2), 459–463. https://doi.org/10.55446/IJE.2025.2613
2. Saha, T., and Chandran, N. (2021). Comparative study of insecticide resistance management strategies against brinjal shoot and fruit borer (*Leucinodes orbonalis*) (Lepidoptera: Crambidae). *The Indian Journal of Agricultural Sciences*, 91(9), 1311–1315. https://doi.org/10.56093/ijas.v91i9.116076
3. Shirale, D., Patil, M., and Parimi, S. (2017). Insecticide resistance in field populations of *Leucinodes orbonalis* (Lepidoptera: Crambidae) in India. *The Canadian Entomologist*. https://doi.org/10.4039/tce.2017.13

4. Shirale, D., Patil, M., and Parimi, S. (2020). Geographic susceptibility study of newer insecticides to Indian populations of *Leucinodes orbonalis*. *Indian Journal of Plant Protection*, 44(4).
5. Niranjana, R. F., et al. (2018). Efficacy of insecticides for the management of brinjal shoot and fruit borer, *Leucinodes orbonalis*. *Indian Journal of Plant Protection*, 46(1).
6. Saha, T., and Chandran, N. (2021). Comparative study of insecticide resistance management strategies against brinjal shoot and fruit borer. *The Indian Journal of Agricultural Sciences*, 91(9), 1311–1315.