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Bt Brinjal: India's First Genetically Engineered Food Crop

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Brinjal (*Solanum melongena L.*) is one of the most important vegetable crops cultivated in India and many Asian countries. However, its production is severely affected by the shoot and fruit borer (*Leucinodes orbonalis*), a destructive insect pest responsible for major yield losses and extensive pesticide use. Conventional pest management relies heavily on repeated insecticide applications, leading to environmental and health concerns. Biotechnology has provided an alternative approach through the development of Bt brinjal, India's first genetically engineered food crop. Bt brinjal was developed by introducing the Cry1Ac gene from *Bacillus thuringiensis*, enabling the plant to produce insecticidal proteins that specifically target the shoot and fruit borer. This article highlights the importance of brinjal cultivation, the challenges posed by insect pests, the mechanism of Bt technology, development of Bt brinjal, its benefits and concerns, and future prospects of biotechnology-based pest management in horticultural crops.

Keywords: Bt brinjal; Genetic engineering; Cry1Ac; Shoot and fruit borer; Biotechnology; Pest resistance

Introduction

Brinjal (*Solanum melongena L.*), also known as eggplant or aubergine, is one of the most widely cultivated vegetable crops in India. It is valued for its nutritional importance, culinary versatility and economic significance. India is considered one of the major centres of brinjal diversity and cultivation. The crop is rich in vitamins, minerals, dietary fibre and antioxidants, making it an important component of daily diets. Despite its importance, brinjal cultivation faces severe challenges due to insect pests and diseases. Among these, the shoot and fruit borer (*Leucinodes orbonalis*) is regarded as the most destructive pest affecting brinjal production. The larvae bore into shoots and fruits, causing direct damage, reduced market quality and significant yield losses. Farmers often depend on repeated pesticide sprays for pest management, sometimes applying insecticides several times a week during the cropping season. Excessive pesticide use increases production costs and creates environmental and health-related concerns. To overcome these limitations, biotechnology has been used to develop insect-resistant brinjal varieties. Bt brinjal was developed by introducing insecticidal genes from *Bacillus thuringiensis* into brinjal plants. This innovation represented a major milestone in agricultural biotechnology and sustainable pest management.

Major Pests in Brinjal

Brinjal is attacked by several insect pests throughout its growth period. Important pests include aphids, whiteflies, jassids and mites. However, the shoot and fruit borer (*Leucinodes orbonalis*) is considered the most serious pest due to the extensive crop damage it causes. The

larvae initially bore into tender shoots, resulting in wilting and drying of young branches. During the fruiting stage, larvae enter developing fruits and feed internally, making the produce unmarketable. Since the larvae remain protected inside plant tissues, chemical insecticides often fail to provide effective control. Yield losses caused by shoot and fruit borer may range from 50–70% under severe infestation conditions. The dependence on chemical pesticides for pest management has raised concerns regarding pesticide residues, environmental pollution and risks to farmer health. Therefore, the development of sustainable and environmentally friendly pest management strategies became essential.

Bt Technology

Bt technology is based on the use of insecticidal proteins produced by the soil bacterium *Bacillus thuringiensis*. This bacterium naturally produces Cry proteins that are toxic to specific groups of insect pests. Scientists identified the Cry1Ac gene responsible for producing insecticidal proteins effective against lepidopteran insects such as the shoot and fruit borer. Using genetic engineering techniques, the Cry1Ac gene was introduced into the brinjal genome through *Agrobacterium*-mediated transformation. The transformed plants gained the ability to produce Cry proteins in their tissues. When larvae of *Leucinodes orbonalis* feed on Bt brinjal plants, the Cry proteins bind to receptors present in the insect gut. This damages the gut lining, disrupts digestion and eventually causes larval death. As a result, the crop becomes resistant to the target pest and requires fewer pesticide applications.

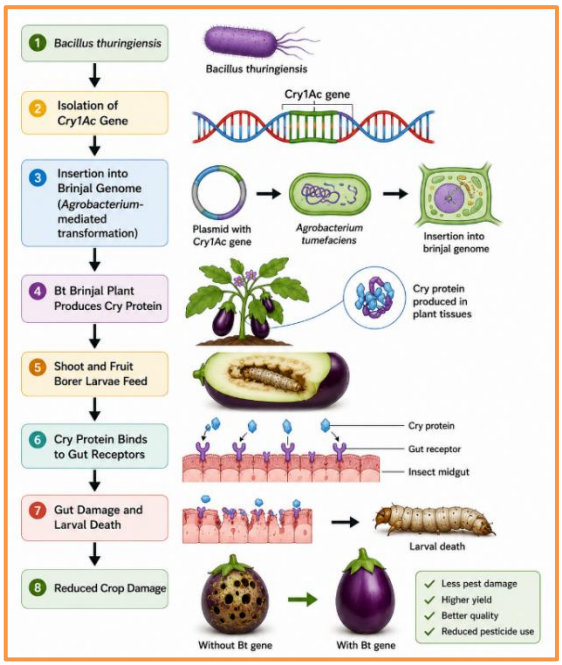

Figure 1. Mechanism of Bt Gene-Mediated Insect Resistance in Brinjal

Development of Bt Brinjal

Bt brinjal was developed through genetic engineering approaches aimed at controlling the shoot and fruit borer. The Cry1Ac gene from *Bacillus thuringiensis* was inserted into brinjal varieties using transformation techniques. The genetically modified plants were then evaluated for insect resistance, agronomic performance and biosafety. The development of Bt brinjal involved collaborations among biotechnology companies and research institutions. It became India's first genetically engineered food crop developed for commercial cultivation. Field evaluations demonstrated effective resistance against shoot and fruit borer, significantly reducing pest damage and pesticide use. Bt brinjal represented an important advancement in horticultural biotechnology because it demonstrated how genetic engineering could be used for sustainable crop protection and improved agricultural productivity.

Table 1. Advantages and Concerns Associated with Bt Brinjal

Advantages	Concerns
Reduced pesticide use	Biosafety concerns
Effective pest control	Public acceptance issues
Increased crop yield	Regulatory challenges
Better fruit quality	Risk of insect resistance
Lower production cost	Environmental concerns
Reduced pesticide residues	Debate on GM food safety

Benefits and Concerns of Bt Brinjal

Bt brinjal offers several advantages for farmers and the environment. One of the major benefits is the reduction in pesticide applications required for controlling shoot and fruit

borer. Reduced pesticide use lowers production costs and decreases pesticide exposure among farmers and consumers. Bt brinjal also improves fruit quality and increases marketable yield by protecting fruits from insect damage. Environmental benefits include reduced contamination of soil and water due to lower insecticide use. The technology also supports sustainable agriculture by integrating biotechnology-based pest management strategies. Despite these advantages, Bt brinjal has generated debates related to biosafety, environmental impact and consumer acceptance. Concerns have been raised regarding the long-term ecological effects of genetically modified crops and the possibility of insects developing resistance to Bt toxins. Public perception and regulatory policies continue to influence the adoption and commercialization of genetically engineered crops in several countries.

Future Prospects

Advances in biotechnology are expected to further improve pest management strategies in horticultural crops. Modern genome editing technologies such as CRISPR-Cas systems provide opportunities for precise modification of crop genomes without introducing foreign DNA. RNA interference (RNAi)-based technologies are also being explored for targeted insect control. Future research may focus on developing brinjal varieties with multiple stress resistance traits, including resistance against insects, diseases and environmental stresses. Biotechnology combined with integrated pest management practices can contribute significantly to sustainable vegetable production and food security.

Conclusion

Bt brinjal represents a major milestone in agricultural biotechnology and sustainable pest management. The introduction of the Cry1Ac gene enabled effective resistance against shoot and fruit borer, reducing dependence on chemical insecticides and improving crop productivity. Although concerns regarding biosafety and public acceptance remain important, biotechnology offers valuable opportunities for developing environmentally sustainable horticultural crops. Continued scientific research, proper regulatory evaluation and public awareness will play important roles in shaping the future of genetically engineered crops in agriculture.

References

1. Shelton, A. M., et al. (2009). The development and status of Bt brinjal. *Plant Biotechnology Journal*, 7, 1–12.
2. Choudhary, B., & Gaur, K. (2009). *The Development and Regulation of Bt Brinjal in India*. ISAAA Briefs.
3. Romeis, J., et al. (2008). Integration of insect-resistant genetically modified crops within IPM programs. *Annual Review of Entomology*, 53, 103–126.
4. Kumar, S., et al. (2011). Management of shoot and fruit borer in brinjal. *Indian Journal of Agricultural Sciences*, 81, 1082–1087.
5. Qaim, M. (2020). Role of genetically modified crops in sustainable agriculture. *Food Security*, 12, 503–519.