Volume 4, Issue 6
June I 2026

Agri Roots
e- Magazine

www.agrirootsmagazine.in

ISSN: 2583-9071

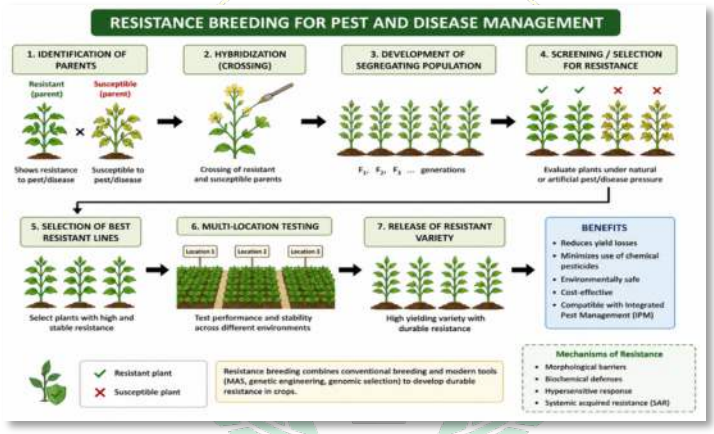
Resistance Breeding for Pest and Disease Management

ARTICLE ID: 0389

Raushan Kumar Paswan

Student, School of Agriculture and Environmental Science, Shobhit University, Meerut

Agricultural crops are continuously exposed to a wide variety of pests and pathogens, which cause major yield losses across the world. Traditionally, farmers have relied on chemical pesticides to manage these problems. However, excessive use of these chemicals has led to environmental pollution, the development of resistance in pests, and serious health risks. In this context, resistance breeding has emerged as a reliable and sustainable alternative, as it focuses on developing crop varieties that can naturally withstand biotic stresses (Agrios, 2005).



Concept of Resistance Breeding

Resistance breeding involves developing crop varieties that have heritable traits enabling them to resist or tolerate pests and diseases. These resistance traits may come from natural genetic variation or may be introduced through breeding methods and modern biotechnological approaches (Allard, 1999).

Types of Resistance

Vertical Resistance

Vertical resistance is controlled by one or a few major genes and provides a high level of protection against specific pathogen races. However, this type of resistance is often short-lived because pathogens can quickly evolve and overcome it (Flor, 1971).

Horizontal Resistance

Horizontal resistance is governed by many genes and offers partial but long-lasting resistance against a wide range of pathogen strains. It is generally more stable and durable over time (Van der Plank, 1963).

Mechanisms of Resistance

Plants show resistance through different mechanisms, such as:

- Morphological barriers like thick cuticles and trichomes that prevent pest entry
- Biochemical defenses involving the production of phenols, alkaloids, and enzymes that are harmful to pathogens
- Hypersensitive response, where infected cells die quickly to stop the spread of pathogens

- Systemic acquired resistance (SAR), which strengthens the overall defense system of the plant (Agrios, 2005)

Methods of Resistance Breeding

Conventional Breeding

Traditional methods include selection, hybridization, and backcrossing to transfer resistance genes from donor plants to high-yielding varieties (Allard, 1999).

Mutation Breeding

This method involves inducing mutations using radiation or chemicals to create genetic variation, from which resistant plants can be selected.

Marker-Assisted Selection (MAS)

MAS uses molecular markers linked to resistance genes, making the breeding process faster and more precise (Collard & Mackill, 2008).

Genetic Engineering

Genetic engineering allows the introduction of specific resistance genes directly into crops. For example, Bt crops produce insecticidal proteins from *Bacillus thuringiensis*, which protect them from insect pests (James, 2017).

Advantages of Resistance Breeding

- Reduces the use of chemical pesticides
- Environmentally safe and sustainable
- Cost-effective over the long term
- Works well with Integrated Pest Management (IPM) strategies

Limitations

- It is a time-consuming process
- Resistance can break down due to pathogen evolution
- Limited availability of resistance genes in some crops

Future Prospects

Recent advancements in genomics, gene editing technologies like CRISPR-Cas9, and genomic selection are transforming resistance breeding. These innovations allow precise modification of genes and help in developing durable resistant crop varieties more quickly (Borrelli et al., 2018).

Conclusion

Resistance breeding is an important approach for sustainable pest and disease management. By combining traditional breeding techniques with modern biotechnological tools, it is possible to develop crop varieties with long-lasting resistance, ensuring both food security and environmental safety.

References

1. Agrios, G. N. (2005). *Plant Pathology* (5th ed.). Academic Press.
2. Allard, R. W. (1999). *Principles of Plant Breeding* (2nd ed.). John Wiley & Sons.
3. Borrelli, V. M. G., Brambilla, V., Rogowsky, P., Marocco, A., & Lanubile, A. (2018). The enhancement of plant disease resistance using CRISPR/Cas9 technology. *Frontiers in Plant Science*, 9, 1245.
4. Collard, B. C. Y., & Mackill, D. J. (2008). Marker-assisted selection: An approach for precision plant breeding. *Philosophical Transactions of the Royal Society B*, 363(1491), 557–572.

5. FAO (Food and Agriculture Organization). (2019). *Integrated Pest Management Guidelines*. FAO Publications.
6. Flor, H. H. (1971). Current status of the gene-for-gene concept. *Annual Review of Phytopathology*, 9, 275–296.
7. James, C. (2017). Global status of commercialized biotech/GM crops. *ISAAA Brief No. 53*. International Service for the Acquisition of Agri-biotech Applications.
8. Singh, B. D. (2015). *Plant Breeding: Principles and Methods*. Kalyani Publishers.
9. Van der Plank, J. E. (1963). *Plant Diseases: Epidemics and Control*. Academic Press.