OPEN ACCESS Freely available online

Journal of Plant Biochemistry & Physiology

Perspective

Responses to Biotic Stresses

Wilton Mathew*

Department of Botany, University of Nairobi, Nairobi, Kenya

INTRODUCTION

Biotic stresses refer to challenges posed to plants by living organisms, including pathogens (such as bacteria, fungi, viruses, and nematodes) and herbivores (including insects and other animals). Plants have evolved complex defense mechanisms to detect, respond to, and mitigate the impact of these biotic stressors. Understanding these responses is crucial for developing strategies to enhance plant resistance and improve agricultural productivity sustainably.

DESCRIPTION

Recognition and signaling

Plants possess sophisticated mechanisms to recognize and distinguish between beneficial microbes, harmless organisms, and potential threats like pathogens or herbivores. They employ Pattern Recognition Receptors (PRRs) that detect conserved molecular patterns, such as Pathogen-Associated Molecular Patterns (PAMPs), triggering a basal immune response known as Pamp-Triggered Immunity (PTI). This initial response involves the activation of defense-related genes, production of antimicrobial compounds, and reinforcement of cell walls to hinder pathogen entry.

Effector-Triggered Immunity (ETI)

Upon encountering virulent pathogens, plants can activate a more specific and robust defense mechanism called Effector-Triggered Immunity (ETI). ETI is initiated when plant Resistance (R) proteins recognize pathogen effectors-molecules secreted by pathogens to suppress host defenses or manipulate cellular processes. R proteins activate downstream signaling cascades that amplify defense responses, often leading to localized cell death (hypersensitive response) at the infection site to restrict pathogen spread.

Induced Systemic Resistance (ISR)

Plants can also induce systemic resistance against pathogens following localized infections or exposure to beneficial microbes. This phenomenon, known as Induced Systemic Resistance (ISR), involves the activation of defense pathways in tissues distal to the initial infection site. ISR is mediated by signaling molecules such as salicylic acid, jasmonic acid, and ethylene, which orchestrate broad-spectrum defenses and prime the plant's immune system for enhanced responsiveness to subsequent attacks.

Chemical defenses and secondary metabolites

Plants produce a diverse array of secondary metabolites, including phytoalexins, terpenoids, phenolics, and alkaloids, which serve as chemical defenses against pathogens and herbivores. These compounds often possess antimicrobial properties, deter feeding by herbivores, and can act as signaling molecules in defense signaling pathways. For instance, glucosinolates in cruciferous plants and alkaloids in Solanaceae contribute to their resistance against herbivores and pathogens.

Mechanical barriers and physical responses

Plants employ various physical barriers and structural adaptations to deter herbivores and limit pathogen ingress. These include thickened cuticles, trichomes (leaf hairs), and thorns that impede herbivore feeding and egg-laying. Some plants produce resinous exudates or latex that trap and repel herbivores or pathogens, while others form lignified barriers to wall off infected tissues and prevent pathogen spread.

Symbiotic interactions

Certain plants engage in beneficial symbiotic relationships with microorganisms, such as mycorrhizal fungi and rhizobia. These symbioses not only enhance nutrient uptake and tolerance to abiotic stresses but also contribute to plant defense against pathogens. Mycorrhizal fungi can induce systemic resistance and prime plant defenses, while rhizobia facilitate nitrogen fixation and improve plant health and productivity.

Genetic resistance and breeding

Breeding for genetic resistance is a cornerstone of sustainable crop protection strategies. Identifying and deploying plant varieties with natural or engineered resistance traits against

Correspondence to: Wilton Mathew, Department of Botany, University of Nairobi, Nairobi, Kenya; Email: wiltonM@go.ke

Received: 24-Jun-2024, Manuscript No. JPBP-24-32297; **Editor assigned:** 27-Jun-2024, PreQC No. JPBP-24-32297 (PQ); **Reviewed:** 11-Jul-2024, QC No. JPBP-24-32297; **Revised:** 11-Aug-2025, Manuscript No. JPBP-24-32297 (R); **Published:** 18-Aug-2025, DOI: 10.35248/2329-9029.25.13.368

Citation: Mathew W (2025) Responses to Biotic Stresses. J Plant Biochem Physiol. 13:368.

specific pathogens or pests can reduce reliance on chemical pesticides and minimize yield losses. Modern molecular techniques, including genome editing and marker-assisted selection, expedite the breeding of resistant cultivars tailored to local environmental conditions and production challenges.

CONCLUSION

Plants have evolved an intricate array of defense mechanisms to combat biotic stresses posed by pathogens and herbivores. These responses involve complex signaling pathways, activation of immune defenses, production of antimicrobial compounds, and physical adaptations. Understanding and harnessing these defense mechanisms through integrated pest management strategies, breeding for genetic resistance, and enhancing beneficial interactions offer promising avenues to enhance agricultural sustainability and food security in the face of evolving biotic challenges. This ongoing evolution underscores the need for continuous adaptation and innovation in agricultural practices to mitigate the impact of biotic stresses on crop yield and quality.