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THE EFFECT OF PHYTOHORMONES ON PLANT GROWTH AND DEVELOPMENT

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Abstract:

The article describes in detail the effect of phytohormones on plant growth and development and its advantages, their environmental safety in the production of agricultural products, the ability to reduce energy consumption per unit of product, improve food quality, and the activity of phytohormones on plants.

Keywords: Auxin, Abscisic acid, gibberellins and cytokinins, nanopesticides.

Introduction

Plant growth and development is a complex biological process that depends on many internal and external factors. One of the internal factors is phytohormones, i.e. biologically active substances that are naturally produced in plants. Phytohormones regulate the division, differentiation, growth and response of plant cells to stress. At the same time, plant hormones are biochemical substances that increase the development and economic efficiency of plants in various situations, such as stress, and also regulate the plant.

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When phytohormones are given to plants or their seeds, their morpho-physiological properties improve, increasing stress resistance, as well as strengthening the immune system and increasing resistance to various diseases. As a result, they are used in agriculture to improve yield and quality and to overcome biotic and abiotic stresses by maintaining a delicate balance between metabolism.[1]

The main types include gibberellins, cytokinins, auxins, abscisic acid, ethylene, and brassinosteroids. Each phytohormone has its own unique effect on the plant, and they interact with each other to coordinate growth and development processes.

Objectives

In recent years, climate change has led to significant ecological changes and is increasingly placing greater demands on agricultural systems worldwide. As a result, environmental conditions, abiotic and biotic stresses have intensified their impact on plants, significantly hindering their growth and development and reducing yields. Innovative and effective strategies for sustainable agriculture are needed to address these challenges.

Among new technologies, nanotechnology has attracted great interest due to its transformative potential in agriculture. The application of nanoscale materials, including nanopesticides, nanofungicides, nanofertilizers and nanoherbicides, offers promising avenues for enhancing crop protection and increasing yields. Nanoparticles have unique physicochemical properties that enable precise and targeted delivery of nutrients and protective agents, thereby increasing crop quality and yield under various stress conditions.

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Phytohormone signaling pathways are one of the complex biochemical processes that allow plant hormones to regulate growth, development, and stress responses by transmitting and amplifying specific molecular signals.

Current research suggests that modulating phytohormone signaling pathways can reduce stress-induced damage in plants. However, the complex mechanisms of interaction between phytohormone biosynthesis and expression are still not fully understood. In addition, their role in plant pathology, especially in disease detection and management, is being studied. It also highlights new evidence on the effects of phytohormone signaling pathways, which are crucial for enhancing plant resilience and productivity in stress-prone environments. Thus, phytohormones are of great importance for mitigating stress-related problems and increasing crop yields. A deeper understanding of phytohormone interactions is essential for developing safe and effective technological strategies for the development of promising agricultural products.[2]

Plant hormonal pathways offer opportunities to address pressing global challenges such as food security, climate change, and environmental degradation. By precisely modifying hormonal signaling networks involving abscisic acid, gibberellins, and cytokinins, crops can be engineered to increase tolerance to abiotic stresses, optimize growth, and reduce dependence on chemicals. In addition to agricultural productivity, these modifications can also be used to enhance ecosystem services, including carbon sequestration and nutrient cycling, thereby exploring the importance of long-term monitoring, stakeholder engagement, and adaptive regulatory systems in improving crop productivity in both agricultural and natural ecosystems.[3]

Indeed, new discoveries have been made in the field of plant hormone biology regarding hormone biosynthesis, transport, uptake, and response. That is,

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receptors for many hormones have been identified, which opens up new opportunities for studying the chemical specificity of hormone signaling. Phytohormones cytokinins play diverse roles in plant development and affect many agriculturally important processes, such as growth, nutrient response, and response to biotic and abiotic stresses.

Cytokinin levels in plants are regulated by biosynthesis and inactivation pathways. Cytokinins are sensed by membrane-located histidine kinase receptors and are transduced via His-Asp phosphorelay to activate a family of transcription factors in the nucleus.

Among the phytohormones, auxins, in particular indole-3-oxyl acid (IAA), are used as major growth regulators in plants. The main functions of this phytohormone are: stimulation of cell elongation, formation of adventitious roots and lateral roots, and control of phototropism and gravitropism.

Auxins often interact with cytokinins; for example, the ratio of auxin to cytokinin in roots and stems determines the growth pattern.

Summary

Phytohormones play a central role in plant growth and development. Although the effects of each hormone are unique, their interactions coordinate the processes of growth and development.

Cytokinins regulate gene expression and metabolic processes, auxins promote elongation and root development, gibberellins regulate growth and seed development, stress response, ethylene regulates fruit pre-ripening and stress response, and brassinosteroids regulate cell division and stress tolerance. Thus, phytohormones together provide a balanced and flexible control system for all plant organs and processes

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