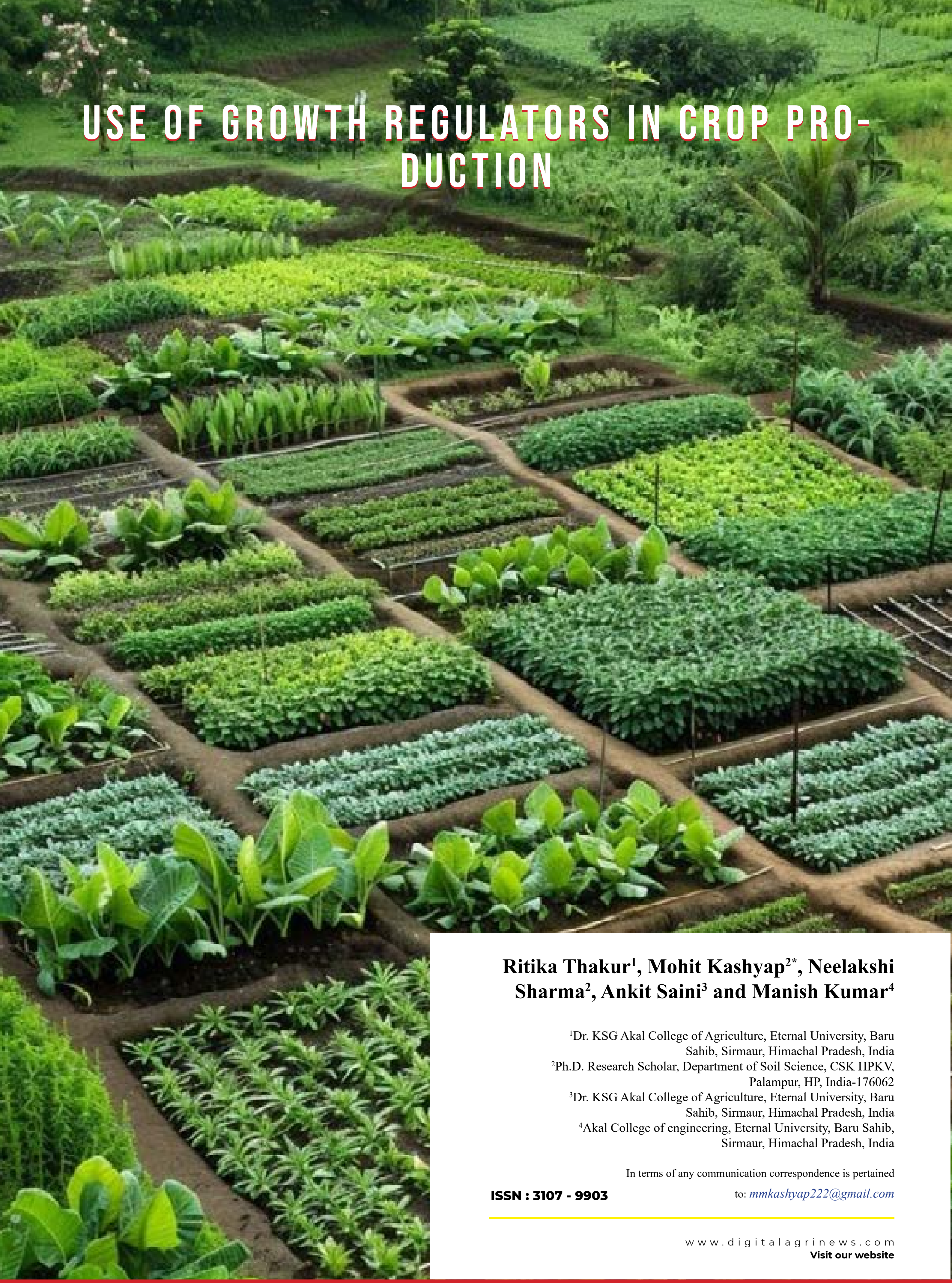

USE OF GROWTH REGULATORS IN CROP PRODUCTION

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Abstract

Plant growth regulators (PGRs) are organic compounds, other than nutrients, that influence physiological processes at low concentrations in plants. Their application in crop production has revolutionized agricultural practices by improving yield, enhancing crop quality, and managing plant growth under stress conditions. This article reviews the types, mechanisms, and applications of growth regulators in various crops and discusses their role in sustainable agriculture. The potential benefits and limitations associated with their use are also highlighted to provide comprehensive insights for researchers, agronomists, and farmers.

Keywords: Growth regulators, crop production, plant hormones, yield improvement and sustainable agriculture.

Introduction

Plant growth regulators (PGRs) play a vital role in regulating plant physiological and biochemical processes such as cell division, cell elongation, flowering, fruiting, seed germination, ripening, and senescence. These compounds, naturally produced within plants or synthetically manufactured, function in very small concentrations and significantly influence plant growth and development (Taiz and Zeiger, 2010). In modern agriculture, PGRs have emerged as important tools for improving crop productivity, maintaining quality, and enhancing stress tolerance under changing environmental conditions. With the rapid increase in global population and the growing demand for food, sustainable intensification of agriculture has become essential. However, climate variability, soil degradation, irregular rainfall patterns, temperature fluctuations, and increasing biotic and abiotic stresses have severely affected crop productivity and agricultural sustainability (Davies, 2010). Under such conditions, the application of plant growth regulators provides an effective approach for optimizing plant growth and ensuring stable yields. PGRs improve physiological efficiency by regulating nutrient uptake, photosynthesis, flowering behavior, fruit setting, and stress-responsive mechanisms in plants. Different classes of plant growth regulators including auxins, gibberellins, cytokinins, ethylene, and abscisic acid influence specific developmental processes and contribute to improved crop performance. Auxins are mainly associated with root initiation and cell elongation, while gibberellins promote stem elongation and seed germination. Cytokinins delay senescence and enhance cell division, whereas ethylene regulates fruit ripening and abscisic acid plays a crucial role in stress management and stomatal regulation (Davies, 2010). The balanced application of these regulators helps improve crop architecture, nutrient utilization efficiency, flowering synchronization, and overall productivity. Furthermore, the use of PGRs has gained importance in horticultural and field crops for improving yield quality, shelf life, and resistance against environmental stresses. Their role in mitigating drought, salinity, heat stress, and nutrient imbalance has become increasingly significant under climate change scenarios. However, excessive or improper application may adversely affect plant metabolism and environmental safety, emphasizing the need for scientific and judicious use of these compounds. Therefore, understanding the mechanisms, applications, and agronomic importance of plant growth regulators is essential for achieving sustainable crop production and food security. This article highlights the major types, physiological functions, and practical applications of PGRs in modern agriculture along with their potential benefits and limitations in crop production systems.

Types of Growth Regulators

Growth regulators are classified into five major groups based on their functions and chemical nature:

1. **Auxins:** Promote cell elongation, root initiation, and differentiation. Commonly used for fruit setting and weed control.

2. **Gibberellins:** Stimulate stem elongation, seed germination, and flowering. Used to increase fruit size and break seed dormancy.

3. **Cytokinins:** Promote cell division and delay leaf senescence. Useful in tissue culture and enhancing grain yield.

4. **Ethylene:** Involved in fruit ripening and leaf abscission. Applied to synchronize fruit ripening and induce flowering in some crops.

5. **Abscisic acid (ABA):** Regulates stress responses and stomatal closure, helping plants tolerate drought conditions.

Mechanism of Action

Growth regulators act by interacting with specific receptors in plant cells, triggering a cascade of biochemical and molecular responses that alter gene expression and enzyme activities. This results in modified physiological outcomes, such as enhanced growth or improved stress resistance. Regulation is highly concentration-dependent, and the timing of application is critical to achieving desired results (Taiz and Zeiger, 2010).

Applications in Crop Production

1. **Improving Crop Yield:** Auxins and cytokinins, when applied exogenously, stimulate flowering, fruit development, and grain filling, leading to increased yield. For example, gibberellins are widely used in grapes to enhance berry size.

2. **Controlling Plant Growth:** Plant height can be regulated by growth retardants, a class of PGRs that inhibit gibberellin biosynthesis. This leads to sturdy and lodging-resistant

crops such as cereals.

3. **Enhancing Stress Tolerance:** ABA and some cytokinins improve plant tolerance to drought, salinity, and cold by regulating stomatal closure and antioxidant activities.

4. **Seed Germination and Dormancy:** Gibberellins break seed dormancy and promote uniform germination, which is critical for crop establishment.

5. **Fruit Ripening and Quality:** Ethylene is used commercially to synchronize the ripening of fruits like tomatoes and bananas, improving marketability and post-harvest life.

Advantages and Limitations

The use of growth regulators in agriculture offers numerous benefits, including improved yield, better crop quality, and efficient resource use. They can reduce the need for chemical inputs and enhance sustainable farming practices. However, challenges remain, such as the correct dosage, risk of phytotoxicity, environmental persistence, and variable effectiveness under field conditions. Integrated management practices and continued research are essential for optimizing the use of PGRs.

Conclusion

Growth regulators are indispensable tools in crop production, offering diverse applications to manipulate plant growth and development effectively. Their strategic use can significantly contribute to achieving food security and sustainable agriculture goals. Future developments in biotechnology and molecular biology are expected to unlock new potentials for growth regulators, paving the way for precision agriculture.

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