



# AGRI MAGAZINE

(International E-Magazine for Agricultural Articles)

Volume: 03, Issue: 04 (April, 2026)

Available online at <http://www.agrimagazine.in>

© Agri Magazine, ISSN: 3048-8656

## Role of Plant Growth Regulators in Enhancing Sustainability of Crop Production

\*Dammu Harika and Santhosh Korav

Department of Agronomy, School of Agriculture, Lovely Professional University  
(Phagwara), Jalandhar-144411, Punjab, India

\*Corresponding Author's email: [harikadammu2@gmail.com](mailto:harikadammu2@gmail.com)

Sustainable crop production is essential to meet the increasing food demand of the growing global population while protecting natural resources. Plant growth Regulators (PGRs) are organic compounds that influence plant physiological processes even at very low concentrations. they regulate plant growth, development, flowering, fruiting, and stress tolerance. The Application of plant growth regulators such as Auxins, Gibberellins, Cytokinins, Ethylene, and abscisic acid play a significant role in improving crop productivity and sustainability. These regulators help in enhancing nutrient uptake, improving stress resistance, increasing yield, and maintaining crop quality. The proper use of plant growth regulators can reduce the dependency on excessive fertilizer and pesticides, thereby supporting environmentally sustainable Agriculture. This article discusses the role of plant growth regulators in improving crop growth, yield, and sustainability in agriculture production systems.

**Key words:** Plant growth Regulators, Sustainable Crop Production, Plant Hormones, Nutrient Use Efficiency, Stress tolerance, Agriculture Sustainability.

### Introduction

Agriculture today faces major challenges such as climate change, declining soil fertility, water scarcity, and excessive dependence on chemical fertilizers and pesticides. Sustainable crop production aims to maintain productivity while conserving natural resources and protecting the environment. In this context, plant growth regulators (PGRs) have emerged as promising tools for improving crop performance in an environmentally friendly manner. Plant growth regulators are naturally occurring or synthetic organic compounds that modify plant physiological processes at very low concentrates. They regulate various aspects of plant growth including cell division, elongation, flowering, fruit development and stress responses and PGRs are also act as signaling molecules that coordinate plant growth and development under different environmental conditions. The major classes of plant growth regulators include auxins, gibberellins, cytokinins, abscisic acid and ethylene. Each of these hormones plays a unique role in plant metabolism and development. Their application in agriculture has shown promising results in improving crop yield, stress tolerance, and resource use efficiency. More recently, several other compounds that can regulate various facets of plant growth and development have been described, such as oligosaccharides, brassinosteroids, jasmonates, salicylates and polyamines, strigolactones.

### Concept of Sustainable Crop Production

Sustainable crop production refers to agriculture production such a way that does not impose any harm to environment, biodiversity, and quality of agricultural crops. producing crops sustainably increases the ability of the system to maintain stable levels of food production and quality for long term without increasing the demand and requirements of agricultural

chemicals inputs to control the system. It deals with keeping the soil alive with organic matter, integrated pest management and reduction in usage of pesticides, protecting biodiversity, ensuring food safety and food quality, and fertilizing the soil with organic fertilizers. Sustainable agriculture production leads to lowering of greenhouse gas emission and carbon footprint of overall world and sustainable usage of resources ensures the pollution free environment for future generations and also improves the productivity with minimal external inputs. Enhances the crop resilience to stress and also promotes efficient nutrient management. Plant growth regulators help to achieve these objectives by regulating physiological processes that improve plant efficiency and productivity.

## Major Types of Plant Growth Regulators and their Functions

### Auxins

Auxins are Among the first discovered plant hormones and play a vital role in cell elongation, root development and apical dominance. Auxins under environmental stresses influence the plant growth responses. In contrast, subsequent alternations in auxin homeostasis due to such environmental changes can result in distorted growth and development in plants, causing altered morphogenesis. Such stress-induced morphogenic responses are an acclimation strategy, which helps prevent or reduce the damaging effects of environmental stresses.

The genetic studies and in vitro assays claimed that auxins biosynthetic pathways have one tryptophan (Trp)-independent and four Trp-dependent pathways, namely indole-3-acetamid (IAM) pathway, indole-3-acetaldoxime (IAOx) pathway, tryptamine (TAM) pathway, and indole-3-pyruvic acid (IPM) pathway. Among them, the TAM and IPA pathways said to be contributed to plant development.

### Gibberellins

Gibberellins are responsible for stem elongation, seed germination, flowering and fruit development. Gibberellic acid (GA3) is commonly used in agriculture to enhance plant growth and yield. application of gibberellins can increase plant height, leaf area, and biomass production. they also help break seed dormancy and improve germination rates. In crops like rice, wheat, gibberellins improve grain filling and overall yield. For instance, under water deficit conditions, decline in endogenous GA level by GA2ox6 ectopic expression improved the seed yield and drought stress tolerance in rice. Moreover GA regulate redox homeostasis through stimulating electron mobilization in *H. vulgare*.

### Cytokinin

Cytokinin regulate cell division and delay leaf senescence. They promote shoot development and enhance photosynthetic activity by maintaining chlorophyll content in leaves. By delaying leaf aging, cytokinin extend the productive phase of plants, resulting in higher biomass and grain yield. they also improve nutrient mobilization and distribution within the plant. Cytokinin (E.G, Zeatin, kinetin) are substituted adenine derivatives that regulate the plant cell cycle, primarily in areas of active division. cytokinin counter the effects of auxins, promoting lateral bud development and growth.

### Abscisic Acid

It was discovered early 1960s. Abscisic acid (ABA) plays a critical role in plant stress tolerance. it helps plants respond to environmental stresses such as drought, salinity, and temperature extremes. ABA regulate stomatal closure during drought conditions, reducing water loss during transpiration. This mechanism improves water use efficiency and helps plants survive under water-limited conditions. it also responsible for breaking seed dormancy.

### Ethylene

Ethylene is in gaseous form and involved in many vital morpho-physiological process such as triple responses in germinating seeds, developing flowers, ripening fruits, and triggering plant responses against environmental stimuli. The ETIO1 (ethylene over producer) act positively in salt stress by maintaining Na<sup>+</sup>/K<sup>+</sup> homeostasis and ROS production. Moreover it plays a crucial role in altering plants response to pathogen attack, external mechanical wounding, UV radiations, and nutrients deficiency.

**Brassinosteroids**

Brassinosteroids (BRs) are polyhydroxylated steroid PHs. They regulate several physiological and biochemical process in the plant, such as cell elongation, cell division, photomorphogenesis, xylem differentiation, growth and development and reproduction. The BRs are closely related to Auxins, through the modulation of its transport, coordinating the topic responses of plant organs and promoting lateral root primordial initiation during lateral root development.

**Jasmonates**

Jasmonates are a broad grouped, which are covering various compounds, such as Jasmonic acids (Jas), jasmonic acid methyle ester (JAME), precursor of the Jas; octadecanoids cis (+) 12 oxophytodienoic acid (OPDA amino acid conjugates, and metabolites such as 12-OH-JA and 11-OH-JA, and often these compounds are involved in plant responses to biotic and abiotic stresses. Furture, signeling related to defense mechanism of insect or pathogen are derived wounding is mediated by jasmonates.

**Salicylic acid**

Among phenolic endogenous growth regulators, salicylic acid is one of the most vital growth regulators and been characterized in almost all plant species belonging to diversified groups. However, in plants subjected to salinity and osmotic stresses, the SA role remained somewhat ambiguous in various plant species depending on the intensity and duration of osmotic stress.

**Polyamines**

Polyamines (Pas) are small alipathic nitrogenous bases produced as a result of cellular metabolism. The PAS have not planted hormones, but due to their involment in regulating several growth and development process and responses to abiotic stress in plants, they have been proposed as a new category of plant growth regulators. Pas act as regulatory molecules in key cellular processes such as cell division, cell differentiation, DNA and protein synthesis, and gene expression.

**Strigolactones**

Strigolactones (SLs) are carotenoid derived PHs, which executed from 80% of the plants that propose a symbiotic relationship with arbuscular soil mycorrhiza. These PHs were originally discovered as an ecologically signal” for parasitic seed germination and symbiotic relationship among plants and beneficial microbes.

**Melatonin**

In 1995, two groups of researchers simultaneously identified the presence of melatonin(N-acetyl-5-ytrytamine) in vascular plants for the first time. Melatonin is pleiotropic molecule with many diverse actions in plants. It considered as antioxidant with important actions in the control of RO and reactive nitrogen species (RNS), among other free radicals, among other free radicles and harmful oxidative molecules present in plant Deficiency Stress and Relation with Plant Growth and Development.

**Role of plant growth regulators in sustainable crop production****Improving crop yield and productivity**

Plant growth regulators enhance the crop yield improving physiological processes such as photosynthesis, nutrient uptake and carbohydrate metabolism .application of PGRs can increase biomass accumulation and improve reproductive development, leading to higher grain yield.

**Enhancing nutrient use efficiency**

Efficient nutrient utilization is essential for sustainable agriculture. PGRs improve root growth and nutrient absorption, reducing the need for excessive fertilizer application. This helps minize environmental pollution caused by nutrient leaching.

**Increasing stress tolerance**

Climate change has increased the frequency of abiotic stresses such as drought, salinity, and heat stress. PGRs help plant tolerate these stresses by regulating physiological and biochemical mechanisms. For example like ABA improves drough tolerance, Cytokinins

delay stress -induced senescence and salicylic acid enhances plant defense responses. These mechanisms allow crops to maintain productivity under unfavorable conditions.

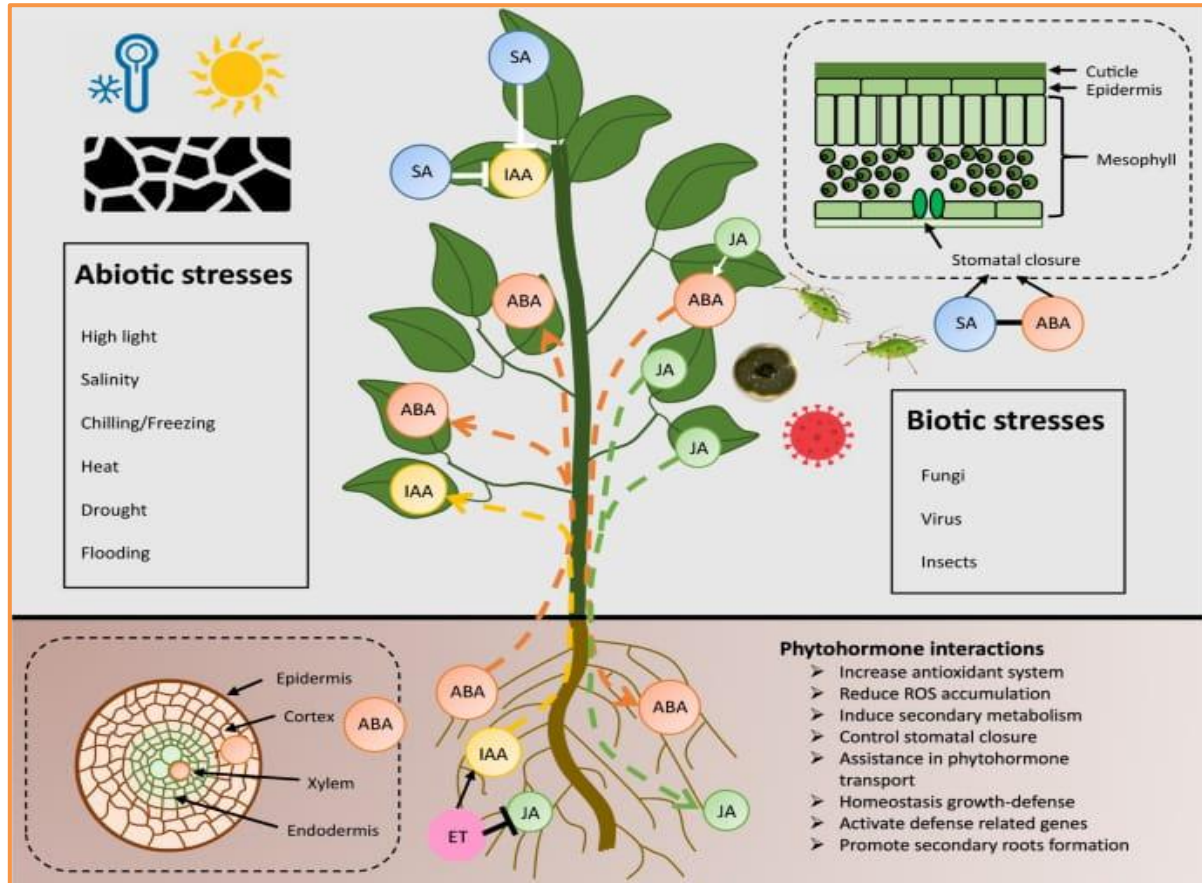


Figure 1

**Improving water use efficiency**

Water scarcity is a major constraint in agriculture. PGRs regulate stomatal activity and root growth, which improves water uptake and reduce water loses. As a results, crop can produce higher yield with limited irrigation.

**Enhancing crop quality**

In Addition to increasing yield, PGRs improve the quality of agricultural produce. They influence fruit size, shape, color, and shelf life. for example, gibberellins increase fruit size in grapes, while ethylene regulates uniform ripening in fruit such as tomatoes bananas.

Plant growth Regulation

Regulation of plant physiology growth, development, metabolism)  
Improved Root growth and photosynthesis

Better nutrient and water use efficiency

Enhanced stress tolerance

Sustainable crop production

**Future prospects**

Increasing concerns about environmental sustainability, the use of plant growth regulators is expected to expand in modern agriculture. Advances in biotechnology and plant physiology may lead to the development of more efficient and targeted PGRs with precision agriculture

and integrated of PGRs with precision agriculture and integrated crop management systems will further enhance their effectiveness in sustainable farming.

## Conclusion

Plant growth regulators play a significant role in improving the sustainability of crop production by enhancing plant growth, increasing nutrient and water use efficiency, and improving tolerance to environmental stresses. Their application in agriculture offers an eco-friendly approach to increasing crop productivity while minimizing environmental impact. Therefore, integrated PGRs in to modern farming practices can contribute significantly to achieving sustainable agriculture development.

## References

1. El Sabagh, A., Islam, M. S., Hossain, A., Iqbal, M. A., Mubeen, M., Waleed, M., Reginato, M., Battaglia, M., Ahmed, S., Rehman, A., Arif, M., Athar, H.-U.-R., Ratnasekera, D., Danish, S., Raza, M. A., Rajendran, K., Mushtaq, M., Skalicky, M., Brestic, M., ... Abdelhamid, M. T. (2022). Phytohormones as Growth Regulators During Abiotic Stress Tolerance in Plants. *Frontiers in Agronomy*, 4, 765068. <https://doi.org/10.3389/fagro.2022.765068>
2. Rademacher, W. (2015). Plant Growth Regulators: Backgrounds and Uses in Plant Production. *Journal of Plant Growth Regulation*, 34(4), 845–872. <https://doi.org/10.1007/s00344-015-9541-6>