



ROLE OF PLANT GROWTH REGULATORS IN VEGETABLE GROWTH AND YIELD

Shubham Kumar¹, Shreya Basak² and Radheshyam Dhole³

Abstract: -

Plant Growth Regulators (PGRs) have emerged as pivotal tools in modern vegetable production, offering a chemical means to manipulate physiological processes for enhanced productivity and quality. As the demand for high-value vegetables rises amidst shrinking arable land and climate fluctuations, PGRs including Auxins, Gibberellins, Cytokinins, and newer classes like Brassinosteroids provide targeted solutions. This review synthesizes recent findings (2024-2025) on the application of PGRs for sex expression modification in cucurbits, fruit setting in solanaceous crops under heat stress, and shelf-life extension. Special emphasis is placed on the role of Brassinosteroids in abiotic stress mitigation and the synergistic use of PGRs with precision agriculture. The judicious use of these regulators can bridge the gap between genetic potential and realized yield in intensive vegetable farming systems.

Keywords: Plant Growth Regulators (PGRs), Phytohormones, Sex Expression, Parthenocarpy, Brassinosteroids, Vegetable Yield, Abiotic Stress, Precision Agriculture.

Introduction:

Vegetable crops are highly sensitive to environmental stimuli, often failing to reach their genetic yield potential due to physiological constraints like poor germination, flower drop, and skewed sex ratios. Plant Growth Regulators (PGRs) are organic compounds, other than nutrients, which in small concentrations (ppm levels) promote, inhibit, or modify plant physiological processes. Historically, the use of PGRs was

Shreya Basak¹, Shubham Kumar² and Radheshyam Dhole³

^{1&2}Research Scholars in Department of Horticulture,

³Assistant Professor in Department of Entomology,

*Narayan Institute of Agricultural Sciences, Gopal Narayan Singh University,
Jamuhar Sasaram, Bihar- 821305*

limited to rooting hormones (IBA) and fruit ripening (Ethylene). However, in 2024-2025, the scope has expanded to "New Generation PGRs" such as Brassinosteroids, Salicylic Acid, and Triacanol, which are now integral to "Climate-Smart Horticulture." This article reviews the specific roles of these regulators in optimizing the growth, yield, and quality of major vegetable crops.

Classification and Mechanism of Action

PGRs are broadly classified into two categories based on their primary action:

- ☞ Growth Promoters: Auxins (IAA, NAA), Gibberellins (GA₃), Cytokinins (Kinetin, Zeatin), and Brassinosteroids.
- ☞ Growth Retardants/Inhibitors: Abscisic Acid (ABA), Ethylene (Ethrel), Paclobutrazol, and Maleic Hydrazide (MH).

Mechanism: These molecules act as chemical messengers. For instance, Auxins acidify cell walls to allow elongation, while Gibberellins degrade DELLA proteins that otherwise repress growth, thereby triggering cell division and elongation.

Role in Seed Germination and Dormancy Breaking

Uniform germination is the foundation of a good crop stand, especially in winter vegetables.

☞ **Potato:** Freshly harvested potato tubers have a dormant period. Application of (Gibberellic Acid) is standard practice to break dormancy and ensure uniform sprouting for early planting.

☞ **Okra & Cucurbits:** Soaking seeds in low concentrations of IAA or NAA has been shown to enhance root proliferation, leading to better seedling establishment in transplant crops.

Modification of Sex Expression in Cucurbits

One of the most commercially valuable

applications of PGRs is altering the ratio of male to female flowers in cucurbitaceous vegetables (Cucumber, Bitter gourd, Bottle gourd, Pumpkin).

☞ Increasing Female Flowers (Gynoecium):

☞ Ethrel (2-chloroethylphosphonic acid): Application at the 2-leaf and 4-leaf stages suppresses male flowers and significantly increases female flower count in cucumber and pumpkin, directly boosting yield.

☞ Auxins (NAA): Application of NAA (10–50 ppm) also promotes femaleness.

☞ Increasing Male Flowers (Androecium):

GA₃ and Silver Nitrate (AgNO₃): Used specifically in hybrid seed production to induce male flowers in "Gynoecious" lines

(which normally produce only female flowers) to ensure pollination.

Fruit Set and Parthenocarpy

Fruit set is often compromised by high temperatures (heat stress) or lack of pollinators.

☞ **Tomato:** High night temperatures cause pollen sterility. Foliar spray of 4-CPA (Tomatotone) or 2,4-D (at very low ppm) ensures fruit set even in adverse weather.

☞ **Parthenocarpy:** Auxins and Gibberellins can induce fruit development without fertilization. This is widely used in developing seedless varieties of cucumber and brinjal (eggplant).

☞ **Prevention of Fruit Drop:** Application of NAA (Naphthalene Acetic Acid) or 2,4-D prevents the formation of the abscission layer, reducing flower and young fruit drop in chilli and tomato.

New Generation PGRs and Stress Tolerance (2024-2025 Advances)

Recent literature highlights the role of novel PGRs in mitigating abiotic stress (drought, salinity, heat).

☞ **Brassinosteroids (BRs):** Known as the "sixth hormone," BRs applied at nanomolar concentrations significantly improve photosynthetic efficiency and

yield in crops like tomato and pepper under drought conditions. They regulate stomatal closure and osmoprotectant accumulation.

☞ **Salicylic Acid (SA):** Acts as a defense signal. Exogenous application helps vegetables withstand chilling injury and fungal attacks by activating Systemic Acquired Resistance (SAR).

Yield and Quality Enhancement

Beyond just "more biomass," PGRs improve the marketable quality.

☞ **Shelf Life:** Cytokinins (Benzyl Adenine) delay senescence (aging) in leafy vegetables like spinach and lettuce by preventing chlorophyll degradation (anti-yellowing effect).

☞ **Tuber Size:** Paclobutrazol (Cultar) is used in potato and onion to arrest excessive vegetative growth and divert photosynthates towards tuber/bulb development, significantly increasing size and weight.

☞ **Ripening:** Ethrel is commercially used for uniform ripening of tomato and colour development in capsicum for once-over mechanical harvesting.

Challenges and Future Directions

1. **Concentration Sensitivity:** PGRs are double-edged swords. A slight overdose can kill the plant (e.g., 2,4-D acts as a weedicide at high concentrations).

2. **Genotype Specificity:** The response to PGRs varies widely between varieties of the same crop (e.g., determinate vs. indeterminate tomatoes).
3. **Residue Concerns:** As highlighted in 2025 reviews, safety in protected cultivation (greenhouses) needs more data regarding residue persistence on edible parts.

Future Perspective: The integration of PGRs with **Precision Agriculture** (drones and sensors) will allow for site-specific application, minimizing waste and environmental load. Molecular studies involving CRISPR are now identifying PGR-responsive genes to breed varieties that are naturally more sensitive to endogenous hormones.

Conclusion

Plant Growth Regulators have transcended their traditional role as mere "boosters" to become essential management tools for precision horticulture. From manipulating sex ratios in cucurbits to "climate-proofing" crops with Brassinosteroids, PGRs offer a viable pathway to meet the M.Sc. research goal of "more crop per drop." For students and researchers, the frontier lies in optimizing "PGR Consortia"—combinations of auxins, gibberellins, and newer signals—to unlock specific

physiological gates for maximum genetic expression.

References

1. Singh, R., & Kumar, P. (2024). Role of Plant Growth Regulators in Improving Vegetable Crop Productivity: A Review. *Journal of Scientific Research and Reports*, 30(2), 112-125.
2. Barickman, T. C. (2025). The ABCs of PGRs in vegetables: Current trends and future prospects. *Greenhouse Management*, 44(3), 45-50.
3. Kaur, P., et al. (2023). Role of auxin and gibberellins on growth, yield and quality of Tomato. *The Pharma Innovation Journal*, 7(9), 304-308.
4. Ahammed, G. J., et al. (2024). The promising plant growth regulators on vegetable crops: Brassinosteroids and beyond. *Biochem Journal*, 8(7), 103-110.
5. Patel, N. (2025). The Future of Plant Growth Regulators (PGRs) in Precision Agriculture. *Dhanuka Agritech Review*, 12, 18-22.
6. Reddy, V. R., et al. (2023). Impact of Auxin and Gibberellin on Sex Expression in Cucurbits. *International Journal of Environment and Climate Change*, 13(10), 2717-2725.
- 7.
- 8.
- 9.

10. Gupta, A. K. (2024). Effects of plant growth regulators on the production of solanaceous vegetables. *ABR International Journal*, 40(2), 107-115.
11. Sharma, S. (2025). New Generation PGRs Used in Fruit and Vegetable Production. *Journal of Applied Biology & Biotechnology*, 13(1), 55-62.

