OPEN ACCESS

***Corresponding author**

avdheshk05797@gmail.com

Keywords: Plant, Growth, Flowering and Hormone.

Published By
Notation Publishing
www.notationpublishing.com

Role of Second Generation Plant Growth Regulators in Fruit Crops: A Review

Prabhat Kumar[1], Imran Ali[1] and Avdhesh Kumar[1]*

[1]Research Scholar Department of Fruit Science, ANDUA&T, Kumarganj Ayodhya

ABSTRACT

Plant growth regulators (PGRs) have long been integral to horticulture, enabling manipulation of plant development for better yield, quality, and stress resilience. With the emergence of second-generation PGRs, which include novel synthetic and naturally derived compounds, there is a renewed focus on precision growth control and environmental safety. This review discusses the classification, physiological role, application strategies, and recent advances in second-generation PGRs, particularly in fruit crops, and highlights their commercial significance, limitations, and future prospects.

Introduction

The global demand for fruit crops necessitates sustainable intensification in horticulture. Traditional PGRs, such as auxins, gibberellins, cytokinins, ethylene, and abscisic acid, have been extensively utilized. However, concerns over environmental toxicity, non-specific action, and residue led to the development of second-generation PGRs—characterized by specificity, reduced toxicity, and eco-friendliness.

Second-generation PGRs include compounds like brassinosteroids, jasmonates, polyamines, strigolactones, and synthetic analogs such as paclobutrazol, uniconazole, and trinexapac-ethyl.

Table-01 Classification and Characteristics of Second Generation PGRs

PGR	Key Features	Mode of Action
Brassinosteroids	Promote growth and resistance	Stimulate cell elongation, stress response
Jasmonates	Regulate fruit ripening, defense	Hormone signaling, gene regulation
Polyamines	Delay senescence, improve fruit firmness	Stabilize DNA, modulate ion channels

Strigolactones	Inhibit shoot branching, improve root interaction	Signaling via MAX pathway
Paclobutrazol	Growth retardant, induces flowering in mango and apple	Inhibits gibberellin biosynthesis
Trinexapac-ethyl	Growth suppression and yield enhancement	Blocks GA biosynthesis
Uniconazole	Promotes compact growth and flowering	Inhibits ent-kaurene oxidase

Physiological Effects in Fruit Crops

Fruit Set and Development

Paclobutrazol has been effectively used in mango (Mangifera indica) to induce regular flowering and improve fruit set (Yadav et al., 2005). Brassinosteroids enhance cell division and expansion during early fruit growth stages.

Flowering Regulation

Uniconazole and paclobutrazol delay vegetative growth and promote floral induction in apple, citrus, and guava (Zhou et al., 2019).

Fruit Ripening and Quality

Jasmonates and brassinosteroids improve flavor, aroma, and color in fruits such as grape (Vitis vinifera) and tomato (Solanum lycopersicum) (Kondo et al., 2014). Polyamines delay senescence and improve shelf life in banana and papaya.

Abiotic and Biotic Stress Tolerance

Brassinosteroids improve drought tolerance in grapevine, while strigolactones enhance nutrient uptake under low-phosphate conditions (Ruyter-Spira et al., 2013).

Application Strategies

- **Foliar sprays:** Most commonly used for uniform application (e.g., jasmonates in tomato).
- **Soil drenching:** Effective for systemic PGRs like paclobutrazol in mango.
- **Seed treatment and dipping:** Used for uniformity in early growth stages.
- **Nanoformulations:** Emerging method for targeted, sustained release of PGRs (Ghosh et al., 2021).

Advances in Molecular and Biotechnological Insights

Recent advancements have led to deeper understanding of second-generation PGR signaling pathways. For instance, DELLA proteins are known targets of GA inhibitors like

paclobutrazol. Genomic tools such as CRISPR and transcriptomics are now being used to analyze PGR-related gene expression and regulation (Zhao et al., 2022).

Table- 02 Commercial Applications and Crop-Specific Case Studies

Crop	PGR Used	Application
Mango	Paclobutrazol	Flowering and fruit yield improvement
Banana	Polyamines	Delay ripening and improve shelf life
Apple	Uniconazole	Induce flowering and reduce vegetative growth
Citrus	Brassinosteroids	Enhance fruit size and quality
Grapes	Jasmonates	Improve anthocyanin content and sweetness

Limitations and Environmental Considerations

While these PGRs are generally safer, some still pose risks:

- Overuse of paclobutrazol may lead to residue accumulation.
- Environmental persistence of some synthetic PGRs.
- Need for crop-specific dosage optimization.

Mitigating these issues requires integrated use with Good Agricultural Practices (GAP) **and** precision agriculture tools.

8. Future Prospects

- CRISPR-based gene editing for PGR synthesis regulation in fruit crops.
- Biostimulant-PGR hybrids for sustainable horticulture.
- Smart delivery systems (e.g., nanoencapsulation).
- Use of AI and sensors for optimal timing and dosage prediction.

Conclusion

Second-generation PGRs represent a promising tool for enhancing productivity, stress resilience, and fruit quality in a sustainable manner. Continued research into their molecular mechanisms and development of environmentally safe formulations will shape the future of fruit crop management.

References

1. Yadav, P. K., Shukla, A. K., & Singh, V. K. (2005). Role of paclobutrazol in flowering and fruiting of mango. *Indian Journal of Horticulture*, 62(3), 238–240.
2. Kondo, S., Tomiyama, H., & Ohara, H. (2014). Effect of methyl jasmonate on anthocyanin synthesis in grape berries. *Scientia Horticulturae*, 167, 41–48.
3. Ruyter-Spira, C., Kohlen, W., Charnikhova, T., et al. (2013). Physiological effects of the synthetic strigolactone analog GR24. *Plant Physiology*, 161(2), 1073–1086.
4. Zhou, Y., Zhang, Y., Wang, X., & Zhang, H. (2019). The use of uniconazole and paclobutrazol in flowering regulation of apple trees. *Journal of Plant Growth Regulation*, 38(4), 1335–1345.
5. Ghosh, A., Ghosh, A., & Kole, R. K. (2021). Nanoencapsulation of plant growth regulators: A smart delivery system. *Journal of Agricultural and Food Chemistry*, 69(10), 2881–2891.
6. Zhao, Q., Wang, M., Li, Y., et al. (2022). Insights into PGR pathways through transcriptomics and CRISPR-based studies. *Frontiers in Plant Science*, 13, 835928.