AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 04 Issue: 08 August 2023 Article No: 10

Innovative Approaches to Stimulate Fruit Crop Growth using Plant Growth Regulators

Parveen[1] and RPS Dalal[2]

[1]Ph.D., Scholar, Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana.
[2]Senior Horticulturist, Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana

SUMMARY

New generation growth regulators are organic substances derived from plants or synthesized artificially. They play a crucial role in the growth and development of plants. Among them are brassinosteroids, jasmonates, salicylic acid, polyamines, strigolactones and prohexodione-Ca, which have practical applications in commercial fruit crop cultivation. These bioregulators offer a range of benefits in fruit crops including growth retardation, prevention of leaf, fruit abscission, reduction of preharvest fruit fall, induction of resistance to abiotic stress, improvement of disease, pest resistance and various other functions. Consequently, these bioregulators have provided fruit farmers with an expanded repertoire of growth hormones to choose from for their crops.

INTRODUCTION

To address the growing consumer demand and overcome the challenges associated with fruit production it is necessary to explore innovative approaches. Among these approaches is the utilization of advanced plant growth regulators in fruit crops. Plant growth regulators (PGRs) or plant bio-regulators (PBRs) are organic compounds that when applied in small concentrations have the ability to influence various physiological processes in plants excluding nutrient functions. By employing these new generation PGRs we can potentially enhance fruit production and meet the evolving needs of consumers. There are five well-known classical growth hormones namely auxins, gibberellins, cytokinins, ethylene and abscisic acid. Each of these hormones serves a specific function in the growth and development of plants. In the context of fruit crops these hormones have already been commercially exploited. However, there is a recent and emerging trend in the use of new generation growth regulators in fruit crops. These regulators can be effectively utilized at various stages of fruit cultivation starting from propagation to enhancing fruit quality as well as inducing resistance to biotic and abiotic stresses. The new generation of plant growth regulators includes brassinosteroids, jasmonate, salicylic acid, polyamines, karrikins, strigolactones, as well as retardants such as 1-MCP and prohexadione-Ca. Recent studies conducted through gene expression analysis have provided evidence that these new generation regulators play a crucial role in the endogenous modulation of significant traits within the plant system. A study reported the role of karrikins in promoting papaya seed germination. Similarly, brassinosteroids and their analogues have been found to enhance stem and cell elongation, as well as improve the yield of fruit crops. Jasmonates, including methyl jasmonate (MeJA), are known to regulate fruit ripening and induce disease resistance in grapes (Jia *et al.* 2015). Salicylic acid plays a crucial role in conferring fruit fly resistance in mango and bacterial blight resistance in pomegranate through systemic acquired resistance mechanisms. According to Zheng *et al.* (2018) that Strigolactones which are derived from carotenoids play a crucial role in protecting citrus crops against major biotic stress. In the case of bananas the devastating disease known as Panama wilt particularly the tropical race 4 can be combated by utilizing MeJA (Sun *et al.* 2013). Furthermore, MeJA has proven to be an effective inducer of resistance against fusarium wilt. In the context of apple trees the semi-dwarfing rootstock M26 has been found to possess MdWRKY genes which are responsible for dwarfism. These genes act by reducing the endogenous levels of brassinosteroids, ultimately resulting in dwarfism (Zheng *et al.* 2018).

1-Methylcyclopropene

1-MCP or 1-methylcyclopropene is a gaseous hormone employed as a synthetic plant growth regulator. Its primary commercial application lies in impeding the activity of ethylene in fruit crops. When applied as a preharvest spray, 1-MCP offers a multitude of advantageous effects on fruit crops. These include postponing the fruit harvest date, augmenting fruit weight, firmness, minimizing fruit drop during harvest, suppressing the internal production of ethylene in fruits and mitigating fruit storage disorders.

Brassinosteroids (BR)

Brassinosteroids a group of plant polyhydroxy steroids widely distributed throughout various parts of plants including Brassicaceae. When applied BR has been found to reduce fruit abortion, fruit drop, while enhancing pollen tube growth and fertilization. Additionally, it acts as a preventive measure against premature fruit detachment and regulates the activity of defense-related enzymes thus fortifying the plant's defense mechanisms against various pathogenic microorganisms. Furthermore, BR plays a crucial role in promoting shoot elongation, flowering, petiole elongation, leaf expansion and contributing to overall plant development. The utilization of derivatives of brassinosteroids such as homobrassinolides can improve various aspects of plant physiology. These compounds enhance photosynthesis and facilitate the movement of metabolites towards the flowers. As a result, there is a reduction in flower drop, an increase in fruit set and a delay in fruit abscission. Additionally, by preserving pectin material in the middle lamella, brassinosteroids influence the expression of sex in plants and promote the growth of pollen tubes. This dual effect leads to improved fruit set and prevents the premature shedding of flowers. It should be noted that the combined application of auxin and brassinosteroids has been observed to induce dwarfism in autotetraploid apple plants.

Jasmonic Acid (JA)

Jasmonic acid derived from linolenic acid which serves as a vital immune hormone in plants. It has the ability to undergo various conversions one of which results in the formation of Methyl jasmonate (MeJA). Originally, MeJA was identified as a secondary metabolite present in the essential oils of jasmine plants. The role of jasmonic acids extends to the regulation of numerous plant physiological processes as well as plant growth and development. Its concentration is typically highest in flowers, reproductive tissues, young leaves while, being lowest in roots and mature leaves. Jasmonic acid actively participates in the regulation of senescence, leaf development, inhibition of leaf abscission, response to plant injuries and defense mechanisms. The application of 0.4% prohydrojasmon (PDJ) through pre-harvest spraying on 'Kent', 'Shelly', and 'Maya' mango varieties resulted in enhanced red skin color and increased accumulation of anthocyanins particularly in the outer fruit located within the tree canopy (Sudheeran *et al.* 2019). The exposure of fruits to sunlight activated the phenyl propanoid pathway which was stimulated dual by the pre-harvest application of PDJ.

Peptide Hormones

Active peptide hormones are generated through the proteolytic cleavage of large molecular weight precursors. In plants peptide hormones are water-soluble and can be categorized into three types: non-secreted peptides, post-translationally modified small peptides and cysteine-rich peptides (CRPs). The small peptide signals found in plants encompass systemin, PSK (phytosulfokine), HypSys (hydroxyproline-rich glycopeptide systemin), Pep1, CLE (CLAVATA3/embryo surrounding region related)/TDIF (tracheary element differentiation inhibitory factor), PSY (plant peptide containing sulphated tyrosine), CEP (C-terminally encoded peptide) and RGF/CLEL/GLV (root signals). Peptide hormones have gained widespread acceptance as signaling messengers in various plant growth and development processes including defense responses, self-incompatibility, callus growth, root growth and organ abscission.

Polyamines

Polyamines are essential biological compounds found ubiquitously in living organisms. These compounds have a relatively low molecular weight and contain aliphatic nitrogen groups. At cellular pH levels polyamines function as cations making them polycationic compounds. When exposed to salt stress conditions such as high levels of NaCl, the availability of precursors like ornithine and arginine increases leading to the biosynthesis of polyamines. This can be facilitated by the induction of specific enzyme activities. Consequently, the levels of putrescine, spermine and spermidine consistently rise under salt stress conditions. Moreover, polyamines play a protective role in plants against salinity by enhancing K^+/Na^+ homeostasis. They achieve this by restricting the influx of Na^+ into the roots thus preventing the loss of K^+ from the cells.

Prohexadione – Ca

Prohexadione-calcium also known as calcium 3-hydroxy-5-oxo-4-propionyl-cyclohex-3-enecarboxylate or Pro-Ca serves as a plant bioregulator primarily employed to influence the growth of plants and the formation of

fruits particularly in pome fruits. Its main purpose is to restrict excessive vegetative growth in fruit trees and other crop plants. Structurally, this chemical bears a resemblance to 2-oxoglutaric acid. Consequently, it inhibits the activity of dioxygenases involved in gibberellin production which depend on this molecule as a co-substrate (for instance, GA_{20} 3ß-hydroxylase). Additionally, Pro-Ca assists in reducing the formation of ethylene, minimizing fruitlet abortion, enhancing fruit set, preventing the occurrence of bacterial and fungal diseases as well as deterring insect pests in fruit crops.

Salicylic Acid (SA)

Salicylic acid (SA) is a secondary metabolite derived from Ortho-hydroxybenzoic acid and is obtained from the white willow tree (*Salix alba*). It was discovered in 1979 that SA acts as an elicitor in tobacco plants inducing resistance against the Tobacco mosaic virus (TMV). This application in plants is involved in their responses to pathogen attack and the development of systemic acquired resistance. In the context of mature litchi fruits (*cv*. Purbi), the treatment of salicylic acid (1.0 mM) combined with chitosan (2%) has proven highly effective in reducing pericarp browning, weight loss, decay loss and maintaining higher levels of anthocyanins, phenolics, flavonoids, ascorbic acid and antioxidant capacity. This effectiveness is attributed to the antisenescence property of SA which helps delay the degradation of ascorbic acid in the fruit during storage (Kumari *et al.* 2015).

CONCLUSION

The utilization of new generation bio-regulators presents a promising alternative to enhance both the yield and quality of fruit crops. These bio-regulators possess organic properties ensuring their safety during usage and offer effective solutions for developing resistance against biotic and abiotic stresses in fruit crops. While, they exhibit immense potential for commercialization their application is currently limited to a few major fruit crops. However, by leveraging modern biotechnological interventions these new generation plant growth regulators can be internally modified and employed in breeding programs to create novel varieties that can be commercially exploited thus addressing significant production challenges in the future of fruit production.

REFERENCES

Jia, H., Zhang, C., Pervaiz, T., Zhao, P., Liu, Z., Wang, B., Wang, C., Zhang, L., Fang, J. and Qian J. (2015). Jasmonic acid involves in grape fruit ripening and resistant against *Botrytis cinerea*. *Functional and Integrative Genomics*, **16**: 79–94.

Kumari, P., Barman, K., Patel, V.B., Siddiqui, M.W. and Kole, B. (2015). Reducing postharvest pericarp browning and preserving health promoting compounds of litchi fruit by combination treatment of salicylic acid and chitosan. *Scientia Horticulturae*, **197**: 555–563.

Sudheeran, P.K., Love, C., Feygenberg, O., Maurer, D., Ovadia, R., Oren-Shamir, M. and Alkan, N. (2019). Induction of red skin and improvement of fruit quality in 'Kent', "Shelly" and 'Maya' mangoes by preharvest spraying of prohydrojasmon at the orchard. *Postharvest Biology and Technology*, **149**: 18–26.

Sun, D., Lua, X., Hua, Y., Lia, W., Honga, K., Mob, Y., Cahillc, D.M. and Xiea, J. (2013). Methyl jasmonate induced defense responses increase resistance to *Fusarium oxysporum* f. sp. *cubense* race 4 in banana. *Scientia Horticulturae*, **164**: 484–491.

Zheng, H., Kumarb, N., Gonzalez, P. and Etxeberriac, E. (2018). Strigolactones restore vegetative and reproductive developments in Huang longbing (HLB) affected, greenhouse-grown citrus trees by modulating carbohydrate distribution. *Scientia Horticulturae*, **235**: 89-95.

Zheng, X., Zhao, Y., Shan, D., Shi, K., Wang, L., Li, Q., Wang, N., Zhou, J., Yao, J., Xue, Y., Fang, S., Chu, J., Guo, Y. and Kong J. (2018). MdWRKY9 overexpression confers intensive dwarfing in the M26 rootstock of apple by directly inhibiting brassinosteroid synthetase MdDWF4 expression. *New Phytologist*, **217**: 1086–1098.