



Role of Plant Growth Regulators in Flowering, Fruit Set and Yield of Fruit Crops

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Plant growth regulators (PGRs) are organic compounds, either natural or synthetic, that play a crucial role in regulating plant physiological processes at very low concentrations. They significantly influence growth, flowering, fruit set, development, and overall productivity of fruit crops. PGRs are broadly classified into growth promoters such as auxins, gibberellins, cytokinins, and brassinosteroids, and growth inhibitors like abscisic acid and ethylene. These regulators interact synergistically or antagonistically to maintain hormonal balance, thereby controlling plant growth and reproductive development. Auxins are primarily involved in cell division, elongation, apical dominance, and induction of parthenocarpy, while also reducing fruit drop by preventing abscission layer formation. Gibberellins promote stem elongation, flowering, fruit set, and increase fruit size by enhancing cell elongation. Cytokinins stimulate cell division, delay senescence, and improve fruit set through enhanced nutrient mobilization. On the other hand, abscisic acid acts as a growth inhibitor and stress hormone, while ethylene plays a key role in fruit ripening, senescence, and abscission. Application of PGRs has been found to significantly improve flowering intensity, fruit set percentage, and fruit retention in various fruit crops such as guava, ber, papaya, and pomegranate. Growth regulators like NAA, GA₃, and CCC enhance yield by increasing fruit number, size, and weight, while reducing premature fruit drop. Additionally, PGRs improve fruit quality attributes including total soluble solids, sugar content, color development, and overall marketability. Thus, plant growth regulators serve as effective tools in modern horticulture for manipulating plant growth and development, leading to increased productivity and improved fruit quality. Their proper and judicious use plays a vital role in achieving sustainable and profitable fruit production.

Keywords: Plant Growth Regulators, Fruit Retention, Parthenocarpy, Auxins, Gibberellins

Introduction

Plant growth regulators (PGRs) are organic compounds that may be natural or synthetic in origin and are capable of modifying or controlling one or more physiological processes within plants. These substances are required in very low concentrations but exert profound effects on plant growth, development, and productivity. They may either promote or inhibit growth depending on their nature, concentration, and site of action. While naturally occurring hormones regulate internal plant processes, synthetic compounds are widely used in horticulture to manipulate plant behavior for improved yield and quality. Growth retardants are a special group of synthetic compounds that reduce vegetative growth and promote reproductive development. Important examples include AMO-1618, Phosphon-D, CCC (Cycocel), maleic hydrazide (MH), B-995, jasmonic acid, and paclobutrazol. Similarly, growth inhibitors such as abscisic acid (ABA), gallic acid, coumarin, and synthetic compounds like TIBA regulate physiological and biochemical processes by suppressing

growth. The interaction among plant growth regulators is also significant. In some cases, they exhibit a synergistic effect, where the combined action exceeds the sum of individual effects, as seen with auxins and gibberellins promoting stem elongation. In contrast, antagonistic effects occur when hormones act oppositely, such as auxins promoting apical dominance while cytokinins counteract it. Such interactions play a crucial role in regulating flowering, fruit set, and yield in fruit crops.

Classification and Nature of Plant Growth Regulators

Plant growth regulators are broadly divided into growth promoters and growth inhibitors. Growth promoters include auxins, gibberellins, cytokinins, and brassinosteroids, which enhance various growth processes. Growth inhibitors include abscisic acid and ethylene, which regulate senescence, dormancy, and abscission. Each group has specific roles and originates from different parts of the plant. Their synthesis, transport, and action are closely linked to plant developmental stages such as flowering and fruiting.

Role of Auxins in Flowering, Fruit Set and Yield

Auxins were first discovered by F.W. Went in 1926 from coleoptile tips of oat seedlings. These are primarily synthesized in the growing apices of roots and shoots and are derived from the amino acid tryptophan. Natural auxin includes indole-3-acetic acid (IAA), while synthetic auxins include NAA, IBA, and 2,4-D. Auxins play a significant role in plant growth by regulating apical dominance, cell division, and cell enlargement. In fruit crops, auxins are particularly important in flowering and fruiting processes. They help in flower initiation and promote fruit set by stimulating ovary growth. One of the most important roles of auxins is the induction of parthenocarpy, leading to the development of seedless fruits. Auxins also prevent the formation of the abscission layer, thereby reducing premature fruit drop. Studies have shown that the application of NAA significantly reduces fruit drop in crops like guava and ber. For instance, foliar spray of NAA at appropriate concentrations during flowering and fruit development stages improves fruit retention and ultimately enhances yield.

Role of Gibberellins in Flowering and Fruit Development

Gibberellins are the second major group of growth hormones, named after the fungus *Gibberella fujikuroi*. They are synthesized in the shoot apex, young leaves, and root system and are easily translocated within the plant. Their precursor is kaurene. Gibberellins are known for their role in promoting stem elongation, breaking dormancy, and inducing flowering in certain plants. They are particularly important in overcoming genetic dwarfism and promoting bolting and flowering in long-day plants. In fruit crops, gibberellins enhance fruit set by promoting pollen germination and fertilization. They also increase fruit size by stimulating cell elongation. Experimental evidence indicates that application of GA₃ significantly reduces fruit drop and increases fruit retention in crops like ber and guava. Moreover, gibberellins contribute to yield improvement by increasing fruit weight and size. Their application in crops such as pomegranate and guava has been reported to enhance both yield and fruit quality parameters like sugar content.

Role of Cytokinins in Growth and Fruit Set

Cytokinins were first isolated from coconut milk and later identified by Miller and Skoog. They are synthesized in root apices, developing fruits, and endosperm tissues, where active cell division occurs. Their precursor is isopentenyl adenine. The primary function of cytokinins is to promote cell division and differentiation. They play a vital role in bud development, shoot growth, and breaking dormancy. In fruit crops, cytokinins enhance fruit set by promoting cell division in developing fruits. They also influence nutrient mobilization and delay senescence, thereby contributing to improved fruit growth and yield. The combined use of cytokinins with other growth regulators often results in better flowering and fruiting performance.

Role of Abscisic Acid Ethylene

Abscisic acid (ABA), also known as dormin, acts as a growth inhibitor and plays a key role in stress responses. It is synthesized in leaves and is responsible for stomatal closure during drought conditions. ABA induces dormancy and inhibits seed germination and growth processes.

Ethylene

Ethylene, a gaseous hormone discovered by Neljubow, is involved in fruit ripening, senescence, and abscission. It is synthesized from methionine and is widely found in ripening fruits. In fruit crops, ethylene is extensively used for artificial ripening. Application of ethrel (ethephon) leads to uniform ripening, improved color development, and enhanced fruit quality. Studies have shown that ethylene treatment improves the organoleptic qualities of fruits such as mango and banana, making them more acceptable to consumers.

Role of Plant Growth Regulators in Flowering

Plant growth regulators significantly influence flowering by regulating hormonal balance. The application of NAA and GA₃ has been reported to increase the number of flowers per plant in several fruit crops. Growth retardants like CCC also promote flowering by reducing excessive vegetative growth. Experimental findings indicate that higher flower production is achieved with treatments such as NAA (200 ppm) and CCC (1000 ppm), which enhance floral initiation and development. This ultimately leads to increased fruiting potential.

Role in Fruit Set and Retention

Fruit set is one of the most critical stages in fruit production. Application of plant growth regulators like NAA, GA₃, and CCC significantly improves fruit set percentage. For example, combined application of boron and NAA has been reported to achieve fruit set as high as 76 percent in guava. Similarly, GA₃ application has shown significant improvement in fruit set in papaya and custard apple. Cytokinins and growth retardants also contribute to better fruit set by enhancing cell division and hormonal balance. Fruit retention is closely linked with reduced fruit drop. Application of NAA at flowering and fruit development stages has been widely reported to minimize fruit drop and improve retention in crops like ber, guava, and citrus.

Role in Yield Enhancement

Yield improvement is the ultimate goal of using plant growth regulators. The application of NAA, GA₃, and other PGRs has been shown to significantly increase yield in various fruit crops. For instance, foliar application of NAA at appropriate concentrations increases fruit number, fruit weight, and overall yield in crops like guava, pomegranate, and sapota. Similarly, GA₃ application enhances fruit size and yield in ber and pomegranate. The increase in yield is primarily due to improved flowering, better fruit set, reduced fruit drop, and enhanced fruit development. Thus, PGRs play a crucial role in maximizing productivity in fruit crops.

Role in Fruit Quality Improvement

Plant growth regulators also improve fruit quality by influencing biochemical processes. Application of NAA and GA₃ has been reported to increase total soluble solids (TSS), sugars, and ascorbic acid content in fruits. Ethylene treatments enhance ripening, color development, and flavor. The use of PGRs also improves fruit size, shape, and overall marketability. For example, GA₃ application in mango and sapota improves sugar content and fruit quality, while ethrel enhances ripening and color in fruits like banana and mango.

Conclusion

Plant growth regulators (PGRs) play a fundamental and indispensable role in regulating the growth, development, and productivity of fruit crops. Being active in very low concentrations, these organic compounds effectively control key physiological and

biochemical processes such as flowering, fruit set, fruit retention, and fruit development. The coordinated action of growth promoters like auxins, gibberellins, and cytokinins, along with growth inhibitors such as abscisic acid and ethylene, ensures proper hormonal balance within the plant system. Auxins contribute significantly to flower initiation, fruit set, and prevention of fruit drop through inhibition of the abscission layer and induction of parthenocarpy. Gibberellins enhance flowering, improve fruit set, and increase fruit size and yield by promoting cell elongation and overcoming dormancy. Cytokinins support cell division, delay senescence, and improve fruit development by enhancing nutrient mobilization. On the other hand, abscisic acid and ethylene regulate stress responses, dormancy, ripening, and abscission, thereby influencing fruit quality and maturity. The application of PGRs such as NAA, GA₃, and CCC has been widely reported to improve flowering intensity, increase fruit set percentage, reduce premature fruit drop, and ultimately enhance yield in fruit crops like guava, ber, papaya, pomegranate, and sapota. Additionally, these regulators improve important fruit quality parameters including size, total soluble solids, sugar content, color, and overall market acceptability. Therefore, plant growth regulators serve as powerful tools in modern horticulture for manipulating plant growth and achieving higher productivity and better quality fruits. However, their successful use depends on proper selection, concentration, and timing of application. Judicious and scientific use of PGRs can greatly contribute to sustainable and profitable fruit production.