



Seed to Splendor: Exploring the role of Gibberellic acid on Ornamentals

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INTRODUCTION

In many plants, the flowering response is closely linked to endogenous hormonal levels, which are directly or indirectly associated with their developmental stage. Plant hormones are a group of naturally occurring organic substances which influence the physiological processes even at low concentrations. They have ability to accelerate or to retard the plant growth. Among those hormones, GA is most widely used and plays multiple role in plant, such as seed germination, trigger transitions from meristem to shoot growth, juvenile to adult stage, flowering, breaking of dormancy, etc.

The Gibberellic Acid (GA₃) is a tetracyclic diterpenoid compound stimulating plant growth and development. There were more than 130 GAs discovered, that have been classified into two groups based on their number of carbon atoms: C₁₉-GAs (with one carboxylic group at the C-7 position, e.g., GA₂₀ and GA₉) and C₂₀-GAs (with two carboxylic groups at the C-7 and C-19 positions) respectively.

Physiological role of GA:

1. Breaking of seed dormancy: The signalling pathway of gibberellic acid in seed dormancy involves a complex interaction of hormones, enzymes and gene expression. Abscisic acid is a hormone that promotes seed dormancy and maintaining seeds in a dormant state until favourable conditions for germination are met. Under specific environmental conditions, such as light exposure, the synthesis of gibberellic acid is initiated in the embryo of the seed. Once gibberellic acid is produced, it triggers a signalling to promote seed germination and inhibits seed dormancy. The key components of the gibberellic acid signalling pathway includes:

Gibberellic acids (GAs) serve as important regulator in the process of seed germination, particularly in stimulating the production of α -amylase and hydrolytic enzymes in the aleurone layer of seed. There are distinct parts of seed: embryo, the endosperm and the seed coat. The endosperm, which surrounds and nourishes the embryo, consists of two main components: the aleurone layer and the starchy endosperm located at the center. The starchy endosperm is composed of cells with thin walls that contain starch grains. Enveloping the starchy endosperm is the aleurone layer, which has thick cell walls and contains protein bodies. When a seed begins to germinate, Ga3 trigger the production of α -amylase in the aleurone layer. α -amylase is an enzyme that plays a vital role in breaking down complex carbohydrates, particularly starch, into simpler sugars. This enzymatic activity is crucial because it enables the release of stored food reserves that exist within the starchy endosperm. As the α -amylase enzyme breaks down, it generates soluble sugars, amino acids and other by products. These breakdown products are then transported from the starchy endosperm to the developing embryo. This transport mechanism ensures that the growing embryo receives the necessary nutrients, such as sugars and amino acids, which are essential for its growth during germination of seed.

- a. **Gibberellin receptors:** Gibberellic acid binds to specific receptors known as gibberellin receptors or GID1 (Gibberellin Insensitive Dwarf1) receptors. This binding activates the receptors, leading to subsequent events in the signalling pathway
- b. **DELLA proteins:** The activated gibberellin receptors initiate the degradation of DELLA proteins, which are negative regulators of gibberellic acid signalling. The degradation of DELLA proteins relieves their inhibitory effects on germination and allows the downstream signalling pathway to proceed.

- c. **Gene expression:** The degradation of DELLA proteins leads to the activation of specific transcription factors, such as GAMYB (GA-Myb), which regulates the expression of genes involved in germination processes.

- d. **Activation of hydrolytic enzymes:** The expression of genes induced by gibberellic acid leads to the production of hydrolytic enzymes, such as α -amylase, which breaks down stored starch into sugars, providing energy for germination.

1. **Bolting:** GA can have both positive and negative effects on bolting, depending on the plant species and the specific stage of development. Bolting refers to the rapid elongation of the flowering stem or the formation of a floral stalk in certain plants.

In some biennial or vernalisation plants, gibberellic acid can promote bolting by stimulating stem elongation and floral development. These plants have a requirement for a prolonged period of cold temperatures (vernalisation) to induce flowering. However, if vernalisation conditions are not met or insufficient, exogenous application of gibberellic acid can bypass the vernalisation requirement and induce premature bolting and flowering. Gibberellic acid can act as a growth regulator to restrict stem elongation and delay the bolting process, allowing the plants to allocate more energy towards vegetative growth before transitioning to the reproductive phase.

2. **Flowering:** flowering is complex process and can vary depending on the plant species, cultivar, stage of development and environmental factors.

- a. **Induction of flowering:** Gibberellic acid can induce flowering in certain plant species, especially those having specific requirements or inducible flowering pathways. It can overcome the inhibitory effects of factors such as short day lengths or low temperatures, which may delay or prevent flowering. By providing exogenous gibberellic acid, the plants receive the signal to initiate and promote

flowering. For instance, in some long-day plants that require extended daylight to initiate flowering, application of gibberellic acid can compensate for insufficient day length and trigger the flowering process.

- b. Flowering time regulation:** Gibberellic acid interacts with other flowering-related hormones, such as photoperiodic pathways and vernalization (cold exposure) to determine the timing of flowering
 - c. Enhancement of flower size and development:** Promotes stem elongation and cell expansion, which can result in more number of branches, larger floral structures and enhanced floral display. This effect is particularly beneficial in ornamental crops.
- 3. Vase life of flowers:** The potentiality of flowers to remain fresh and attractive after being harvested and placed in a vase or floral arrangement called as life vase.
 - a. Delaying senescence:** Gibberellic acid can delay the senescence (aging) process in cut flowers. It helps to maintain the quality and prolong the post-harvest life of flowers by inhibiting the breakdown of cellular components and slowing down the deterioration of tissues. This allows the flowers to maintain their visual appeal and freshness for a longer period
 - b. Improved water uptake:** By promoting the opening of xylem vessels improved water uptake to keep the flowers hydrated and prevents dehydration, which can lead to wilting and reduced vase life.
 - c. Promotion of floral opening:** In certain flower species, gibberellic acid can facilitate the opening of flower buds and promote full bloom. This effect is particularly beneficial for flowers that have tight buds or require external stimuli, such as warm temperatures or longer day lengths to fully open. By applying gibberellic acid, the flowers can achieve their optimal bloom and extend their vase life.
 - 4. Controlling plant height:** In some flower crops, excessive stem elongation can lead

to weak and floppy plants. Gibberellic acid can be used to regulate plant height by promoting or inhibiting stem elongation. This helps in maintaining compact and sturdy plants, which are easier to manage and transport minerals.

- 5. Sex expression:** In some plants, gibberellic acid used to induce feminization in monoecious plants, where both male and female flowers are present on the same plant.
 - a. Root growth:** Interaction of GA with other hormones, such as auxins and cytokinins in balanced ratio can modulate the overall root growth response. For example, GA and auxins may have synergistic effects on root growth, while GA and cytokinins may have antagonistic effects. Gibberellic acid can affect not only root length but also root architecture. It can promote lateral root formation and branching, leading to a denser and more extensive root system.
 - 1. Stimulatory effect:** Gibberellic acid stimulates cell elongation, leading to longer roots and increased root biomass. This effect is particularly observed in young seedlings. GA can enhance the ability of roots to explore the soil for resources by increasing their length and branching.
 - 2. Inhibitory effect:** Higher concentrations of gibberellic acid or prolonged exposure to GA can lead to reduced root growth and decreased root biomass and inhibits the root growth.

CONCLUSION

The effects of gibberellic acid (GA) on plant growth and development are complex and varied depending on the specific plant species, growth stage, concentration of GA applied and environmental conditions. GA has been shown to have significant effects on elongation, flowering promotion, seed germination, yield aspect and plant architecture modification. This helps in improvement of yield and quality of flowers.