Impact of Growth Retardant on Biochemical, Physiological and Yield Characters of Cotton

Fensi N. Chaudhari, H. R. Ramani, M. D. Khunt and P. S. Patel
Main Cotton Research Station, Navsari Agriculture University, Surat-395007
Corresponding Authors: hiteshramani2007@gmail.com

Plant growth retardants (PGR's) represent diverse chemistries and mode of action, and provide numerous possibilities for altering crop growth and development (Oosterhuis *et al.*, 1998). PGR's provide farmers with a new management tool for controlling undesirable vegetative growth. An objective for using PGR in cotton is to balance vegetative and reproductive growth as well as to improve yield and its quality (Zhao and Oosterhuis, 2000). Visual growth-regulating activity of MC, CCC being expressed as reduced plant height and width.

What Are Growth Retardants?

Growth retardants are chemicals that inhibit or slow down the growth of plants. They function by interfering with specific biochemical pathways that regulate plant growth and development.

Cell division: Growth retardants primarily target cell division and elongation, leading to shorter, more compact plants with increased branching and leaf density.

Branching: They may promote branching by limiting vertical growth, which can be beneficial for achieving desired plant shapes and size.

Size of plant: By slowing down growth, retardants can help manage plant height and volume, which is useful for both aesthetic and practical reasons in agriculture and horticulture.

Types of growth retardants used in agriculture

- **Chlormequat chloride** is a widely used growth retardant that inhibits gibberellin biosynthesis, leading to reduced stem elongation and increased branching.
- **Mepiquat chloride** is another common growth retardant that effectively reduces stem elongation and increases cotton boll production.
- **Uniconazole** is a triazole-based growth retardant that inhibits gibberellin biosynthesis, leading to shorter stems and higher boll set.

Mode of Action: Growth retardants primarily work by inhibiting the biosynthesis of gibberellins, which are essential plant hormones that regulate cell elongation.

Growth retardants are often associated with larger boll size, leading to increased fiber yield per plant. By reducing gibberellin levels, growth retardants decrease cell division and elongation, leading to shorter stems and increased branching in cotton plants. This altered plant architecture promotes a more compact growth habit, which enhances the efficient utilization of light, nutrients, and water for optimal boll development.

Impact on Growth Parameters

Growth retardants are known to significantly reduce plant height, leading to more compact plants.

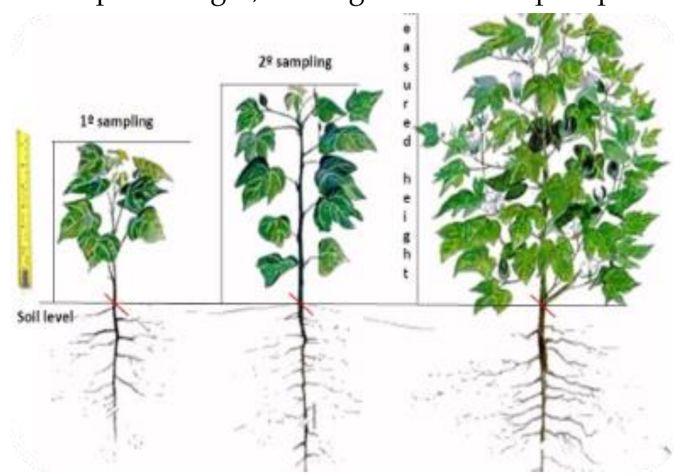

Fig. 1. Effect of growth retardant

Fig. 2. Effect on branching

Growth retardants promote increased branching, resulting in a higher number of bolls per plant and potentially greater yield. Growth retardants can either increase or decrease leaf area depending on the specific type and application rate.

Fig. 3. Effect on leaf area

Growth retardants are often associated with larger boll size, leading to increased fiber yield per plant (Rademacher, W., 2000).

Biochemical Impact

Inhibition of Gibberellin Biosynthesis: Gibberellins (GAs) are plant hormones that promote stem elongation, seed germination, and flowering. Most growth retardants inhibit different steps in the gibberellin biosynthesis pathway, reducing the levels of active gibberellins plant (Sabagh, *et al.,* 2021).

Examples: Paclobutrazol, uniconazole and Chlormequat chloride inhibit gibberellin biosynthesis, leading to shorter, more compact plants. Growth retardants can affect chlorophyll content, which influences photosynthesis and ultimately plant growth. They can alter carbohydrate metabolism, leading to changes in the amount of sugars available for growth and development. Growth retardants can also affect protein synthesis, impacting the plant's ability to build new tissues and structures.

They can influence the activity of key enzymes involved in plant growth and development, altering biochemical pathways. Some growth retardants, such as Chlormequat chloride (CCC), can reduce chlorophyll content in plants. Other growth retardants, like paclobutrazol, can increase chlorophyll content, leading to enhanced photosynthesis.

Growth retardants can modulate the activity of enzymes involved in stress response, helping plants cope with environmental challenges.

Physiological Impact

Reduction of Cell Elongation

Growth retardants reduce cell elongation by interfering with the cell wall's extensibility. This results in shorter internodes and overall reduced plant height (Grossmann *et al.,* 1984).

Examples: Daminozide and Ancymidol are known to reduce cell elongation without affecting the number of cells.

Antioxidant Enzyme activity

By modifying growth patterns and enhancing antioxidant enzyme activity, growth retardants can help plants better withstand environmental stresses such as drought, high salinity, and temperature extremes.

Examples: Paclobutrazol and uniconazole improve the activity of antioxidant enzymes like superoxide dismutase (SOD) and peroxidase (POD).

Nutrient Uptake Efficiency

Growth retardants can improve nutrient uptake efficiency by promoting a more extensive root system relative to the shoot. This enhanced root-to-shoot ratio allows the plant to absorb more water and nutrients from the soil. Growth retardants significantly reduce stem elongation, resulting in shorter, more compact cotton plants and reduce Hight of plant.

Leaf Area Index: Growth retardants can impact the Leaf Area Index (LAI) by increasing it, influencing canopy structure and light utilization.

Reduced Transpiration: Growth retardants can reduce transpiration, the process by which plants lose water through their leaves.

Impact on Plant Density and Architecture

Growth retardants inhibit stem elongation, resulting in shorter plants. Growth retardants can promote branching, leading to a higher number of fruiting sites. A combination of reduced stem elongation and increased branching leads to a higher plant density, increasing yield potential.

Impact on Yield: Improved nutrient uptake can lead to better growth and higher yields, as the plant can more effectively utilize available resources.

Conclusion

Growth retardants hold promise for improving cotton yield and fiber quality by regulating plant growth and enhancing stress tolerance. However, further research is needed to understand their long-term effects and ensure sustainable use. Precise application and management, along with knowledge of their interactions with environmental conditions, are key to optimizing cotton production.

References

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