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Growth Retardants in Altering Structure and Physiological Response of Plants

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Introduction

The growth behaviour and yield formation of crop plants are governed by their genetic potential, climatic conditions, and the supply of nutrients. Specific control of these processes by the application of plant bioregulators of natural or synthetic origin is increasingly emerging in recent years. Because of their specific properties in regulating shoot growth, the plant growth retardants have become the most widely used group of bioregulators in agricultural and horticultural practice.

Growth Retardants

The morphological effects of growth retardants are accompanied by alterations in the developmental and physiological behavior of treated plants. Many researchers, farmers, scientists understand that plant growth retardants (PGRs) are an effective tool to help control plant stretch. But did you know there are other benefits to using certain PGRs as well? The PGRs that block the gibberellic acid (GA) pathway control growth because GA is a plant hormone that stimulates cell elongation in plants. By inhibiting GA, there is less cell elongation (i.e., stretch). PGRs that work in this manner include those that contain ancymidol, chlormequat chloride, daminozide, fluprimidol, paclobutrazol and uniconazole etc.

The AI (active ingredient) is the compound in the product that suppresses stem elongation. Although all PGRs control stem elongation, the mode of action is not the same for all PGRs. Gibberellins (GAs) are plant hormones responsible for stem elongation. Most PGRs inhibit different steps during the production (biosynthesis) of GA in plants. Thus, PGRs suppress stem elongation by blocking GA production within plants. However, as we discuss in the case of ethephon below, not every PGR works this way. In addition to their modes of action, AIs differ in relative activity, difficulty of use, site of absorption, application methods, and shelf life

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Action on Gibberellins

Greener leaves are one additional benefit to using these types of PGRs. This happens for two reasons. First, the cells are smaller, so chlorophyll is more concentrated in the cell. Second, there is an increase in chlorophyll production because some metabolic energy is diverted from GA synthesis into chlorophyll production.

Plants treated with PGRs can also exhibit improved water use and less water stress. This is likely due to the reduction in leaf size that PGRs provide, which require less water than their larger-leafed, non-PGR-treated counterparts. Some researchers also believe that the blocked GA pathway causes an increase in abscisic acid production, which promotes stomatal closure that reduces water loss and improves water use as well. In some cases, use of PGRs may also help suppress disease. Fluprimidol and paclobutrazol both block sterol production in fungi, which fungi need to grow. Although neither product will provide season-long suppression of fungi development, it certainly is an added PGR benefit.

Examples

Daminozide (commonly known as B-Nine® or Dazide®) is one of the most common PGRs used in the floriculture industry. At the end of the GA production process daminozide renders a key enzyme for GA production useless, thus reducing GA levels. Daminozide has the lowest level of activity compared to other AIs.

Chlormequat chloride (commonly known as Cycocel®, Citadel®, or Chlormequat E-Pro®) is another very popular PGR. Unlike daminozide, chlormequat chloride inhibits GA production early in the process. Chlormequat chloride has activity when applied to both the leaves and the roots, but it is primarily applied as a foliar spray due to the higher concentrations required for adequate control when applied as a drench. Applicators frequently tank mix chlormequat chloride with daminozide. Because the two products have different sites of inhibition in the GA production process, such a mix can be highly effective at suppressing elongation.

Ancymidol, Flurprimidol, Paclobutrazol, and Uniconazole Ancymidol (A-Rest® or Abide®), flurprimidol (Topflor®), paclobutrazol (Bonzi®, Downsize®, Paczol®, or Piccolo®), and uniconazole (Concise® or Sumagic®) are all listed together due to their similar chemical structures. They all inhibit GA production at similar sites in the GA production process. Generally speaking, these PGRs have the strongest efficacy relative to

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other AIs, so applicators typically apply lower concentrations. All of these chemicals can be applied to the shoots or roots, which allows a broad range of application choices including foliar sprays, substrate drenches, liner dips, and media sprays.

Ethephon Unlike other PGRs does not inhibit GA production. Plants take up ethephon through the leaves where it is converted to ethylene in plant cells. The increased ethylene causes cells to limit elongation and increase in width instead. The release of ethylene reduces apical dominance, which can increase axillary branching. However, if the application is made close to flowering, the ethylene can result in flower abortion and delayed flowering.

Conclusions

Farmers are privileged to have a wide range of PGRs available that have diverse modes of sites of absorption, action and activity without harming the environment. Thus, the PGRs are used for influencing physiological response of plants by altering the architecture of plants.