A BRIEF HISTORY OF PLANT GROWTH REGULATORS

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Humans are continually attempting to control and manipulate their environment to avoid the extremes of nature. There are air-conditioned cars, homes, tractors, and even greenhouses. Plants are now being given 200 ppm mineral nutrients at each watering and short poinsettias can result with growth-retarding chemicals. Regulating plant height is perhaps the most commonly used scientific technique.

Plant growth regulation began in England in 1880 with Charles and Francis Darwin, two of the world's great observers of nature. While working with germinating seeds, they showed that coleoptiles (shoots) curved toward light, but did not curve if the growing points of the coleoptile were covered or shaded.

In 1911 Boysen-Jensen showed by a conduction of a stimuli that the curvature of the seedlings could be prevented by making a cut high up on the shaded side of the coleoptiles and inserting pieces of mica. If the mica were not placed in the cut, the stimulus could cross the wound. He further showed the translocation of some factor by cutting the coleoptile tip off, placing it on a block of gelatin, and then setting the gelatin on the severed stump. When illuminated, curvature would still result.

With these simple observations the door was opened for hormone work which has led to growth regulatory chemicals from herbicides (2,4-D) to growth retardants (B-9).

Indoleacetic Acid

It was not until 1919 that Paal developed and showed a clear concept of a growth hormone being secreted by the tip and if the tip were replaced the coleoptile curved even in darkness. The concept of growth substance was formulated based on the coleoptile tip regulating growth below.

Finally, in 1928 Went cut off the coleoptile tips, placed them on gelatin blocks, allowed the growth substance to diffuse into the blocks, removed the tips and placed the gelatin onto freshly decapitated coleoptiles and observed growth responses. This was the first time a growth hormone was extracted.

In 1934 Kogl showed that this same substance which caused shoot elongation also inhibited root elongation. In the same year Thimann and Went demonstrated that the growth substance which stimulated the rooting of stem cuttings was identical with the growth substance of the coleoptile. Snow in 1935 observed that this same substance indole-3-acetic acid (IAA) stimulated the cambium tissue to divide. Promotion or inhibition of elongation of shoots or roots, as well as organ formation and regeneration and cell division was controlled by one compound at various concentrations. Indoleacetic acid could commercially be used as a rooting aid, but it is unstable, so we use a few parts per million of IBA, (indolebutyric acid), a cousin to IAA, in talc powder instead.

Gibberellin

The gibberellin group was first shown to exist in 1926 in Taiwan by Kurosawa and isolated in 1938 as metabolites of a fungus which caused excessive growth of rice plants. It was soon recognized that the growth habit of many species of flowering plants was influenced by these agents. More than 35 different gibberellins with unique, but similar, structures have been identified since 1945.

One important gibberellin function is the elongation response. Dwarf peas treated with GA_3 elongate 5 times the rate of the untreated and are similar to the height of normal peas.

Ethylene

Ethylene has a long history dating to 1864 in Germany when illuminating gas was observed to damage plants. In Russia (1901) it was shown that the active ingredient in illuminating gas was ethylene, and in 1908 Crocker and Knight demonstrated that the ethylene in illuminating gas caused premature aging of carnations. Ethylene as a gas is a very simple compound (C_2H_4), and is now recognized as a plant-produced hormone. However, it was not until 1910 that it was suggested that oranges give off a gas which promotes the ripening of bananas. Ethylene can cause a multitude of plant responses from promotion of flowering in the bromeliads to flower inhibition.

Cytokinins

Other plant hormones which have little or no horticultural use at this time are the cytokinins which were first discovered in the 1950's and which promote cell division. DNA from herring sperm which was aged or heated was found to stimulate cell division in tobacco pith culture in 1961. Skoog and his group in Wisconsin found that the active ingredient was called kinetin and now the entire class of compounds is called cytokinins as is zeatin, for example, isolated from corn in the 1960's. Cytokinins have been used to retard aging in leaf tissue and to promote lateral bud development. No doubt when cytokinins are as old as IAA, we in floriculture will have some practical daily use for them.

Abscisic Acid

Lastly, in 1965 a plant hormone called abscisic acid (ABA) was isolated from cotton which stimulated abscission of leaves and also was associated with dormancy. ABA has a wide variety of effects on promoting aging, inhibiting seed germination, inducing dormancy, and regulation of transpiration by controlling guard cell shape. Currently no practical use is applicable to floriculture.

Growth Retardants

Growth retardants used in floriculture are artificial compounds and not natural plant hormones such as the various classifications of chemicals just described. Growth retardants slow cell division or reduce height or cell elongation of shoot tissue without adverse developmental or formative effects.

In 1949 the literature described the first growth retardant, a nicotiniums compound, to reduce bean stem elongation by 75 percent. In 1950 a series of quaternary ammonium carbamates was reported to retard the stem growth of snap beans. The most active of these compounds was Amo-1618. In 1955 the phosphoniums were reported and Phosfon-D and Phosfon-S were ultimately developed. These affected a much wider range of species than any of the previously reported compounds.

In 1960 a new group of quaternary ammonium compounds was reported. The most active of these became known as CCC. In 1962-63 a group of substituted succinamic acid compounds was tested and B 995 was found. With CCC and B-9 stem elongation on a wide host of plants could be retarded.

The reason for selective responses of plants to growth retardants is not fully known or understood. Growth retardants have been more active with dicots, and it was not until the advent of A-Rest in 1969 that such monocot species as Lilium were effectively controlled. It is true that Phosfon retarded stem elongation of Easter lily, but it caused injury.

We hope this chart of the various chemicals will aid you. However, keep in mind that it was Darwin in 1880 looking at germinating seedlings bending toward light that started it all some 96 years ago. What of the future of plant growth control?

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