PRIMER ON **PLANT HORMONES**

Hormones - Some Theories

by Erik Biksa

Growers manipulate or take advantage of the enviroment to produce responses in plants. These include rooting, vegetative growth, branching, flowering, setting seed or fruit, and dormancy. Hormones in plants influence these reactions. They can be produced within the plant as a result of environment. In some instances, they are supplied to the plant by the grower. There is some debate as to the roles of hormones in plants, and some debate as to whether or not additional hormones have been documented.

There are five generally accepted types of hormones that influence plant growth and development. They are: auxin, cytokinin, gibberellins, abscisic acid, and ethylene. It is not one hormone that directly influences by sheer quantity. The balance and ratios of hormones present is what helps to influence plant reactions. The hormonal balance possibly regulates enzymatic reactions in the plant by amplifying them, leading to the results the grower wants to see. Following is a brief description of the role of hormones in plant responses:

Auxins:

Auxins are produced in significant quantities in the upper growth regions of plants, promoting cell elongation. It travels from the shoot tip to base when the plant is actively growing, playing a role in the formation of plant roots.

IAA is an auxin in it's natural state. Synthetic rooting hormones contain compounds such as IBA typically ranging in concentrations from 1000-10,000 ppm. When cuttings are taken, and dipped for rooting, here's part of what happens: The plant stops growing stem tissue. The cells that have been developing but have not yet been dedicated to any specific type of growth (i.e. stem development) are stimulated by the auxin such as IBA to become roots. These cells are now set to grow roots, and will further multiply and develop to produce a healthy root system, which will develop hormones that influence the upper development of the plant. Synthetic auxins sprayed on tomato vines will allow fruit to develop without pollination. Auxin that is usually produced by the seeds has been replaced, so no seeds will develop.

An overdose of auxin will actually inhibit cell elongation, because the plant will produce another hormone to try and balance the act. When applied to seeds, auxins also help to promote femaleness in dioecious plants (plants having females and males). The concentration of auxin is usually highest at the main growing point of the plant, surpressing lateral/side shoot growth. Growers have often pinched the tips of the plants in order to promote extensive branching and to keep plants short and sturdy. Bending and tying the growing point downwards will also have a similar effect without damaging the concentration of auxins within the plant.

Cytokinins:

Cytokinins are produced in the plant's roots and move upwards through the plant to the growing tips. As the roots system grows larger, it produces more cytokinins, which in turn, signals the plant to grow and branch more. As the plant continues to grow and branch, it produces more auxin in the growing points. Remember auxin influences root development, so the plant grows more roots, producing more cytokinin, etc. Less cytokinin with more auxin signals root growth. More cytokinin, less auxin triggers more shoot growth.

Kelp meal is a natural source of cytokinins. Kelp based products contain kelp extracts in easy to apply liquids. Additions of these products at the roots during the vegetative stage will result in rapid growth and branching. It is best applied to the root zone, but a quick foiliar spray can be used to perk up growth. A fine spray in early flowering will help to build the framework for a bountiful harvest, as it plays a role in longevity of plants. Flowering might be slightly extended, adding to quality and results. During the vegetative stage an abundance of cytokinins will help to remove dominance (due to higher concentrations of auxin) from the main growing tip, leading to bushier plants. Applications of cytokinins can reduce aging in plants and can improve the shelf life of veggies and cut flowers.

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Giberellins:

Giberellins are produced by the roots and growing leaves. It promotes cell elongation and cell division. In seeds, it is activated by water and helps to break seed dormancy leading to germination. Some plants such as lettuce, in high temperature will "bolt" growing an upright seed stock, this can be attributed to an abundance of gibberellins.

In dioecious plant species (those types of plants having females and males) the application of giberellic acid (typically foiliar sprays) can cause female plants to develop male flowers, thus, pollinating themselves. These plants generally turn out to be all female. So if a grower has two different or same types of a favorite specimen, they can apply giberellic acid as a spray once or twice during flowering. The plants should only be harvested for their pollen for transfer to an unsprayed and desirable female. The offspring might be more susceptible to hermaphordism (both male and female flowers on the same plant) than their parent under environmental stress such as photoperiod interruptions or being root bound.

Giberellins also act against abscic acid in breaking the dormancy in the growing points of plants.

Abscisic Acid:

Abscisic acid is produced in the buds/shoot tips of the plants. It plays a key role in slowing plant growth and promotes dormancy (overwintering) in plants. This function also helps to slow cell elongation, possibly promoting tighter internodal spacing (distance between growing points) for tight flower spikes. ABA (abscisic acid) plays an important role in plant survival. It can prevent plant wilt, as it triggers stomata (tiny holes in leaves plants used to take in CO2 and release O2 for photosynthesis) to close during drought conditions, so the plant requires less water because it has shut down its growth process.

This creates the assumption that abscisic acid is a "stress" hormone. Furthermore, abscisic acid plays a role in leaf abscission, the process where the lower leaves of the plant begin to drop near maturity or from severe stress.

Ethylene:

Ethylene is present as a gas produced by the plant. As levels of ethylene increase with plant development while other hormones are balancing in accordance, the effects of ethylene become more pronounced. Ethylene promotes fruit ripening, or "maturing". This signals the plant that it's life cycle is changing or ending. Tomatoes turn red and small flowers begin to wither. It will signal the plant to transfer it's nutrients back into the stem tissue from the leaves and other storage tissue.

Abscission (the process where leaves drop) is attributed to decreasing levels of auxin produced by the leaves, allowing further expression of abscisic acid and ethylene. This response is brought on by shortening days and cooler nights.

Tomatoes can be grown with an ethylene inhibitor, shipped green for shelf life and resistance to handling damage, and then exposed to a sealed environment with controlled levels of ethylene to ripen the fruit at their point of destination. Burning fossil fuels, such as CO2 generators produce small amounts of ethylene. Inefficient and un-inspected burners may produce ethylene levels high enough to seriously harm plants. Ethylene is found in abundance in the skin of ripening fruit such as apples or green bananas. By placing unripened plant material in a paper bag with a green banana you can hasten ripening, bringing out flavour and aroma. If done at warmer temperatures fresher material will convert stored starches to sugars.

The above helps to shed some light on the role of hormones in plants. Growers should be cautious when applying hormones to plants. Excessive amounts could be detrimental to the plants development, causing serious set backs in plant functions. Synthetic hormones should also be handled with caution. Some are known to be mutanagenic and carcinogenic in mammals. However, used safely, at the right time, and in the right amount, hormones provide the grower with an additional means of plant manipulation. Sterilized coconut milk is used in tissue culture for stimulating shoot development as it contains cytokinins. Most agar base recipes call for 100ml per liter of medium. Malt can be used to provide auxin for root growth. A great deal of information regarding hormones can be found in publications dealing with tissue culture. The key to remember is that no one hormone controls plant processes, it is the balance of all hormones influenced by environmental factors which the grower must control in order to achieve the results they desire.