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Plant Growth Regulators in Vegetable Crops

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Introduction:

Plant growth regulators (plant hormones) are an organic compound and small in quantity, can be natural or synthetic, it modifies or controls one or more specific physiological processes within a plant. But, the sites of action and production are different. If the compound is produced within the plant, it is called a phytohormone Substances applied externally also can bring about modifications. A large number of chemicals tend to increase the yield of certain plants such as corn and sugarcane. Both internal plant hormones and lab created hormones are called plant growth regulators. Hormones usually move within plant from a site of production to site of action.

There are 6 plant processes that effect growth which are

- Photosynthesis
- Respiration
- Absorption
- Transpiration
- Translocation
- Reproduction

About hormone

- From the Greek word *hormaein*, meaning "to excite", Latin word, Hormao= "to urge on"
- Plant hormones differ from animal hormones in that:
  - Unlike animal hormones, plant hormones are not made in tissues specialized for hormone production. (e.g., sex hormones made in the gonads, human growth hormone - pituitary gland)

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- Unlike animal hormones, plant hormones do not have definite target areas (e.g., auxins can stimulate adventitious root development in a cut shoot, or shoot elongation or apical dominance, or differentiation of vascular tissue, etc.).

Transport of PGRs

- Are produced in one part of a plant and then transported to other parts, where they initiate a response.
- They are stored in regions where stimulus is and then released for transport through either phloem or mesophyll when the appropriate stimulus occurs.
- Organic substances which at low concentration (less than 0.001 m) promote growth along the longitudinal axis.

General mechanism of hormone action

- Hormones regulate plant growth and development
- Hormones regulate plant growth and development by affecting
- cell division
- cell elongation
- cell differentiation
- Only small amounts of hormones are necessary to trigger the signal-transduction pathways that regulate plant growth and development.

Role of Plant Growth Hormone in vegetable Production

The role of plant regulators in various physiological and biochemical processes in plants is well known. Growth regulators are known to affect

- Seed germination,
- Seed dormancy,
- Vegetative growth,
- Nodulation,
- Tuberization,
- Fruit ripening and yield
- Hybrid seed production
- Fruit setting and fruit size
- Types of hormones

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There are five classes of phytohormones:

1. Auxins,
2. Gibberellins
3. Cytokinins
4. Abscisic acid and
5. Ethylene
6. Others

1. Auxin: the first plant hormone

- ✓ Greek word: auxein means to increase or to grow
- ✓ It was the first growth hormone discovered in the plants
- ✓ It required for the viability (along with CK)
- ✓ Produced in apical and root meristems, young leaves, seeds in developing fruits

- **Transportation**
  - ✓ Auxin is transported from the site of synthesis to the site of action, which is not far away.
  - ✓ Nevertheless, auxin is also translocated to other regions of the plant body.
  - ✓ The transportation of auxin is polar, *i.e.*, from apex to the base, which is called basipetal movement, but acropetal movement *i.e.* from the base to apex has also been observed but the amount transported is almost negligible.
  - ✓ The ratio between basipetal and acropetal movement is approximately 3:1.
- **Site of synthesis**
  - ✓ The natural auxin found in plants is called Indole Acetic Acid (IAA) and it is the first of the phytohormones to be discovered.
  - ✓ Indole acetic acid is mostly synthesized in the stem and root apexes.
  - ✓ Shoot apexes synthesize more auxin than the root species.
- **Effect on general metabolism**
  - ✓ Isolated tissues, hypocotyls segments, epicotyl segments, leaves, excised roots and even whole plants have been used to monitor various biochemical and physiological responses to hormone treatment.
  - ✓ Auxin has been found to accelerate cellular metabolism in treated tissues. Particularly respiratory rate increases by at least by 20%.

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- **Effect on cell elongation**
  - ✓ Auxin promote growth in stem and coleoptiles, while inhibiting growth in roots
- **Effect on adventitious root formations**
  - ✓ Roots developing from any part of the plant body other than the radicle are called adventitious roots.
  - ✓ But the exogenous supply of auxins to stem and leaf cuttings readily induces the new root formation, which ensures vegetative propagation.
  - ✓ The synthetic hormones like IBA and NAA are more effective in new root formation than the native IAA.
- **Effect on apical dominance**
  - ✓ The suppressive effect of apical buds on the growth of lateral buds is often called apical dominance.
  - ✓ Apical dominance has been explained as due to the action of auxin present in the main apex.
  - ✓ This view is amply supported by an experiment, where if the stem tip is cut off, the axillary buds found below sprout immediately.
  - ✓ Auxin present in main apex somehow inhibits the growth of the axillary bud.
  - ✓ The severity of apical dominance is greater on the axillary buds present nearer to the main apex.
  - ✓ Nevertheless, apical dominance exerted by the auxins can be overcome by the application of cytokinins to axillary buds. This is because cytokinin induces cytokinesis **(**cell division of cytoplasm its refered as cytokinesis**).**

✓ **Effect on Parthenocarpy:**

- ✓ Development of fruits without fertilization is known as parthenogcarpy and the fruit is
- ✓ said to be parthenocarpic fruit.
- ✓ Auxins have been found to be effective in inducing parthenocarpic fruits in some plants.
- ✓ Some botanists suspect that pollen tubes carry some enzymes which produce more auxin.
- ✓ It is important to note that the synthesis of more auxins not lead to fertilization.

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- ✓ Whether the act of fertilization has any stimulatory effect on the synthesis of auxin is not clear nonetheless many plants respond to auxin treatment produce parthenocarpic fruits.

Auxin- Agricultural Uses

- ✓ Rooting of the cuttings
- ✓ Prevention of pre-harvest fruit drop
- ✓ Parthenocarpic fruit
- ✓ Fruit setting
- ✓ Controls of flowering
- ✓ Defoliation of the plants
- ✓ Prevention of abscission
- ✓ Thinning of compact fruits
- ✓ Selective weed killers

2. Gibberellic acid

- ✓ Gibberillic acid was first discovered in Japan under unusual circumstances.
- ✓ Farmers in Japan, before the World War, found that their paddy crop plants were afflicted with a strange disease called Bakane.
- ✓ The diseased plants showed unusual growth where plants were very tall, weak and sterile.
- ✓ 125 GAs are known and numbers are still increasing.

- **Why GA3 is mostly used then the other GAs?**

  Because, it's had very simple structure which is easily breakdown and mixed in the nature of unexcited site. Also, GA3 is easily available than the other GAs. Thus, it's used more than other GAs.

  Effect of GA on of Plants

  - **Effect on General Metabolism**
    - ✓ Gibberellins, as growth promoting hormones, accelerate the rate of cellular metabolic pathways such as respiration, protein synthesis etc.
    - ✓ During the germination of cereal grains, GA is known to promote mobilizing the food materials for the growing embryo. It plays a significant role in metabolizing lipids to glucose and then to sucrose through gluconeogenesis process.

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Effects on cell elongation

- **Effect on Genetic Dwarfism**
  - ✓ Genetic dwarfism, in many plants including garden peas and some species of French beans, is controlled by single genes.
  - ✓ Such genetic dwarfs respond very favorably to GA treatment and in response to the hormone they grow as tall as normal tall varieties.
- **Effect on Vernalization**
  - ✓ GA is known to overcome cold treatment for plants requiring vernalization, but it can also break the seed dormancy.
  - ✓ Quantitative estimation of GA in vernalized seeds do not increase in GA content, the concentration of GA increases significantly; these studies suggest that cold treatment *per se* does not increase GA content, but provides the ability to synthesize more GA during germination and growth.
- **Effects on parthenocarpy**
  - ✓ Where auxins fail, GAs are found to be very effective in inducing Parthenocarpy. In addition to it, GA induced parthenocarpic fruits are larger in size and sweeter in content.
  - ✓ GA is used to increase the total yield of grape fruits.
  - ✓ It is also highly effective in increasing the yield and sugar content of sugar cane.
  - ✓ However, the application of GAs should not be more than what is required in grape cultivation; otherwise, fruits will be damaged.
- **Anti-gibberelins: AMO-1618, CCC (cycocel), Phosphon-D, Paclobutrazol, SADH (Succinic Acid Dimethyl Hydrazide)**

Gibberellins applications

- ✓ Germination
- ✓ Rooting
- ✓ Leaf expansion
- ✓ Hyponasty of leaves
- ✓ Flowering
- ✓ Break the dormancy

3. Cytokinin

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- **Site of Synthesis**

✓ Cytokinins are found in root tips, xylem, young leaves; endosperms of developing fruits, germinating seeds and tumour tissues.

✓ Most of the cytokinins required for the plant body are synthesized in the root tips.

✓ Transportation is through xylem stream.

- **General Metabolism**

✓ Cytokinins effect on respiration is very interesting.

✓ It enhances the rate of respiration in the callus, but the same hormone when applied to senescing leaves, brings down the rate of respiration, retards the degradation of chlorophyll and enhances the rate of chlorophyll synthesis.

✓ The root nodule development in legumes and its metabolic activity is subtly regulated by the interaction between auxins and cytokinins.

- **Effect on Dormancy**

✓ Dormant buds that develop due to certain adverse environmental factors remain inactive for a long time.

✓ If such buds are treated with cytokinins they come out of dormant state and sprout.

✓ This is due to the effect of cytokinin in activating cell division which was prevented by mitotic blocks present in the dormant besides.

✓ Interestingly, cytokinins also overcome auxin imposed apical dominance and stimulate the growth of the axillary buds.

Cytokinin promotes the movement of nutrients

- **Cytokinin modify apical dominance and promote lateral bud growth**

Cytokinins application

✓ Cell division

✓ Increase the Shelf life of fruits

✓ Quickening of root induction

✓ Increasing the yield and oil content in groundnut

✓ Breaking dormancy

✓ Delaying the senescence

4. ABA: Stress hormone

✓ Abscissin has been isolated from a wide variety of plants. The amount of ABA found

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- ✓ Parthenocarpy
- ✓ Fruit setting & size
- ✓ Fruit drop
- ✓ Stem elongation
- ✓ Pollen germination
- ✓ in plants varies from species to species and from organ to organ.
- ✓ For example, in the pulp of avocado fruits the concentration of ABA is 10 mg/kg. And in the dormant buds of cocklebur, it is 20 mg/kg.
- ✓ Again depending upon the environmental conditions, the concentration of ABA varies in the same part or the organ of the plant body.
- ✓ In the leaves of *phaseolus vulgaris*, if the plant is subjected to water stress within 90 minutes the amount of ABA raises from 15 mg/kg to 175 mg/kg.
- ✓ Intense light and other dormancy inducing factors are highly effective in increasing the concentration of ABA is the plant body.

Application of ABA

- ✓ Bud dormancy
- ✓ Senescence
- ✓ Abscission
- ✓ Flower initiation
- ✓ Stomatal physiology
- ✓ Release of ethylene
- ✓ Counteract GA
- ✓ Stress hormone

5. Ethylene A ripening hormone

- Application of Ethylene
  - ✓ Abscission
  - ✓ Natural ripening and climacteric rise
  - ✓ Degreening of citrus and banana
  - ✓ Ripening
  - ✓ Sex expression in cucurbits
  - ✓ Floral development

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- ✓ Mechanical harvesting

Other known hormones

Brassinolides – found in the rapeseed. They promote cell elongation and cell division, differentiation of xylem tissues, and inhibit leaf abscission. Plants that are deficient in brassinolides suffer from dwarfism.

Salicylic acid - activates genes in some plants that produce chemicals that aid in the defense against pathogenic invaders.

Jasmonates - are produced from fatty acids and seem to promote the production of defense proteins that are used to fend off invading organisms. They are believed to also have a role in seed germination, and affect the storage of protein in seeds, and seem to affect root growth.

Batasins: they have been isolated from yam plants (*Dioscorea batatus*) that cause dormancy in bulbils.

Morphactins

- Which are also a group of plant growth regulators but its not naturally,
- Like, chlofluron, chlorflurenol, dichlorflurenol, flurelol, etc.

Method of application

- Seed treatment
- Foliar application
- Dipping method (Seedling or planting material)
- Pre-harvest spray
- Post-harvest spray
- Steam application

Conclusions

- Lastly concluded that, by the applications of plant growth regulators and other chemicals stimulate the expecting growth of the plants.
- Also increase or decrease the plant growth as per the demand of the markets.
- Also increase the shelf life of fruits and its physical appearance.
- Regulate the plant processes as per our needs.

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- But, time of applications, methods of application and concentration of PGRs are appropriate for the plants.

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