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Role of Plant Growth Regulators in Vegetable Production

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Introduction

Plant growth regulators or Phytohormones are organic substances produced naturally in higher plants, controlling growth or other physiological functions at a site remote from its place of production and actives in minute amounts. These are the compounds other than nutrients, synthesized in one part of the plant and translocated to another part wherein in a very low concentration; they cause a biochemical and physiological response. If the compound is produced within the plant tissues (i.e. endogenously) it is known as plant hormone. Plant growth regulators include both internal plant hormones and synthetic chemicals with similar physiological activities to plant growth hormones or compounds that can modify plant growth in other ways. They have two groups: growth promoters (Auxins, gibberellins and cytokinin) and growth inhibitors (Abscisic acid and ethylene). Auxins are the hormones first discovered in plants and later gibberellins and cytokines were also discovered. The primary site of action of plant growth hormones at the molecular level remains unresolved. The concentration of hormones required for the plant response is very low (10^{-6} to 10^{-5}M), comparing with the requirement of mineral and vitamin for plants. The biosynthesis of plant hormones within plant is more diffuse and not always localized. Plant hormones are not nutrient, but chemicals that in small amounts promote and influence the growth, development, and differentiation of cells and tissues. Auxin was the first hormone to be discovered in plant and at one time considered to be only naturally occurring plant growth hormones.In1926, Frits Went performed an experiment that explained all the previous results. He named the chemical messenger Auxin. Three types of plant

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hormones Auxins, Gibberellins and Cytokinin were discovered in the early decades of the twentieth century, in 1930's and in 1960's respectively.The Abscisic acid was first isolated by Addicott in 1963 from cotton bolls.In 1934 R. Gane found that the ripening causing volatile substance was ethylene. But ethylene was recognized as a plant hormone by Crocker in 1935.

Classification of Plant Growth Regulators

- **Auxin:** Charles Darwin was the first who proposed the existence of Auxin in 1880. It was the first class growth regulator that was discovered. The term auxin was coined by Kogl and Haagen Smit (1931) designating those plant hormones which are especially concerned with cell enlargement or the growth of the shoots. Went (1926 and 1928) isolated auxin from the Avena coleoptile tips by a method called Avena coleoptile or curvature test and concluded that no growth can occur without auxin. Auxins are widely distributed throughout the plant however, abundant in the growing tips and leaves. Auxins are those compounds that give positive effect on formation of bud, enlargement of cells and root initiation and they are also helpful for the formation of other growth hormones. IAA is natural occurring auxin while NAA, IBA, 2,4-D etc. are synthetic in nature.
  - **Precursor:** Tryptophan
  - **Site of production**: Shoot and root tips, young expanding leaves and seeds
- **Gibberellin:** Kurosava was the Japanese scientist who discovered gibberellins in 1926. Kurosava noted that some plants in rice fields were taller, thinner and paler than the normal plants; had longer and narrower leaves markedly overgrowing their unaffected neighbours; and were sometimes devoid of fruits too. The named this disease as "*bakanae*" meaning foolish seedlings. Sawada (1912) suggested that the diseses is due to a substance secreted by a parasitic as comyceteous fungus, *Gibberella fujikuroi* (the perfect form is *Fusarium moniliforme*, in infecting the disesed plants. Later in Yabuta (1935) and Hayashi (1939) isolated this growth promoting substance in crystalline from and named it as gibberellin which has now been growth promoters, collectively known as Gibberellin.
  - **Precursor:** Terpenoids
  - **Site of production:** Embryos, roots and young leaves.

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- **Cytokinins:** The word for cytokinin is a generic name for all naturally occurring substance that are known to promote cell division. The term, cytokinin was proposed by Letham (1963). They are also known to delay senescence. Skoog in 1995 experimented that when pith tissues of "*Nicotiana tabaccum*" were separated from the vascular tissues they grew without division of cell. The first common natural cytokinin identified was purified from immature maize kernels and named Zeatin. There are so many different synthetic cytokinins such as 6-benzylamino purine (BAP), kinetin, 6-(benzyl-amino)-9-(2- tetra hydropropanyl)-9H-purine (PBA), 1, 3- diphenylurea, thidiazuron (TDZ), etc. Kitnetin was discovered from the tobacco pith callus. But there are two types of Cytokinins: Adenine type- Kinetin, Zeatin (synthesized in plants) and Phenyl urea type (not synthesized in plants).
    - **Precursors**: Purine Base
    - **Site of Production**: They are synthesized in root apex, endosperm of seeds, young fruits, where cell division takes place continuously.
- **Abscisic Acid:** These were previously called Dormin or Abscisin mainly because of their regulatory effect on abscission and dormancy. This hormone is widespread in higher plants and is found in many different organs and tissues (both old and young) of plants. ABA induces abscission of the leaves of a wide variety of plants and fruits of some plant species. It is also called plant stress hormone. It acts as inhibitory chemical compound that gives direct effect on growth of bud, seed and dormancy of bud. It has inhibitory effect and occurs naturally in plants. It inhibits mRNA and synthesis of protein. It is also known as domains which act as anti- Gibberellins
- **Ethylene:** This hormone is a gaseous plant hormone which is synthesized from methionine and it is synthesized in all organs of plant. Ethylene is a small hydrocarbon, the colorless flammable gas and is denoted by formula C_2H_4 or $H_2C= CH_2$. It is found in ripened fruits, flowers, leaves and nodes of stem. Synthesis of ethylene is inhibited by carbon dioxide and requires oxygen.
    - **Precursor**: Methionine
    - **Site of Production**: Cells undergoing senescence and ripening fruits.

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Other Growth Hormones

- **Brassinosteroids:** Brassionsteroids are the sixth group of plant hormones with significant growth-promoting activity. Brassinosteroids were first isolated and characterized from the pollen of rape plant, *Brassica napus* L. These are considered as hormones with pleiotropic effects, as they influence carried developmental processes like growth, germination of seeds, rhizogenesis, flowering and senescence. Brasinosteroids also confer resistance to plants against various abiotic stresses.
- **Jasmonic Acid**: It participates in leaf senescence, defense mechanism against fungi, inhibits premature germination of oil containing seeds (*Brassica* spp.)
- **Uniconazole**: Retards bolting in Radish, Chinese Cabbage
- **Morphactins**: It Suppress apical dominance in *Luffa acutangula*. Decreases the germination percentage in Radish.
- **Polyamines**: Polyamines are strongly basic molecules with low molecular wait that have been found in all organism studied thus far. They are essential for plant growth and development and also affect the process of mitosis and meiosis.
- **Strigolactones**: Strigolactone implicated in the inhibition of shoot branching.
- **Florigen**: These hormones are synthesized in the older leaves and transferred to the growing region where it starts the floral and bud initation.
- **Vernalin**: It is used to undergo and bring nervalisation in some plants.
- **Salicylic acid**: Salicylic acid activate genes in some plants that produce chemicals that aid in the defence against pathogenic invaders.
- **Anthesins**: Its newly discovered hormones responsible for flower formation which is used by horticulturists to induce the early flowering in some plants.

Benefits of Using Plant Growth Regulators

- Promote and accelerate root formation on cutting
- Increases size and crispness of stalks of celery- achieved by the application of GA.
- Delays senescence of fruits.
- Enhance seedless fruits
- Stem elongation
- It stimulates the formation of adventitious roots

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- Helps in pollination
- Promotes seed germination and seedling growth
- Used for breaking of dormancy
- Promotes growth of dwarf plants

Conclusion

Plant growth regulators has an potential in vegetable production to increases the yield, quality, synchronization in flowering, earliness cold and high temperature fruit setting , sex modification, increase post-harvest life and resistance to biotic and a biotic stresses of vegetables to better meet the requirements of food supply in general. But more research in needed to develop simple, economical and technical viable production system of bio regulators. Bio-regulators must be toxicologically and environmentally safe.

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