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Plant Hormones Auxins: Distribution, Types and Physiological Effect

Plant growth substances or growth regulators are organic substances, other than nutrients, which in low concentration regulate growth, differentiation and development by promoting or inhibiting the same. Plant growth substances are also called phytohormones.

Technically a plant hormone is an organic compound synthesized in one part of a plant and translocated to another part, where in very low concentration, it causes a physiological response. The response in the target organ need not be promotive, because processes such as growth or differentiation are sometimes inhibited by hormones, especially abscisic acid.

Many plant physiologists use the term plant growth substances rather than plant hormone, for it can include both the native (endogenous) and the synthetic (exogenous) substances found to modify plant growth. Those substances elaborated by the plant are referred to as phytohormones whereas the others are called synthetic plant growth substances.

Five major kinds of endogenous plant growth substances are present in plants—auxins, gibberellins, cytokinins, abscisic acid, and ethylene. With the exception of abscisic acid and ethylene, which are represented by single molecules in plants, there are multiple forms of the endogenous plant growth substances.

Auxins:

The term auxin was first used by Frits Went in 1926, who discovered that some unidentified compound probably caused curvature of oat coleoptiles toward light. He demonstrated that a substance present in the tips could diffuse from them into a tiny block agar.

The activity of this auxin was detected by the curvature of the coleoptile caused by enhanced elongation on the side to which the agar block was applied. This Avena-curuature test, first developed by F. W. Went, is not only the first but to-date the best biossay for auxin.

The test centres around two important aspects of auxin-action (a) the transport of auxin is strictly polar, diffusing from the morphological top to a morphological base (b) the degree of curvature is proportional to the amount of auxin.

Thimann (1948) defined an auxin as "an organic substance which promotes growth along the longitudinal axis when applied in low concentrations to shoots of plants freed as far as possible from their own inherent growth-promoting substances."

Auxin Distribution in Plants:

Thimann (1934) working on etiolated seedlings of Avena found that the auxins occurred in their highest concentrations in the shoot tip; the root tips contained the least amounts. Thimann and Skoog found that in light-grown plants apical buds contained most auxin, young leaves contained lesser quantities and mature leaves, the lowest quantities. Auxin is synthesised in shoot apices, leaf primordia and developing seeds and it is now believed that the auxins-synthesis may take place in all parts of the plant.

Types of Auxins:

Recently several substances showing auxin-action have been isolated from plant materials.

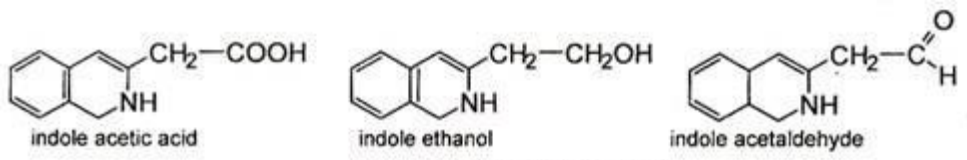


Fig : Naturally occurring auxins

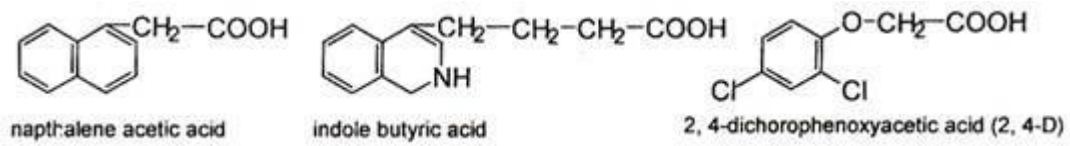
Indole 3-Acetic Acid (IAA) is the universal natural auxin. It was discovered by Kogl et al (1934). Related chemicals are indole 3-acetaldehyde, indole 3-acetonitrile, phenylacetic acid and 4-chloro indole acetic acid. But in a majority of plants, Indole-3-acetic acid (IAA) is found to be present in much larger quantities than any other auxin.

Auxins generally occur as complexes, usually bound with an aminoacid or sugar. These complexes serve as precursor substances and six different precursor molecules for auxins have been reported. Many workers, including Thimann, reported that the aminoacid, Tryptophan, figures prominently in the auxin formation. Many Indole compounds too serve as precursor of auxins.

Auxin synthesis is conditioned by the presence of light and zinc. Too high or too low temperature is found inimical to IAA formation. It is thus suggested that auxin synthesis is an enzyme- mediated process.

Synthetic Auxins:

Many synthetic auxins cause many of the physiological responses common to IAA and are generally considered to be auxins. Of these Napthalene acetic acid (NAA), Indole butyric acid (IBA), 2,4- dichloro-phenoxyaectic acid (2,4-D), 2-methyl-4-chloro-phenoxyaectic acid (MCPA) and 2,4,5-trichloro- phenoxyacetic acid are the best known.



naphthalene acetic acid indole butyric acid 2, 4-dichorophenoxyacetic acid (2, 4-D)

Antiauxins:

Antiauxins are a group of chemicals that can prevent auxin-action in plants. They were first discovered by Skoog (1942). Transcinnamic acid, ascorbic acid, 7-phenyl butyric acid are some of these antiauxins. Probably, an antiauxin competes with an auxin for the same site of reaction and thus inhibits auxin-action.

Physiological Effects of Auxins:

1. Cell enlargement: Early studies on coleoptile growth as a result of cell enlargement showed that IAA and other auxins promote cell enlargement. It is the most fundamental activity of auxins.

2. Inhibition of lateral buds: The development of axillary (lateral) buds is inhibited by IAA produced at the apical meristem and transported down the stem. If the source of auxin is removed by excising the apical meristem, the lateral buds are released from the inhibitory state and undergo development.

3. Leaf abscission: The concentration of IAA in cells near or within the abscission zone appears to delay the abscission process.

4. Cambial activity: Degree of cambial activity is directly proportional to auxin concentration (Avery et. al. 1947). Auxins promote cell division within the cambial region.

5. Root growth: Auxin promotes root initiation but only at extremely low concentration (10^{-7} to 10^{-13} M) depending on the species and age of roots. At higher concentrations, cell enlargement is always inhibited.

6. Auxins are employed in agriculture to induce rooting, parthenocarpy, flowering and as weedicides (2, 4-D).

7. Abscission and senescence: Auxins influence the development of abscission or separation layer. Application of Auxins to leaves and fruits can thus prevent their premature falling.

8. Apical dominance: Apical meristem suppresses the growth of lateral buds. This condition is known as apical dominance.

9. **Eradication of weeds:** Few synthetic Auxins also act as herbicides and are used to kill weeds.

10. Parthenocarpy: Fruit development in the absence of pollination and fertilization is called parthenocarpic development and the fruits thus formed are called parthenocarpic fruits.

11. Initiation of flowering: Spraying of dilute solution of Auxins like 2, 4-D, and NAA, initiates flowering almost simultaneously. Flowering can be inhibited by spraying high concentration of Auxins.

12. Cell division: Auxins induce cell division under following conditions: During injury for healing of wound, During grafting for producing graft union, During secondary growth by initiating cell divisions in the cambium, In culture tissue.

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