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A Review of Hormone: AUXIN

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Abstract: ***Terrestrial Plants are immobile and cannot move away from environmental stress condition and that can negatively affect their growth and development. As a result they have to develop various biochemical and physiological mechanism to respond and adapt to these stress condition. Plant hormones or phytohormones which are released inside plant which helps to overcome stress condition and for better growth of plants, plants hormones are various types. IAA, IBA, 2,4D, NAA etc are the types of auxins and cell elongation, initiation of root in callus during plant tissue culture etc. are the functions of auxin.***

Keywords: Growth regulators, Hormones, Phytohormones, Auxin

1. Introduction

Plant hormones which are chemical messenger and naturally occurring substance helps in coordinating cellular activities in plants and regulates function such as growth, germination and various other physiological process.Total 8-9 types of phytohormones are founded among them major hormones are auxins, gibberellins, abscisic acid, cytokinins, ethylene, etc.

The term 'auxin' emerged out from the greek word '*auxein*,which means to enlarge/grow.Auxin activity was classically defined as the ability to stimulate elongation in coleoptile and stem sections, but also rooting (Went, 1934). Plant hormone produced at stem tip or apical meristem it is place where auxin mainly occurs which promotes cell elongation (Sauer M., et. al., 2013) but Auxin molecules are found in all tissues in a plant. Auxins, abscisic acid, cytokinins, ethylene and gibberellins are commonly recognized as the main classes of naturally occurring phytohormones.Among the plant hormones auxins were the first of plant hormones to be discovered and was chemically isolated in 1928, Dutch botanist Fritz W. from the tip of oat coleoptiles.

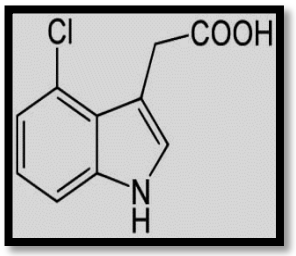
Auxins can be defined as naturally occurring and synthetic. Naturally occurring auxins, indole-acetic acid (IAA), indole-butyric acid (IBA), 4-chloroindole-3-acetic acid (4-Cl-IAA), indole-3-propionic acid and phenyl-acetic acid (PAA).Whereas,1-Naphthalene-acetic acid (NAA), 2,4-dichlorophenoxyaceticacid (2,4-D), 2,4,5-trichlorophenoxy-acetic acid, 3,6-dichloro-2-methoxybenzoic acid (dicamba), and 4-amino-3,5,6- trichloropiconiolinic acid (picloram) are types of synthetic auxin.Synthetic auxin shows growth-promoting properties, but they are not always as active as IAA.

During normal and stress environment condition regulation of plant development is greatly influenced by hormones. They initiate and control adaptation process.Auxin, cytokinins, and auxin-cytokinin interactions are generally considered to be the most important for organized development and regulating growth in plant tissue and organ cultures. Flowering, change ripening, fruit setting, and physiochemical during storage are the function performed by growth regulators and are necessary for the growth and development of plants or organisms.

They are used in agriculture and horticulture, in home gardening, rooting, fruit setting, fruit thinning, and fruit-drop control. Other compounds like auxin used as weedicides and defoliating agent.Ethylene production is also triggered by auxin.

Phytohormones are synthesized in plants at very low concentrations. They do not have any nutritional function, but act as signaling compounds that encourage and influence plant development and physiology. Structurally different plant hormones have been identified, such as auxin, cytokinin, abscisicacid, ethylene, gibberellin, brassinosteroid, strigolactone, salicylic acid, and jasmonate etc. (Sauer M., et. al., 2013). The molecular mode of auxin action can be significantly explored with employing synthetic auxin-like molecules. Auxin is modified& metabolized actively, and it is intracellularly characterized, which can have a great influenceon its activity and availability. (Sauer M., et. al., 2013).

Table 1: Over View of Auxin

Hormone	Origin	Structure	Common Name	Natural Or Synthetic Form	Function
Auxin	Apical tip of plant		4-Chloroindole-3-acetic acid (4-Cl-IAA)	• IAA: Indole-3-acetic acid • IBA: Indole-3-butyric acid • NAA: Naphthalene acetic acid • 2,4-D: 2,4-dichlorophenoxyacetic acid	• Apical dominance • Lateral- root initiation • Leaf abscission • Vascular differentiation • Flower bud formation • Fruit development

Types of Auxins

IAA:Much auxin-related research has put attention on the activity of the dominant naturally occurring auxin: Indole-3-Acetic Acid (IAA). It is controlling many important physiological processes including cell enlargement and division, tissue differentiation, and responses to light and gravity and IAA is often used in horticulture to promote adventitious root growth and are used commercially to create root stem cuttings and to promote uniform fruit and flowering growth etc. Some synthetic analogues [including 2,4-dichlorophenoxyaceticacid (2,4-D) and 1-naphthaleneacetic acid(NAA)] have also been extensively used. However, there are other naturally occurring molecules with auxin activity, and Auxin is well known for its ability to regulate various growth and developmental processes. (Frick EM, Strader LC. 2018).

IBA: Indole-3-butyric acid (IBA) has been actively research for many years. IBA is almost identical to IAA with having exception of an added CH2 group, still the activity of IBA is relatively different than IAA. IBA was initially found in potato tubers (Blommaert, 1954). . IBA is involved in developmental processes, such as cell division, leaf epinasty, stem bending (Zimmerman and Wilcoxon, 1935), root hair elongation (Strader and Bartel, 2009; Růžička et al., 2010), and cell expansion (Strader et al., 2010).

IBA is hormone occurring in auxin group which used as an element in many commercial horticultural plant rooting products. It is also used for micro propagation. Function like regulation of root apical meristem size, root hair elongation, lateral root development, and formation of adventitious roots.

NAA is a synthetic plant hormone used for plant tissue culture like vegetative propagation. And other synthetic hormone is 2, 4-Dichlorophenoxyacetic acid it does not occur naturally in the environment. Growth of citrus fruit is regulated with 2, 4-D, it is also used as herbicides and pesticides(Tofanelli M.B.D. et al., 2014).

BIOSYNTHESIS

First time IAA was isolated by Fritz. W from human urine the most commonly detected natural auxin in indole-3-acetic acid(IAA), but on the basis of species, plant's age, season and the conditions under which it has been growing, other natural auxins have been identified such as 4-chloroindole-3-acetic acid,indole-3-acrylic acid,indole-3-butyric acid (IBA) (Enders T.A. and Strader L.C., 2015).

Tryptophan is amino acid to which IAA is chemically similar and tryptophan accepted to be the molecule from which IAA is derived. Three methods have been proposed to explain this conversion: simple conversion of tryptophan to IAA is, Tryptophan is converted to indolepyruvic acid through a transamination reaction where amino group is transferred to keto acid to form amines. Indolepyruvic acid is then converted to indoleacetaldehyde by a decarboxylation reaction which releases carbon dioxide. The final step incudes oxidation of indoleacetaldehyde gives rise to indoleacetic acid. Tryptophan undergoes decarboxylation resulting in tryptamine. Tryptamine is then deaminated by oxidation to form indoleacetaldehyde. Further indoleacetaldehyde oxidized to produce indoleacetic acid. Recently in the year 1991 as this 3rd mechanism has developed. IAA can be produced via a tryptophan-independent mechanism. This mechanism is imperfectly understood, but has been proven using trp (-) mutants. Certain other experiments have manifestedthat, this process is actually the preferred mechanism of IAA biosynthesisin some plants. (Woodward A.W and Bartel B, 2005).

2. Objective and Functions

Auxins tend to be concentrated in the meristems, growth centers which are at the forefront of growth. Centers release auxin molecules, which are then distributed towards plant body to roots. In this manner, the plant can coordinate its size, and the growth and development of distinct tissues based on the gradient of the auxin concentration (Overvoorde P. et al., 2010).

Auxin strongly influence processes such asinitiation of cell division,cell growth, cell wall acidification, , and organization of meristem giving rise to either unorganized tissue (callus) of defined organs (generally roots) and promote vascular differentiation (Bandurski et al., 1995; Brock and Kaufman, 1991).Auxin acts as key players in maintaining apical dominance, promoting root formation, affecting abscission and tropistic curvatures, fruit ripening and impeding senescence (Addicott, 1982; Chandler and Thorpe,1986; Liu and reid, 1992; Aloni, 1995; Tamas,1995).

3. Applications

Auxin concentration was higher in parthenocarpic ovaries than in normal ones and it increase to reach the first maximum two days after anthesis in the seedless fruits and six days later in the seeded ones (Pandolfini T., 2009).IAA is prime auxin found in plants.Synthetic auxin derivatives are still important herbicides for example 2, 4-dichlorophenoxyacetic acid is one of the world's most widely used weed killer (Grossmann K., 2003).Auxin influences cell division,cell elongation and cell differentiation.It diverse effect in plants might also extend to animals, as photo activatedauxin seems to have potential as a cytokinin in cancer therapy (Rechenmann C.P., 2010).Almost about century auxin have attracted so much attention it is because they have the capacity to influence growth. The availability of auxins in a plant is fulfilled through its biosynthesis. Auxin biosynthesis is a complex process,in the recent past;a considerable progress has been made in understanding the multiple pathways and the molecular mechanism of auxin biosynthesis (Chandler 2009; Normanly 2010; Mano and Nemoto 2012).

4. Conclusion

The auxin has extensive applications in a plant. It present at apical meristem of plant which helps in cell elongation which determines growth. Auxins carry out development changes in plants such as hydrotropism, geotropism, and phototropism which form the shape of plant body. At the different sites of the plant different types of auxin plays their crucial role in plants development.Synthetic auxins are also playing their role in various places such as it can be use as herbicides, pesticides, etc.

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