ROLE OF IAA IN PLANT GROWTH, DEVELOPMENT, AND INTERACTION WITH OTHER PHYTOHORMONES.

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Abstract:
Phytohormones are chemically synthesized molecule which are used different physiological functions of that one of phytohormone is called as Auxin One of the derivatives is considered as IAA (Indole Acetic Acid) An important factor in a plant's growth and development is phytohormones. The molecular underpinnings of numerous phytohormones, including their production procedures and crucial signalling. components IAA, also known as indole-3-acetic acid, is a hormone or regulator of plant growth. It is a particular auxin. It is a hormone that exists naturally in plants. It influences a variety of physiological processes and controls the expansion and development of plants. It can also be found in some bacteria and fungi, where it regulates gene expression and different physiological reactions. In this investigation we have discuss about the different aspect growth of plants' IAA also relation to plant pathogen interaction, We also discuss the different impact of IAA level and root development

Keywords : IAA, Auxin, Impact of Auxin in Plants, Root development and plant-pathogen interaction

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Introduction:

Phytohormones have a significant impact on a plant's growth and development. Many phyto-hormones' molecular foundations, including their biosynthesis processes, essential signalling elements, and transcriptional outcomes, have been explored over the course of decades of research. While the incredible complexity of each phytohormone route has been uncovered by this research, the links between the pathways are less clear. Evidence suggests that the numerous phytohormones behave as an interconnected network that cooperates to govern plant growth and development, in contrast to the classical approach in which each hormone regulates a set of distinct processes or enhances reactions to particular stimuli. These interactions essentially describe the phenomena wherein one hormone directly influences a feature of a distinct hormone to precisely regulate another hormone. This may be accomplished by directly changing the level of another hormone. Numerous elements of a plant's growth, development, and reaction to biotic and abiotic stress are regulated by plant hormones. Numerous studies have been conducted to better understand certain plant hormones, with an emphasis on their mechanisms of action and the processes they control. (Emenecker & Strader, 2020). Indole-3-acetic acid (IAA) controlled the radial location and leaf size during organ development in the shoot of Arabidopsis. Leaf production is restored when the natural auxin indole-3-acetic acid (IAA) is micro-applied to the apex of such pins. Similar to endogenous IAA, exogenous IAA stimulates flower development in Arabidopsis pin-formed1-1 inflorescence apices, where flower development is inhibited by a mutation in a potential auxin transport protein. It has been reported that auxin is essential for organogenesis to occur in both the vegetative tomato meristem and the Arabidopsis inflorescence meristem. In this study, organogenesis always strictly coincided with the site of IAA application in the radial dimension, whereas in the apical–basal dimension, organ formation always occurred at a fixed distance from the summit of the meristem. Its has been purpose that auxin determines the radial position and the size of lateral organs but not the apical–basal position or the identity of the induced structures (Reinhardt et al,.2000).

Auxin is believed to be produced in developing apical tissues and transferred through a polar transport system that can be inhibited by certain chemicals to the roots and mature stem. It is still unclear precisely which cells in the shoot tip produce auxin, and it is also unclear whether auxin is produced in the meristem itself. In stem tissues, the polar transport system has also been extensively researched (Davies, 1995). In very small quantities, phytohormones—chemical signals made by plants—coordinate the growth and development of the plants. Others, such as ethylene, abscisic acid, and jasmonates, limit growth activities by regulating growth inhibitory processes in plants, such as dormancy, abscission, senescence, etc. Autins, cytokinins, gibberellins, and brassinoste-roids promote shoot growth while others, such as ethylene, abscisic acid, and jasmonates, control growth activities. Auxins, one of the many phytohormones, function as a master regulator, controlling the majority of plant activities either directly or indirectly, and are therefore largely to blame for the developmental patterns in plants. (Ahmed, & Hasnain,2014)

IAA, also known as indole-3-acetic acid, is a hormone or regulator of plant growth. It is a particular auxin. It is a hormone that exists naturally in plants. It influences a variety of physiological processes and controls the expansion and development of plants. It can also be found in some bacteria and fungi, where it regulates gene expression and different physiological reactions. The first plant hormone identified was auxin. Charles Darwin and his son Francis Darwin noticed phototropism in the coleoptiles of canary grass and came to the conclusion that a substance at the coleoptile's tip affected the coleoptile's bending. Human urine was initially used to separate auxins. From oat seedling coleoptiles, F.W. Went extracted auxin. Auxin is interesting since it appears to be regulating the majority of plant growth and developmental responses. Additionally, interac-tions with other plant hormones usually involve auxin transport and response. (Weijers & Wagner 2016).Auxin controls cell division and expansion at the molecular level to influence plant growth and development. Unlike auxin, which is traditionally thought of as a "growth hormone" A major regulator of plant growth and development is the phytohormone auxin. The various restrictions that auxin exerts on cell division and cell growth are crucial to many facets of these processes. Despite recent advancements in the discovery of auxin, the precise processes by which auxin regulates these crucial cellular responses are still poorly understood. receptors and auxin signaling pathways' constituent parts. According to certain threshold concentrations and reactions that are cell- or tissue-specific, auxin is a key regulator of these cellular and developmental processes. Years ago, it was believed that the ideas of auxin sensitivity of a defined tissue and auxin concentration-dependent responses were incompatible (Perrot-Rechenmann, 2010). When they are artificially produced, phytohormones, which are naturally occurring substances, are referred to as plant growth regulators. Typically, environmental conditions that affect plants include drought and high soil and water salinity. Plants exposed to saline conditions may grow less slowly as a result of poor water relations or the metabolism-altering actions of certain ions. In saline environments, many tactics are being used to maximise plant development. One of them is to create genotypes of various crops that are salt resistant. Conventional plant breeding techniques are time-consuming, labor-intensive, and dependent on genetic variety in attempts to increase resistance to salinity (Javid et al,.2011).

The involvement of plant growth regulators in root development has been amply supported by numerous physiological and genetic research. Auxin has become recognised as a master regulator due to its clear function in root development. (Saini et al,.2013). Auxin stimulates a chain of events that results in root morphogenesis and development. Other plant hormones, such as cytokinins, brassino steroids, ethylene, abscisic acid, gibberellins, jasmonic acid, polyamines, and strigolactones, either work in concert with auxin or work against it. Recent years have seen an enhancement in our understanding of root growth thanks to the accessibility of biological resources, the creation of contemporary instruments, and experimental methods. Plant hormones have a symbiotic relationship with root development and differentiation in plants. One of the most well studied classes of plant hormones is auxin. Embryogenesis, organogenesis, tissue patterning, and tropisms are just a few of the many aspects of plant growth and development in which it plays a role (Quint et al,. 2013 and Saini et al,.2013). Indole-3-butyric acid (IBA) is a minor endogenous auxin that effectively promotes adventitious, root development and is frequently used in horticultural practises.(Saini et al,.2013).

Indole-3-acetic acid (IAA) is the primary auxin present in most plants and is responsible for root system architecture and various stages of root development. The paradigm change in the study of the developmental flexibility of roots from traditional to novel molecular genetic method logies strongly shows that auxin plays a crucial role in the formation of main roots (PR), lateral roots (LR), and root hairs (RH) (Osmont et al,.2013 and Saini et al,.2013).It is evident that auxin and GA co-regulate pollination and fertilisation through crosstalk even though they play distinct roles during fruit set and subsequent cell proliferation and expansion. Auxin/Indole-3-Acetic Acid (Aux/ IAA) and auxin response factor (ARF) proteins facilitate Auxin-GA communication, and products of the auxin-responsive Gretchen Hagen3(GH3) gene family maintain phytohormone homeostasis by conjugating free auxin molecules. (Fenn, & Giovannoni,2021)

Auxin Role in Plant Root development :

Without any doubt auxin plays an important and crucial role in plant development, in concert with a range of various other hormones so far identified (Edelmann 2022) In fact, it is this key observation that has been repeatedly demonstrated in countless studies dealing with IAA regulated root growth — it established the basis for a model on root growth regulation that has dominated research forthe last hundred years (Overvoorde et al,.2010)The most prevalent auxin class plant hormone, indole-3-acetic acid (IAA), influences a variety of aspects of plant growth and development. Additionally, a number of studies have demonstrated that IAA functions as a signalling molecule in microbes because to its impact on gene expression in various microbes (Fu et al,.2015)

IAA promotes root initiation and induces growth of pre-existing roots as well as adventitious root formation, or branching of the roots (Varga and Bruinsma, 1976). The total root development is promoted when more native auxin travels down the stem to the roots. The yield can be increased by the longer, branching roots because they can absorb more nutrients from the soil and store them in the plant's sink (Wang et al., 2005). Effect of exogenous IAA on the in vitro and in planta (colonisation) growth of Nostoc was evaluated by adding this drug to the culture media used to grow mutant Nostoc alone or in conjunction with rice root, under the previously stated growth conditions. IAA was added to the culture media used for free grown or root attached Nostoc in a concentration exactly equal to or double that created by the difference in its concentration between wildtype and mutant strains in order to recreate the concentration of IAA in the mutant strain (ipd C).For comparison with the approach for estimating chlorophyll-a, the plate counting method was also used to count the number of free grown and root associated Nostoc To count the colony-forming unit, pulverised root extracts and Nostoc culture dilutions were plated on agar plates. Growth and colonization was estimated after incubation of 15days.(Hussain et al,.2015)

Impact of Auxin on the Plants :

Compounds called auxins have a favourable impact on cell growth, bud development, and root initiation. Together with cytokinins, they influence the growth of stems, roots, and fruits as well as the transformation of stems into flowers. They also encourage the production of other hormones. The first class of growth regulators to be identified was auxins. According to (Lindsey, K. et al.2002), they modify cell wall flexibility, which impacts cell elongation. They encourage the division of cambium, a subclass of meristem cells, as well as the differentiation of secondary xylem in stems. Auxins work to stimulate lateral root formation and growth as well as to restrict the growth of buds lower down the stems (apical dominance). When a plant's growth point stops producing auxins, leaf abscission begins. After pollination, auxins in seeds control particular protein synthesis, leading the flower to build a fruit to house the growing seeds; Large amounts of auxins are poisonous to plants; they are most toxic to dicots and least hazardous to monocots. This feature has led to the development and use of synthetic auxin herbicides such as 2,4-D(2,4-dichloro phenoxy acetic) and 2,4,5-T for weed control. When taking plant cuttings, auxins, particularly 1-Naphthaleneacetic acid (NAA) and Indole-3-butyric acid (IBA), are frequently used to promote root growth. Indole-3-acetic acid, also known as IAA, is the most prevalent auxin found in plants (Toungos, 2018). Many facets of typical plant growth and development are controlled by the hormone auxin. Auxin is crucial for plant-microbe interactions, especially those between plant hosts and disease-causing pathogenic microbes. It is now well accepted that in many plant-pathogen interactions, indole-3-acetic acid (IAA), the auxin form that has been studied the most, causes illness. IAA can function as a plant hormone that modifies host signalling and physiology to improve host vulnerability and as a microbial signal that directly effects the pathogen to promote virulence, according to recent studies, but there are still many unanswered questions. (Kunkel, & Johnson 2021)

The highest yield and blossom count are produced by IAA in tomatoes. The action of NAA in cell elongation results in increased cell enlargement, cell division, and differentiation, which in turn result in an increase in the number of flowers, fruit set, size, and weight of fruit. Application of NAA increases tomato yield due to improved plant growth and a faster rate of plant development.

Relation of Plants Pathogen and Auxin level in Plants :

Numerous pathogenesis-related processes are encouraged by an increase in auxin levels and/or auxin signaling in infected host tissue, including epiphytic colonisation, stimulation of host cell division (Melotto, & Kunkel, 2013). (e.g. gall formation), inhibition of host defences, and promotion of pathogen growth in plant tissue (Barash, & Manulis-Sasson, 2009). Auxin can be thought of as a virulence factor in situations where the pathogen creates it on its own (Kazan, & Lyons, 2014). However, in some interactions, the pathogen activates the host's auxin biology through the action of virulence proteins that have evolved to influence host auxin biology, causing auxin accumulation or auxin signalling. Growing evidence links plant biotic and abiotic stress to the plant hormone auxin, which controls numerous aspects of plant growth and development (Fu, & Wang, 2011). Various diseases, such as P. syringae, Xanthomonas oryzae, and Magnaporthe oryzae, are made more susceptible by auxin. (Llorente, et al,.2008) A number of bacteria that produce gall exude auxins and cytokinins into the host to promote the growth of tumours or galls and infection. The necrotrophic fungal infections B. cinerea, Plectosphaerella cucumerina, and Alternaria brassicicola, on the other hand, are resistant to auxin signalling, which encourages resistance(González-Lamothe et al,. 2012). Through synergistic interactions with JA signalling, auxin signalling may also influence the onset of illness(Melotto, & Kunkel, 2013)..

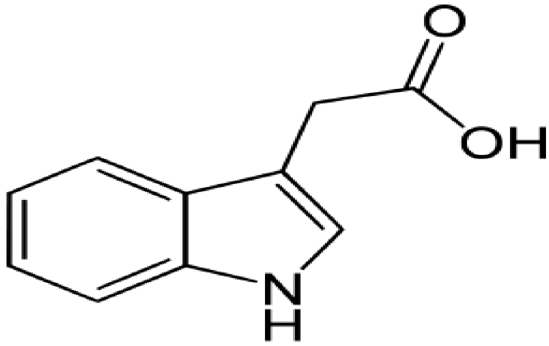

Fig no 01 Structure of IAA(Indole Acetic Acid)

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