# Auxin: Most Useful Plant Growth Regulator in the field of Agriculture

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## Abstract

Hormones promote growth within plants. Plant hormones are unequally distributed throughout the stems and roots, which results in parts of the plant growing in a particular direction. Some chemicals occurring naturally within plant tissues have a regulatory, rather than a nutritional role in growth and development. These compounds are generally active at very low concentrations, are known as *plant hormones* or *plant growth substances*. Some of the natural growth substances are prepared synthetically or through fermentation processes and can be purchased from chemical suppliers. When these chemicals have been added to plant tissue culture media, they are termed plant growth regulators in this book, to indicate the fact that they have been applied from outside the tissues (*i.e.* exogenously).

Auxins are the most important for regulating growth and morphogenesis in plant tissue and organ cultures. These synthetic regulators have been discovered with a biological activity, which equals or exceeds that of the equivalent natural growth substances.These however, can also affect the synthesis of other classes of hormone or growth regulator such as abscisic acid, sterols or brassinosteroids. The Present article focused on the uses and other physiological effects of Auxin.

**Keywards: Plant Growth Rgulators (PGR), Auxin, Synthetic Chemicals, Brassinosteriods etc.**

## Introduction:

Auxins are very widely used in plant tissue culture and usually form an integral part of nutrient media. They promote, mainly in combination with cytokinins, the growth of calli, cell suspensions and organs, and also regulate the direction of morphogenesis. The word auxin has a Greek origin: *auxein* means to enlarge or to grow. At the cellular level, auxins control basic processes such as cell division and cell elongation. Since they are capable of initiating cell division they are involved in the formation of meristems giving rise to either unorganised tissue, or defined organs. In organised tissues, auxins are involved in the establishment and maintenance of polarity and in whole plants their most marked effect is the maintenance of apical dominance and mediation of tropisms.

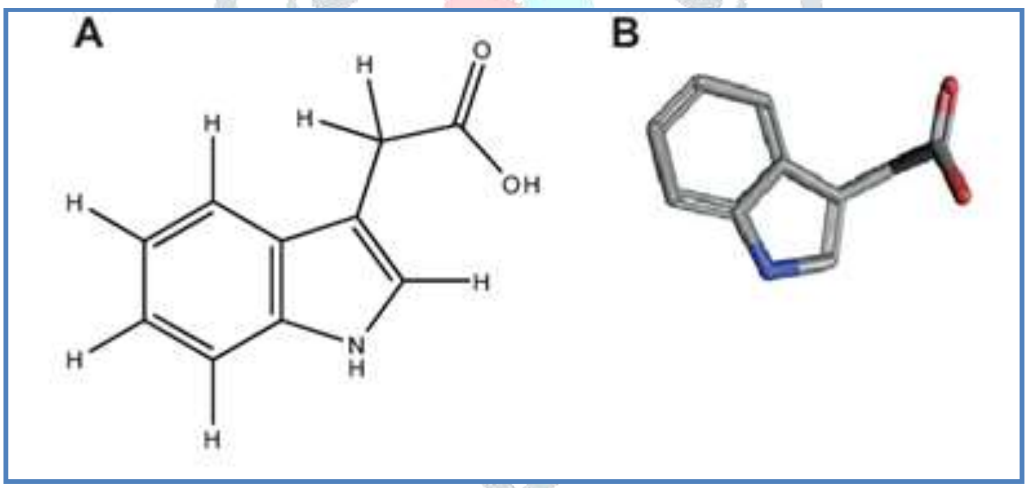
The choice of auxins and the concentration administered depends on:

- The type of growth and/or development required;
- The rate of uptake and of transport of the applied auxin to the target tissue;

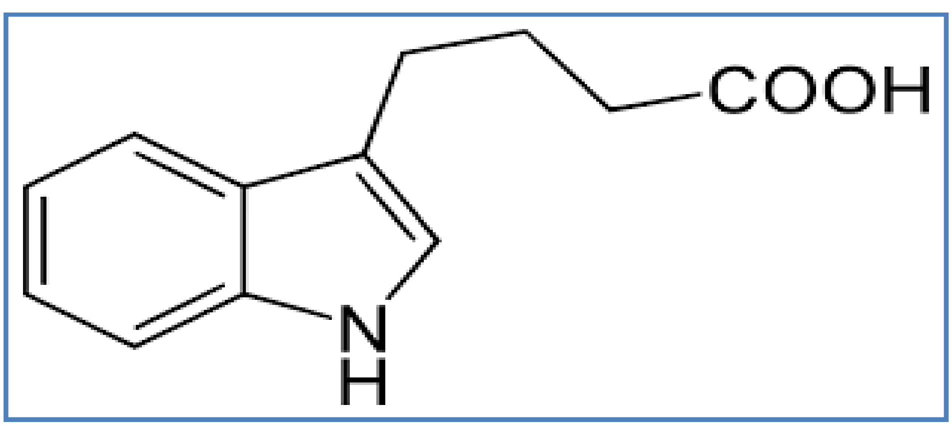
- The inactivation (oxidation and/or conjugation) of auxin in the medium and within the explant;
- The natural levels and the endogenous synthesis within the explant;
- The sensitivity of the plant tissue to auxin (and other hormones as well);
- The interaction, if any, between applied auxins and the natural endogenous substances.

**NATURALLY OCCURRING AND SYNTHETIC AUXINS:**

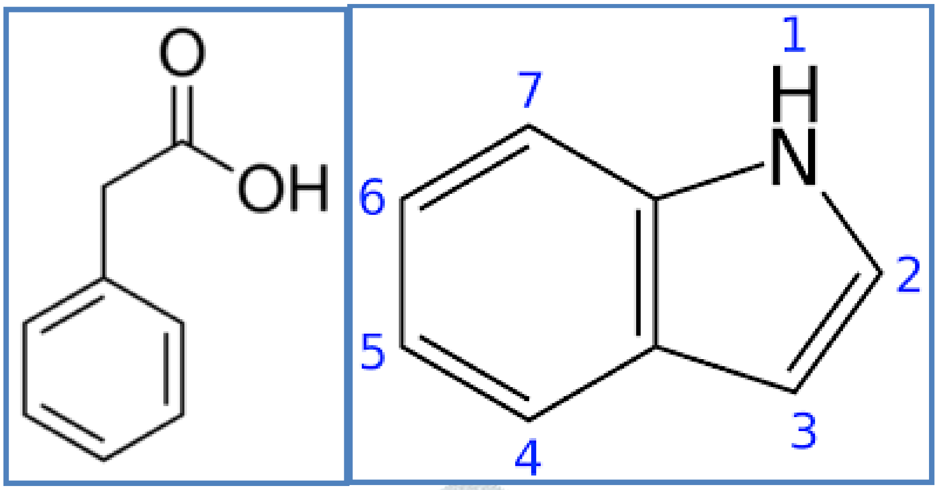
The most commonly detected natural auxin is IAA (indole-3-acetic acid) but endogenous occurrence of 4-chloro-IAA and indole-3-butyric acid (IBA) have also been demonstrated. Furthermore, the weak auxin phenylacetic acid (PAA) (4) occurs naturally in plants and there are precursors and metabolites of IAA present in plant tissues, like indole-3-pyruvic , tryptamine or tryptophol. In addition, the intermediate of agrobacterial IAA biosynthesis, indole-3-acetamide has been detected in plant tissues . Most of the IAA produced within plants is conjugated to other compounds to form esters, amides or glycosyl esters. The most commonly occurring IAA-conjugates are indole- 3- acetylaspartic acid (IAAsp) and a range of IAA glucose esters (IAAGlu). Conjugation seems to be a mechanism for storing IAA in cells, stabilising the level of free auxin in the plant, and metabolising its excess. Auxin in conjugated molecules is protected from oxidative breakdown and may be released again through the action of enzymes.




**Indole -3- Acetic acid**



**Indole-3-butyric acid**




IAA may be used as an auxin in plant tissue culture media, but it tends to be oxidised in culture media and is rapidly metabolised within plant tissues. However, this characteristic can be useful, because in some plants, callus induced by IAA (together with cytokinins) frequently gives rise to shoots or embryos as its effective concentration becomes diminished. IAA has also been used with other regulants to induce direct morphogenesis (including the rooting of microcuttings), and for meristem and shoot cultures in *Bougainvillea* and *Sinningia*. Decreasing IAA concentration may be important: in apple microcuttings high IAA at the beginning of culture induces root formation but, later on, the growth of roots is promoted by lower IAA concentrations. However, for many purposes, it is necessary or desirable to use one of the many synthetic analogues of IAA. These analogues have different structures but similar biological properties and are also called auxins. The synthetic auxins 2,4-dichlorophenoxyacetic acid (2,4- D) and naphthalene acetic acid (NAA) are not oxidised, but they can also be converted to conjugates with glucose

The synthetic auxins (including selenienylated IAA and 2,4-D) most commonly used in tissue cultures. N-(indole-3-acetyl) amino acids (*e.g*., conjugates with glycine, alanine, valine, leucine etc.) may serve as an efficient source of IAA in tissue cultures but are only very infrequently used to this purpose.

**PHYSICAL AND CHEMICAL PROPERTIES OF AUXINS:**

Natural and synthetic auxins are low-molecularweight, organic substances, containing either an indole or an aromatic ring. They are crystalline and only slightly soluble in water, but readily soluble in organic solvents (ethanol, methanol, acetone, diethyl ether and dimethyl sulphoxide, DMSO) or, as weak acids, in alkaline watery solutions. With the exception of IAA they are stable and persist in the media for tissue cultures. IAA is less stable and is especially sensitive to the light (mainly UV) and to oxidants (see below). Both naturally occurring indolic auxins and their synthetic counterparts, in spite of their different structures, have similar physiological effects. For auxin activity, an aromatic ring is needed at a distance of 0.55 Å from a carboxyl group. Indeed, all active auxins are weak organic acids. The relative degree of activity of individual auxins in different growth processes is very variable. It differs not only from plant to plant, but also from organ to organ, tissue to tissue, cell to cell and, moreover, also with the age and physiological state of the plant (tissue). Probably due to its high instability, IAA is usually less effective than synthetic auxins like 2,4-D or NAA.

## PHYSIOLOGICAL EFFECTS OF AUXINS:

In most auxin effects, a bell-shaped concentration/activity curve can be observed. At low concentrations (0.1 - 10 μM) the effect usually increases with concentration, but concentrations higher than 10 μM are often inhibitory. This inhibitory effect is usually due to an increase in ethylene production at higher auxin concentrations

## CELLULAR LEVEL:

A stimulatory effect on cell elongation can be demonstrated in segments of coleoptiles or stems at physiologically significant IAA concentrations. Auxin is in most cases active in the concentration range 0.1 – 10 μM. Activation of cell elongation by auxin is mediated by increased proton efflux and changes in gene expression. Both these theories were later combined into 'dual-sites' hypothesis . This hypothesis can explain the time-course of a typical biphasic auxin-induced elongation curve consisting of short-term (acid growth) and long-term (gene expression) responses (see also Cleland, 2004 for recent review). In nature, an increase in cell division is most obvious in the spring in trees, when young buds produce auxin, which stimulates cell division in the cambium. Auxin, together with cytokinins, is also involved in bud initiation and growth. Cell division seems to be regulated by the joint action of auxins and cytokinins each of which appears to influence different phases of the cell cycle. Auxins exert an effect on DNA replication, while cytokinins seem to exert some control over the events leading to mitosis. Normal cell divisions require synchrony between the S phase and cell division, suggesting that auxin and cytokinin levels in cultures need to be carefully matched.

Auxin starvation resulted in G2-arrest in tobacco cell suspension. Activation of cell division is also coupled with activation of cdc 2, the main cell cycle regulating kinase. Cells are thought not to enter mitosis unless cytokinin is present.

## TISSUE AND WHOLE PLANT LEVELS:

Auxins stimulate differentiation of vascular bundles and, as already discussed, they take part in differentiation of buds and roots. Auxin is gradually canalised by a positive feedback mechanism where increasing conductivity of auxin conducting cells leads to canals of cells efficiently transporting auxin. Polar transport of auxin (see above) is fundamental for the establishment and maintenance of polarity of the plant and its organs. Inhibition of polar auxin transport leads to many abnormalities and in embryos it can lead to death. Auxins are known for their ability to promote adventitious root formation. This action is definitely also coupled with stimulation of cell division – increased expression of cyclin B1 and cdc2 was observed well before the first cell division. Early stages of lateral root formation are also regulated by polar auxin transport IBA is by far the most commonly used auxin to obtain root initiation in conventional cuttings. It has been shown that IBA is readily converted to IAA, but it probably also has an effect on its own .

Polar transport of auxin is the decisive force of apical dominance. Removal of the tip, the main auxin source, or inhibition of auxin transport leads to the outgrowth of axillary buds. Also dominance of fruits is mediated by auxin transport. Uneven distribution of auxin is considered to cause differential growth rates in different sides (upper/lower or irradiated/shaded) of coleoptile or root and their bending in gravitropic or phototropic reactions.

## Use of Auxins in Field of Agriculture:

There are many types of plant hormones. They are used in agriculture and horticulture to have a specific effect.Auxins were the first class of plant hormones to be discovered. Their main function is to help plants grow and auxin stimulates plant cells to elongate. The apical meristem of a plant is one of the main places where auxin is produced. The apical meristem is also the location that all other parts of a plant grow from - the stem, leaves, and flowers. Auxins are one specific group of hormones that are used:

- as weed killers
- as rooting powders

**Weed killers:**

Selective weed killers kill some plants, but not others. This can be useful for getting rid of dandelions in a lawn without killing the grass. The selective weed killer contains a growth hormone that causes the weeds to grow too quickly and die. Because the weeds have broader leaves, the weed killer is absorbed in larger quantities by the weeds than it is by the grass. Selective weed killers can reduce biodiversity within treated areas due to specific plants being killed. Rooting powder contains plant hormones to promote growth.

Plant cuttings can be dipped in hormone rooting powder before planting.

Synthetic plant hormones are used to control plant growth. For example, rooting powder contains growth hormones that make stem cuttings develop roots quickly.

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