**PLANT GROWTH HORMONES**

**Growth** may be defined as a permanent and irreversible change in the weight, volume, size and shape of an organism.

**Phases of growth**Plant growth has been divided into three main phases:

1. **Meristematic phase**The cells of root apex and shoot apex are in meristematic phase. The cells are in a continuous state of cell division. Meristematic cells are rich in protoplasm and they are devoid of vacuoles. They have distinct nucleus and thin membraneous primary cell wall composed of cellulose.
2. **Cell elongation phase**Just behind the meristematic zone is present the region of cell elongation. In this region new cells undergo increase in length and breadth. The amount of cytoplasm also increases. Along with it, the cells develop vacuoles and secondary cell wall.
3. **Differentiation phase**Differentiation phase is also called the phase of maturation. The cells present just below the region of elongation acquire their final shape and simultaneously differentiate into different types of cells and tissues.This is known as the zone of cell differentiation.

**Plant growth hormones**

Plant growth hormones or plant growth regulators are organic substances which are synthesized in special tissues of plants and are transported to other issues where they in very small quantities regulate the growth processes taking place.The term hormone was first for use by starling in 1906.

Plant growth hormones are simple and small molecules having diverse chemical organisation. These are indole compounds (indole-3 acetic acid); adenine derivatives (furfurylamino purine); carotenoids; derivatives of fatty acid (Abscisic acid);terpine(gibberellic acid) or gases (ethylene C**2** H**4**)etc.

Main plant growth hormones are of following types:

**Auxins**

the term oxygenauxin has been derived from a greek word which means “to increase”. It was first isolated from human urine.The term auxinis used for indole-3 acetic acid and other natural and artificial compounds which can promote growth. It is usually synthesized in the apical region of stem and root and transported to the site of action. Some auxins obtained from plants are indole-3 Acetic Acid, indole pyruvic acid etc.

Darwin (1880) while experimenting on canary grass ( *Phalariscanariensis*) found that when the coleoptyle tip of the plant was exposed with light from one side then the coleoptyletip bends towards the direction of light. If the tip isdecapitated, no such bending response is observed.This proves that some special substance is synthesized in the apical region.

**Chemical nature of auxin**Auxins are of two types natural and synthetic.

**Natural auxin** Indole-3 acetic acid is found in all plants.Indole-3 butyric acid is found in maize and mustard.

**Synthetic auxin** some synthetic chemical compounds also act as auxin for example naphthalene Acetic Acid, 2,4-dichlorophenoxyacetic acid (2,4-D), 2,4,5-trichlorophenoxy acetic acid (2,4,5-T) etc.

**Functions of auxins** Functions of auxins are as follows:

1. **Cell division and cell enlargement**A suitable amount ofauxincatalyzes cell division in plants for example formation of callus, division of cambium and healing of damaged tissue.Auxins is responsible for shoot elongation through cell division.
2. **Apical dominance**Thegrowth of apical bud in higher plants interferes with the growth of lateral buds. This phenomenon is called apical dominance.Removal of the apical bud leads to growth of lateral buds. This technique is utilised in tea plantations and hedge making.
3. **Root differentiation in plants**In rose cuttings spraying of auxin promote the development of adventitious roots.
4. **abscission** In apple and pear spraying of auxins indefinite concentrations helps in avoiding premature fall of leaves and fruits.
5. **Parthenocarpy**Auxin can help in the production of fruits without fertilization in tomato, lemon, orange, banana, grapes etc.
6. **Callus formation**Auxin promotes callus formation.ifauxinis applied on the cut ends of a stem, the cells divide to form a callus.
7. **Control of dormancy**The produce of Some crops which are not available round the year need to be stored in storage houses for example potato.During storage due to the proliferation of buds the starch content decreases. Spraying of auxin stops bud proliferation.
8. **Control of lodging**The stem of some plants such as wheat are weak and therefore plants lodge during a strong winds and rain. Application of auxins make the stem strong and lodging is avoided.
9. **Initiation of flowering** in pineapple crops ifNAA is sprayed in low concentration all the flowers and fruits develop at the same time.
10. **Eradication of weed** Spraying of synthetic auxins, 2 4-D on crops results in destruction of dicot plants. It does not affect monocot plants.
11. **Higher concentration of auxin** promote shoot growth but inhibits root growth.

**Gibberellin**

This hormone was discovered by Japanese scientist Kurosawa in 1926.He observed that some plants in rice field where exceptionally long with long pale leaves and fewer grains. He named this disease bakane disease or foolish Seedling disease of rice. Later, it was reported that the disease is caused by a fungus *Gibberellafujikuroi* now called*Fusariummoniliforme*.

 Besides fungi, this hormone is found in higher plants also. Yabuta and Sumiki(1938) first of all isolated this hormone in crystal form. So far more than 135 types of gibberellins have been reported from plants.

**Functions of gibberellins**

1. **Elongation of genetically dwarf plants**Spraying of gibberellin can remove genetic dwarfism in some plants such as pea, bakla (*Viciafaba*), corn etc. In sugarbeet application of gibberellin removes rosette habit and helps in elongation of stem. This phenomenon is called bolting.
2. **Parthenocarpy** Gibberellin treatment helps in production of seedless fruits in some plants such as apple, tomato, pear, grapes etc.
3. **Breaking of dormancy** The dormancy of winter birds in the tuber of potato can be broken by the application of gibberellin. This function is contrary to the action of abscisic acid.
4. **Seed germination** Gibberellin promotes the synthesis of alpha amylase enzyme in germinating seeds. This results in hydrolysis of starch present in endosperm and cotyledons which help in seed germination.
5. **Substitution for cold treatment**In some biennial plants, for flowering a low temperature stimulus is required.Due to this, flowering in these plants only occurs in next winter.Application of gibberellin replaces the requirement of low temperature stimulus and flowering can occur in the same year. In some other plants longer duration of exposure to light is required for flowering. In these plants also, gibberellin can replace this equirement. f
6. **Delay in senescence**Gibberellin can delay the senescence of fruit trees and thus sustained availability of these products in the market.
7. **Stem elongation** Treatment with gibberellin can bring internodal elongation in sugarcane. This increases the sugar yield.

**Ethylene**

Denny in 1924 observed that ethylene gas induced the ripening of fruit. Zimmerman *et al*(1931) reported that ethylene promoted abscission of leaves.In 1962, ethylene was recognised as a plant hormone by Berg.

In plants ethylene hormone is synthesized in ripening fruits, leaves, flowers, fruits and seeds.Ethylene is simple gaseous plant growth regulator.It is synthesized in large amount in tissues undergoing senescence and also ripening fruits.Ethylene affects lateral growth in plants.It promotes senescence and abscissionmainly in leaves and fruit.It is very effective in fruit ripening.Ethylene increases the rate of respiration during fruit ripening.This increase in respiration rate is called climacteric.

Ethylene breaks the dormancy of seeds and buds.It initiates seed germination in groundnut.It is also responsible for germination of potato tubers.Ethylene promotes rapid elongation of paddy foliage submerged in water. This helps the leaves keep above water level.Beside this ethylene promotes growth of root and root hairs.This helps in increasing the absorptive area of the plants.

Ethylene helps in flowering and fruit maturation in pineapple.It also helps in flowering of mango.As ethylene regulates many physiological processes, it is the most widely used growth regulator in agriculture.

Ethephon is the mostly used form of ethylene.Ethephoneasily form solution with water and also has a smooth transport in plants. It also releases ethylene in sustained manner. Ethephon increase the rate of ripening in tomato and apple. It accelerates abscission of flowers and fruits (cotton, Cherry and walnut etc.). Application of ethephon increases the number of female flower in cucumber and thus increases crop yield.