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FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES

- These are organic compounds other than nutrients, which in small amounts promote, inhibit or otherwise modify any physiological process in plant. **Or** It may be defined as any organic compounds which are active at low concentrations (1-10 ml) in promoting, inhibiting or modifying growth and development in plants.
- The naturally occurring (endogenous) growth substances are commonly known as *Plant Hormones*, while the synthetic ones are called *Growth Regulators*.

Plant Hormones

- It is an organic compound synthesized in one part of plant and translocated to another parts, wherein very low concentration causes a physiological response.
- The plant hormones are identified as promoters (auxins, gibberellin, cytokinins), inhibitors (abscisic acid and ethylene) and other hypothetical growth substances (Florigen, death hormone, etc.).

Auxin

- Auxin is a greek word derived from Auxin which means to increase. It is a generic term for chemicals that typically stimulate cell elongation by loosening cell wall but auxins also influence a wide range of growth and development response.
- The chemical isolation and characterization was done by Kogi et al. (1934). Auxins are the first identified hormones of which IAA seems to be the major naturally occurring endogenous Auxin in plants and crops.
- Besides IAA, plants contain three other compounds which are structurally similar and elicit many of the same response as that of IAA, 4, Chloro indole acetic acid (CIAA), Phenylacetic acid (PAA), Indole butyric acid (IBA).

Site of Auxin Synthesis

- Auxins are synthesized in stem tips and in young tissues and move mainly down stem (*Basipetal Movement*) i.e from shoot tip to root.
- Synthetic compounds are classified into five major categories:

1. Indole acids
2. Napthalene acids
3. Chlorophenoxy acid
4. Picolinic acid.
5. Derivatives.

Role of Auxin

1. Cell division and enlargement: IAA + GA, example - cambial growth in diameter.
2. Tissue Culture: Shoot multiplications (IBA and BAP), callus growth (2, 4-D), root multiplication IAA and IBA (1-2 mg).
3. Breaking dormancy and apical dominance (inhibition of lateral buds): NAA
4. Shortening internodes: Apple trees (NAA) dwarf branch fruit.
5. Rooting of cutting: (10-1000 ppm-NAA, IAA, Phenyl acetic acid)
6. Prevent Lodging: NAA develop woody and erect stem.

7. Prevent Abscission: premature leaf, fruit and flower fall (NAA, IAA and 2,4-D).
8. Parthenocarpic fruit: Grapes, Banana and Orange (IAA).
9. Flower Initiations: Pineapple uniform flowering and fruit ripening (NAA) and delay flowering (2, 4-D).
10. Weed Iradication: 2, 4-D.

Gibberellins

- It is the active principle isolated from the soil borne fungus *Gibberella fujikuroi*.
- The concentration of GA3 is usually highest in immature seeds, reaching up to 18 mg/kg fresh weight in *Phaseolus species*, but it decreases rapidly as the seeds mature.
- In general, roots contain higher amounts of GA3 than shoots.
- Gibberellins have also been found effective in overcoming both kinds of dormancy in buds as well as seeds.

Role of Gibberellins

1. GA : Synthesis in leaf and induce shoot elongation (IAA + GA3), by effecting cell elongation or cell division or both.
2. Enhance metabolic activity: Mobilization of reserved food material, promote growth and height, increase root activity and kinetin production in root- translocate to growing bud.
3. Shoot elongation: GA3 spray increases height of seedlings.
4. Delay senescence: Increase photosynthetic and protein synthesis so decrease abscission.
5. Increase cambial growth and differentiation: Induce flower and fruit set (IAA+GA3).
6. Dwarf plant (genetically) to normal height: GA3.
7. Promote flowering in Long Day Plants: Substitute for long day condition and cold treatment (vernalization).
8. Induction of parthenocarpy in grapes: Three physiological events: Rachis cell elongation, flower thinning and berry enlargement.
9. Breaking dormancy and leaf expansion.

Cytokinins

- First endogenous cytokinin was isolated from maize kernels named as zeatin.
- Germinating seeds, roots, sap streams, developing fruits and tumor tissues are rich in cytokinins.
- Cytokinins imbibed seeds germinate better in dark than unimbibed lettuce seeds.
- Similarly cytokinins together with gibberellins effectively breaks the photodormancy of celery (*Apium graveolens*) seeds.

Synthetic cytokinins are: Kinetin, Benzyladenine and Ethoxy ethyladenine.

Role of cytokinin

1. Cell division, elongation and enlargement.
2. Tissue culture morphogenesis.
3. Induction of flowering and fruit development.
4. Parthenocarpy.
5. Apical dominance overcoming.

6. Breaking dormancy.
7. Delay senescence.

Improves N2 metabolism.

Ethylene

- Neljubow (1901) is credited with having identified the active growth regulating component of the illuminating gas as ethylene.
- Ethylene is formed naturally in plants in amounts sufficient to bring about regulatory effect and it might be considered as plant hormones.
- Ethylene may be active in alleviation of secondary dormancy also. (Ross, 1984).
- Recently a synthetic chemical known as ethrel, ethephon, chloroethyl phosphonic acid (CEPA) has been reported to release ethylene when applied to plants.

Role of Ethylene

1. Breaking dormancy.
2. Induce ripening of fruits.
3. Induce abscission of leaves.\
4. Inhibit elongation and lateral bud growth

Growth Retardant

- The term growth retarding chemical or growth retardant is that chemical slows cell division and cell elongation of shoot tissues and regulate plant height physiologically without formative effects.

E.g: AMO 1618, Phosphon-D, CCC, Chloromequat and Alar.

- These do not occur naturally in plants and acts in retardation of stem elongation, preventing cell division.
- Plant growth retardants are defined as synthetic organic chemicals that cause a retardation of cell division steps in pathways of hormone biosynthesis without evoking substantial growth distortions.

Inhibitors

- These suppress the growth of plants.
- There are phenolic inhibitors and synthetic inhibitors and abscisic acid(ABA).

Phenolic inhibitors: E.g. Benzoic acid, Salicylic acid, Coumaric acid and Chlorogenic acid.
Synthetic inhibitors: E.g. Maleic hydrazide, Tri-Iodobenzoic acid(TIBA), SADH etc.

- An inhibitor from young leaves of Betula sps. prevent the growth of apical buds . E. g. ABA and Dormin.

Role of Abscissic acid (ABA):

1. To stop elongation.
2. Induce dormancy.
3. Delay germination.
4. Inhibit growth process.

Methods of Application

Growth regulators can be applied in different ways like

1. Spraying method.
2. Injection of solution into internal tissues.
3. Root feeding method.
4. Powder form.
5. Dipping of cuttings in solution.
6. Soaking in dilute aqueous solution.

Various Uses of Plant Growth Regulators

Propagation of Plants

- A number of plants are propagated by stem, leaf cutting and by layering. For promotion of rooting, the most commonly utilized hormone is IBA followed by NAA.
- Gibberllic acid causes inhibition of root formation in cutting. Cytokinins also help in quick and profuse root formation in cuttings and layers.
- By use of auxins, profuse root formation is observed in cuttings of guava, fig, pomegranate, crotons, rose, hibiscus, etc.

Seed Germination

- Many seeds have natural dormancy which can be got over by dipping the seeds in auxins.
- Soaking seeds of french beans and peas in 10-20ppm solution of GA for 12 hours before sowing, significantly improves the yield and quality.
- Dipping sweet potatoes in 5ppm GA solution for 5minutes before sowing increases sprouting and yield of potatoes.

Control of Plant Size

- In fruits and vegetables, application of higher doses of nitrogenous fertilizers spraying cycocel (growth retardant), the superfluous growth of leaves is checked.
- By spraying 10ppm solution of morphactin in potato, the growth of plant is reduced and thereby the size of tubers is increased.
- The growth retardants are useful in checking the growth of hedges in ornamental gardens there by reducing the cost of trimming the hedges.

Regulation of Flowering

- In Pineapple, due to later flowering the fruit get ready in rainy season.
- This deteriorates the quality of the fruit.
- This difficulty can be overcome by spraying 5-10 ppm solution of NAA before flowering.
- Application of 100-200 ppm GA in Dahlia plants induces early flowering.
- Sometimes, it is necessary to delay flowering. E.g. Crossing of varieties which do not flower simultaneously. Hence, the crossing becomes difficult.

Control of Sex Expression

- In number of cucurbits, such as ridgegourd, bittergourd, watermelon, cucmber and pumpkins which have proportion of male flowers is more than female flowers.
- For better yield, it is necessary to increase the number of female flowers.
- This can be achieved by application of auxins which increases the number of female flowers and decreases the number of male flower.

- The commonly used auxins are NAA and ethrel.

Control of Fruit Set and Growth of Fruit

- Spraying NAA, TIBA, and PCPA on flowers increases the fruit set.
- Dipping of grape bunches (young fruits) in GA solution increases the berry size in Thompson seedless grape.

Control of Fruit Drop

- In Nagpur Santra, the fruit drop can be controlled by spraying 10-20 ppm NAA or 10 ppm 2,4-D after fruit set.
- The fruit drop in mango can be controlled by these two auxins.

Thinning of Fruits

- Sometimes it is necessary to thin the fruits so as to bring a balance between the supply of nutrients and development of fruit.
- In such cases spraying with mild solution of ethrel or morphactin reduces the fruit load by 25-30 per cent.

Early Ripening and Development of Fruit Colour

- If the fruits could be brought in the market in early part of the season, they fetch good price.
- Spraying with 2,4,5-T and B-9 hastens maturity of apples by 1-4weeks.

Prevention of Sprouting

- In potatoes and onions, after harvest, in storage, the buds start sprouting which makes them unfit for cooking.
- Spraying of malic hydrazide (MH) solution before storing, prevents sprouting and these can be stored safely for 6 months.

Control of Weeds

- The conventional method of controlling the weeds is to remove them by uprooting manually. Successful control of weeds is obtained by spraying 2,4-D in many crops.