PLANT HORMONES

These are compounds, mostly organic while some are gases. They help to regulate some process in the growth and development of plants.

They generally apply to substances made in one part of the plant and translocated to some other parts where they are needed and induce physiological effects.

Plant hormones often called phytohormones are often synthesized in the meristematic and young tissues and often exert there effects after translocation to some relatively distant tissue from the one in which they originate.

The phytohormones include Auxins, Gibberellins, Cytokinins, Abscisic acis, Ethylene etc.

AUXINS

The auxins are formed in the apical meristem of the stem and the root. Also formed in areas of active division such as buds, flowers or inflorescence or growing flower stock and then transported to other parts of the plant to produce a particular physiological effect.

Auxin movement is strictly longitudinal (polar) normally stem apex of the shoot downwards (this is called basipetal translocation). In few cases, upward transpiration current. At low concentration, they stimulate growth while at high concentration they retard growth.

Naturally occurring auxin (i.e IAA) is synthesized from the amino acid, tryptophan. However, certain other synthetic compounds (not formed in the plant) induce reactions in the plants similar to those caused by IAA. Such syntheric auxins include Indole Butyric Acid (IBA), x-Naphthalene Acetic Acid (NAA), 2,4-dichlorophenoxy Acetic Acid (2,4D), NaphtoAcetic Acid, Triodobenzoic Acid.

CYTOKININS

These are hormones with basically the purine structure. Cytokinins (formerly called kinins) include Kinetin (6-furfury/amino purine). In most cases, kinetin's are not known to be natural plant constituent and is probably not a true plant b

Hormones but have many effects on plant growth and development.

A naturally occurring cytokinin Zeatin, formerly isolated from Zea Mays grains is found in other plants. Some closely related compounds have been found to exhibit cytokinins activities such synthetic amino acids will include Benzyl Amino Purine (BAP). The natural cytokinins appear to remain principally in the apical root meristems, infloresences and developing fruits.

Some certain cytokinins have been founded to be constituent of certain ERNA molecules in a number of different organisms. The manner of translocation of cytokinins is probably through the xylem to other parts of the plant.

ABSCISIC ACID (ABA)

This hormone is widespread in higher plants and is found in many different organs (both old & young) of plants. ABA induces abscission (detached of plant parts that are dead) variety of

plants and fruits of some plant species. Some other hormones such as IAA and Ethylene interact with ABA in the control of abscission. ABA appears to be an internal factor inducing dormancy in buds of some woody plants. ABA also prevents or delays the germination of many kinds of seeds.

ABA retards the growth of a large variety of plants tissues, and organs including leaves, coleoptiles, sterms, roots etc. it promotes senescence (process of ageing) through leaf abscission, degeneration of excised leaves and acceleration of decomposition of chlorophyll. This hormone also inhibits flower induction in some long day plants.

ETHYLENE
CH_2CH_2

This gas is synthesized in and released from plant tissues. It exerts marked physiological effect at very low concentrations. When present in excess, it escapes from the plant tissues. This means, ethylene from one plant source may move to and influence the development and physiological reactions of other nearby plants. This hormone operates as a fruit – ripening hormone. E.g. treatments of fruits like bananas, oranges, mangoes etc when matured but not yet fully ripened, with ethylene hasten their ripening. This type of treatment is of commercial importance.

Endogenously generated ethylene plays a role in normal abscission process especially in interaction with IAA and ABA.

GIBBERELLINS
OR
GIBBERELLIC ACID

Gibberellins or gibberellic acid are structurally distinctively and closely knit group of plants hormones. About 35-44 different gibberellins (designated GA_1, GA_2, GA_3 etc) all closely related chemically and found to be naturally occurring in higher plants or in the original fungus source. They are of wide occurrence in vascular plants most especially in very low concentrations. The best known of the gubberellins is gibberellic acid – A_3 (GA_3).

The main sites of synthesis of gibberellins in the higher plants are meristematic leaves, root tips and developing seeds. Translocation of gibberellins occur quite freely in both the xylem and the phloem. The gibberellins rival auxins in their physiological effects in the plants. Gibberellins can substitute at least in parts or real light induction of leaf expansion and also in the breaking of dormancy of some light sensitive seeds e.g. lettuce. Many long day plants have been induced to flower in short days after treatment with gibberellins.

PLANT NUTRITION

CLASSIFICATION OF PLANT MINERAL NUTRIENTS BASED ON THEIR BIOCHEMICAL FUNCTIONS

GROUP 1 – Nutrients part of carbon compounds

1. **NITROGEN (N):** This is a constituent of amino acids, amines, proteins,nucleic acids, nucleotides, co-enzymes, hexoamines.
2. **SULPHUR (S):** This is a component of cysteine and cystine, methionine, proteins, lipoic cell wall, co-enzymes A, thymine, pyrophosphate, biotin, Adenosine -5-phosphosulphate.

GROUP 2 – Nutrients that are important in energy storage or structural integrity.

1. **PHOSPHORUS(P)**: This is a component of nucleotides, oc-enzymes, phospholipids etc. The phosphorus always have a key role in reactions that involve ATP.
2. SILICON (Si): This is deposited as amorphous silica in cell walls. It contributes to cell wall mechanical properties including rigidity and elasticity.
3. BORON (B): This complexes with mannitol, polymannuronic acid, mannan and other constituents of cell wall. Boron is involved in cell elongation and nucleic acid metabolism.

GROUP 3 – Nutrients that remain in ionic form.

1. POTASSIUM (K): This is requires as a cofactor of more than 40 enzymes. It is a principal cation in establishing cell turgor and maintaining cell electro-nentality.
2. CALCIUM (Ca): This is a constituent of middle lamella of cell walls. It is required as cofactors by some enzymes involves in the hydrolysis of ATP and phospholipids. It acts as a second messenger in metabolic regulation.
3. MAGNESIUM (Mg): This is required by many enzymes involves in phosphate transfer. Magnesium is a constituent of chlorophyll molecule.
4. CHLORINE (Cl): This is required for photosynthetic reactions involved in O2 evolution.
5. MANGANESE (Mn): This is required in the activities of dehydrogenases, decarboxylases, kinases, oxidases and peroxydases involved with other cation activated enzymes and photosynthetic O2 evolution.
6. SODIUM (Na+): Sodium is involved in the regeneration of phosohoinol pyruvate in C4-plants and CAM-plants. They substitute for potassium in some functions.

GROUP 4 – Nutrients that are involves in Redox reactions.

1. IRON (Fe): Iron is a constituent of cytochromers, some iron proteins involved in photosynthesis. It is also involved in nitrogen fixation and respiration.
2. ZINC (Zn): Zinc is a constituent of alcohol dehydrogenase, glutamic dehydrogenase, carbonic anhydrase.

3. COPPER (Cu): Copper is component of ascorbic acid oxides, thyroximase, cytochrone oxidase, phenolase etc.
4. NICKEL (Ni): Nickel is constituent of urease (enzyme involved in reaction of uric acid). It can be found in nitrogen fixing bacteria. They are constituent of hydrogenase.
5. MOLYBDENUM (Mb): Constituent of nitrogenase, nitratereductase, Xanthine dehydrogenase.

MYCORRHIZAL FUNGI AND NUTREINT UPTAKE

Most of the mineral elements that go into the roots are mostly by direct acquisition from the soil atmosphere which is full of most of these elements in the soil solution. This process can be modified by association of mycorrhizal fungi with the root system.

Mycorrhizae (plural) are not usual. They are indespread under natural conditions. Much of the worlds vegetation appears to have roots associated with mycorrhizal fungi. 83% of dicot, 79% of monocots and all gymnosperms regularly form mycorrhizal association.

However, plants from the family Cruciferae (Gabbage), chenopodiaceace (spinach), proteacea as well as aquatic plants rarely have myesrrhizae.

Mycorrhizea are absent from rrot in very dry, saline or flooded soils or where soil fertility is extreme (either high or low). Plants grown under hydroponics and young rapidly growing crop plants seldom have mycorrhizea.

The mycorrihazal fungi like others are composed of filamentous hyphae and the mass of hyphae (i.e mycelium). There are two major classes of mycorrhizal fungi. These are:

i Ectotrophic Mycorrhizal Fungi (EMF)

ii Vesicular – Arbuscular Mycorrhizal Fungi (VAM) .

These are the two most important uptake in plants. Others minor classes of mycrrihizal fungi include:

i Ericaceous mycorrhizal fungi,

ii crehidaceous mycorrhizal fungi, which may have limited importance in terms of nutrient uptake by the root of plants.

ECTOTROPHIC MYCORRHIZA FUNGI

EMF typically show a thick sheath or mantle of fungi mycelium around the roots and some of the mycelium penetrate between the cutical cells.

The cutical cells themselves are not penetrated by the fungi hyphae but instead are surrounded by network of hypae called the HARTIG NET. The amount of fungal mycelium is often so extensive that its total mass is comparable to that of the roots themselves. The fungi mycelium also extends where it forms individual hypae or strands containing fruiting body.

The capacity of the root system to absorb nutrients is improved by the presence of external fungi hypea that are much finor than plant roots and can reach beyond the areas of nutrient – depleted soil near the roots.

The actotrophic mycorrhiza fungi infect exclusively tree species including the gymnosperms and woody angiosperms.

VESICULAR ABBUSCULAR MYCORRHIZA FUNGI

Unlike the EMF, the VAM fungi do not produce a compact mantle of fungi mycelium around the roots. Instead, the hypea grow in a less dense arrangement both within the roots itself and extending outwards from the roots into the surrounding cells.

After entering the roots through either the epidermis or a root hair, the hypea not only extend through the regions between cells but also penetrate the individual cells of the cartex. Within the cells of the cortex, the hypea can form oval structures called VESICULES and branched structures called ARBUSCULES. The arbuscules appear to be the sites of nutrient transfer between the fungus and the host plant.

Outside the root, the external myolium (VAM) can extend several centimeters away from the root and may contain spore-bearing structures. Unlike the EMF, VAM fungi make up only a small mass of the fungi material which is unlikely to exceed 10% of the root weight.

VAM fungi are found in association with the root of most species of herbaceous angnosperms. The association of VAM fungi of the roots of plants facilitate the uptake of the roots of plants facilitate the uptake of phosphorus and trace metals such as zinc and copper. By extending beyond the depletion zone for around the roots, the external mycelium improves phosphorus absorption. Research has shown that the roots associated with mycorrhizal fungi can transport phosphorus at a rate more than four times higher than that of a root not associated with mycorrhizal fungi.

The external mycelim of EMF can also absorb phosphate and make it available to plants. In addition EMF proliferate in the organic litter of the soil and hydrolyse organic phosphorus for transfer to the root.

MOVEMENT OF NUTREINT FROM MYCORRHIZAL FUNGI TO PLANT ROOT CELLS

Little is known about the mechanism by which mineral nutrients are absorbed by mycorrhizal fungi and transferred to plant root cells. With EMF, inorganic phosphate may simply diffuse from the hyphae into the net and be absorbed by the root autical cells. With VAM fungi, the situation may be more complex. Nutrient may diffuse cells, alternatively, because some root arbuscles are continually degenerating why new ones are forming. Such degeneration arbuscules may release their internal context to the host root cells. A key factor in the extent of mycorrihizal association with the plant root is the nutritional status of the host plant e.g. moderate deficiency of a nutrient such as phosphorus tends to promote infection. Mycorrhizal association in well fertilized soils may shift from symbiotic relationship to a parasitic one in that the fungus still obtains CHO from the host plant but the host plant nolonger benefit from improved nutrient uptake efficiency. Under such conditions the host plant may treat mycorrhizal fungi as it does other pathogens.

PLANT GROWTH ANALYSIS

If we wish to measure the bio productivity if natural ecosystem or agricultural crops, the component of immediate interest is the total yield or net primary production. It is usually necessary to restrict our interest to above ground parts and in agricultural crops only in economic yield e.g the grains of cereals.

BASIC PRINCIPLES OF MEASUREMENT

Two types of measurement are needed for growth analysis. These are:

1. PLANT WEIGHT: This is usually the oven dried weight (g or kg) or it can be the organic matter or energy content.
2. SIE OF ASSIMMILATORY SYSTEM: This is usually the leaf area (cm2, mm2, m2) but can also be the leaf protein or chlorophyll content.

This primary data of growth analysis can be made on individual plants derived from both canopies through the destructive nature of techniques required the use of homogenous sets of plants or plots of land. In this simple form, plant growth analysis requires little more than a balance, photosensitive paper, graph sheet and a calculator for quit detailed studies of quantitative aspect of dry matter.

The quantitative description of growth is based on several terms. The terminology used here follows that of Hunt (1978) which refers to the components of growth in terms of single letters of single letters for ease of mathematical notation.

COMPONENTS OF CLASSICAL GROWTH ANALYSIS

1. RELATIVE GROWTH RATE (RGR OR R) The relative growth rate of plant or crop is defined at any instant in time (t) as the increase of material per unit of material present. It is the only component of growth analysis which does not require the knowledge of the size of assimilatory systems. (leaves x systems).

$$R = \frac{\text{Log } W_2 - \text{Log} W_1}{T_2 - T_1}$$

OR

$$R = \frac{\text{Log}_2 \text{ TDW}_2 - \text{Log}_2 \text{ TDW}_1}{T_2 - T_1}$$

W_2 = second measured weight

W_1 = first measured weight

TDW_2 = second measured total dry weight

TDW_1 = first measured total dry weight

T_1 = initial time (days, months, etc)

T_2 = final time (days etc)

The unit of RGR or R is:

(Weight Weight $^{-1}$) time $^{-1}$ e.g .gg $^{-1}$ time $^{-1}$ RGR or R represents the efficiency of the plants raw material. The RGR or R serves as a fundamental measure of dry matter production and can be used to compare performance of species or the effects of treatments under strictly defined conditions.

However R, tells little about causal factors which determines the performance. These factors are included in other components of growth analysis such as the net assimilators rate (NAR) or (E) and leaf area ratio (LAR) or (F).

2. NET ASSIMILATION RATE (NAR) OR UNIT LEAF RATE (ULR) : The unit leaf rate (E) of a plant or crop at any instant in time (t) is defined as the increase of plant material per unit of time. The NAR measures the net gain in dry weight of the plant per unit leaf area (kg/m_2).

$$E = \frac{W_2-W_1}{A_2 - A_1} \cdot \frac{\log_2 A_2-\log_2 A_1}{T_2 - T_1}$$

$$E = \frac{W_2- W_1}{T_2 - T_1} \cdot \frac{\log A_2-\log A_1}{{}_A2 - A_1}$$

OR

$$E = \frac{TDW_2 - TDW_1}{T_2 - T_1} \cdot \frac{\log LA_2 - \log LA_1}{LA_2 - LA_1}$$

OR

$$E = \frac{TDW_2-TDW_1}{LA_2 - LA_1} \cdot \frac{\log LA_2 - \log_2 LA1}{T_2 - T_1}$$

Where LA_1 = Initial leaf area

LA_2 = final leaf area

W_1 = Initial measured weight

W_2 = final measured weight

TDW_1 = Initial total dry weight

TDW_2 = Final total dry weight

3. LEAF AREA RATIO (LAR OR F) : The leaf area ratio of a plant or crop at any instant in time (t) is the ratio of assimilatory material per unit of plant material.

$$F = \frac{\frac{LA_1}{W_1} \cdot \frac{LA_2}{W_2}}{2}$$

The unit of F = Area (weight $^{-1}$) i.e $cm^2\ g^{-1}$ or $m^2\ kg^{-1}$

Where LA_1 = Initial leaf area

LA_2 = Final leaf area

W_1 = Initial weight

W_2 = Final weight

For the various components of classical growth analysis considered earlier on (i.e RGR, NAR and LAR) at time (t) (t_1, t_2 etc), you need to measure

i the net gain in dry weight (W). Hence measurement of initial dry weight (W_1) and final dry weight (W_2).

ii the leaf area, the initial (LA_1) and final (LA_2).

iii the time (t) at which all these are measured. Hence one can measure the RGR, NAR and LAR from three parameters: Weight (W), Area (A) and Time (t).

A. The dry weight can be done in electric oven at 700C for 24hours, cooled and weight. The procedure should be repeated and the material should be weighted several times until a constant weight is achieved.
B. The LA can be measured by plucking the entire leaves of the plant in question and spreading over the PLANEMETER or the Lambda LEAF AREA METRE. But where this is not within reach, a rough estimate of the leaf area measurement can be achieved using the graph paper. The entire leaf area is traced on a graph paper and calculated by counting the cm2 covered by the leaf area on the graph sheet.

However, approximation of many incomplete squares often lead to error.

SEED DORMANCY AND GERMINATION

DORMANCY

Dormancy is a physiological quiescence often observed in viable seeds. It is a condition in which a seed with viable embryo fails to germinate under favourable environmental conditions such as good supply of oxygen, adequate moisture and temperature.

TYPES OF DORMANCY

1. Temporary Dormancy
2. Physiological Innate Dormancy

CAUSES OF PHYSIOLOGICAL INNATE DORMANCY

1. Seed hardness: add seed coats can serve as barrier to germination and development of embryo. Hardness of testa or seed covering is another cause.

SOLUTION

a. Scarification
    i. Chemical Scarification: Use of concentrated inorganic acids, conc. Sulphuric acid, ether and acetone absolute ethanol, inorganic salt ($KMNO_4$, Na_2SO_4, NaCl etc).
    ii. Mechanical Scarification: This involves mixing seeds with pebbles, rubbing seeds with sand paper nipping holes or making punctures.

b. Heat Method
    i. Dry Heat: This involves placing seeds above systems which give out heat. E.g. burning fire wood
    ii. Wet Heat: This involves steaming to beak dormancy.
c. Cold Treatment

2. Chemical inhibitors: presence of chemicals such as coumarine, phenols, abscissic acid etc can cause dormancy.

SOLUTION

a. Leaching: Moderate leaching is required to break dormancy and effect germination of seeds. Over leaching can wash away growth promoters.

3. Dormancy due to immature embryo: For example Cola nitida, C. millenii.

SOLUTION

Storage

4. Need for Period of Ripening

SOLUTION
Storage

5. Photoblasticity: This is dormancy due to light sensitivity. e. g ceiba pentandra, milicia excels, nicotiana tabaccum etc.

SOLUTION
Exposure to day length illumination period of 16hrs or more.

GERMINATION

Is a process by which a dominant embryo wakes up grows out of the seed coat and establishes itself as a seedling when supplied with moisture.

Germination is a physiological process which involves a viable embryo spouting into a seedling with the emergence of a radicle (first) and a plumule (later) under favourable environmental conditions.