COORDINATION continuation ……

PLANT HORMONES

Plant growth is regulated by a chemical substance like hormones. These chemical substances are called phytochromes, and are essential for plant growth and development. They exhibit the following characteristics,

- Required in minute quantities
- Their actions are specific
- They don't move away from the site of synthesis
- They are short lived and do not accumulate in the cells and rapidly broken down

The growth regulators may affect growth in different ways. They may promote or inhibit a process. There are five types of growth hormones;

i) Auxins (associated with cell elongation)
ii) Gibberellin (associated with cell differentiation and elongation)
iii) Cytokinin (for cell division)
iv) Ethene (senescence or aging)
v) Abscicic acid (bud dormancy and resting state)

1. AUXINS

They increase the cell elongation at the tip of the shoot. The naturally occurring auxins in plants is known as indole acetic acid(IAA).

FUNCTIONS OF THE AUXIN (IAA)

(a) Cell elongation: It brings about enlargement of shoot and root tips especially at apical meristem. It softens the cell wall of newly divided cells and loosens closely bound filaments of cellulose thus helping the turgor pressure to build and the cell elongates.

(b) Fruit growth: It promotes the enlargement of fruits by stimulating the cell wall to grow in more than one direction. It can induce fruiting in absence of pollination (parthenocarpy)

(c) Promotes cell division at the vascular cambium: This is due he movement of the IAA from the developing shoots to reactivate the growth of cambium during the growing season.

(d) Root initiation: When applied to the roots of cuttings of vegetative propagation it promotes growth of roots.

(e) Apical dominance: This is where bud at the apex of the shoot produces auxin in sufficient concentration to inhibit growth of lateral buds.On removal of the apical bud the lateral buds start moving into branches. This is the principle behind pruning of many plants.

(f) Suppresses abscission of fruits and leaves: Abscission means the shading of leaves and fruits. There is an abscission zone at the base of the leaves and the fruits. This zone cuts off supply of nutrients and water from reaching the organ and the fruits and leaves fall by any force like wind etc. The concentration of auxins declines at the onset of abscission. Leaves and fruits must produce auxins continuously to prevent the formation of abscission zone. IAA work antagonistically to abscisic acid which promotes abscission. In unripe fruit the concentration of auxins is more but it declines on ripening and that of abscisic acid increases to enhance fruit dropping. Auxin prevents abscission because it maintains the structure of cell wall.

RELATIONSHIP BETWEEN GROWTH AND AUXIN CONCENTTRATION IN ROOTS AND SHOOT.

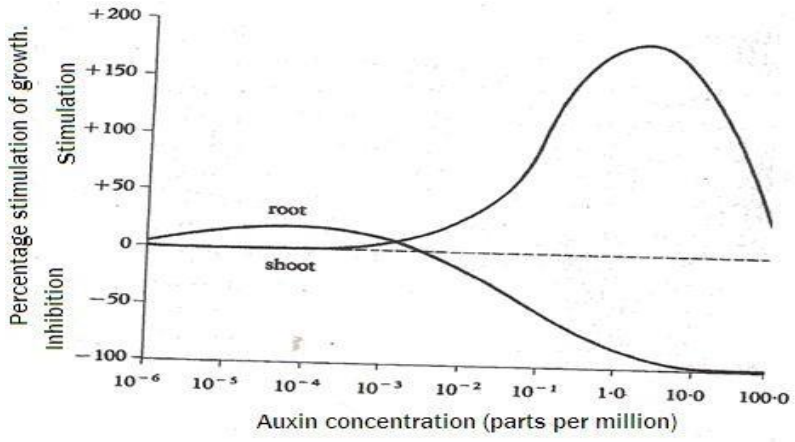
It is known that auxins at much higher concentration inhibit growth in both shoot and root. However, roots are more sensitive to auxin than stems. Roots only respond well to lower concentration of auxins. As the concentration of auxins increase, the growth of roots become inhibited while that of the stem is increased.

When a shoot of a plant seedling is exposed to a unilateral light the auxins is redistributed in higher concentrations in the shaded part and the rate of growth increases on that side and it bends towards light.

In horizontally placed root, the effect of gravity redistributes the auxins in higher concentrations at the lower surface, this inhibits growth on the lower side, and rate of growth becomes greater at the upper side than the lower side and the root bends downwards and towards the gravitational pull.

In horizontally placed shoot, auxins redistribute in higher concentrations at lower side, this promotes more growth at the lower side and the shoot bends upwards and away from gravitational pull. So, it is the redistribution of auxins which accounts for the response of shoots and roots.

A GRAPH SHOWING RELATIONSHIP BETWEEN GROWTH AND AUXIN CONCENTRATION IN ROOTS AND SHOOTS.



2. GIBBERELLINS

These are present in greatest concentration in mature seeds. They are abundant in root and shoot apex, buds and young apical leaves and young embryos. They are transported to other parts of plant through both xylem and phloem.

FUNCTIONS OF GIBBERELLINS.

(a) Internode elongation: They bring about stem elongation by enlargement of cells in the same way as auxins. They also bring about leaf expansion but no effect on the roots. Dwarf variety pea and corn be induced to grow to normal height by the application of gibberellin.

(b) Brings about bolting in rosette plants: When gibberellin is applied to a rosette plant like cabbage it causes bolting i.e. the internodal length increases and plant may flower. Plants like cabbage have a number of leaves around the shoot apex and the Internode length is reduced giving it a rosette appearance. Bolting does not occur if the cabbage plant is kept at warm temperatures due to the destruction of gibberellin.

(c) Breaking of seed dormancy: Gibberellin stimulates the synthesis of enzymes such as alpha-amylase during the seed germination. If a seed imbibes water the embryo is activated and it secretes the hormone gibberellin which diffuse to aleurone layer .In this layer it stimulates synthesis of various digestive enzymes.

(d) Breaking the bud dormancy: It works to break bud dormancy in opposition to abscisic acid.

(e) Control of fruit growth and development: They induce development of fruits without fertilization (parthenocapy). E.g. in apples and pears.

(f) Control of flowering in long day plants: They also sometimes substitute red light and so induce flowering in long day plants and inhibit flowering in short day plants.
They can also change the sex of some flowers like in monoecious plants.

3. CYTOKININS

These are chemical substances which required to stimulate the growing of the cells in the tissues by promoting cell division. They work in presence of auxins and gibberellin.

THE ROLE OF CYTOKININS.

(a) Promotes cell division in apical meristem: Along with auxins they promote cell division in apical meristem as well as meristematic tissues.

(b) Promotes cell differentiation in plants: Where there is more cytokinins and less auxins shoot develops. Less cytokinins and more auxins roots develop. Intermediate cytokinins and auxins both roots and shoots develop, intermediate cytokinins and less auxins activate mitotic division and no differentiation.

(c) Control of apical dominancy: While auxins stimulate apical dominancy. Cytokinins stimulate growth of lateral buds.

(d) Delaying of aging in plants: Cytokinin delays the normal aging in leaves by controlling protein synthesis and mobilization of resources. The chlorophyll does not disintegrate and so

leaves remain green. Protein synthesis and carbohydrates break down continues. Cytokinnin is applied to harvested crops to extend their storage life.

4. ETHENE

It is produced by most or all plants organs and escapes from the plant surface in gaseous forms.

THE ROLE OF ETHENE

(a) Fruit ripening: It is associated with ripening of fruits like bananas, citrus, apples etc. Fruit ripening is a process of senescence when the respiratory activity is very high and large amounts of ethene are produced, when a fruit is enclosed in a bag. The ethene produced by the fruit itself forms a concentration layer hence causes ripening of the fruit.

(b) Inhibition of the stem elongation: It inhibits stem elongation and stimulates the transverse expansion and hence formation of swollen stem.

(c) Sex determination in some plants: Plants which bear both male and female flowers like cucumber, will have sex of one flower changed (male flowers changes to female) on application of ethene to young buds of male flowers.

(d) Senescence: Ethene promotes senescence and produced by the aging leaves and the ripening fruits and finally brings about their abscission.

(e) Abscission: Along with abscisic acid ethene stimulates abscission of leaves. The enzymes produced by both dissolves the cell wall but hold the petal of the leaf. It is the same also in abscission of fruits.

(f) Brings about the straightening of the hypocotyls during seed germination as it breaks through the soil.

(g) In horticulture, ethene Induces flowering in pineapples and ripening of fruits: like tomatoes, grapes and bananas. They are first kept unripe and transported in ventilated compartments and in atmospheres without oxygen.

5. ABSCISIC ACID (ABA)

This is made in leaves, stems, fruits and seeds. Like other growth substances ABA moves in the vascular system, mainly the phloem. It also moves from the root cap by diffusion

ROLES OF ABA

(a) Abscission of leaves and fruits: It works antagonistically to auxins and causes abscission of leaves and fruits. As the leaves or fruits ripen abscisic acid concentration increases and the auxin decreases. ABA causes the cell to die and hardens, this cuts off the nutrient supply just before falling.

(b) Inhibition of mitosis: It inhibits mitosis in vascular cambium as winter approaches.

(c) Dormancy of seeds: The dormancy of seeds is broken down only when ABA Level in the seed is reduced by increasing the level of gibberellins. It inhibits the formation of alpha-amylase in germinating cereal grains.

THE MECHANSM OF ACTION OF PLANT GROWTH SUBSTANCES

The abscisic acid and gibberellins combine with the receptor proteins on the surface of the cell membrane to form the hormone-receptor complex. The complex formed penetrates into the cells and exerts their effect by switching genes on and off.

Abscisic acid s also thought to stimulate the transcription of certain genes whose proteins products accumulate during desiccation. It is those proteins which appear to protect plant tissues during desiccation e.g. in seeds.

Gibberellins are thought to stimulate transcription of genes which results in the production of those enzymes that are necessary for hydrolysis of the food reserves n cotyledon or endosperm thus enabling the embryo to grow.

COMMERCIAL USE OF PLANT GROWTH SUBSTANCES.

- **Selective herbicides (weed killer)** e.g. 2,4-D which destroys broad leaved weeds from cereal fields, such are applied to the leaves from where they are translocated to the rest of the plant and disorganize the and the metabolism of the plant.
- **Growth promoters** e.g. IAA as rooting powder which is applied to the stem cuttings which induce formation of roots in them. It also breaks seed and dormancy.
- **Retard growth** of plants and limit them to heights where they are easy to harvest.
- **Induce flowering** e.g. gibberellins and ethene can be used to induce early flowering in otherwise perennial crop.
- **Induce fruiting** e.g. IAA when applied to un-pollinated flowers of tomato, fruits are formed without fertilization i.e. by parthenocarpy.
- **fruit ripening e.g.** ethene. If ethene is applied to fruits it causes them to ripen. It is particularly useful in fruits like banana which are picked and shipped when green but have to be sold when ripe(yellow) so they are sprayed with ethene in transport.
- **Storage of potatoes or other crops** since they inhibit sprouting or simply prolong seed dormancy

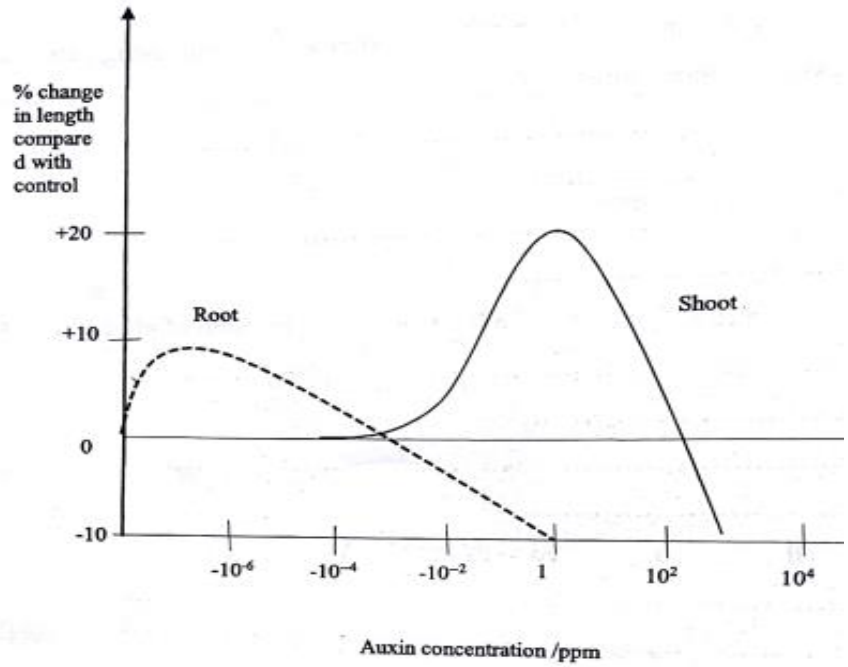
Exercise 2

1. *(a) what are the principle effects of each of the following plant hormones on plant tissue?*
   (i) auxin (03 marks)
   (ii) gibberellin (02 marks)
   (iii) cytokinin (02 marks)
   (iv) abscisic acid (02 marks)

   (b) Explain how the balance between two or more of the hormones listed in (a) controls
   (i) seed dormancy and germination (03 marks)
   (ii) leaf senescence and abscission (03 marks)

   (c) What is a bioassay? Describe how the auxin concentration of solution could be determined by bioassay (05 marks)

2. *The figure below is a graph that shows the response of oat seedlings to various concentrations of externally applied auxin.*



(a) Give two differences between the response of shoot and roots shown by the graph (02 marks)

(b) Describe how action of auxin on cells of the shoot promote growth (03 marks)

(c) State two commercial uses of auxins in nature (02 marks)

(d) Outline differences between plant hormones and animal hormones (02 marks)

End.