PLANT GROWTH AND DEVELOPMENT

Growth can be defined as the irreversible permanent increase in size of an organ or its parts or a cell.

Plant growth is indefinite . that means plants retain the capacity for unlimited growth throughout the life. For this capacity they have the meristem.

Growth can be measured by variety of parameters like

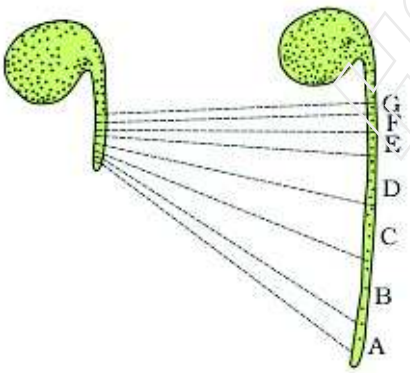
1. increase in fresh weight
2. increase in dry weight
3. increase in length
4. increase in area
5. increase in volume etc.

Phases of growth

The period of growth is generally divided into three.

1. Meristematic phase : here the cells divide constantly. The cells have abundant protoplasm, conspicuous nucleus, primary cell wall.
2. Elongation phase : enlargement of cell occurs occurs. Develop new cell wall depositions in cell
3. Maturation phase : here the cells get maximum size.

We can see the different zones in the given diagram of root tip

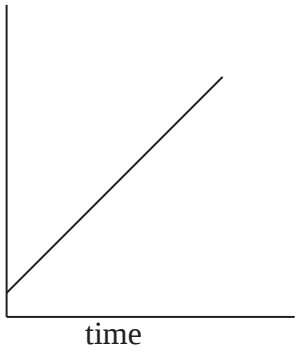


Growth rates

The increased growth per unit time is termed as growth rate. Growth can be expressed mathematically. The growth rate shows an increase that may be *arithmetic or geometrical*.

In arithematic growth the after mitotic cell division, one daughter cell continue to divide but the second one matures.

This type growth is seen in root elongation. If we cite it in graph; that graph will be linear as shown below.



The growth rate here can be expressed as

$L_t = L_0 + rt$

L_t = length at time 't'

L_0= length at time zero

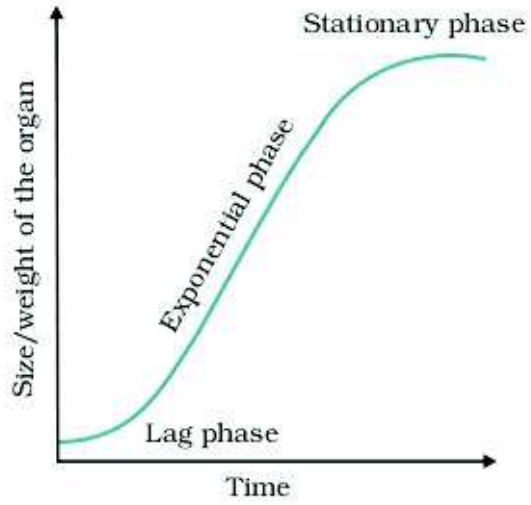
R= growth rate / elongation per unit time

In geometrical growth both the cells formed after the mitosis will divide. It seen in the early stages of the embryo development.

The number of cells go as

1 to 2, 2 to 4, 4 to 8, 8 to 16, 16 to 32, 32 to 64…..

If we draw a graph of this growth we get a 'S' shaped graph as shown in the figure.



We can see three different phases in this graph

1. *lag phase*: here growth is slow
2. *Exponential phase*: here ceel division rapid and exponentially

3. *Stationary phase*: here growth is steady.

This growth can be expressed as

$$W_1=W_0 e^{rt}$$

W_1 = final size
e =base of natural logarithm
W_0 = initial size
r = growth rate
t = time of growth

Differentiation, Dedifferentiation, Redifferentiation

The cells produced in the meristem are differentiated to perform certain specific functions . That means they are matured. This process is called *Differentiation*.

Some times the differentiated cells will get the capacity for division. i.e they become meristematic. This called *Dedifferentiation.* Eg. Inter fasicular cambium.

Later the dedifferentiated cells again become mature. This process is called *Redifferentiation*.

plasticity

The plants respond in various ways to different environment. This ability is called *plasticity.*
Eg. Heterophilly(differet type of leaves) in cotton ,coriander, larkspur in different environment

In buttercup two type of leaves are seen in water and above water.

Plant growth hormones

They are simple chemical compounds which regulate the growth in plants. They are indole compounds (IAA, IBA), or adenine derivatives(kinetin) or derivatives of carotenoids (ABA) or terpenes (gibberllic acid).

Auxins

Auxins are first discovered by Darwin. But first isolated by F.W went from oat seedlings.
IAA was first isolated auxin. They are produced at the growing apex.

Eg. Indole Acetic Acid (IAA)
Indole Butyric Acid (IBA)
Naphthalene Acetic Acid (NAA)
2,4 Dichloro phenoxy acetic acid (2,4-D)

IAA and IBA are obatained from plants.they are natural occurring but NAA and 2,4-D are synthetic hormones.

Roles of auxin

1. Stem elongation :-stimulate the elongation
2. Apical dominance:- in plants the apical tip of the stem inhibit the development of lateral buds. If the apical tip is removed the lateral buds develop. The inhibition of lateral bud formation by the presence of apex is called apical dominance. It is because of the presence of auxin at tip. Eg. It is applied in
3. tea plantations to develop branches. (called as hedge making)
4. Rooting:-it hastens the rooting as well as increases the number of roots formed.
5. Flowering : induce flowering. Can be applie d in the pine apple field for flowering at the same time)
6. Parthenocarpy: induce parthenocarpy in many plants (production of fruits without fertilization is called parthenocarpy), can be applied in making seedless tomato .
7. 2,4- D is a weedicide (kill weeds, i.e it kill only dicot weeds). It is applied in weed free lawn making.

Gibberllins

Bakane disease affected to rice plants in Japan was due to the fungus gibberella fujikuroi. Japanese noticed that this fungus affected grains after germination showing elongated stem. Later a plant hormone gibberllic acid is extracted from this fungus. Later it is grouped in gibnberllin
100s of gibberllin are found as GA_1, GA_2, GA_3, GA_4, GA_5, GA_6……etc

Role of Gibberllins

1. increase the length of axis.
2. Delay the senescese: senescence is the aging process in plants. it can be delayed by gibberllin.
3. Promotes bolting (bolting is the internode elongation just prior to the flowering) in cabbage and in plants with rosette habit.
4. Elongate the fruits like apple
5. used to speed up the malting process in brewing industry.
6. is used to increase the length of sugarcane.

Cytokinin

This term is derived from the term cytokinesis means cell division. Because this hormone induce the cell division. Kinetin was the first discovered cytokinin is a synthetic hormone. Zeatin is the natural cytokinin present in corn kernels and in coconut milk.

This hormnone seen at the places where rapid cell division is seen.

Role of cytokinin:

1. it overcome the apical dominance
2. it delay the senescence
3. promote nutrient mobilisation

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Ethylene:

They are simple gaseous hormone. They are produced in tissues undergoing senescence and ripening fruits.

Role of ethylene:

1. It influences the horizontal growth of seedling
2. It enhances the respiration rate during the ripening of fruit.
3. Rise in the rate of respiration is called respiratory climatic.
4. it breaks seed and bud dormany
5. initiates sprouting of potato tubers.
6. promotes development of female flowers in cucumber.

Ethephon is the widely used liquid compound and is a source of ethylene. It hastens the fruit ripening.

Abscissic acid

It is a plant growth inhibitor. It regulate the abscission and dormancy.

- ABA inhibit the seed germination.
- ABA stimulate the closure of stomata and increase the tolerance of plant to various stress. Therefore it is also called as *stress hormone*.
- By inducing seed dormancy the ABA helps seeds from dessication.
- ABA act as an antagonist to various GA's.

ABA is also called antigibberllin or antagonistic to the action of gibberllin

Photoperiodism

The relative length of day and night is called as photoperiod. The response of plant towards this photoperiod is called photoperiodism. Some plants require a periodic exposure to light for flowering.

Some plants require the exposure to light for a period exceeding a well defined critical duration. Such plants are called Long Day Plants (LDP). While other plants require the exposure to light for a period less than a well defined critical duration . Such plants are called Short Day Plants (SDP). But some plant do not show such response to day and night. Such palnts are called day neutral plants (DNP). It is supposed to be the production of an hormone is responsible for the flowering.

LDP- eg. Wheat, oat, sugar beet, radish, lettuce etc

SDP- eg. Tobacco, soya bean, cannabis

DNP- eg: cotton, oryza, pea

Vernalisation

It is the chilling (low tremperature) treatment of plant for flowering. It prevents precocious reproductive development late in growing season. Some biennial plants like cabbage and carrot are subjected for vernalisation for flowering.