18. **PLANT GROWTH**

Growth is defined as a vital process that brings about a permanent and irreversible change in any plant or its part in respect to its size, form, weight and volume. Growth is restricted only to living cells and is accomplished by metabolic processes involving synthesize of macromolecules, such as nucleic acids, proteins, lipids and polysaccharides at the expense of metabolic energy.

Growth at cellular level is also accompanied by the organization of macromolecules into assemblages of membranes, plastids, mitochondria, ribosome and other cell organelles. Cells do not definitely increase in size but divide, giving rise to daughter cells. An important process during cell division is synthesis and replication of nuclear DNA in the chromosomes, which is then passed into the daughter cells. Therefore, the term growth is used to denote an increase in size by cell division and cell enlargement, together with the synthesis of new cellulose materials and the organization of cellular organelles.

Growth regions

Typical growth regions in plants are the apices of shoot and root. Such growing regions are known as apical meristems, primary meristems or regions of primary growth. These apical meristems are responsible for the increase in length, differentiation of various appendages and formation of plant tissues.

Phases of growth

Growth is not a simple process. It occurs in meristematic regions where the meristematic cell has to pass through the following 3 phases.

1. Cell formation phase
2. Cell elongation phase
3. Cell differentiation (cell maturation)

The cell formation phase is represented by meristematic zone and cell enlargement phase by cell elongation zone.

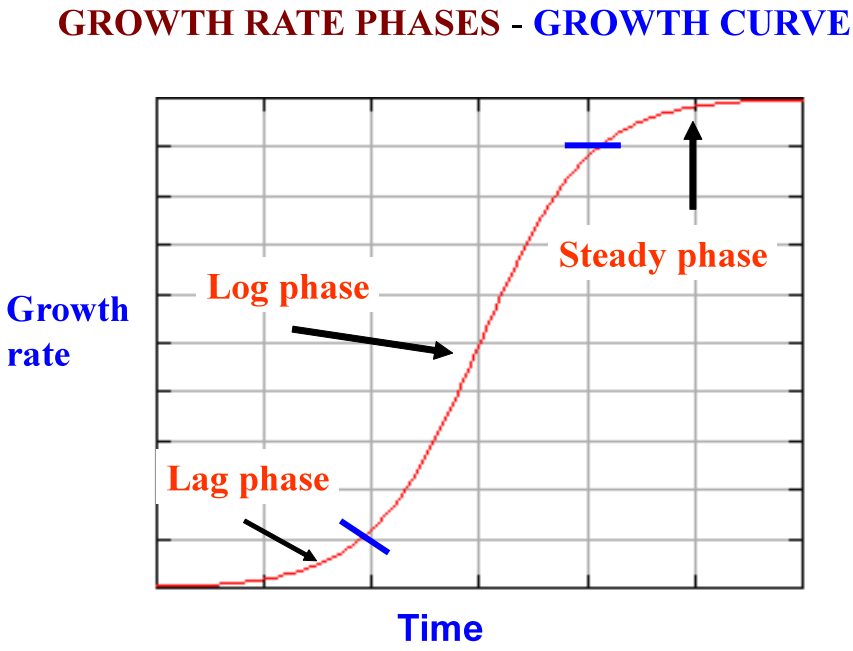
The dividing meristematic cells are thin walled and have dense protoplasm with a large nucleus and with or without very small vacuoles. The intercellular spaces are also absent. The newly formed cells after the first phase of cell division have to pass through the second phase of cell enlargement. During the second phase of cell elongation on account of large quantities of solutes inside the growing cell, water enters the cell due to osmotic effect

resulting in the increased turgidity and expansion and dilation of the thin and elastic cell wall. This phase also results in appearance of large vacuoles.

In the last phase or cell maturation, the secondary walls are laid down and cell matures and gets differentiated into permanent tissue.

Growth curve

Growth curve is a graph obtained by plotting the growth rate of a plant against time factor. The growth rate of a cell, a plant organ, a whole plant or the whole life cycle of plant is measured in terms of length, size, area, volume or weight. It has been found that different growth phases result in 'S' shaped curve or sigmoid curve. In initial stages during the phase of cell formation, the growth rate increases slowly while it increases rapidly during the phase of cell elongation or cell enlargement and again slows down during the phase of cell maturation.



The period during which the course of growth takes place is known as grand period of growth. Thus, in a standard growth curve, three well marked regions can be observed, the initial growth stage (lag phase), the grand period of growth (exponential or log phase) and the steady stage (maturity stage or senescence or stationary phase). The overall growth may be affected by external or internal factors but the S- shaped curve of grand period of growth is

never influenced. This growth curve suits well to the entire life of an annual plant when measured in terms of dry weight against time.

Early growth of the plant is limited by the amount of food reserves in the seed. When the emerged seedlings develop an adequate root system and enough leaf surfaces to support vigorous photosynthesis and anabolism, a period of rapid increase in size is possible.

High metabolic rates are not maintained indefinitely and eventually processes are set in motion that leads to cessation of growth. The factors responsible for the decrease in growth are competition for essential metabolites, growth substances, water, light or the accumulation of inhibitors, toxic substances or waste materials.

Blackman (1919) suggested that the growth of the plants can be represented by equation.

$$W_1 = W_o\, e^{rt}$$

Where, W_1 is the final size (Wt, ht etc) after time t. W_o is the initial size at the beginning of the time period. r is the rate at which plant substance is laid down during time t and e is the base of natural logarithm. Blackman pointed out that equation describes the way in which money placed at compound interest increases with time; the term compound interest law is used to describe such phenomenon. In banks, compound interest is usually applied quarterly or annually so that the increase in amount occurs as a jump. With plant system, compound interest is applied continuously and size increase follows a smooth curve.

From the equation, the final size of an organism (W_1) depends on the initial size (W_o). Larger seed give a larger plant.

In addition, equation shows that plant size also depends on the magnitude of r, the relative growth rate. Blackman suggested that r might be used as a measure of the ability of the plant to produce new plant material and called r as the *efficiency index*. The plants with high efficiency index could be expected to outperform plants with low efficiency index.

Measurement of growth

The measurement of growth is possible in terms of either increase in weight or increase in volume or area. The common and simplest method for the measurement of

growth can be a direct method by which the growth is measured by a scale at regular intervals from beginning to end. The other methods that can be used are horizontal microscope, auxanometers.

Factors influencing growth

Growth is affected by all factors that affect the activity of protoplasm. Both physiological and environmental factors such as water, minerals, photosynthesis, respiration, climate and edaphic factors significantly influence the growth. In general, factors can be grouped into external and internal factors.

External factors

1. Light

It has direct effect on photosynthesis and transpiration. Light in terms of intensity, quality and periodicity influence the growth very much.

Light intensity: A weak light promotes shortening of internodes and affects expansion of leaf. Very weak light reduces the rate of over all growth and also photosynthesis due to poor development of chlorophyll and higher rate of water loss from the plant.

Light quality: The different wavelengths of light have different responses to growth. In blue violet radiation, the internodal growth is pronounced while green colour light promotes the expansion of leaves as compared to complete spectrum of visible light. The red light favours the growth while infra red and UV is detrimental to growth.

Light duration: The re is remarkable effect of the duration of light on the growth. The induction and suppression of flowering depend on duration

2. Temperature

The plants have different temperature requirements based on the region where they are grown. In general, best growth takes place between 28 and 33 C. and it varies from temperate to tropical conditions. The optimum temperature requirement is essential for seed germination, growth, metabolic activities, flowering and yield.

3. Oxygen

The growth of the plant is directly proportional to the amount of oxygen which is essential for respiration during which the food materials are oxidized to release energy.

4. Carbon dioxide

It is one of the major factors that influence the photosynthesis. The rate of photosynthesis increases as the availability of CO2 increases while other factors are not limiting.

5. Water

Water is an essential factor for growth. It is essential for uptake of nutrients, translocation of nutrients and food materials, regulating transpiration and for various physiological processes like photosynthesis, respiration and enzymatic activities.

6. Nutrients and food materials

The rate of growth is directly proportional to the availability of nutrients and food materials. The shortage of food supply affects the growth as it provides the growth material to the growing region and also it provides the potential energy to the growing region.

Internal factors

1. Growth hormones and their availability
2. Resistance to climatic, edaphic and biological stresses
3. Photosynthetic rate and respiration
4. Assimilate partitioning and nitrogen content
5. Chlorophyll and other pigments
6. Source-sink relationship and enzyme activities