Class : Botany
Class : XI

Kannada

Plant Growth and Development

Recall what did you study in previous class

Growth:

- Growth is a characteristic of living beings in which an irreversible permanent increase in size of an organ or its parts occur or even of an individual cell.
- Plant growth is generally indeterminate due to capacity of unlimited growth throughout the life.
- Root apical meristem and shoot apical meristem are responsible for primary growth and elongation of plant body along the axis. Lateral meristem activity leads to increase in girth of plants.

Growth is Measurable

- It is increase in fresh weight, dry weight, length, area, and volume and cell number.

Phases of Growth

- Meristematic phase-the phase of cell formation or cell division. It occurs at root apex, shoot apex and other meristematic region.
- Phase of elongation-cells undergo enlargement. Enlarging cells develop vacuoles, increase in volume and develop new cell walls.
- Phase of maturation- the enlarged cells undergoing structural and physiological differentiation.

Growth Rates

- Growth rate can be defined as the increase in growth per unit time.

Plants Show Two Types of Growth

- **Arithmetic Growth:** Only one daughter cell continues to divide while others differentiate or mature. It is found in root and shoot elongation.
- Represented as $L_t = L_0 + rt$, where, L_t = length at time 't', L_0 = length at time 'zero', r = growth rate/elongation per unit time
- **Geometric Growth:** Initial growth is slow (lag phase), followed by a rapid increase in growth (log/exponential phase), and followed by a phase where growth slows down (stationary phase). Example – all cells, tissues and organs show this type of growth.
- Represented as $W_1 = W_0 + e^{rt}$, where, W_1 = final size, W_0 = initial size at the beginning of the period, r = growth rate, t = time of growth, e = base of natural logarithms.
- **Conditions for Growth Include:** water, oxygen, nutrients and optimum temperature.
- **Differentiation:** In this process, cells derived from root apical and shoot apical meristems and cambium differentiate and mature to perform specific functions.
- **Dedifferentiation -** Process in which living differentiated cells regain their capacity to divide.
- **Redifferentiation** - Dedifferentiated cells are able to divide and produce cells that once again lose the capacity to divide but mature to perform specific functions, i.e., get re-differentiated.

- **Development** – changes in an organism during its life cycle.
- Plasticity – different kinds of structure in response to environment or phases of life. E.g. Heteropylly in cotton and coriander. In these plants, leaves have different shapes based on the phase of life cycle as well as the habitat.
- Development = growth + differentiation
- Development is controlled by Intrinsic (Genetic factors and plant growth regulators) and Extrinsic (light, temperature, water, oxygen).

Plant Growth Regulators / Phytohormones

- **Characteristics** - PGRs are small, simple molecules of diverse chemical composition. They could be indole compounds IAA, adenine derivatives (kinetin), derivatives of carotenoids (abscisic acid), terpenes (gibberellic acid) or gases (ethylene).

The Discovery of Plant Growth Regulators

- Auxin was isolated by F.W. Went from tips of coleoptiles of oat seedlings.
- E. Kurosawa identified gibberellins present in a fungal pathogen Gibberella fujikuroi.
- During mid-1960s, three researches reported the purification and chemical characterisation of inhibitor-B, abscission II and doormen. Later all were proved to be chemically identical. It was named ABA.
- **Cytokinins**- Skoog and Miller crystallized cytokinesis promoting active substance named kinetin.
- Cousins confirmed the release of a volatile substance from ripened oranges and was identified as ethylene.

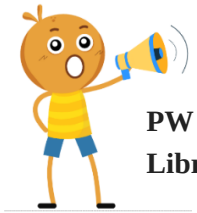
Physiological Effects of Plant Growth Regulators:

- **Auxins**- Initiate rooting in stem cuttings, promote flowering in pineapple, prevent fruit and leaf drop, promote abscission of older mature leaves, Induce parthenocarpy in tomatoes, widely used as herbicides (2,4 – D), kill weeds, Controls xylem differentiation and helps in cell division, used in tea plantations, hedge-making, induce parthenocarpy in tomatoes
- **Gibberellins**- Increase in length of grape stalks, cause apple fruits to elongate and improve its shape, delay senescence, speed up malting process in brewing industry, increases length of stem in sugarcane, hastens maturity period in juvenile conifers, Promotes bolting in beet and cabbage.
- **Cytokinins** - Produce new leaves, chloroplasts in leaves, lateral shoot growth and adventitious shoot formation, Help overcome apical dominance, Promote nutrient mobilization which helps in the delay of leaf senescence.
- **Ethylene**- Promotes senescence and abscission of leaves and flowers, highly effective in fruit ripening, enhances the respiration rate, breaks seed and bud dormancy, initiates germination in peanut seeds, sprouting potato tubers, induces flowering in mango, hastens fruit ripening in tomatoes, petiole elongation in deep water rice plants, synchronising fruit set in pineapples, abscission in flowers and fruits and thinning of cotton, cherry and walnut, promote female flowers in cucumber.
- **Abscisic Acid:** Also called stress hormone. General plant growth and metabolism inhibitor. Inhibits seed germination, stimulates the closure of stomata, plays an important role in seed development, maturation and dormancy, helps seeds to withstand desiccation and other factors unfavourable for growth. In most situations, ABA acts as an antagonist to GAs.
- **Photoperiodism**- It is the response of plants to periods of day/night.
- Some plants require periodic exposure to light to induce flowering. Duration of dark period is equally important for flowering.
- Long Day Plants − Plants that require exposure to light for a period exceeding critical duration to induce flowering.

- Short Day Plants − Plants that require exposure to light for a period less than this critical period to induce flowering.
- Day Neutral Plants − Plants where there is no correlation between exposure to light duration and induction of flowering.
- **Vernalization:** It is the phenomenon of dependence of flowering on exposure to low temperature. It prevents precocious reproductive development late in the growing season and enables the plant to have sufficient time to reach maturity.

Seed Dormancy

- A condition in which seeds are unable to germinate in conditions that are favourable for their germination and in which its development, growth, and numerous other activities are temporarily stopped.



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