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Plant Physiology in Plant Growth and Development

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ABSTRACT:-

Plant physiology is the first and foremost line of defense and medium of interaction with the environmental and climatic conditions. The control and regulatory system for physiological development is dependent on a number of cellular processes. Plant small RNAs possess a very essential place in the network of these systems by providing a reliable and dependable, yet flexible, control system capable of modulating physiological development and transitions. smRNAs regulate gene expressions by target cleavage of mRNA, chromatin modification, and reduction of translational efficiency, ensuring coordinated, balanced, and organized development of physiology. Small RNAs are involved in almost all the developmental pathways including vegetative growth, reproductive growth, phase transitions, and seed development and germination.

Keywords:- Plants, physiological molecular level, growth and development, cell molecules, genetic plants etc.

1 Introduction

Genetic potential of a plant and its interaction with environmental factors decides its growth and development by influencing or modifying certain internal processes. Plant physiology studies about these internal processes and their functional aspects. Plant physiology is a study of Vital phenomena in plant. It is the science concerned with Processes and functions, the responses of plants to environment and the growth and development that results from the responses. It helps to understand various biological processes of the plants like Photosynthesis, respiration, transpiration, translocation, nutrient uptake, plant growth regulation through hormones and such other processes which have profound impact on crop yield.

Plant Physiology: The study of natural phenomena in living plants and is concerned with plant processes, functions and the responses in relation to environment.

Plant physiology is a subdiscipline of botany concerned with the functioning, or physiology, of plants. Closely related fields include plant morphology (structure of plants),plant ecology (interaction with the environment), phytochemistry (biochemistry of plants), cell biology, genetics, biophysics and molecular biology. Plant physiology is the study of vital phenomena in plants. It is the science concerned with processes and functions, the responses of plants to changes in the environment and the growth and development that result from the responses.

Processes: Processes means natural event/ sequence of events. Examples of processes that occur in living plants are

♦ Photosynthesis♦ Respiration
♦ Ion absorption♦ Translocation
♦ Transpiration ♦ Stomatal opening and closing
♦ Assimilation ♦ Flowering
♦ Seed formation and ♦ Seed germination

To described and explain the plant processes is the main task or the first task of plant physiology.

Fundamental processes such as photosynthesis, respiration, plant nutrition, plant hormone functions, tropisms nastic movements, photoperiodism, photomorphogenesis circadianrhythms,environmentalstress physiology,seed germination, dormancy and stomata function and transpiration,

Functions: Function refers to the natural activity of a thing, whether cell, tissue, organ, chemical substance or whatever. Functions are each kind of organ, tissue, cell and cellular organelle in plants and also the function of each chemical constituent, whether ion, molecule or macromolecule.

Responses in relation to environment Although processes and functions are dependent on and modified by such external factors as light and temperature. How processes and functions respond to changes in the environment. Essentially the overall goal of plant physiology is to evolve a detailed and comprehensive knowledge of all the natural phenomena that occur in living plants and thus to understand the nature of plant growth, development and movement.

2 Factors affecting Respiration in Plants

There are eight environmental factors that has significant impact on respiration in plants –

- Oxygen content of the atmosphere
- Effect of water content
- Effect of temperature
- Effect of availability of light
- Impact of respirable material
- Effect of concentration of carbon dioxide in atmosphere
- Protoplasmic conditions, i.e. younger tissues have greater protoplasm as comparedto older tissues.
- Other factors, i.e. fluorides, cyanides, azides, etc.

3 Cell wall biogenesis and expansion

The structure and biosynthesis of plant cell wall

The cell walls of prokaryotes, fungi, algae, and plants are distinctive from each other in chemical composition and microscopic structure, yet they all serve two common primary functions: regulating cell volume and determining cell shape. Because of these diverse functions, the structure and composition of plant cell walls are complex and variable. In addition to these biological functions, the plant cell wall is important in human economics. As a natural product, the plant cell wall is used commercially in the form of paper, textiles, fibers (cotton, flax, hemp, and others), charcoal, lumber, and other wood products. Another major use of plant cell walls is in the form of extracted polysaccharides that have been modified to make plastics, films, coatings, adhesives, gels, and thickeners in a huge variety of products. As the most abundant reservoir of organic carbon in nature, the plant cell wall also takes part in the processes of carbon flow through ecosystems.The organic substances that make up humus in the soil and that enhance soil structure and fertility are derived from cell walls. Finally, as an important source of roughage in our diet, the plant cell wall is a significant factor in human health and nutrition.

The architecture, mechanics and function of plants depend on the structure of the cell wall

In stained sections of plant tissues reveal that the cell wall is not uniform, but varies greatly in appearance and composition in different cell types. Cell walls of the cortical parenchyma are generally thin and have few distinguishing features. In contrast, the walls of some specialized cells, such as epidermal cells, collenchyma, phloem fibers, xylem tracheary elements, and other forms of sclerenchyma have thicker, multilayered walls. Often these walls are intricately sculpted and are impregnated with specific substances, such as lignin, cutin, suberin, waxes, silica, or structural proteins. Despite this diversity in cell wall morphology, cell walls commonly are classified into two major types: primary walls and secondary walls. Primary walls are formed by growing cells and are usually considered to be relatively unspecialized and similar in molecular architecture in all cell types. Nevertheless, the ultra-structure of primary walls also shows wide variation. Some primary walls, such as those of the onion bulb parenchyma, are very thin (100 nm) and architecturally simple. Other primary walls, such as those found in collenchyma or in the epidermis, may be much thicker and consist of multiple layers **(Figure 1)**

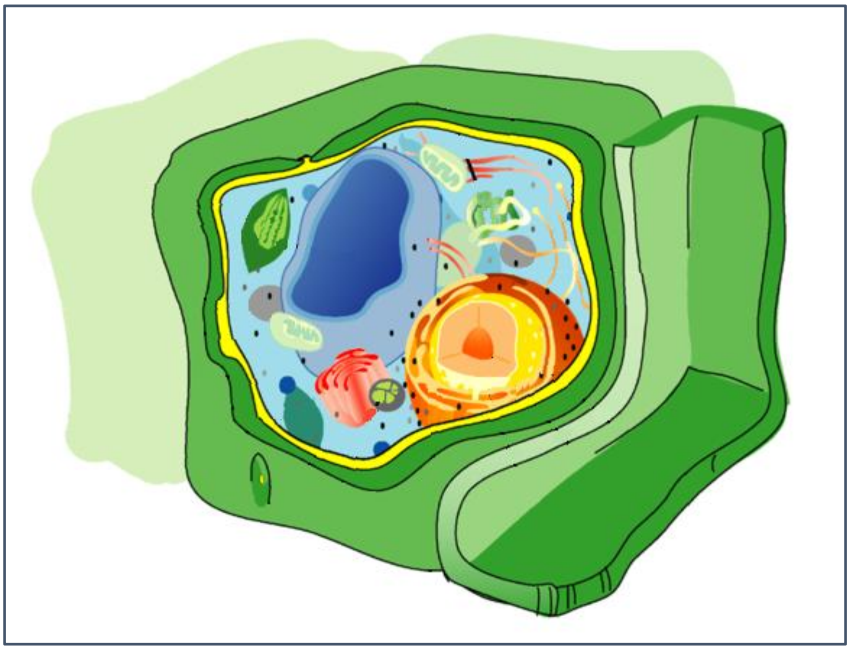

Figure 1: Diagram of the plant cell, with the cell wall in green.

4 Overview of plant growth and development

Growth and Development : Growth and development are the most fundamental and conspicuous characteristics of all living organisms. According to dictionary, growth is the advancement towards maturity and development is a gradual increase in size. The plant physiological definition of growth is 'an irreversible increase in mass, weight or volume of a living organism, organ or cell.

The development of a mature plant from a single fertilized egg follows a precise and highly ordered succession of events. The fertilized egg cell, or zygote, divides, grows, and differentiates into increasingly complex tissues and organs. In the end, these events give rise to the complex organization of a mature plant that flowers, bears fruit, senesces, and eventually dies. These events, along with their underlying genetic programs and biochemistry, and the many other factors that contribute to an orderly progression through the life cycle, constitute development. The meaning of the terms growth, differentiation and development Three terms routinely used to describe various changes that a plant undergoes during its life cycle are growth, differentiation, and development. Growth is an irreversible increase in volume or size Growth is a quantitative term, related only to changes in size and mass. For cells, growth is simply an irreversible increase in volume. For tissues and organs, growth normally reflects an increase in both cell number and cell size. Growth can be assessed by a variety of quantitative measures. Growth of cells such as bacteria or algae in culture, for example, is commonly measured as the fresh weight, cell number or packed cell volume in a centrifuge tube. For higher plants, however, fresh weight is not always a reliable measure. Most plant tissues are approximately 80 percent water, but water content is highly variable and fresh weight will fluctuate widely withchanges in ambient moisture and the water status of the plant. Dry weight, determined after drying the material to a constant weight, is a measure of the amount of protoplasm or dry matter (i.e., everything but the water). Dry weight is used more often than fresh weight, but even dry weight can be misleading as a measure of growth in certain situations. Consider the example of a pea seed that is germinated in darkness. In darkness, the embryo in the seed will begin to grow and produce a shoot axis that may reach 25 to 30 cm in length. Although we intuitively sense that considerable growth has occurred, the total dry weight of the seedling plus the seed will actually decrease compared with the dry weight of the seed alone prior to germination. The dry weight decreases in this case because some of the carbon stored in the respiring seed is lost as carbon dioxide. In a situation such as this, either fresh weight or the length of the seedling axis would be a better measure of growth. Length, and perhaps width, would also be suitable measures for an expanding leaf. There is not any special universal measure unit to characterize plant growth.

It should be obvious that many parameters could be invoked to measure growth, dependent to some extent on the needs of the observer. Whatever the measure, however, all attempts to quantify growth reflect a fundamental understanding that growth is an irreversible increase in volume or size.

Differentiation refers to qualitative changes that normally accompany growth Differentiation occurs when cells assume different anatomical characteristics and functions, or form patterns. Differentiation begins in the earliest stages of development, such as, when division of the zygote gives rise to cells that are destined to become either root or shoot. Later, unspecialized parenchyma cells may differentiate into more specialized cells such as xylem vessels or phloem sieve tubes, each with a distinct morphology and unique function. Differentiation is a two-way street and is not determined so much by cell lineage as by cell position with respect to neighboring cells. Thus, even though some plant cells may appear to be highly differentiated or specialized, they may often be stimulated to revert to a more embryonic form. For example, cells isolated from the center of a tobacco stem or a soybean cotyledon and cultured on an artificial medium may be stimulated to reinitiate cell division, to grow as undifferentiated callus tissue, and eventually to give rise to a new plant. It is as though the cells have been genetically reprogrammed, allowing them to reverse the differentiation process and to differentiate along a new and different path. This ability of differentiated cells to revert to the embryonic state and form new patterns without an intervening reproductive stage is called totipotency. Most living plant cells are totipotent – something akin to mammalian stem cells – and retain a complete genetic program even though not all of the information is used by the cell at any given time.

Development is the sum of growth and differentiation Development is an umbrella term, referring to the sum of all of the changes that a cell, tissue, organ, or organism goes through in its life cycle. Development is most visibly manifested as changes in the form of an organ or organism, such as the transition from embryo to seedling, from a leaf primordium to a fully expanded leaf, or from the production of vegetative organs to the production of floral structures. Embryogenesis, vegetative, and reproductive development are the stages of sporophytic development of higher plants. During embryogenesis, the single-celled zygote elaborates a rudimentary but polar organization that features groups of undetermined cells contained in the shoot and root apical meristems. During vegetative growth, indeterminate patterns of growth, which reflect inputs from both intrinsic programs and environmental factors, yield a variable shoot and root architecture. During reproductive development, vegetative shoot apical meristems are reprogrammed to produce a characteristic series of floral organs, including carpels and stamens, in which the haploid gametophytic generation begins.

5 Physiological aspects of growth and development

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, ribosomes 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 cellulose organelles. Growth is also defined as a vital process which brings about a permanent change in any plant or its part in respect to its size, form, weight and volume.

- **The nature of plant meristems**

Unlike animals, which are characterized by a generalized growth pattern, plant growth is limited to discrete regions where the cells retain the capacity for continued cell division. These regions are called meristems. Two such regions are the apical meristems located at the tips of roots and stems. These regions of active cell division are responsible for primary growth, or the increase in the length of roots and stems.

- **Regulation of plant growth and development**

The plant cells are able to sense and respond to a wide range of external and internal signals. The main external signals are light and temperature. The effect of different temperature rates are discussed in chapters dealing with the whole plant water relationship. Also, as it is part of the stress physiology, a detailed discussion will be given later. Intracellular regulation of growth and development is connected mainly to the plant genetical studies. Extracellular factors of plant morphogenesis are plant growth regulators (PGRs), which often called as plant hormones or phytohormones.

6 Material and Methods

Following practical methods used for draw the conclusions based on objectives.
1. To demonstrate that the light is necessary for photosynthesis. 2. To demonstrate that the CO2 is essential for photosynthesis 3. Measurement of water potential, 4. Measurement of leaf area by various methods, 5. Preparation of solutions for physiological studies in plants. 6. Methods of measuring water status in roots, stems and leaves.7. Imbrications and seed germination. 8. Breaking seed dormancy 9. Seed viability 10. Plant growth analysis 11. Laboratory visit and to understand use of IT in plant science. 12. Application of IT in plant physiological studies.

7 Conclusions

Plants are very important because they are the backbone of all life on Earth and an essential resource for human beings. They provide food, air, habitat, medicine and help to distribute and purify water. Make sure you celebrate the worlds plants and help to conserve them.

A well-known fact is that plant growth, development and senescence are under the regulation of the system of natural growth regulators: natural inhibitors and phytohormones. These substances could be transported in the cell or even between the plant tissues and organs. These processes are part of the so-called "biological clock" and rhythms that take place in plants.

The fate of these regulating substances, their role in biosynthesis and other transformations in the plant, in the soil and in the alleopathic ecosystems is the main topic of this book. The leaf as an organ of photosynthesis is a center of formation of the primary products, their metabolites, also it is involved in subsequent evacuation of hormones into reserve organs, and later aging. The role of photosynthesis in the growth as a determining factor of productivity is obvious. In addition to this, the main primary mechanisms of ontogenesis have been examined which, in parallel with the growth, are involved into the yield of crop formation.

The primary mechanisms of ontogenesis include formation of morphological structures, functioning of meristems, formation of leaf primordial, and correlations in plant growth and development. All these processes are controlled by genome and by the system of phytohormones within the space and time. Each organ, including the leaf, experiences together with a whole plant the main stages of development such as embryo development, youth, maturity and aging. The final stage, dying off, is followed by abscission of the plant organ.

Undoubtedly, the leaf activity depends on the the well being of the whole plant including its age. This interconnection serves as a basis for development of the leaf itself that is formed in the system of an integral plant organism. One of the most important functions of the leaf is the accumulation of photosynthetic assimilates and the ability to transport these assimilates into the vital organ of the plant. The leaf capability to evacuate metabolites sideways the growth point of stem or root is of no less importance. In this case a peculiar cascade of "transfer stations" is formed. These stations can be considered as a system of independent pairs, that is the donors and acceptors. The pair leaf parenchyma-phloem ends is localized at the beginning of this system. Then the pair leaf cutting-stem phloem is positioned, and so on. In each of the given pairs the hormone gradients playa great role in determining the factors channelling metabolites from the leaf into the vital organ.

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