**Introduction to crop physiology and its importance in Agriculture**

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.

# 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.

# Function :

Function means natural activity of a cell or tissue, or organ or a chemical substance. So, the second task of plant physiology is to describe and explain the function of an organ, tissue, cell and cell organelle in plants and the function of each chemical constituent, whether it may be an ion, molecule or a macro molecule.

Both processes and functions are dependent on the external factors and are modified by the external factors such as light and temperature. Since these two factors are modified by the external factors, the third task of plant physiology is to describe and explain how processes and functions respond to change 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 productivity. Many aspects of practical agriculture can benefit from more intensive research in plant physiology.

**Crop:** it is a group of plants grown as a community in a specific locality and, for a specific purpose.

# Crop Physiology :

Crop physiology is the study of the ways in which plant physiological processes are integrated to cause whole plant responses in communities. The subject matter of crop physiology includes the ways in which the knowledge of plant physiology is applied for better management of crops.

# A brief history of Crop Physiology:

W.L. Balls (1915): Crop physiology, with the aim of understanding the dynamics of yield development in crops, really began with the work of W.L. Balls. Along with Holton he analysed the effects of plant spacing and sowing date on the development and yield of Egyptian Cotton plants within crop stands, not in isolated plants. It was from his work the term ‘crop physiology’ came into existence. From then onwards, various scientists have started applying the advances in physiological knowledge for better crop management.

1924- In England- a rapid development of the methods of growth and yield analysis by different investigators (V.H. Blackman, F.G. Gregory, G.E. Briggs etc.) was started. With the development of various methods of growth analysis, they started explaining ‘the physiology of crop yield’

1947: The concept of LAI (Leaf area index) was developed by D.J. Watson. This index has provided a more meaningful way of analyzing growth in crops, and stimulated renewed interest in crop physiology.

1950’s: Studies on photosynthetic rate of the leaf and the loss of photosynthates by respiration was studied by the development of ‘Infra Red Gas Analysis (IRGA)’method. This method has facilitated the estimation of short term rates of Photosynthesis and respiration by crops in the field.

1953: Monsi and Saeki explained about the manner of light interception by the crop canopy with their concept of light interception coefficient.

1963: Hesketh and Moss showed that photosynthesis by leaves of Maize, Sugarcane and related tropical grasses could reach much higher rates, with less marked light saturation, than leaves of other plants. (This was the starting point for research to find other photosynthetic CO2 fixation path ways like C4, and CAM Mechanisms). The differences in pathway are associated with differences in photosynthetic rate, in response to light intensity, temperature and oxygen level, in photorespiration, in leaf anatomy and chloroplast morphology, in rate of translocation, and in the efficiency of water use, which can have profound effects on the physiology of yield determination.

Later on, several research works were carried out to understand the processes like translocation of food materials, their partitioning towards economic yield, storage mechanisms, physiology of flowering, effect of stressful environmental factors on crop growth and development, role of plant growth regulators in increasing the crop productivity

etc. All these areas have enriched the knowledge of physiological processes and their role in deciding the crop yield.

# Importance of crop physiology in agriculture:

Many aspects of Agriculture and Horticulture can be benefitted from more intensive research in plant physiology to provide practical solutions in agriculture and horticulture. Understanding the physiological aspects of seed germination, seedling growth, crop establishment, vegetative development, flowering, fruit and seed setting and crop maturity, plant hormone interaction, nutrientphysiology, stress (biotic/abiotic) physiology etc., provides a reasonable scientific base for effective monitoring and beneficial manipulation of these phenomenon’s. Since in agriculture we are interested in economic yield which is the output of these phenomenons and well beingness of plants, Plant Physiology provides a platform for getting better yield of crops. Studying these phenomenon with a view to develop better crop management practices forms the subject matter of crop physiology. The importance of physiology in agriculture and horticulture can be seen from the following examples;

1. Seed Physiology

Seed is the most important input in agriculture. Germination of seed and proper establishment of seedling depends upon various internal and external factors. Knowledge of Seed physiology helps in understanding of different physiological and morphological changes that occur during germination. Any deviation in these processes causes Seed dormancy. The dormant condition of the seed bars immediate use of harvested seed for next crop which is important in intensive agriculture. By understanding the causes and effects of this problem, Crop physiologists have come up with different methods of breaking the seed dormancy. Example: When ever Paddy is used as a seed material in the very next season it is recommended to treat the seed either with HNO3 or with GA.

1. Optimum seedling growth and plant population

By knowing the process of radicle and plumule emergence and their function we can achieve best plant health, which is the outcome of best plant physiology. By knowing the different inputs requirement of plants (water, nutrients, sunlight) we can easily manage the plant population to get highest yield. Input interaction of plants within their body is the matter of plant physiology.

1. Growth measurement of crops

The first prerequisite for higher yields in crops is high total dry matter production per unit area. High dry matter production is a function of optimum leaf area (Optimum leaf area Index) and Net Assimilation rate. (CGR = LAI X NAR).

Example: Pruning operation in horticultural crops like Mango is done based on this principle of proper canopy management for better photosynthesis.

1. Harvest index

The difference between total amount of dry matter produced and the photosynthates used in respiration is the net product of photosynthesis. Economic yield depends on how the dry matter is distributed among different organs of the plant. Partition of total dry matter amongst the major plant organs is of interest to the farmers as they are more interested in its partition towards economic yield. Example: excessive vegetative growth period in Ground nut produces less number of Pods as the reproductive period gets constricted. Thus, groundnut varieties with relatively extended period of reproductive growth are desirable.

1. Mode of action of different weedicides

The use of herbicides to kill unwanted plants is widespread in modern agriculture. Majority of Herbicides -about half of the commercially important compounds—act by interrupting photosynthetic electron flow (Ex. Paraquat, diuron) or electron flow of respiration. In Photosynthesis when the electron transport is blocked, it virtually stops light reaction of photosynthesis. When light reaction is stopped the dark reaction does not happen and thus CO2 is not fixed as carbohydrate. Therefore, the weed is killed by starvation.

1. Nutriophysiology

Nutriophysiology is yet another important area to under stand crop physiology. For the healthy growth of a crop around 17 essential elements are required. Knowledge of nutriophysiology has helped in identification of essential nutrients, ion uptake mechanisms, their deficiency symptoms and corrective measures. It also helps to check the toxicity symptoms of various nutrients. The use of fertilizers and their intake by plants can be totally understand by studying plant physiology.

1. Photoperiodism

Response of plant to the relative length of day and night is called as photoperiodism. This concept was used to choose photo insensitive varieties. The semi dwarf Rice varieties that have revolutionized agriculture, are lodging resistant, fertilizer responsive, high yielding and photo insensitive. Photo insensitivity has allowed rice cultivation in nontraditional areas like Punjab. Even in traditional areas rice-wheat rotation has become possible only due to these varieties.

1. Plant growth regulators

Plants can regulate their growth through internal growth mechanisms involving the action of extremely low concentrations of chemical substances called Plant growth substances, phytohormones or Plant growth regulators. The regulation of flowering, seed formation and fruit setting has been controlled through the application of different hormones at the appropriate time of plant height and age.

1. Agriculture being predominantly rainfed in nature, so development of drought resistant varieties is very important. Root zone depth, density of roots, plant water potential, relative water content, water use efficiency, xerophytic characters of leaves

etc. are some of the characters helped to bred drought tolerant varieties and to develop efficient irrigation management practices (sprinkler and drip irrigation).

1. Post-harvest Physiology

Post harvest losses of agriculture and horticulture are causing a great distress to farming community. Moisture and temperature are the two important factors causing physiological changes that reduce the post harvest quality of grains. Control of moisture content and maintenance of low temperatures have proved effective in storage of grains. Being perishable in nature the magnitude of post harvest loss is comparatively higher in horticultural crops. Example: In recent years a method called ‘modified atmospheric storage’ was developed for prolonged post harvest life of fruits and vegetables. Shelf life of cut flowers can be increased by application of kinetin (cytokinin). This will reduce the burst of ethylene and thus reduces the rate of senescence.

Thus, physiological understanding of crop plants provides the fundamental scientific base about various aspects of metabolism, growth and development. This is immensely important for crop improvement or technology improvement in agriculture or horticulture.