3. FACTORS AFFECTING PLANT GROWTH

Plant growth factors control or influence plant characteristics as well as adaptation. In general, there are two factors affecting plant growth and development : genetic and environmental.

The genetic factor is also called internal factor because the basis of plant expression (the gene) is located within the cell. The environmental factor is considered external, and refers to all factors, biotic and abiotic, other than the genetic factor. Both plant growth factors interact in various ways. The genetic factor determines the character of a plant, but the extent to which this is expressed is influenced by the environment.

A. Genetic Factor

The genotype of a plant affects its growth. For example, selected varieties of rice grow rapidly, maturing within 110 days, whereas others, in the same environmental conditions, grow more slowly and mature within 155 days.

A producer has control over the genetic factor by his choice of variety.

B. Environmental Factors

Environmental factors which affect plant growth can be classified as abiotic factors and biotic factors.

Abiotic Factors

The abiotic factors that affect plant growth and development include topography, soil, and climatic factors. They are the non-living

components of the environment which, along with the biotic factors, determine the extent to which the genetic factor is expressed in the plant.

➢ Topography

Topography is a nonliving or abiotic factor that refers to the "lay of the land." It includes the physical features of the earth such as the land elevation, slope, terrain (flat, rolling, hilly, etc.), mountain ranges and bodies of water.

The steepness of a slope affects plant growth through differential incidence of solar radiation, wind velocity and soil type. The altitude or elevation of the land with respect to the level of the sea surface influences plant growth and development primarily through temperature effect. The relationship of this abiotic factor to temperature is like that of distance from the equator to the arctic poles. Temperature decreases by 1^0C for every 100 metre increase in altitude in dry air.

➢ Soil

Soil is the outermost layer of the surface of the earth in which plants grow. It is composed of eroded rock, mineral nutrients, decaying plant and animal matter, water and air. This abiotic factor is likewise important in crop farming and is treated under the heading - Soil and Climatic Adaptation or Requirement of crops.

Most plants are terrestrial in that they are anchored to the soil through their roots, with which they absorb water and nutrients. But epiphytes and floating hydrophytes do not need soil to live. Variations in the physical, chemical, and biological properties of the soil have distinct

effects on plant growth and development, depending on natural adaptation.

There are two properties of the soil having pronounced direct effects on plant growth and crop production: physical and chemical properties. There are also biological factors or living organisms in the soil such as the earthworms, insects, nematodes and micro organisms like bacteria, fungi, actinomycetes, algae, and protozoa. These organisms help in improving soil structure, tilth (breaking and powdering of soil lumps), aeration, water permeability and soil nutrient availability.

The physical and chemical properties of the soil are referred to as edaphic factors of the plant environment. The physical properties include the soil texture, soil structure, and bulk density which affect the capacity of the soil to retain and supply water, while the chemical properties consist of the soil pH and Cation Exchange Capacity (CEC) which determines its capacity to supply nutrients.
It is now known that this abiotic factor (soil) is not essential as such for plant growth. Rather, it is the nutrients that are present in the soil that make plants grow and enable them to complete their life cycle.

- **Climate**

The climatic factors which affect plant growth include:

- Humidity
- Aeration
- Light
- Temperature
- Moisture

In nature, there is an interaction between these factors and they all affect each other. In a controlled environment, such as a nursery or

open field seed bed, temperature is the most influential factor in this interaction. A plant has the natural ability to regulate its level of activity according to environmental conditions, such as at specific levels of temperature and humidity. At extreme temperatures and humidity, such as when it is extremely dry or humid or extremely hot or cold, growth will stop, which may lead to the plant dying if the conditions persist. Environmental conditions therefore play an important role in the ability of a plant to grow and in general plant health. Effectively controlling these factors enables one to propagate and grow healthy plants.

- **Humidity**

Humidity, also referred to as relative humidity, is the amount of water vapour in the air at a given temperature, and is expressed as a percentage. This means that at 20% relative humidity, 20% of any given volume of air will consist of suspended water molecules. Humidity levels are especially important in allowing the plant to carry on with its metabolic processes at desired rates. The ideal relative humidity for propagation ranges between 80% and 95% for seeds and cuttings, and in the region of 60% outdoors for budding, grafting and seedbed methods. Seed germination is faster at higher humidity levels, as is the case of cuttings. In warm and dry areas, the level of humidity often falls below 55% on hot summer days, making budding and grafting more delicate and requiring close monitoring.

- **Aeration**

Plants can only grow and survive in a balanced environment, where both oxygen (O_2) and Carbon dioxide (CO_2) are sufficient. The processes of respiration and photosynthesis make use of both O_2 and CO_2 to sustain the growth and development of the plant.

In the open, such as under shade-cloth or in seedbeds, the ambient air movement is sufficient to aerate plants. In structures such as tunnels, ventilation becomes important. Ventilation extracts warm air containing the CO_2 produced by plants from tunnels, thereby maintaining a balanced environment.

- **Light**

All green plants require light for growth to take place. Some plants (most species) prefer growing in direct sunlight, while others prefer growing in the shade where they are subjected to indirect sunlight. Light is essential for photosynthesis, while light quality, which is determined by the wavelength of the light, also influences germination and flowering.

Plants grown under protection such as greenhouses and shade-houses, require adequate light for the process of photosynthesis. If the plant does not receive enough light, which may be due to shading or over-crowding, it displays symptoms of retarded growth.

In seed germination, red light, with a wavelength of 660 nanometre (nm), is used in chambers to stimulate germination of certain kinds of seeds. Incandescent globes are commonly used as an artificial source for red light for this purpose, while fluorescent tubes provide the blue light required for photosynthesis after germination. These lights are used extensively and kept on for as long as possible. It is not uncommon to have lights on 24 hours a day week round.

The depth of sowing light sensitive seed also determines the time seeds take to geminate, because light cannot penetrate deeply into the soil. Therefore light sensitive seeds should be planted shallower than non-sensitive seeds.

With no or inadequate light, weak seedlings of poor quality are produced. These seedlings display an excessive elongation, referred to as etiolation.

- **Temperature**

If heat and light, which cause an increase in temperature, is not controlled properly, plants may suffer from heat injury. The ideal temperature for propagation is 29°C, and it must be monitored closely.

In propagation chambers, the temperature can often be maintained at this ideal level by heating and cooling systems. The heat is also used for increasing the humidity in the chambers, by drenching the trays and dampening the floor.

- **Moisture**
    - Moisture is essential for germination and healthy plant growth.
    - Too much water suffocates the plant roots, and can cause diseases such as root rot, damping off, and collar rot. The other extreme is insufficient water supply, or drought, and is detrimental to all plants, but even more so to cuttings and young seedlings. A uniform and constant water supply is required for seed germination to produce healthy and vigorous seedlings, and for seedlings to grow into healthy plants.
    - In all propagation methods, the properties of the growth-medium determine the quality and quantity of water that will be

available for uptake by the plant. A good medium is one that has a low salinity level, sufficient water holding capacity (50-60 %), make water available to the plant easily, and the ability to allow lateral water movement.

- In the case of germination, the seed, and the later seedling stage, has to be kept in media wetted to field capacity, being the maximum amount of water that a particular soil can hold.

Biotic Factors

The effect of these biotic factors on plant expression may be advantageous or disadvantageous, depending on how they interact with the plant. These interactions include mutualism, herbivory, parasitism, and allelopathy.

Mutualism

Mutualism is a species-to-species interaction in which both the biotic factor and the plant are benefited by the relationship. Examples of beneficial influence of biotic factors on plant growth and development through mutualism are:

(1) The symbiotic relationship of the Rhizobium bacteria and leguminous plants.

N fixing nodules formed by Rhizobium in legumes

The Rhizobia live in the roots of the legume and obtain their supply of energy from the host plant. In exchange, the Rhizobia fix atmospheric nitrogen and supply it to the plant in absorbable form.

Nitrogen is an essential macronutrient for plant opment. It is a component of enzymes, DNA, and the chlorophyll molecule.

(2) Forest and fruit trees and other plants including annual crops associate with micorrhizal fungi which aid in the absorption of water and nutrients, such as phosphorus and zinc, from the soil.

(3) Birds, insects and bats serve as vectors(agents) of pollination, the transfer of pollen from an anther to a stigma, which is a precondition for the development of fruits and seeds from flowers in the angiosperms. As a reward, the pollinators feed on the nectar that the flower secretes or obtain some other benefit from the plant.

➢ Herbivory

In herbivory, plant-eating organisms called herbivore, such as ruminant animals, rodents (eg. Rats, squirrels), insects, and molluscs feed on plant parts. Herbivores with significant deleterious effects on crop growth and yield are called 'pests'. Damage caused by these biotic factors are varied such as death of the entire plant or organs, reduced root, stem, leaf or inflorescence mass, total defoliation, bores and holes on plant parts, and other marks of feeding.

➢ Parasitism

Parasitism is an interaction between two organisms in which one organism, called parasite, is benefited, but causes harm to another, called host. The parasite steals its food from the host. Micro organisms such as fungi, bacteria and virus injure crops by causing diseases and are called pathogens. Examples of parasitic plants are the loranthus, cuscuta, and some orchids.

Loranthus on mango tree

➢ Plant Interaction and Allelopathy

The word allelopathy derives from two separate words. They are *allelon* which means "of each other", and *pathos* which means "to suffer". Allelopathy refers to the chemical inhibition of one species by another. The "inhibitory" chemical is released into the environment where it affects the development and growth of neighboring plants.

Allelopathic chemicals can be present in any part of the plant. They can be found in leaves, flowers, roots, fruits, or stems. They can also be found in the surrounding soil. Target species are affected by these toxins in many different ways. The toxic chemicals may inhibit shoot/root growth; they may inhibit nutrient uptake; or they may attack a naturally occurring symbiotic relationship thereby destroying the plant's usable source of a nutrient.