

PROTECTED CULTIVATION AND POST HARVEST TECHNOLOGY (ASAE3204)

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Plant Response to Greenhouse Environments

- **Light, Temperature,**
- **Relative humidity,**
- **Ventilation and**
- **Carbon dioxide and**
- **Environmental requirement of agriculture and**
- **Horticulture crops inside green houses.**

INTRODUCTION

- The productivity of a crop is influenced not only by its heredity but also by the microclimate around it.
- The components of crop microclimate are **light, temperature, air compositions** and **the nature of the root medium**.
- In open fields, only manipulation of nature of the root medium by tillage, irrigation and fertilizer application is possible.
- The closed boundaries in greenhouse permit control of any one or more of the components of the micro climate.

LIGHT

- Light energy, carbon dioxide (CO_2) and water all enter in to the process of photosynthesis through which carbohydrates are formed.
- The production of carbohydrates from carbon dioxide and water in the presence of chlorophyll, using light energy is responsible for plant growth and reproduction.
- The **rate of photosynthesis** is governed by available fertilizer elements, water, carbon dioxide, light and temperature.

Light intensity requirements of photosynthesis are vary considerably from crop to crop.

- The light intensity is measured by the international unit known as **Lux**.
- Green house crops are subjected to light intensities varying from **129.6klux** on clear summer days to **3.2 Klux** on cloudy winter days.
- In general, for most other crops foliage is deeper green if the greenhouse is shaded to the extent of about 40% from mid spring (May) to mid autumn (August and September).
- Thus, it is apparent that light intensity requirements of photosynthesis are vary considerably from crop to crop.

How the wavelength of light affects the plants growth? ? ?

- Light is classified according to its wave length in nanometers (nm).
- All the light are not useful in photosynthesis process.
- Glass screens are opaque to the most UV light and light below the range of 325nm.
- Visible and white light has wavelength of 400 to 700nm.
- Infrared light (700 to 750nm) affects plants, besides causing photosynthesis.

- The set of wavelengths absorbed by a pigment is its **absorption spectrum**.
- The absorption spectra consists of three key pigments in photosynthesis: **chlorophyll *a*, chlorophyll *b*, and β -carotene**.
- The set of wavelengths that a pigment doesn't absorb are reflected, and the reflected light is what we see as color.
- Plants appear green to us because chlorophyll *a* and *b* does not absorb green color, instead they reflect it back to atmosphere.
- Chlorophyll molecules absorb blue and red wavelengths.

- The visible spectrum of light that is used in photosynthesis.
- In the blue and red bands, the photosynthesis activity is higher, when the blue light (shorter wavelength) alone is supplied to plants, the growth is retarded, and the plant becomes hard and dark in colour.
- When the plants are grown under red light (longer wavelength), growth is soft and internodes are long, resulting in tall plants.
- Visible light of all wavelengths is readily utilized in photosynthesis.

TEMPERATURE

- Temperature is a measure of level of the **heat** present.
- All crops have temperature range in which they can grow well.
- Below a certain range, the plant life process stop due to ice formation within the tissue and cells are possibly punctured by ice crystals.
- At the upper extreme, enzymes become inactive, and again process essential for life cease.
- **The rate of reactions controlled by the enzyme often double or triple for each rise of temperature by 10 °C, until optimum temperature is reached.**
- Further, increase in temperature begins to suppress the reaction and finally stop it.

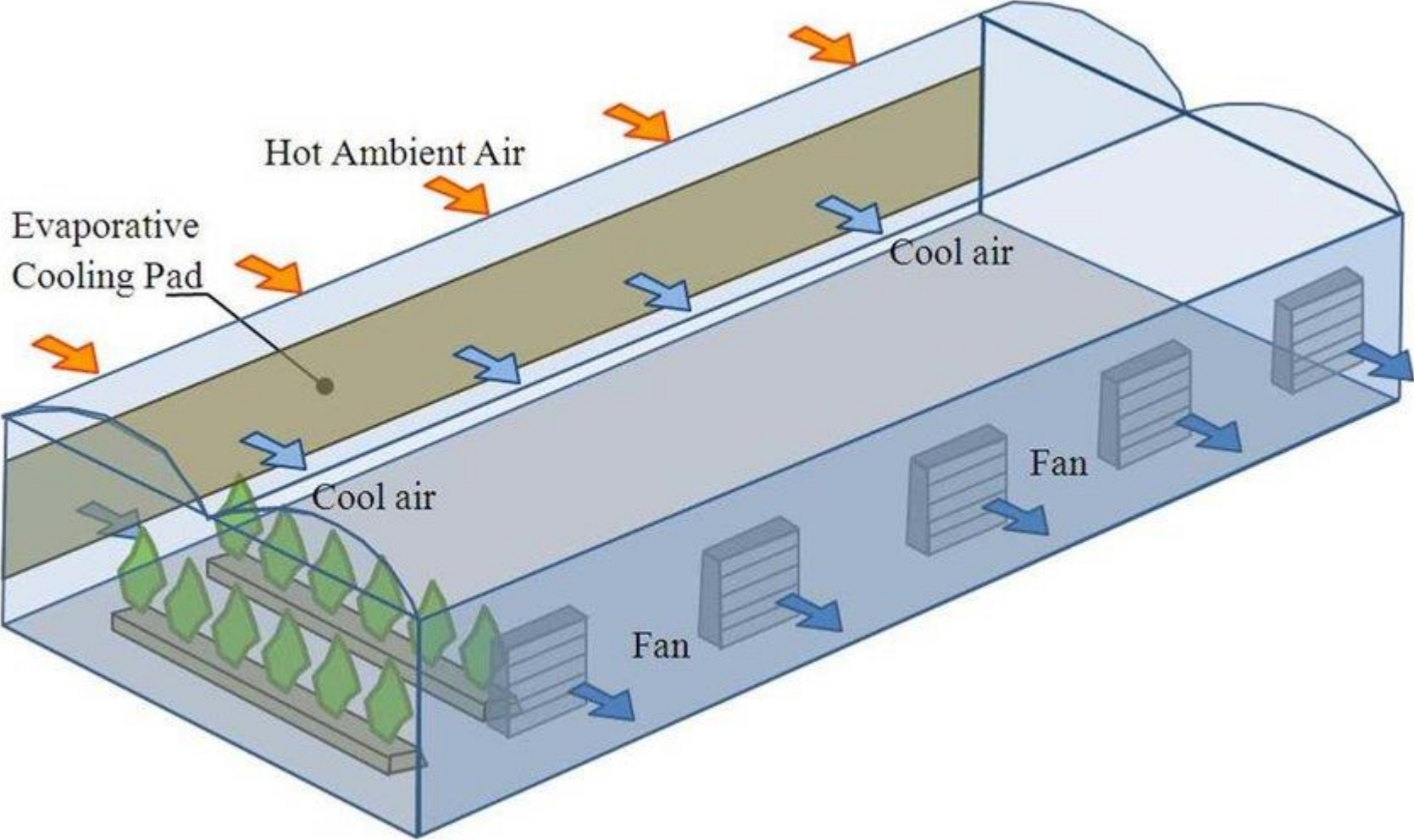
- Green house crops are grown at a day temperature, which are 3 to 6°C higher than the night temperature on cloudy days and 8°C higher on clear days.
- The night temperature of green house crops is generally in the range of 7 to 21°C.

RELATIVE HUMIDITY

- As the green house is a closed space, the **relative humidity** of the **green house air** will be **more** when compared to the ambient air, due to the moisture added by the evapo-transpiration process.
- Some of this moisture is taken away by the air leaving from the green house due to ventilation.
- In order to maintain the desirable relative humidity levels in the green houses, processes like **humidification or dehumidification** are carried out.
- For most crops, the **acceptable range** of relative humidity is between **50 to 80%**. However for plant propagation work, relative humidity up to **90%** may be desirable.

- In summer, **due to sensible heat addition** in the daytime, and also in winters for maintaining the night time temperatures of the green house air, more sensible heat is added causing a **reduction** in the **relative humidity of the air**.
- For this purpose, **evaporative cooling pads** and **fogging system** of **humidification** are employed.
- **Ventilators**, **chemical dehumidifiers** and **cooling coils** are used for de- humidification.

Evaporative cooling pad



Fogging system



Ventilation

- A green house is ventilated for either
 1. Reducing the temperature of the green house air or
 2. For replenishing carbon dioxide supply or
 3. For moderating the relative humidity of the air.
- Air temperatures above 35⁰C are generally not suited for the crops in green house.
- It is quite possible to bring the green house air temperature below this upper limit during spring and autumn seasons simply by providing adequate ventilation to the green house.

TYPES OF VENTILATION

- **Active ventilation** is the use of equipment to force air into or out of the structure.
 - **Fans** are the key method of actively venting a greenhouse.
 - Fans can also be fitted in greenhouses to **move or circulate air within the greenhouse**.
- **Passive ventilation** uses openings (vents) which naturally draw air through the greenhouse.
 - Vents are the most common ventilation method used in greenhouse production.
 - **Roof ventilation** is a more effective method of air exchange than side wall ventilation.

- In case of small green houses (less than 6m wide) natural ventilation can be quite effective during spring and autumn seasons.
- However, fan ventilation is essential to have precise control over the air temperature, humidity and carbon dioxide levels.

Passive or natural ventilation



Active or forced ventilation



Carbon dioxide

- Under normal conditions, carbon dioxide (CO₂) exists as a gas in the atmosphere slightly above 0.03% or 345ppm.
- During the day, when photosynthesis occurs, the plants in a green house draw down the level of CO₂ to below 200ppm.
- Under these circumstances, **infiltration or ventilation** is done which **increases** the level of CO₂, to maintain the ambient levels of CO₂.
- If the level of CO₂ is less than ambient levels, CO₂ may retard the plant growth.

- In cold climates, maintaining ambient levels of CO₂ by providing ventilation may be uneconomical, due to the necessity of heating the incoming air in order to maintain proper growing temperatures.
- In such regions, enrichment of the green house with CO₂ is followed.
- The exact CO₂ level needed for a given crop will vary, since it must be correlated with other variables in greenhouse production such as light, temperature, nutrient levels, cultivar and degree of maturity.

Assignment(06.01.2020)

1. Environmental requirement of agriculture and
2. Horticulture crops inside green houses.