

Manipulation of CO₂, light, humidity and temperature for vegetable production



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Environmental influence on plant growth

Climatic factors	Influence
Radiation/Light	Photosynthesis, Photo morphogenesis, Photoperiodism
Temperature	Cell division and elongation Respiration, Photosynthesis Water uptake, Transpiration
Relative Humidity	Quality of plant
CO ₂ level	Photosynthesis, Respiration
Air circulation	Temperature, Humidity and CO ₂ level in greenhouse
Rainfall	Relative Humidity

Climatic requirement for various crops

Vegetables	Germination Temperature (° C)	Approx days to emergence	Day (° C)	Night (° C)
Tomato, Brinjal	21-24	3-4	18-21	12-18
Capsicum, Chilli	26-28	4-6	18-21	12-18
Cole Crops	18-24	2-3	10-18	8-14
Most of the Cucurbits	24-30	2-3	21-24	12-18

*Source- Anonymous 1990, Vegetable Production training manual, AVRDC, Tainan, Taiwan

Climate control techniques

Parameters	Technical Options to control	Equipments required
Light /Radiation	To increase light intensity and day length- Artificial lighting	Incandescent lamp, Fluorescent lamps, High intensity discharge lamps
	To decrease light intensity and day length-Shading /Screening, White washing	Shade nets, Black out screens, Aluminets,White wash etc.
Temperature	To increase temp.- Heating	Heaters, Hot water heating, Steam heating etc
	To decrease temp.- Cooling-	Misters, Foggers, Roof Sprinklers
	Shading-	Shade nets/Screens White wash etc.
	Ventilation (Air circulation)-	Vents, Exhaust fans etc.
Relative humidity	To increase humidity-	Humidifiers, Foggers, Misters
	To decrease humidity-	Heaters, Vents, Dehumidifiers
Co ₂ concentration	Co ₂ enrichment	CO ₂ burner,PureCO ₂ , Fuel gases etc.

Measuring Equipments –

Sr. No.	Parameter	Measuring Equipments
1.	Light /Radiation	Line Quantum Sensor, Radiation-meter, LUX meter
2.	Temperature	Glass thermometer, Bimetal s thermometer, Infra red thermometer
3.	Relative Humidity	Psycrometer,Hygrometer,Electric moisture meter
4.	CO ₂ Concentration	CO ₂ meter,CO ₂ Analyser
5.	Wind Speed	Anemometer
6.	Wind Direction	Wind Vane
7.	Rain / Precipitation	Rain gauge, Rain Indicator

Maintenance of Greenhouse

- Cleaning of top plastic.
- Application of Distemper/Chalk - Reduction of light intensity and temperature.
- Greasing - Door wheels, Racks, Motor & Gear assembly, Handles of side vents & Wheels of shade nets.
- Painting – White or Silver colour in every two year to avoid rusting

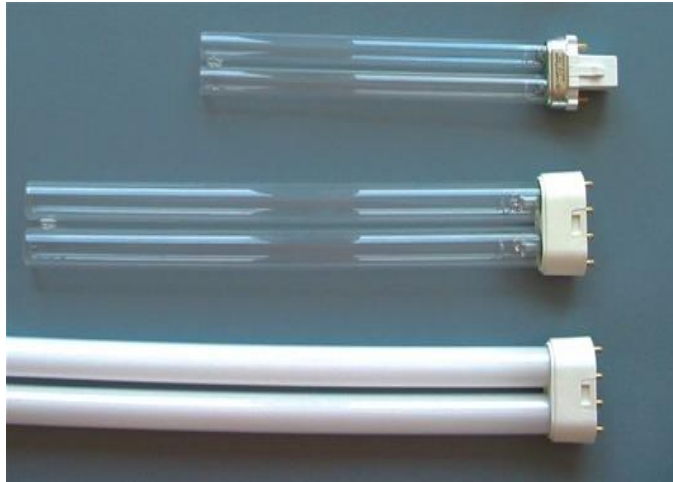


Artificial lighting –

Different types of lamps are used to supply the light in the greenhouse or to enhance the day length.



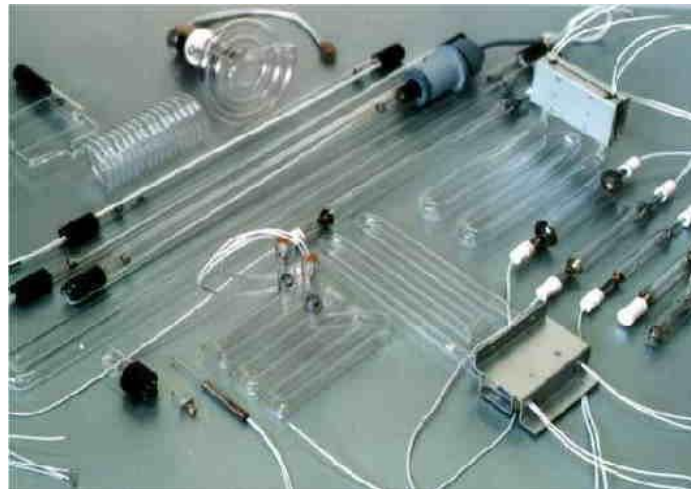
Artificial lighting lamps



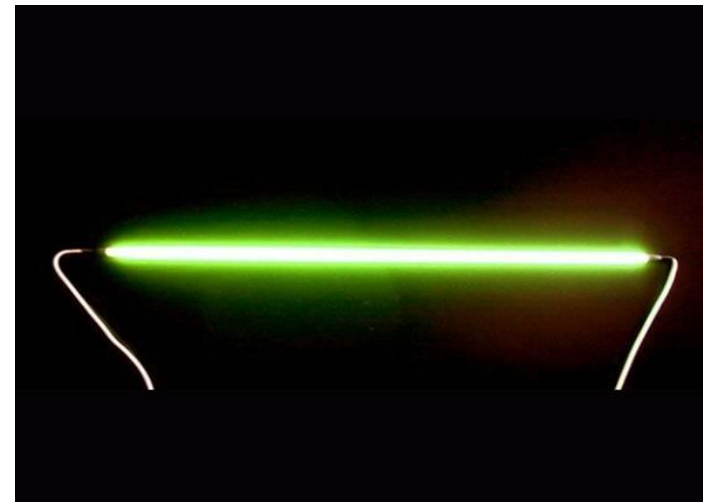
Incandescent lamp



High pressure sodium lamp



High pressure mercury lamp



Fluorescent lamp/tube

Shading methods-

To impart shade, inside the greenhouse shade nets are used. In various colours/grades shade nets are available in the market.



Thermal screen- It can be used to reduce heat loss and also called as energy saving screen. Heat loss is influenced by outside temperature, wind speed and time of the day. Thermal screen should not be used during the day as valuable light will be lost. The most common factors on which the closing of the thermal screen are based are time, outside temperature and wind speed.



Aluminet Screen

Heating- Heating is generally required in the temperate regions where temperature goes down below 10 °C.

Centralized heating system- Heat is generated at one location and distributed to the all greenhouse locations



Centralized heating system

Localized heating system- The heating devices are located in the greenhouses for e.g. heaters in the poly houses

Green house cooling –

The practical options for greenhouse cooling are **Misting, Fogging, Ventilation, Evaporative cooling** (using fan & pad system) and **Shading**.

Side ventilation

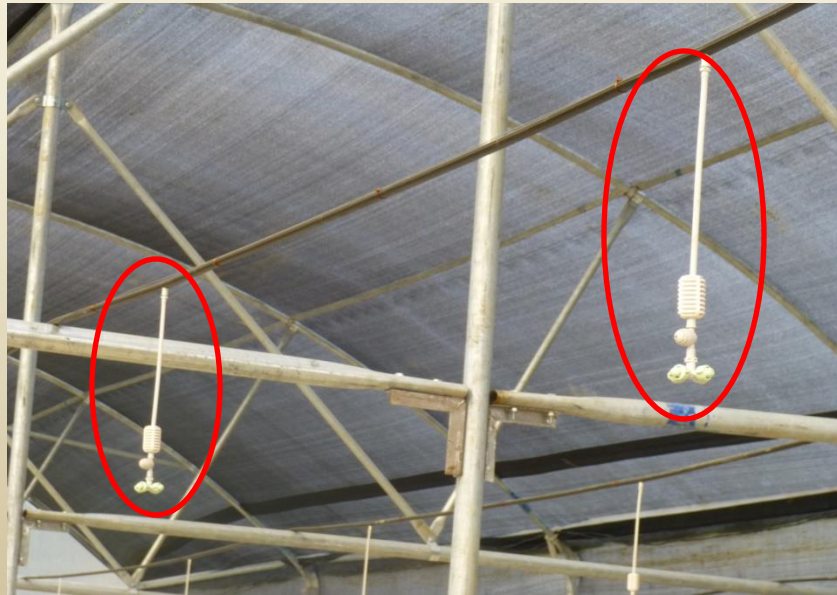


Top Ventilation



Misting and Fogging –

Misting and Fogging systems are commonly used for uniform cooling inside the greenhouse in the tropical and sub tropical regions. Fogging helps in decreasing the temperature by 4-5 °C. It is usually done for 8-10 times in the afternoon for 1 to 3 minutes. However, it depends on the inside temperature, humidity, stage of the crop etc. Generally foggers are installed overhead while misters are placed on the beds. Misting systems is used for roses in particular. For all other greenhouse crops fogging system is used.



Carbon di-oxide (CO₂) enrichment

The CO₂ enrichment can be done by 3 methods

- 1. Use of CO₂ burner**
- 2. Pure CO₂**
- 3. Fuel gases**

CO₂ enrichment is practiced in the closed greenhouse structure. Concentration of 1000 to 1500 ppm is the levels generally established in the greenhouse.

Line Quantum Sensor



Visible light meter-

It measures the light in the band of 400-700 nm. This light meter has a silicon plate. As more light falls on it, the resistance decreases and a stronger current can pass through this silicon. By this the radiation or light is measured in Lux or Klux.



Visible light meter (Lux meter)

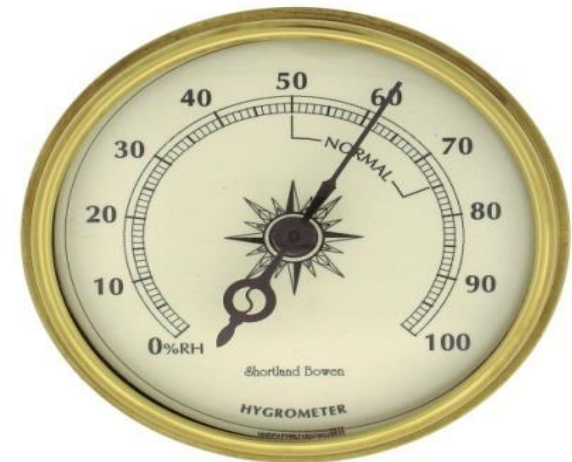
Psychrometer makes two temperature measurements i.e. dry bulb temperature (DBT) and wet bulb temperature (WBT). RH is measured by the difference in between the DBT and WBT readings. DBT sensor measures the temperature of the greenhouse air. WBT is enclosed in a moistened wick from which water can evaporate freely. Heat is needed for evaporation of this water. This heat is given by WBT sensor. These DBT and WBT sensors are placed in the aspirated screen



Hygrometer and **Hygrograph** are used to measure the RH of the air. In the hygrometers moisture sensitive human hairs or specially treated synthetic fibres are used which extend with the increase in humidity. The activity of extension of hair or fiber is transmitted to a pointer or writing lever. The relative humidity is measured in percentage.



Thermo hygrograph



Hygrometers

Digital thermo hygrometer- electronic device used for instant measurement of temperature and relative humidity inside of the green house.



Digital thermohygro meter

Fan for air circulation



CO₂ Analyzer

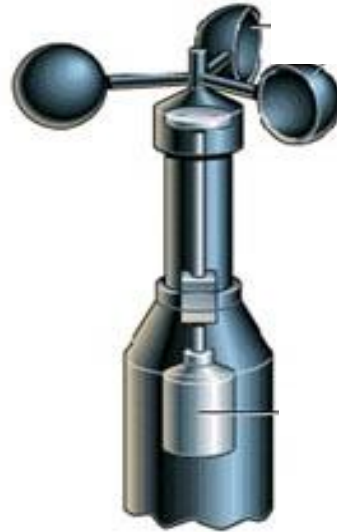
The handy or portable digital CO₂ analyzers are also available in the market with the fine accuracy, but these are very costly. CO₂ is measured in percentage or ppm.



CO₂ Analyser

Wind speed measurement-

To measure the wind speed the anemometer is used. The wind makes rotating the small paddle and internally the rotations are counted.



Anemometer

Wind direction meter –

The wind direction meter is used at the weather station. It has a vane with an arrow indicating direction of the blowing wind.

Automatic Weather Station





Thank You !!!

