Unit 5

# Greenhouse Operations

## Introduction

A greenhouse environment for achieving the required level of precision and efficiency is bound to be complex and dynamic. To be able to dynamically control the environmental parameters of the micro climate inside a greenhouse, it requires huge cost, trained labour while all along being market sensitive. Therefore, entire range of greenhouse control and automation are key elements of success in terms of profitability. Since most of the environmental controls and biological dynamics of plant metabolism are often interdependent, these controls become crucially important for successful greenhouse production. If we can control critical components and factors under dynamic and precise automation, then only the desirable efficiency of micro climate inside the greenhouse can be called successful.

For effective production under greenhouses, the following environmental operations and their regulations are essential.

(i) Temperature
(ii) Light intensity
(iii) Relative humidity
(iv) pH and EC
(v) Carbon dioxide
(vi) Ventilation

## Session 1: Equipment for Environmental Parameter Monitoring in Greenhouses

Greenhouse cultivators strive to maximise their production from a limited space covered. To achieve their goal, cultivators purchase inputs and avail best of the know-how to operate several tools to avoid making serious mistakes during the course of crop production. For measuring different environmental parameters, the required equipment/instruments are described below.

### Thermometers

*Fig. 5.1: Infrared Thermometer*

A minimum/maximum thermometer is a must for greenhouse growers. The temperature in the greenhouse has a great influence on nutrient uptake, plant growth, pollination, fruit set, fruit cracking, discolouration, flower size, stem length, etc. The thermometer is located at the centre of the greenhouse and at the plant level, not facing the sun. Optimum temperatures for flower cultivation range between 18–26 °C.

### Humidity meters

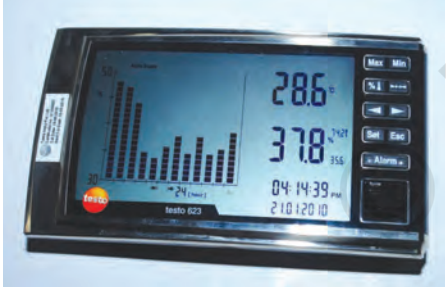


*Fig. 5.2: Hygrometer*

These meters are used to adjust the desired level of relative humidity. Best crop growth can be achieved when humidity ranges between 60 and 80 per cent.

High relative humidity in the greenhouse results in less transpiration leading to less movement of nutrient. If the levels of humidity are above and below the desired level, it results in high incidence of pests and diseases. Hygrometer is used for measuring atmospheric humidity and temperature.

### pH meters

*Fig. 5.3:* pH *meter*

Ideally, the pH of the soil and water has to be 6–6.5 and that of nutrient solution should be 5.6–6.5. A good quality pH meter should be used to regularly check the pH of the nutrient solution as well as the pH of the growing medium. The pH meter, like all other equipment, should be calibrated beforehand for accurate data collection. At a low pH, the hydrogen

ions saturate media exchange sites and increase the potential for leaching and losing nutrient content such as calcium, magnesium, potassium and ammonium. A high media pH can cause micronutrient deficiencies even when they are present in sufficient quantity.

## Electrical conductivity (EC) meter

EC is a measure of soluble salts in water and is measured in terms of millimhos per centimetre (mmhos/cm), deciSiemens per metre (dS/m), or milliSiemens per centimetre (mS/cm). They are all indeed similar on numerical count, i.e., numerical value remains same per unit area, only the reference varies. An analysis should be done for the nutrient feed solution and for the root medium. The EC measurement alone does not indicate the types of fertiliser in the nutrient solution, but this measurement can provide a good indication of the total amount of fertiliser being applied. A root-zone EC of above 1.0 mS/cm should alert cultivators about starting of salt build-ups. It necessitates flushing the growing medium. It is important to know the EC of water before mixing the fertiliser.

## Lux meter

It is used for measuring the intensity of light in the greenhouse. Lumen is the metric unit of light intensity and the term lux refers to the number of lumens per sq m of surface area.

*Fig. 5.4: Lux meter*

## $CO_2$ Enrichment or Maintenance

Portable $CO_2$ meters are commercially available to monitor carbon dioxide concentration. Generally, the value of carbon dioxide inside the polyhouse is around 1000 ppm in the morning hours and declines as the day progresses. The presence of more quantities of carbon dioxide helps in enhancing the net photosynthetic rates. Operation of side curtains in naturally ventilated greenhouses helps in the replacement of reduced carbon dioxide levels naturally.

## Practical Exercises

**Activity 1: Measurement of temperature inside a greenhouse.**

*Materials required*: thermometer, pen, notebook, etc.
*Procedure*

- Visit a greenhouse in nearby area after consulting the farmer.
- Take a digital thermometer to monitor the temperature at different locations and height inside the greenhouse.
- Measure the temperature just above the ground level, at crop height level and at about 4 m height.
- Note down the readings at entry point, mid of the greenhouse and at the farthest point.
- Observe the difference in temperatures at different locations inside the greenhouse.

## Check Your Progress

**A. Fill in the blanks**

1. Ideally, the pH of the nutrient solution should be between _____ and _____.
2. Generally, the value of carbon dioxide inside a polyhouse during early day hours would be around _____ ppm.
3. Best crop growth of flowers can be achieved when humidity ranges between _____ and _____ %.
4. Optimum temperatures for flower cultivation range between _____ and _____.

**B. Mark the correct answers**

1. High media pH can cause deficiencies of _____.
   (a) micronutrient (b) water
   (c) humus (d) plant hormone
2. Measuring soluble salts in water is _____.
   (a) $Co_2$ (b) pH
   (c) EC (d) Temperature
3. Which of the following does not come under environmental parameters?
   (a) Humidity (b) pH
   (c) Light (d) Temperature

**C. Descriptive questions**

1. Describe the equipment used for environmental parameters monitoring in greenhouses.

_____

_____

_____

**D. Match the columns**

| A | B |
|---|---|
| 1. Humidity and temperature | (a) 6–6.5 |
| 2. Ideal EC in greenhouse soil | (b) Hygrometer |
| 3. Ideal pH of soil and water | (c) Lux meter |
| 4. Measuring light intensity | (d) >1 in mS/cm |

## Session 2: Management of Environmental Parameters in a Greenhouse

Climatic parameters and their management are essential for quality and quantity of greenhouse crop production. These parameters can be managed and regulated naturally as well as artificially by using different equipment. The equipment may be operated manually, hydraulically or electrically. The type of climate control systems used also depends on the size and number of the greenhouses.

The use of a particular equipment or their combinations depend on the type of crop grown and the type of greenhouse suitable for its cultivation. The equipment can be low-cost, manually operated to auto controlled high-cost systems.

The purpose of using different systems inside the greenhouse could be for cooling, heating, lowering or enhancing humidity, enriching gaseous composition, lighting, irrigation, fertigation, fogging, pesticide spraying, etc.



**Table 5.1: Equipment/System and its function used in protected cultivation**

| Purpose | Equipment/System and its function | Parameters that are managed inside the greenhouse |
|---|---|---|
| Cooling | **Equipment/System used: Vents/Side Curtains**<br>**Function:** Heat inside the greenhouse escapes through top vent and fresh air enters the structure through side windows when side curtains are opened. This can be done manually or with actuators which can be operated electrically.<br>**Shade net Function:** Cooling can also be achieved by collapsible shade nets that can be operated manually or mechanically inside the greenhouse. | Temperature, relative humidity and gaseous composition |

| | | |
|---|---|---|
| | **Fogging Function:** Cooling can also be achieved through operation of foggers for increasing humidity inside the structure. The result is a cooling effect due to evaporation. However, it should be used cautiously when targeted to control temperature and droplet formation on leaves has to be avoided. | |
| Ventilation | **Equipment/System used**<br>**Vents/Side curtains**<br>**Function:** Air inside the greenhouse can be exchanged continuously with cross ventilation, natural air convection or artificial forced ventilation.<br>**Exhaust fan and pad**<br>**Function:** These systems are used in forced ventilated systems. These systems can be operated manually or with actuators which can be operated electrically. | Temperature, relative humidity and gaseous composition |
| Shading | **Equipment/System used**<br>**Function:** Shade nets of different shading percentages are used to normally reduce the light intensity during the critical crop stages as per the requirement of the crop. Different crops require different percentage of shading.<br>Shading can be achieved by installing and operating the collapsible shade nets inside the greenhouse. Spreading and rolling back of shade nets preferably outside the structure can be achieved manually or by electrical actuators. While silver shaded nets are installed inside the greenhouses which can be opened (spread) during intense sunlight and cloudy days, these are closed during cold nights. | Light intensity, temperature |
| Humidity | **Equipment/System used**<br>**Foggers/De-humidifier Function:** These are used for regulating the humidity inside the greenhouse as per the crop requirement.<br>Foggers are used to increase the humidity levels inside the structure. These can also be used to bring down the temperature inside the structure. Alternately, de-humidifiers are used to decrease the humidity inside the structure, when the humidity levels are above the desired levels. Though it is rare.<br>**Hygrometer/Hygrothermometer:** Hygrometer is used to measure atmospheric relative humidity inside the greenhouse.<br>Hygrothermometer is used to measure atmospheric temperature and relative humidity both inside the greenhouse.<br>Portable digital type instruments are commercially available for use. | Humidity, temperature |

| | | |
|---|---|---|
| Carbon dioxide | **Equipment/System used**<br>**Side curtains closing, $CO_2$ Burner, $CO_2$ Cylinders, Fuel Gases**<br>**Function:** Management of carbon dioxide inside the greenhouse is possible with the closing of side curtains in the evening hours till morning. $CO_2$ released by the plants naturally during the night can be trapped and accumulated for its use by plants in the day.<br>$CO_2$ burners, $CO_2$ cylinders, fuel gases can also be used for artificial enrichment of carbon dioxide levels, though they are rarely used. | Carbon dioxide |
| Heating | **Equipment/System used**<br>**Central heating systems or localised heating systems**<br>**Function:** Heating systems are used to generate heat where the outside atmosphere has near zero or sub-freesing temperatures. In India, heating systems are rarely used.<br>The natural heat can also be conserved inside the greenhouse by closing the side curtains in the evening hours till morning in the winter season. | Heat, temperature |
| Lighting/ Darkening | **Equipment/System used**<br>**Lamps/Black nets**<br>**Function:** Some crops need longer or shorter day or nights for their critical growth at the flowering and fruiting stage. This happens naturally only during summers and winters, however, this can managed with artificial lights for increasing day hours, and black nets to increase night hours for year round production inside the greenhouse.<br>The artificial lighting can include incandescent, fluorescent, mercury or halide lamps. | Light |
| Climatic parameters and quality measuring instruments | **Lux meter:** It is used to measure the visible light intensity inside the greenhouse. It consists of silicon plate to sense the light. The unit of measurement is in Lux.<br>**pH meter:** It is used to measure acidity or basicity of the soil and water used in greenhouse cultivation.<br>**EC meter:** It is used to measure the dissolved salts in soil, and water used in greenhouse cultivation. This is measured in dS/m or milli Mhos/cm.<br>**Thermometer:** It is used to measure temperature inside the greenhouse. Portable digital thermometers are commercially available. The unit of measurement is °C.<br>**Portable observatory:** All the greenhouse parameters such as temperature, humidity, light, wind speed and wind direction can also be measured with portable observatory. This helps take decision to regulate the climatic parameters inside the greenhouse. | Light, pH, EC and relative humidity |

| | | |
|---|---|---|
| Irrigation and fertigation | **Drip Irrigation and Fertigation System**<br>These consist of suitable drippers, emitting pipes, piping network and control valves, filtration unit, fertigation equipment and pump.<br>**Functions:** These are used to supply quality irrigation water precisely and timely right up to the base of the plant as per the daily water requirement of the crop. This can be controlled using control valves which can be operated manually or automatically depending on the type of crop and technology used.<br>Filters are used to filter the irrigation water used from different sources. These filters are installed at the header unit before the injection of water inside the piping network. Common type of filters used are sand filter, hydro cyclone filter and disc/screen filters. These filters can be operated manually or automatically.<br>Fertigation equipment is used to inject soluble/liquid fertilisers, pesticide/fungicides, chemicals inside the drip system accurately and timely as per the need of the crop. The commonly used fertigation equipment include venturi, fertiliser tank, injection pump and electrically or hydraulically operated dozers. | Optimum amount of water and doses of macro and micro nutrients as per the requirements of crop and crop stage |

## Practical Exercises

**Activity 1: Monitor humidity and temperature in greenhouse**

*Material required*: humidity meter or hydro-thermometer, thermometer pen, notepad, etc.

*Procedure*

- Visit a greenhouse in nearby area after consultation with a farmer.
- Measure the temperature and humidity of greenhouse immediately after entering.
- Open the side curtains and after 30 minutes measure the temperature and humidity.
- After that ask the farmer to operate the fogger for 30 seconds.
- Measure the temperature and humidity again.
- Observe the temperature and humidity values that you collected.

## Check Your Progress

**A. Fill in the blanks**

1. Humidity is regulated inside the greenhouse by _____.
2. To increase night hours in the greenhouse round the year is _____ used.

3. Net used to reduce the light intensity is known as _____.

**B. Mark the correct answers**

1. Hygrometer is used to measure _____.
   (a) pH
   (b) Relative Humidity
   (c) EC
   (d) Light intensity
2. An equipment used in forced ventilated system is _____.
   (a) exhaust fan and pad system
   (b) sensors
   (c) $CO_2$ burner
   (d) de-humidifier
3. The presence of more quantities of carbon dioxide helps in enhancing the _____.
   (a) respiration rate
   (b) transpiration rate
   (c) photosynthetic rates
   (d) evaporation rate

**C. Descriptive question**

1. Describe different equipment and their functions used in protected cultivation.

_____

_____

_____

**D. Match the columns**

| A | B |
|---|---|
| 1. EC | (a) Fogger |
| 2. Cooling equipment | (b) Venturi |
| 3. Decrease humidity | (c) dS/m |
| 4. Fertigation equipment | (d) De-humidifier |