

## **Unit- II**

### **LOAD**

#### **(8)**

The structure of greenhouse has to carry the following loads and is to be designed accordingly.

#### **Dead Load:**

Weight of all permanent constructions, cladding, heating and cooling equipments, water pipes and all fixed service equipments to the frame.

#### **Live load:**

Weights imposed by use by hanging baskets, shelves and persons working on roof. The greenhouse has to be designed for a maximum of  $15 \text{ kg/m}^2$  live load. Each member of roof should be capable of supporting  $45 \text{ kg}$  of concentrated load when applied at its centre.

#### **Wind load:**

The structure should be able to withstand winds of  $110 \text{ km/hour}$  and at least  $50 \text{ kg/m}^2$  of wind speed.

#### **Snow load:**

These are taken up as per average snowfall of location.

Greenhouse should be able to take

- a. Dead load plus live load or
- b. Dead load plus wind load plus half live load

## **CONTROL OF TEMPERATURE AND LIGHT**

#### **(9)**

Crop production can become highly accelerated through the use of greenhouse environment control system or automation. With this form of environmental control the greenhouse stays constant to provide optimal conditions that are most favourable for maximum yield. Management of greenhouse environment is directed at optimising the photosynthesis process in the plants, the plant's ability to utilise light at maximum efficiency. The important factors which are manipulated to grow vegetables in greenhouses are as follows:

#### **Temperature:**

- During summer inside temperature rises higher than that of optimum levels for this evaporative cooling/ventilation provision is there.
- Forced air heaters-installed in ridge area of greenhouse which require a minimum space. Sufficient BTU (British Thermal Unit) output to heat the greenhouse on the coldest day.
- Natural and compressed gas heaters should be rented for safety, to prevent crop damage.
- Thermostat located at plant level where: plants are growing where sunlight do not directly affect them.
- For heating, electric heaters, gas heaters, paraffin heaters are used.
- For cooling, wind ventilation system, chimney ventilation system, fan ventilation system, hinged ventilators, automatic vent operators, extractor fans are used.

### **Light:**

Greenhouse crops grow best in light whose wavelength range from 400 to 700 nanometers. Different ways of controlling light intensity and photoperiod in greenhouse are

- Shading nets- The best is made of a thin layer of aluminium foil attached to a layer of black plastic strip fixed with nylon fibres. More expensive system.
- High pressure sodium lamps-Most effective type of supplemented light but the cost of investment is high.
- Incandescent lamps as supplementary lighting as they are cheap.
- Fluorescent lamps produce linear light that gives off more efficient and uniform lighting than incandescent types.

## **CONTROL OF CO<sub>2</sub> AND HUMIDITY**

(10)

### **CO<sub>2</sub>:**

Inside an un-enriched greenhouse, the CO<sub>2</sub> concentration drops below the atmospheric level whenever the CO<sub>2</sub> consumption rate by photosynthesis is greater than the supply rate through the greenhouse vents. The solution is to increase the ventilation rate through forced air, to improve design and management of the ventilation system, or to provide CO<sub>2</sub> enrichment to enhance crop photosynthesis under the low radiation conditions. Enrichment reportedly increases crop yield and quality under a CO<sub>2</sub> concentration of 700-900  $\mu\text{mol mol}^{-1}$ . One of the main restrictions is the short time duration available for an efficient use of CO<sub>2</sub> enrichment, due to the need to ventilate for temperature control. The fact that greenhouse have to be ventilated during a large proportion of the daytime makes it uneconomical to maintain a high CO<sub>2</sub> concentration during the daytime. However, supplying CO<sub>2</sub> even when ventilation is operating to maintain the same CO<sub>2</sub> concentration in the greenhouse as outside and enriching to levels of

about 700-800  $\mu\text{mol mol}^{-1}$  during the periods when the greenhouse is kept closed, usually in the early morning and the late afternoon.

Optimal  $\text{CO}_2$  enrichment depends on the margin between the increase in crop value and the cost of providing the  $\text{CO}_2$  gas. Attempting to establish the optimal concentration by experiment is not feasible because the economic value of enrichment is not constant but varies with solar radiation through photosynthesis rate, and with greenhouse ventilation rate through loss of  $\text{CO}_2$ . The optimal  $\text{CO}_2$  set point depends on several influences: the effect of  $\text{CO}_2$  on the photosynthetic assimilation rate, the partitioning to fruit and to vegetative structure, the distribution of photosynthate in subsequent harvests, and the price of fruit at those harvests, as well as the amount of  $\text{CO}_2$  used, greenhouse ventilation rate and the price of  $\text{CO}_2$ . The reduction in production caused by depletion is comparable to the reduction resulting from the lower temperature caused by ventilation to avoid depletion, compensating the effect of depletion is much cheaper than making up the loss by heating. The two principal sources of  $\text{CO}_2$  for enrichment are pure gas and the combustion gases from a hydrocarbon fuel such as low sulphur paraffin, propane, butane or natural gas.

### **Dehumidification:**

Condensation is a symptom of high humidity and can lead to significant problems, including germination of fungal pathogen spores, including Botrytis and powdery mildew. Condensation occurs when warm, moist air in a greenhouse comes in contact with a cold surface such as glass, fibreglass, plastic or structural members. Condensation can be a major problem and it is unfortunately one which, at least at certain times of the year, is almost impossible to avoid entirely.

#### **How to dehumidify greenhouse?**

- Combined used of heating and ventilation systems
- Absorption using a hygroscopic material
- Condensation on cold surfaces
- Forced ventilation usually with the combined used of a heat exchanger
- Anti-drop covering materials

The use of anti-drop covering materials is an alternative technology for greenhouse dehumidification. (The “anti-dripping” films that contain special additives which eliminate droplets and form instead a continuous thin layer of water running down the sides) The search for anti-drip cover materials has been mainly focused on the optical properties of the cover materials.

#### **When to dehumidify?**

Dusk: Reduce humidity to 70-80% as night falls to prevent condensation.

Dawn: Reduce humidity to prevent condensation, and jumpstart transpiration as the sun rises.