ENGG-232

Practical Manual

Practical No. # 1

STUDY OF DIFFERENT TYPES OF GREEN HOUSES

Greenhouse - A greenhouse is a framed or an inflated structure covered with a transparent or translucent material in which crop could be grown under the condition of at least partially controlled environment and which is large enough to permit to persons to work within it to carry out cultural operation.

OR

Greenhouses are framed or inflated structures covered with transparent or translucent material large enough to grow crops under partial or fully controlled environmental conditions to get optimum growth and productivity

.

Classification of greenhouses: Greenhouse structure of various types is used for crop production. Although there are advantages in each type for a particular application, in general there is no single type greenhouse, which can be constituted as the best. Different types of greenhouses are designed to meet the specific needs.

The different types of greenhouses based on shape, utility, material and construction are briefly given below:

1. **Greenhouse type based on shape:**

For the purpose of classification, the uniqueness of cross section of the greenhouses can be considered as a factor. The commonly followed types of greenhouses based on shape are:

(a) Lean to type greenhouse.
(b) Even span type greenhouse.
(c) Uneven span type greenhouse.
(d) Ridge and furrow type.
(e) Saw tooth type.
(f) Hoop style
(g) Trusted roof
(h) Gable frame
(i) Circular
(j) Quonset greenhouse.
(k) Interlocking ridges and furrow type Quonset greenhouse.
(l) Ground to ground greenhouse.

2. **Greenhouse type based on Utility**

Classification can be made depending on the functions or utilities. Of the different utilities, artificial cooling and heating are more expensive and elaborate. Hence based on this, they are classified in to two types.

a) Greenhouses for active heating.
b) Greenhouses for active cooling.

3. **Greenhouse type based on construction**

The type of construction predominantly is influenced by structural material, though the covering material also influence the type. Higher the span, stronger should be the material and more structural members are used to make sturdy tissues. For smaller spans, simple designs like hoops can be followed. So based on construction, greenhouses can be classified as

a) Wooden framed structure.

b) Pipe framed structure.
c) Truss framed structure.

4. **Greenhouse type based on covering material**

Before the II world war, most of the greenhouses were constructed using glass as the glazing material with the development of plastic film and rigid sheets, now greenhouse are covered with them. PE, PVC, EVA, acrylic, polycarbonates, FRP, Polyester, PVF are some of the plastic material used for greenhouse construction. The polyhouse refers to a greenhouse glazed with polyfilm.

Covering materials are the important component of the greenhouse structure. They have direct influence on greenhouse effect, inside the structure and they alter the air temperature inside. The types of frames and method of fixing also varies with covering material. Hence based on the type of covering material they may be classified as

a) Glass glazing.
b) Fibre glass reinforced plastic (FRP) glazing
  i. Plain sheet
  ii. Corrugated sheet.
c) Plastic film
  i. UV stabilized LDPE film.
  ii. Silpaulin type sheet.
  iii. Net house.

5. **Based on the cost of construction involved** (which includes various factors mentioned from a to c)
   a. High cost Green House
   b. Medium cost Green House
   c. Low cost Green House

6. **Classification on the basis of Span :**

(a) Single span, Ground to Ground or free standing

When only one span is used as described in shape, then they are called as single span structures. Many single span structures can be erected. It permits convenient expansion / contraction of business. Also it permits the production of a different plant materials by maintaining different micro-climate in different units. Flexibility can be seen with this type. No Gutter is required.

(b) Multispan structure :

Economy in construction, cooling, heating operations and cultural operations. No flexibility. Different crops can not be grown in one structure. Gutter is required.

7. **Types accepted by Govt. of Maharashtra :**

Type	**Description**
GH-I	Partially controlled, open ventilator type cooling is effected through ventilation i.e. difference of temperature gradient inside and outside. Normally ventilated.
GH-2	Completely controlled, No ventilator, Temperature is controlled with Exhaust fans and cooking pad. For better performance, suitable technical design should be done.
GH-3	Completely controlled, Double inflated poly film. To keep tow layers of poly films away from each other, blower and motor should be provided. Provision of Co_2 apparatus, computer, exhaust fans & cooling pads. Greenhouse operations should be automatic.

Practical No. # 2

Study of Greenhouse Covering and Construction Material

Glazing (Covering) materials for greenhouse :

The covering of a greenhouse or any structure with transparent material is known as glazing. The glazing material includes glass, poly film, poly carbonate, FRP, EVA, acrylic, polyester, PVF. Except poly film all other covering materials are rigid panels or sheets. Various factors to be considered while selecting the greenhouse covering material are weight, light transmission, thermal stability, durability to outdoor weathering and resistance to impact. The selection of a covering materials depend up on the purpose for which the greenhouse facility is intended. In temperature regions where high temperature, are required, the glazing material with high light transmission and for Infra-Red absorption must be selected. Also in temperate regions covering material should be selected such that the loss of heat by conduction should be minimum. In selection of covering material another important aspect is the service life of material. For fiberglass reinforced polyester and polycarbonate service life is ranging from 5 – 12 years. Considering all the covering materials polyethylene has the best service life of 2 to 6 month. If polyethylene film is stabilized with UV rays, the life can be extended to 2-3 years.

Radiation properties of covering material :

When a beam of radiation is incident on a material, part of it may be reflected back, a part may be absorbed by the material and remaining portion will be transmitted. Depending upon the material composition and surface properties, the radiation absorptivity, reflectivity and transmissivity values are determined for a given material, the values of three coefficients must add to 1.0 with reference to a particular radiation beam. A transparent material transmits a large portion of light through it, whereas an opaque material either reflects or absorbs the incident radiation. A translucent material may transmit a large portion of radiation but the transmitted light is diffuse in nature.

Light that is utilized in photosynthesis is termed as photo synthetically active radiation (PAR) and comprises the wavelengths from 400 nm to 700 nm. Transmission of PAR through polyethylene can vary with the brand of and the chemical additives in polyethylene (Table 1.2). Uv-stabilized polyethylene, on average, transmits about 87 per-cents PAR. IR-absorbing polyethylene, which reduces radiant heat loss, transmits about 82 percent of PAR. The amount of light passing through two layers of greenhouse covering is approximately the square of the decimal of the amount passing through one layer. Where 87 percent (0.87) passes through one layer of UV-inhibited polyethylene, only 76 per cent ($0.87)^2$ passes through two layers. PAR transmission through two layers of IR-absorbing polyethylene is 67 per- cent.

Table 1.2 Light Transmission values for various greenhouse covering.

Sr. No.	Covering Material	No. of layers	Per cent transmission (PAR)
1	Glass (double-strength flood, 3.2 mm)	1	88
		2	77
2	Glass (low-iron, 3.2 mm)	1	90-92

		2	81-85
3	FRP (clear, 0.640 mm)	1	88
		2	77
4	Polyethylene	1	87
	(4 or 6 mil, 0.10 or 0.15 mm, UV stabilized)	2	76
5	Polyethylene	1	82
	(4 or 6 mil, 0.10 or 0.15 mm, IR-absorbing)	2	67
6	Vinyl, clear	1	91
7	Vinyl, hazy	1	89
8	Polyvinyl fluoride film (4 mil, 0.10 mm)	1	92
9	Acrylic panels (8 or 16 mm)	2	83
10	Polycarbonate panels (6 or 8 mm)	2	79

Selective covering material should do the following for ideal greenhouse:

1. It should absorb the small of UV in the radiation and convert a part of it to fluoresce into visible light.
2. It should transmit the visible light portion of the solar radiation which is utilized in photosynthesis by the plants.
3. Cost of the covering material should be minimum.
4. Should have service life of 10 to 20 years.
5. It should reflect or absorb IR radiations which are not useful to plants.

Degradation of glazing material :

The degradation refers to the loss of light transmissivity of a greenhouse glazing material over a period of time. This is also known as weather ability. The traditional glazing material i.e. glass, retains it's transmissivity over a period of several years. On the other hand, the plastic glazing are generally degraded by the U.V. radiation, temperature, air pollutants and other factors. An ordinary PE film is fast degraded by U.V. radiation, becomes brittle and losses it's strength and utility within a period of 3-4 months. However, incorporation of UV stabilizer while manufacturing the PE film increases the service life if the film to more than two years.

Tedlar film (PVF) maintains their transmissivity for a long time. PVC films are susceptible to dust accumulation FRP sheets losses their transparency fast, within a period of 2-3 years. But the panel surface is covered with thin layer of Tedlar film then the light transmission in checked. A twin wall pc panel may also get adversely affected by UV, but a coating of acrylic minimizes the loss of light. Acrylic thin wall panels resists weather ability to a great extent.

Some of the properties of important glazing materials are illustrated in below table .

Properties of important glazing materials

Glazing / Properties	Glass	PE	FRP	Acrylic
1. Cost/sq. ft. (Rs.)	15-20	2.50	15	25
2. Life (years)	15	2-3	2-3	10-15
3. Transmissivity (%)	90	88	65-90	83
4. Weight	Heavy	Light	Medium	Medium
5. Handling	Difficult	Easy	Easy	Easy
6. Manufacturing	Difficult	Easy	Medium	Medium
7. Frame work	Heavy	Light	Light	Medium
8. Recycling	No	Yes	No	No
9. Flexibility	No	Yes	No	No
10. Fitting work	Difficult	Easy	Difficult	Difficult

11.Degradation rate	Slow	Fast	Fast	Slow

Greenhouse construction materials:

Commonly used materials used to build frames for green houses are bamboo, wood, re-enforced concrete, aluminum, steel. The selection of these materials was based on their physical properties and requirements of design. Selection of construction material also depends upon life expectancy and cost of the material. Generally common construction materials used in greenhouse are as wood, Galvanized Iron, Aluminum, Steel, Reinforced cement concrete and plastic.

Wood :

Bamboo and wood are used for the construction of low cost greenhouse. The wood is used for making frames. Generally side posts and columns are made from wood. The frame includes, columns, bottom cord, truss members, purl in, knee bracing, wind bracing fitting members etc. The commonly used woods are pine and cascading, which are strong and less expensive. Wood should be treated for protection from high moisture and termites and painted for better light conditions in the greenhouse. Coal tar is good preservative for underground portion of wood. In pipe framed greenhouses, wooden battens can be used in the frames for filing the glazing material. In tropical areas to form the gable roof of a greenhouse bamboo is often used. Natural decay resistance woods, such as redwood or cypress should be treated, in desert or tropical regions.

Galvanized Iron and steel :

Steel and Galvanized Iron members are generally used in frame works of the greenhouse structure. To protect iron or steel against corrosion they are galvanized. In galvanizing the external surface of iron or steel is coated with a thin layer of zinc. Steel components to be used in greenhouse frames should be hot dipped galvanized to avoid rusting. In hot dip galvanizing process, the cleaned member is dipped in molten zinc which provides a layer of zinc alloy to steel. In cold process called as Electro-galvanising the member is zinc plated. G.I. pies, tubular steel and angle iron are used for side posts, columns and purlins, as the wood is becoming score and more expensive. The common problem of rusting of iron structural members is eliminated with galvanization process and makes structural members rust proof. In general for pipe frames G.I. pipes are used as side posts, columns, cross ties and purlins. For truss frames, flat steel, tubular steel or angle iron is welded together to form a truss consisting of rafters, chords and struts. The angle iron purlins are bolted to each truss running throughout the length of the greenhouse.

Aluminum and Reinforced cement concrete :

Many times frames may be all aluminum or steel or a combination of the both materials. Comparatively Aluminum and hot dipped G.I. are maintenance free. Aluminum and steel must be protected from direct contact with the ground to prevent corrosion. Aluminum or steel must be thoroughly painted with bitumen tar, if there is a danger of any part coming into contact with the ground. Aluminum profile with C shape is also used for fixing the film. Generally foundation is made from R.C.C. Foundation should be strong enough to support the super structure against various forces. Pit or pile foundation is common because columns are widely spaced. The depth of foundation should be at least 60 cm. reaching to hard strata with width of 60 cm. The foundation may be RCC, CC or telescopic. The telescopic foundations are easier and less costly. Greenhouse crop may be grown in soil or without soil. The floor of the greenhouse should have drainage. For soil less cultivation, some times porous concrete floors having the depth of 10 cm. are prepared.

Practical No. # 3

STUDY OF COOLING SYSTEMS AND VENTILATION OF GREEN HOUSES

A need to cool a greenhouse arises whenever the greenhouse air temperature exceeds the upper limit of the crop tolerance. Failure to bring down the temperature effectively may result in either partial or total crop failure within only a very short period of time. Consideration for appropriate cooling systems is essential because temperatures are on higher side for long period in most of the parts of India. Process of cooling system includes selection of cooling method and its designing. Ventilation is the process of allowing the fresh air to enter into the enclosed area by darning out the air with undesirable properties. In greenhouse context, ventilation is essential for reducing temp, replenishing Co_2 ,and controlling RH .Ventilation requirements GH vary greatly depending upon the crop grown and the season of Production .selection of relevant components of equipment's and provision of controls.

Methods of Greenhouse cooling:

Several methods based on Convection / Forced air movement with/ without the evaporation of water are available for cooling of greenhouses. They are explained below.

Ventilation:

Ventilation is the process of allowing the fresh air to enter into the enclosed area by driving out the air with undesirable properties. In greenhouse context, ventilation is essential for reducing Temperature, replenishing CO_2 and controlling Relative Humidity. Ventilation requirements for Greenhouse vary greatly depending upon the crop grown and the season of the production.

Ventilation with roof and side ventilators:

The top ventilators are provided in the roof and rollable curtain arrangement is made by the four sides. The hot air from greenhouse is removed from top ventilators and it is replaced by ambient air from sides. Top ventilators are having the depth of 0.6 to 1.0 m. whereas; side curtain has the width of 1.5 to 3.0 m depending upon the column height. The ventilation area should be at least 20% of floor area for effective ventilation .Generally, such type of structure is affected structure .The air movement in such structure is affected by temperature difference between inside and outside. The wind has also considerable effect on air movement. The cooling system of naturally ventilated structure can not be designed precisely because temperature difference and wind (velocity & direction) are highly variable. The correct placement of top ventilators and proper greenhouse orientation will have partial control cover temperature inside greenhouse.

Roof shading:

Partial shading is used to reduce the intensity of sunlight in the cropped area. Shading can be done by two methods.

a) Application of white wash: Application of white wash with any white material like distemper or lime over glazing material in comparatively and less expensive method. Such a paint washes off by itself by the rain.

b) Shading screen : It can be used for a part of growing season or a specific level of shade is required .The material may be PP .PE or Polyester with different grades of shade like 20%,25%, 35% ,50%,75%and 90%.

Evaporative cooling :(EC)

The degree of cooling obtained from an evaporative system is directly related to the dry-wet bulb difference that occurs with a given set of climatic condition. Evaporative cooling systems are most effective in areas where a consistently low relative humidity exists. Generally, the period of lowest humidity occurs during the hottest part of the day when the greatest degree of cooling is required and Evaporative cooling is more effective .The relative humidity increases as night temperature declines and little or on cooling is required .

a) Fan and Pad system:

It is adaptable to both large and small greenhouses. In this system, low velocity and large volume fans draw air through wet fibrous pads mounted on the opposite side or end wall of the greenhouse. The outside air is cooled to 3-12^{0}C depending upon sunlight intensity, relative humidity and the amount of shading compound applied.

The pad can be made of different materials viz. gravel, straw, wood fiber, khus, honey comb paper & charcoal. Most of the greenhouse will require about I m of pad height for every 20 m of pad to fan distance. Pad design system should provide at least 6 lit water/min per running meter of the pad system of 1 m height. Due to continuous watering, pads accumulate salts, sag and thus create openings that allow hot air to enter the greenhouse. The efficient pad material is of honey comb cellulose paper but it is very costly.

Placement of exhaust fans also affects the distribution of cooled air. They should not be located more than 9 m part otherwise warm areas will develop. Fans should be placed on the side against the direction prevailing winds. Termostatistically operated F & P system is desirable for uniform and automatic control of temperature. Humidstate may be installed to avoid excess humidity. EC is F & P system for existing greenhouses.

b) High pressure mist system:

Water is sprayed into the air above the plants at pressure of 35-70 kg.cm^2 from low capacity nozzles (1.9 to 2.8 H4).A fine mist fills the greenhouse atmosphere ,cooling the air as it evaporates. Although most of the mist evaporates before reaching the plant level, some of the water settles on the foliage where it reduces leaf temperature .Temperature difference of 5-14^0 C can be obtained between high pressure mist and fan cooled greenhouses. It is more effective during the warmest part of the day.

c) Low pressure mist system:

Misting with water pressure less than 7kg/cm^2 have achieved air temperature 5 ^{0}C cooler in a greenhouse compared to natural ventilation. The water droplets from a low pressure misting system are quite large and do not evaporate quickly. Leaching of nutrients from soil is a serious drawback in using this.

Practical No. # 4

STUDY OF INSTRUMENTS IN GREENHOUSE

Various instruments are used for measuring environmental parameters in Greenhouse. These parameters are :

1. Temperature. 2. Solar intensity 3. Humidity 4. Leaf area index
5. Photosynthesis rate etc.

Instruments for temperature measurement:

1.Thermometers :

Types:

A) Liquid in glass thermometers (e.g. Hg. Alcohol colour with dye)

Range-Minimum -37.5 ^{0}C for pentane.

Highest 340 ^{0}C Hg up to 560 ^{0}C by filling space above Hg with CO_2/N_2 at High pressure

B) Bimetatic Thermometers : In this, the unequal expansion of two dissimilar metals, that have been founded together into narrow strip and coiled, is used to move a pointer round a dial.

C) Gas Thermometer : It is more accurate than liquid-in-gas thermometers, it measures the variation in pressure of gas kept at constant volume.

D) Resistant Thermometer : It is based on the change in resistance of the conductor or semi-conductors with the temp. range. Platinum, nickel and copper are the metals most commonly used in resistance thermometers.

E) Thermister : It is a thermally sensitive variable resister made of ceramic like semi-conducting material. They exist in small thin disc/thin chip/Wafer/large rod. The oxides of Cu, Mn, Ni, Co. Li are blended in suitable proportion and impressed into desired shapes from powders and heat treated to recrysatlize them, resulting in a desired ceramic body with the required resistance temperature characteristics. These are extremely useful for dynamic temp. measurements. It's operating range is -100 ^{0}C to 300 ^{0}C with accuracy of $\pm$ 0.01 ^{0}C.

F) Thermocouple : It is also called as *thermo-electric sensor*. Two wires of different metals twisted and brazed or held together normally from copper and Constantine. The magnitude of thermo-electric motive force (e.m.f.) is related to the temp. difference. Which is measured by a mill voltmeter or can be connected to temperature indicator.

G) Digital Electronic Temperature Indicator :

It directly display the temperature measured with the help of thermocouples and are available in multi-channels so that more than one reading can be recorded for different locations (inside/outside etc.) One end of the thermocouple is placed at location and other end is connected to the digital electronic temp. indicator which is calibrated to measure the direct reading of temperature.

2. Radiation measuring instruments :

Instruments for measuring solar radiation are basically of two types. The accepted terms of these are as follows :-

A) **Pyrheliometer –** An instrument using a collimated detector for measuring solar radiation from the sun and from the small portion of the sky around the sun (i.e. beam radiation).
B) **Pyranometer –** An instrument for measuring total hemispherical solar (beam + radiation) radiation usually on a horizontal surface. If shaded from the beam radiation by a shade ring or disc a pyronometer measures diffuse radiation.
C) In addition, the terms, solarimeter and actinometer can be used. Soloarimeter can be interpreated to mean the same as pyranometer where as actinometer usually refers to a pyrheliometric instrument.

Sunshine Recorder :

It is used for measuring the duration, in hour of bright sunshine during the course of the day.

Photosynthesis Analyser :

Portable Photosynthesis System : This system extends the boundaries of gas exchange research by providing a portable instruments. It makes rapid simultaneous measurements of photosynthesis rates and stomatal conductance with typical CO_2 depletion of only 2 to 100 ppm and very small RH changes the measurements are made very near ambient conditions.

Leaf Area Index (LAI) :

Measurement the amount of foliage and its distribution is fundamental to radiation penetration. Direct measurements of canopy structure are tedious and labour intensive in small canopies and nearly impossible in large forest canopies. The instrument used to measure leaf index is LAI-2000.

Measurement of Humidity :

The amount of water (vapour) content in the atmosphere (Green house)i.e. humidity is an important parameter in the growth of the GH. Plants.

Absolute Humidity – It is defined as the mass of water vapour present in unit volume of moist air (gm/m^3).

Relative Humidity (RH) – The ration between actual water vapour content of air and the amount of vapour the air could hold at saturation at the same temp. expressed as a percentage. The R.H. is measured with the help of hygrometer.

$$RH = \frac{P}{P_s}\, x\, 100$$

$$at\ same\ temperature$$

Measurement of pH : It indicates the acidity and alkalinity of the soil.

Data logger : It is an instrument which can measure the various parameters simultaneously. It is equipped with different probes required for different parameters. The output is displaced on computer monitor or separate display unit.

Practical No. # 5

STUDY OF IRRIGATION SYSTEM FOR GREENHOUSE

A well-designed irrigation system will supply the precise amount of water needed each day throughout the year. The quantity of water needed would depend on the growing area, the crop, weather conditions, the time of year and whether the heating or ventilation system is operating. Water needs are also dependent on the type of soil or soil mix and the size and type of the container or bed .Watering in the greenhouse most frequently accounts for loss in crop quality. Though the operation appears to be the simple, proper decision should be taken on how, when and what quantity to be give to the plants after continuous inspection and assessment. Since under watering (less frequent) and over watering (more frequent) will be injurious to the crops, the rules of water application systems, such as hand watering. Perimeter watering, overhead sprinklers, boom watering and drip irrigation which are currently in use will be discussed in this chapter.

1. Rules of Watering

The following are the three important rules of application of irrigation water.

Rule 1: ***Use a well-drained substrate with good structure***

If the root substrate is not well drained and aerated, proper watering cannot be achieved. Hence substrates with ample moisture retention along with good aeration is indispensable for proper growth of the plants. The desired combination of coarse texture and highly stable structure can be obtained from the formulated substrates and not from field soil alone.

Rule 2: ***Water thoroughly each time***

Partial watering of the substrates should be avoided; the supplied water should flow from the bottom in case of containers, and the root zone is wetted thoroughly in case of beds. As a rule, 10 to 15% excess of water is supplied. In general, the water requirements for soil based substrates is at a rate of 20 I/m^2 of bench, 0.3 to 0.35 liters per 16.5 cm (6.5 in) diameter pot.

Rule 3: ***Water just before initial moisture stress occurs***

Since overmastering reduces the aeration and root development, water should be applied just before the plant enters the early symptoms of water stress. The foliar symptoms, such as texture, colour and turgidity can be used to determine the moisture stresses, colour , feel and weight of the substrates are used for assessment.

2. Hand Watering

The most traditional method of irrigation is hand watering and in present days is uneconomical. Growers can afford hand watering only where a crop is still at a high density, such as in seed beds or when they are watered at a few selected post or areas that have dried sooner than others. In all cases, the labour saved will pay for the automatic system in less than one year. It soon will become apparent that this cost is too high. In addition to this deterrent to hand watering, here is a great risk of applying too little water or of waiting too long between watering. Hand watering requires considerable time and is very boring. It is usually performed by inexperienced employees, who may be tempted to speed up the job or put it off to another time. Automatic watering is rapid and easy and is performed by the grower himself. Where hand watering is practiced, water breaks should be used on the end of the hose. Such a device breaks the force of the water, permitting a higher flow rate without washing the root substrate out of the bench or pot. It also lessens the risk of disrupting the structure of the substrate surface.

3. Perimeter Watering

Perimeter watering system can be used for crop production in benches or beds. A typical system consists of a plastic pipe around the perimeter of a bench with nozzles that spray water over the substrate surface below the foliage (Fig.14.1).

Either polyethylene or PVC pipe can be used. While PVC pipe has the advantage of being very stationary, polyethylene pipe tends to roll if it is not anchored firmly to side of the bench. This causes nozzles are rise or fall from proper orientation to the substrate to put out a spray arc of 180^0, 90^0 or 45^0. Regardless of the types of nozzles used. They are staggered across the benches so that each nozzles projects out between two other nozzles on the opposite side. Perimeter watering systems with 180^0 nozzles require one water valve for benches up to 30.5m (100ft), in length. For benches over 30.5m (100 ft) water main should be installed and up to 61.0m (200 ft), a water main should be installed on either side, one to serve each half of the bench. This system applies 1.25 l/min/m of pipe .Where 180^0 and 90^0 or 45^0 nozzles are alternated; the length of a bench serviced by one water valve should not exceed 23 m (75 ft).

4. Overhead Sprinklers

While the foliage on the majority of corps should be kept dry for disease control purposes, a few crops do tolerate wet foliage. These few crops can most easily and cheaply be irrigated from overhead. Bedding plants, azalea liners, and some green plants are crops commonly watered from overhead (Fig.14.2). A pipe is installed along the middle of a bed .Riser pipes are installed periodically to a height well above the final height of corp. A total height of 0.6 m (2 ft) is sufficient for bedding plants flats and 1.8 m(6 ft) for fresh flowers. A nozzle is installed at the top of the each riser. Nozzles vary from those that throw a 360^0 pattern continuously to types that would otherwise fall on the ground between post and is wasted. Each tray is square and meets the adjacent tray. In this way intercepted .Each tray has a depression to accommodate the pot and is then angled upward from the pot toward the tray perimeter. The trays also have drain holes, which allow drainage of excess water and store certain quantity, which is subsequently absorbed by the substrate.

5. Boom Watering

Boom watering can function ether as open or a closed system, and is used often for the production of seedlings grown in plug trays .Plug trays are plastic trays that have width and length dimensions of approximately 30x61 cm (12x24 in), a depth of 13 to 38 mm (0.5 to 1.5 in), and contain about 100 to 800 cells. Each seedling grows in its own individual cell. Precision of watering is extremely important during the 2 to 8 week production time of plug seedlings. A boom watering system generally consists of a water pipe boom that extends from one side of a greenhouse day to the other. The pipe is fitted with nozzles that can spray either water or fertilizer solution down onto the crop. The boom is attached at its center point to a carriage that rides along rails, often suspended above the center walk of the greenhouse bay. In this way, the boom can pass from one end of the bay to the other. The boom is propelled by and electrical motor. The quantity of water delivered per unit area of plants is adjusted by the speed at which the boom travels.

6. Drip Irrigation

Drip irrigation, often referred to as trickle irrigation, consists of laying plastic tubes of small diameter on the surface or subsurface of the field or greenhouse beside or beneath the plants. Water is delivered to the plants at frequent intervals through small holes or emitters located along the tube. Drip irrigation systems are commonly used in combination with protected agriculture, as an integral and essential part of the comprehensive design. When using plastic mulches, row covers, or greenhouses, drip irrigation is the only means of applying uniform water and fertilizer to the plants. Drip irrigation provides maximum control over environmental variability; it assures optimum production with minimal uses of water, while conserving soil and fertilizer nutrients; and control over environmental variability; it assures optimum production with minimal uses of water, fertilizer, labour and machinery costs .Drip irrigation is the best means of water conservation. In general, the application efficiency is 90 to 95 % compared with sprinkler at 70% and furrow irrigation at 60 to 80%, depending on soil type, level of field and how water is applied to the furrows. Drip irrigation is not only recommended for protected agriculture but also for open field crop production, especially in arid and semi-arid regions of the world.

Drip irrigation is replacing surface irrigation where water is scarce or expensive, when the soil is too porous or too porous or too impervious for gravity irrigation, land leveling is impossible or very costly, water quality is poor, the climate is too windy for sprinkler irrigation, and where trained irrigation labor is not available or is expensive .In drip irrigation weed growth is reduced ,since irrigation water is applied directly to the plant row and not to the entire field as with sprinkler, furrow or flood irrigation. Placing the water in the plant row increases the fertilizer efficiency since it is injected into the irrigation water and applied directly to the root zone. Plant foliage diseases may be reduced since the foliage is not wetted during irrigation. One of the disadvantages of drip irrigation is the initial cost of equipment per acre, which may be higher than other systems of irrigation .However; these costs must be evaluated through comparison with the expense of land preparation and maintenance often required by surface irrigation.

Basic equipment for drip irrigation consists of a pump, a main line, delivery pipes, manifold, and drip tape laterals or emitters (fig. 14.3). The head between the pump and the pipeline network usually consists of control valves, couplings, filters, time clocks fertilizer injectors, pressure regulators, flow meters, and gauges. Since the water passes through very small outlets in emitters, it is an absolute necessity that it should be screened, filtered, or both, before it is distributed in the pipe system is influenced by the topography of the land and the cost of various system configurations. Design considerations should also include the relationship between the various system components and the farm equipment required to plant, cultivate, maintain and harvest the crop.

Practical No. # 6

Cost estimation of poly houses

Type : Naturally ventilated structure, open vent type (GH-1 type)

Given Data : Area – 512 sq.m (32 X 16 m)
Bay size : 8 x 4m,
Vent opening – 0.8 to 1.0 m
Height – Ridge height – 6 m
Height under Gutter – 3.5m.
Polyfilm – UV stabilized, 200 micron.

Cost estimate

Sr. No	Item	Quantity	Rate	Unit	Amount
1.	Columns – 2”, 4m length				
2.	Bottom cord – 2”, 8m length				
3.	Top cords – 2”, (5.3 + 4.5M0 length				
4.	Truss members, 1” (length to be calculated)				
5.	Purlins, 1”,				
6.	Curtain pipe, ½ “ GI				
7.	**Fitting material** i) Wooden button or ii) Plastic gripper or iii) Aluminium profile				
8.	Polyfilm				
9.	Telescopic foundations (on No. basis)				
10.	Doors				
	Sub Total				
	Add 15% for fabrication & erection				
	Add 3% for contingencies				
	Total				

Pr No # 6: COST ESTIMATION OF POLYHOUSES

Prepare an estimate of naturally ventilated greenhouse (GH 1 type) with following data:

Size = 32 x 16 m, **Bay size** = 8 x 4 m , **Height of gutter** = 3 m, **Depth of ventilation** = 0.75 m **Ridge height** = 4.8 m & **Number of Gutter** = one, **Material of Construction -** Galvanized Iron/ steel & **Covering material** = 200 µUV Stabilized Poly Film

Estimation of Cost of (GH1) Polyhouse						
Sr. No.	**Items with specifications**	**Quantity**	**Quantity**	**Unit**	**Rate (`)**	**Amount (`)**
1	**Coloumns** (GI pipe) Diameter of pipe = 50 mm Length (Height) = 3.3 m No of coloumns = 9 No of rows = 3	9 x 3 x 3.3	90	m	139	12510.00

2	**Bottom Cords** (GI pipe) Diameter of pipe = 50 mm Length of pipe = 8 m No of cords = 9 Two times	9 x 2 x 8	144	m	116	16704.00
3	**Top Cords** (GI pipe) Diameter of pipe = 50 mm Length of pipe = 8.9 m No of cords = 9 Two times	9 x 2 x 8.9	160	m	116	18560.00
4	**Central Pipes** (GI) Diameter of pipe = 50 mm Length of pipe = 1.8 m No of cords = 9 Two times	9 x 2 x 1.8	33	m	116	3828.00
5	**Truss members (MS)** Width of member = 25 mm Length of member = 5.7 m *(0.9 + 2.22 + 2 + 0.6 = 5.7 m)* No of members = 9 No of rows = 2	9 x 2 x 5.7	103	m	60	6180.00
6	**Film fixing angle** (MS) Size = 40 x 40 x 5 mm ROOF = 32 m x 4 x 2 = 256 m APRON = 32+32+16+16 = 96 m CURTAIN = 32+32+16+16 = 96 m GABLE = 99 m	256 + 96 + 96 + 99	547	m	45	24615.00
7	**Gripper & Batten** (MS) ROOF = 32 m x 4 x 2 = 256 m APRON = 32+32+16+16 = 96 m CURTAIN = 32+32+16+16 = 96 m GABLE = 99 m (Gripper@ `20/m & Batten @`5/m)	256 + 96 + 96 + 99	547	m	25	13675.00
8	**Gutter** (MS sheet of 2 mm thick) Length of sheet = 33 m Width of sheet = 0.5 m	33 x 0.5	16.5	m^2	1000	16500.00
9	**Curtain pipe** (GI of 15 mm Diameter)		100	m	12	1200.00

10	**Polyfilm** (UV stabilized & 200 μ thick) **ROOF:** Length = 33 m, Width = 4.7 + 0.3 = 5 m, Two pieces Length = 33 m, Width = 4.2 + 0.3 = 4.5 m, Two pieces **CURTAIN:** Length = 33 m, Width = 1.8+ 0.3 + 0.3 = 2.4 m, Two pieces Length = 17 m, Width =1.8+ 0.3 + 0.3 = 2.4 m, Two pieces **APRON:** Length = 33 m, Width = 1.2+ 0.5 + 0.3 = 2 m, Two pieces Length = 17 m, Width =1.2+ 0.5 + 0.3 = 2 m, Two pieces **GABLES:** Length = 17 m, Width = 1.2+ 0.5 + 0.3 = 2 m, Two sides	33 x 2 x 5 33 x 2 x 4.5 33 x 2 x 2.4 17 x 5 x 2.4 33 x 2 x 2 33 x 2 x 2 17 x 2 x 2	330 297 159 82 132 68 68			
	Total Poly film		1136	m^2	24	27264.00
11	**Doors** (Size - 2m x 1.2 m and Two No.)		2		250	500.00
12	**Foundation** (Telescopic) No of Foundation = 9 No of Rows = 3	9 x 3	27		300	8100.00
	Sub total (item No. 1 to 12)					**149636.00**
13	**Fabrication & Errection** Labour charges @ 15 % of Total of items 1 to 12					22445.00
14	**Contingencies** Labour charges @ 3 % of Total of items 1 to 12					4489.00
	Total Cost Greenhouse 32 m x 16 m					**176570.00**
	Cost per square meter					**345.00**

Practical No. # 7

VISIT TO COMMERCIAL GREENHOUSE

A report of visit to greenhouse

Proforma :

1) Site of Greenhouse :i) Size of Green House: ------- X --------- m.
ii) Water Source:
iii) Crop and Variety:
iv) Soil or media Used :
v) Temperature:
vi) Humidity:

2) Type of Greenhouse : i) G. H. 1 / G. H. 2 / G. H. 3
ii) G. H. -Class based on Shape-
iii) G. H. -Class based on Utility-
iv) G. H. -Class based on Covering Material
v) G. H. -Class based on Construction

3) Covering material used in greenhouse / Shade House :
i) Material Used –
ii) Thickness –
iii) UV Stabilized : yes / No
iv) Percent Open Area for shadenet: --------- %

4) Instruments used in Greenhouse :List of Instruments and their use

5) Irrigation method used in Greenhouse :
I) Drip Irrigation System:- a) Type- Online / Inline
b) Size of Main/ Sub-Main and Lateral: -----, ----- and ----mm
c) Discharge of Emitters: ------------ LPH
d) Lateral spacing: -----------m, Emitter Spacing:- ------------m
e) Type of Filter:- sand/ Screen/ Disc/ Hydro-Cyclone----------------
f) Filter Flow Rate ------------cu.m / hr.

6) Cooling System : Fan Pad / High Pressure Mist System/ Low Pressure Mist System

7) Material of Construction of Greenhouse :a) Structure :Wooden Frame / Pipe frame / Truss Frame :
b) Pipe Size :-