Lecture-11

Plant propagation structures

Learning objective

- Utility of plant propagation structures
- Different types of Plant propagation structures

Introduction

The structures which facilitate propagation of plants are called propagation structures. Propagation structures are required for propagating plants by seed, cuttings and grafting. Propagation structures are of two types; i) The first type a structure with temperature control and ample light, such as a green house, modified quonset house, or hot bed-where seeds can be germinated or cuttings are rooted or tissues culture micro-plants are rooted and acclimatized and the ii) The unit is structure into which the younger, tender plants can be moved for hardening, preparatory to transplanting out-of-doors. Cold frames, low polyethylene tunnels or sun tunnels covered by *saran* cloth and lath-houses are useful for this purpose.

Greenhouses

Greenhouse has been used long back by horticulturists as a mean of forcing rapid growth of plants and extending the growing season particularly in colder areas. These are being used for whole sale production and propagation of floricultural plants, nursery stock of fruit crops and vegetable crops.

A greenhouse greatly extends the variety and scope of propagation. Many kinds of green houses are used for propagation but the most suitable type is the one that admits the maximum amount of light. This is important, particularly where most of the propagation is done in late winter and early spring. Good light conditions are essential for the study growth of the seedlings. Experiments have shown that a greenhouse that runs from east-to-west is best for better light penetration in winter and early spring, and consequently preferable for raising seedlings at this time of the year. Moreover, it is important that the green houses should be well away from any kind of shade such as a tree of building, including other greenhouse. Some shelter, however, from north to northeast winds is desirable. These glasshouses may be plastic polyethylene covered or made form fiberglass. Modern greenhouses are well equipped with elaborate structures and have precise control on

temperature, light intensity and humidity. The size and type of greenhouses, primarily depends upon the need of the plant propagator.

Glass covered greenhouses are expensive but they have long life. However, for short –term benefits, plastic covered green houses can also be made. Two types of plastics are available for the construction, polyethylene and fiberglass. Both are lightweight and inexpensive as compared to glass. Plastic covered greenhouses are lighter than glass covered ones but there is very high increase in humidity is such houses, especially in winters, which results undesirable water drops on the plants. It can however be overcome by making adequate ventilation. Polyvinyl chloride (PVC) has also been used in construction of greenhouses but it tends to darken pre-maturely in sunlight.

In India, construction of temporarily low-cost poly-houses is in fashion for raising nursery of fruit plant in off season. Such low cost greenhouses are constructed either on wood or metal framework and are covered with polyethylene sheet of 0.10 to 0.15mm thickness, which is resistant to ultra-violet rays. These houses are equipped with thermostat, cooler or an air conditioner or humidifier etc for rigid control on temperature and humidity. Greenhouses made from fibreless sheet are more durable than the polythene houses, but are quite expensive. In greenhouses, two types of beds are used for raisinggoring seedlings. In greenhouses, the beds may either be prepared on ground itself or raised beds or bench type beds are used.

Greenhouse structures vary from elementary home constructed to elaborate commercial installations. Commercial greenhouses are usually independent structures of even span, gable-roof construction, well proportioned so that the space is well utilized for convenient walk ways and propagating benches. On commercial scale several greenhouses units are often attached side-by-side for eliminating the cost of conversing the adjoining walls with glass or polyethylene. The heating and cooling equipment is more economical to install and operate, as large area can be shared by the same equipment.

Greenhouse construction begins with a metal framework, to which metal rash bars are fastened to support panels of glass or some type of plastic materials. Now a day's metal pre-fabricated green house with pre-bolted trusses are available from several manufacturers. The two most common structural materials for green houses are steel and aluminum. Most greenhouses are made from galvanized steel, which is cheaper, stronger and lighter.

Heating and cooling system in greenhouses: Ventilation, to provide air movement and air exchange with the outside, is necessary in all green houses to aid in controlling temperature

and humidity. The attempt of sloppy green houses near the mud houses in Ladak is an attempt in these directions. The heat can be conserved by proving sealed polyethylene sheeting outside green houses, glass or fibre glasses.

Environmental control: Greenhouses can be cooled mechanically in the summer by use of large evaporative cooling units. The "pad and fan" system is installed at one side of a green house with large exhaust fans at the other end. Fog or sprinklers can be used to cool green houses and maintain humidity but it is costlier than pad fan cooling. A maximum night temperature of 13 to 15.5^0 C and a day temperature of 24^0 C are generally set to start the heaters and fans; respectively. Spraying of green house with whitewash in summer and opening and cooling side and ridge vents with a crank to control temperature and by turning on steam valves at night, whereas humidity is increased by spraying the walls and benches by hand at least once a day.

i) Analog control: In this system proportioning thermostats or electric sensors are used to gather temperature information. Analog controls are costlier than thermostats, but offer better performance.

ii) Computerized environment control: The amplifiers and logic circuit analogs have now been replaced by computerized environmental system, which involves microprocessor, which gathers information on a variety of sensors like temperature, humidity, light intensity, wind directions etc. to provide more precision. Although more costly than thermostats or analogs but computer controls offer significant energy and labour saving and increases production efficiency in propagation. The deviations from the present levels of temperature and humidity can trigger alarms by the computer.

Green house covering materials: The covering materials used for construction of green houses include glass, polyethylene, UV-stabilized polythene, acrylic, polycarbonate and fibreglass. The glass covered greenhouses are expensive but for a permanent long term installation under low light winter conditions because glass has superior light transmitting properties and less expensive relative humidity problems. Polyethylene materials are light weight and relatively less expensive compared to glass. Being light in weight, permits a less expensive supportive frame work than is required for glass. Polyethylene has relatively short life than glass. The UV-stabilized sheets can last for 3-4 years. Polyethylene having a thickness of 100-200 micron is generally used. The acrylic is highly weather resistant and does not yellow with age, has excellent light transmission properties and retains twice the heat of glass, but it is more costly and brittle.

Polycarbonate: It is probably, the most widely used structures sheet material today. This material is similar to acrylic in heat retention properties, with 90% light transmission of glass.

It is light in weight 1/6th of glass and easy to install. It is resistant to impact. Polycarbonate textured surface diffuses light and reduces condensation drip. For providing rigid panels fiber glass is used widely for construction of greenhouse. It transmits 80-90% of light. New materials are continuously coming onto the market, for constructing better glass houses.

Hot frames (Hot beds)

A **hotbed** is a bed of soil enclosed in a glass or plastic **frame**. A hotbed is a bed of soil enclosed in a glass or plastic frame. It is heated by manure, electricity, steam, or hot-water pipes. Hotbeds are used for forcing plants or for raising early seedlings. Instead of relying on outside sources of supply for seedlings, you can grow vegetables and flowers best suited to your own garden. Seeds may be started in a heated bed weeks or months before they can be sown out of doors. At the proper time the hotbeds can be converted into a cold frame for hardening. Hot beds are small low structures, used for propagation of nursery plants under controlled conditions. Hot beds can be used throughout the years, except in areas with severe winters, where their use can be restricted to spring, summer and fall. Another form of a hot bed is a heated, low polythene tunnels or sun tunnels that is made from hooped metal tubing or bent PVC pipe, which is covered with polyethylene. The standard size of hot frame is 0.9 by 1.8 m. If polyethylene is used as the covering, any convenient dimensions can be used.

Plastic and PVC tubing with recirculation of hot water are quite satisfactory for providing bottom heat in hot beds. Seedlings can be started and leafy cutting rooted in hot beds early in the season. For small propagation operations, hot beds structures are suitable for producing many thousands of nursery plants, without the higher construction expenditure for larger, propagation houses.

Cold frames

A cold frame is a bottomless box with a removable top. It is used to protect small plants from wind and low temperatures. No artificial heat or manure is used inside a true cold frame but many gardeners experiment with a variety of soil conditions. They utilize the sun's heat. The soil inside the box is heated during the day and gives off its heat at night to keep the plants warm. The frame may be banked with straw or strawy manure to insulate it from the outside air and to retain heat. Cold frames include not only low polyethylene-covered wood frames or unheated sun tunnels that people cannot walk within, but also low-cost, poly-covered hoop houses. The covered frames should fit tightly in order to retain heat and obtain high humidity. Cold frames should be placed in locations protected from wind. The primary use of cold frames is in conditioning or hardening of rooted cuttings or young seedlings prior to field,

nursery row or container planting. Cold frames can be used for starting new plants in late spring. Low-cost cold frame construction is the same as for hot beds, except that no provision is made for supplying bottom heat.

In these structures, only the heat of the sun is retained by the transparent or opaque, white polyethylene covering. When young, tender plants are first placed in a cold frame, the coverings are generally kept tightly closed to maintain a high humidity but as the plants become adjusted, the sash frames are gradually raised or ends of the hoop house to permit more ventilation and drier conditions. The installation of mist line or irrigation provision in cold frame is essential to maintain humid conditions. During sunny days, high temperature condition can be controlled by providing ventilation and shading.

Lath houses

Lath (lath - thin strip of wood) or shade houses provide outdoor shade and protect container-grown plants from high summer temperature and high light irradiance. They reduce moisture stress and reduce the moisture requirement of plants. Lath houses have many uses in propagation, particularly in conjunction with the hardening off and acclimatization of liner plants prior to transplanting and for maintenance of shade requiring plants. In mild climates, they are used for propagation, along with a mist facility and can be used as overwintering structures for liner plants. However, snow load can cause problems in higher latitude regions.

Lath house may be constructed with many kind of materials, although aluminum prefabricated lath house are available, but may be more costly than wooden structure. Most lath houses are covered with high density, woven plastic material such as *saran*, poly propylene fabric and UV-treated polyethylene shade cloth, which come in varying shade percentage and colors. These materials are available in different densities, thus allowing lower irradiance of light, such as 50 percent sunlight, to the plants. They are light weight and can be fastened to supporting posts.

Propagation frames

Sometimes in a greenhouse, the humidity is not enough to allow satisfactory rooting in the leaf cuttings. In such cases, enclosed frames covered with glass or plastic material may be used for rooting of cutting. These frames are useful only on grafted plants as these retain high humidity during the process of healing.

Large inverted glass can also be kept over a container having cuttings. Though, high humidity is required is such frames but ventilation and shading is necessary after the rooting process has started in the cutting. Warm and humid conditions inside these structures provide excellent environment for growth of pathogenic organisms, which may infect the propagation

material. It is therefore, necessary to maintain cleanliness and proper sanitation in such structures.

Net house

Net houses are widely used as propagation structures in tropical areas, where artificial heating is not required and artificial cooling is expensive. In these areas, net houses may be constructed with roofs covered with glass or plastic film and its sides are covered with wire net. It provides necessary ventilation and maintains an ideal temperature for germination of seeds and subsequent growth of the seedlings. The roof of net house may be covered with gunny cloth or even with live plant creeper to cut off the solar radiant energy and to keep the house cool. Net house can be constructed as per the need of the propagator and therefore its size varies with the requirements of the nurserymen.

Bottom heat box

It is a simple box for promoting rooting of cutting in difficult-to-root fruit plants like mango and guava. It consists of two chambers made from galvanized iron sheets. The outer chamber has a height of 70cm with 46 cm width and the inner chamber has a height of 68cm and width of 44cm. The space between the two chambers is filled with glass wool for heat insulation.

Another chamber is fitted inside the inner chamber with the height of 35cm fitted with two electric bulbs at the bottom for providing heat to the cutting. The innermost chamber is filled with soil mixture or any other propagation medium and the cuttings are inserted in it. Two electric bulbs of 100 watt capacity are fitted at the bottom of the chamber to provide heat and light to the cuttings. Similarly, the temperature in the box is maintained and controlled automatically by a thermostat fitted at the bottom of the chamber. The most ideal temperature to be maintained in the box is 30± 2^0C because at this temperature, cuttings of mango, walnut, olive and guava root easily and profusely. The initiation of rooting in cutting varies from species-to-species but in general, it takes 1-2 months for proper development of the roots.

Mist propagation unit

The rooting of softwood leafy cutting under spray or mist is a technique now widely used by nurserymen and other plant propagators throughout the world. The aim of misting is to maintain humidity by a continuous film of water on the leaves, thus reducing transpiration and keeping the cutting turgid until rooting take place. In this way, leafy cuttings can be fully exposed to light and air because humidity remains high and prevents damage even from bright sunshine. Mist also prevents disease infection in the cuttings by way of washing off

fungus spores before they attack the tissues. While the leaves in this process must be kept continuously moist, it is important that only minimum water should be used. This is because excessive water leaches out nutrients from the compost, which may cause starvation. Moreover, a directly injurious effect on the cutting may occur from over watering. Hence, it is necessary to utilize nozzles capable of producing a very fine mist. A small mist propagating units are mostly used by small farmers, whereas, highly advanced impermanent units are used by the commercial nurserymen in advanced countries.

Mist propagation units are used for propagation of "difficult to root, cutting in most advanced countries. Mist beds are constructed within a greenhouse. A fine mist is sprayed intermittently over the cutting at regular intervals during day and night. The mist unit is controlled by a time clock, operating a magnetic solenoid valve and is set in a way to turn on the mist for 3-5 seconds to wet the leaves and turn off for some time and when the leaves are dry. The mist is again turned on.

In general, the mist has 5 control mechanisms. Timer, electronic leaf, thermostat and timer, screen balance and photoelectric cell. The two types of timers are used in a mist unit, one turn on in the morning and off at night and the second operate during day hours to produce an intermittent mist, usually 6 seconds "on" and 90 seconds "off". In electronic leaf, a plastic with two terminals is placed under the mist along with cuttings, the alternate drying and wetting of the terminal breaks of the current, which in turn control the solenoid valve. A thermostat controls the temperature of the mist. In screen balance control mechanisms, stainless steel screen in attached to a lever with mercury switch. When mist is on, water is collected on the screen and when weight of water is more, it trips the mercury switch. The photoelectric controls are based on the relationship between light intensity and transpirations rate.

The mist unit can be set up in a glasshouse or in a polyethylene tunnel. Usually, it is set up on the propagation beds with 1.2 m width. The layout of the jets is very important. While installing mist propagation until, all the jets should be at equal height. For proper functioning of mist, there must be proper supply of water. The water should have good pressure and it must be free from salts. The optimum pH of water to be used in mist unit is 5.5 to 6.5. Hard water or alkaline water may be avoided as it may block the nozzles of the mist chamber and it may accumulate on the young leaves of the cutting and thus inhibit the growth and development of roots. Further, it is essential that a well-drained rooting media should be is used and there should be provision for removal of excess water. Similarly, development of blue and green algal growth is very common in mist propagation structure

which is considered very harmful to the propagating material and thus every care should be taken to keep mist propagating unit free from any type of algae.

After rooting in the mist, hardening of the rooted cutting is important for better success in the field. When cuttings are rooted, misting should not cease abruptly as this may help in drying out of the young plants followed by scorching, instead, a weaving off process should be adopted in which misting is continued but the number of sprays/days gradually reduce. The way is to shift the rooted cutting to a greenhouse, fog chamber, and frames, maintained at higher temperature and low relative humidity. After phase-wise hardening only, the rooted cuttings are planted at permanent location or in the nursery.

Growing rooms

A growing room is an insulated building from which natural light is usually excluded. In it, illumination is provided by artificial means. Growing rooms are now widely used commercially for the production of seedlings of bedding plants, tomatoes and cucumbers in most advanced countries. The seedlings are usually grown in trays or pots kept on benches. To save space, the benches are usually installed in tiers being vertically about 2 feet long and 6 inch wide. Each bench is illuminated with 8 feet long 125-watt fluorescent tubes mounted 1 foot 6 inches above the bench. Seven tubes over each bench provide a light intensity of 500 lumens per square feet, which is adequate for bedding plants. However, if plants grown in such houses have higher requirements for light, more fluorescent tubes can be installed over the benches containing the plants. The heat of the tubes usually maintains a temperature of at least 70^{o} F and excessive temperatures are prevented by use of fans installed in building.

The automatic greenhouse

Today, the modern green houses can be almost completely automated thus assisting propagation. For instance, by the use of thermostats, air and bed temperature can be maintained as per the requirement. Similarly, automatic ventilation allows the ventilators to open and close in relation to temperature. Even, automatic systems of irrigation are installed in the modern greenhouses and water is supplied to the plants through drip or trickle system to each pot or plant by individual nozzle of time switch.

Most advancement in raising of plants under highly controlled environmental conditions has been the use of phytotron facility. National Phytotron Facility is available at IARI, New Delhi.