e-READING MANUAL

HFS- 321

HI-TECH HORTICULTURE

3 (2+1)

B.Sc. (Hons.) AGRICULTURE

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DECLARATION

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AUTHORS

CONTENT

Experiment No-1

Types of Poly houses and Shade Net House

Definition of Polyhouse

Polyhouse farming is a new and widely accepted method of farming in present days. The Polyhouse is a tunnel used with polyethylene in semi-circular shape. Polyethylene sheets stabilize the ultraviolet rays and helps in proper photosynthesis in crops. We can make it in other shapes also but the semi-circular shape is most adopted shape in Polyhouse.

Difference between Polyhouse and Greenhouse

Polyhouse is one of the types of Greenhouses in which polyethylene is used as main material for construction. The durability of the polyhouse is more compared to other types of Greenhouses. The Polyhouse is more advanced in view of the technology.

Types of Poly houses

Based on environmental controlling system poly house are two types following as;

1. Manually controlled polyhouses

2. Naturally ventilated polyhouses

Description

In semi-automatic control system, manual adjustments are needed to maintain the Polyhouse in good condition whereas in automatic system, pre-settings are enough for the maintenance of Polyhouse. Proper alertness and technical skills should be needed while managing semi-automatic Polyhouse. Any deviation from this may result in damage of crop and may lead to loss. In an automatic system of Polyhouse less attention is enough for maintenance, but it is very costlier compared to semi-automatic type.

Shade Net House

A Shade house is a structure enclosed by agro nets or any other woven material to allow required sunlight, moisture, and air to pass through the gaps. It creates an appropriate micro climate conducive to the plant growth. It is also referred as shade net house or net house.

Used of Shade Net House

1. Helps in cultivation of flower plants, foliage plants, medicinal plants, spice & vegetables.
2. Used for fruit and vegetable nurseries as well as for raising of forest species etc.
3. Helps in quality drying of various agro products.
4. Used to protect against pest attack.
5. Protects from natural weather disturbances such as wind, rain, hail, and frost.
6. Used in production of graft saplings and reducing its mortality during hot summer days.
7. Used for hardening tissue culture plantlets.

Planning for a shade house

The shade house structure should be planned taking into consideration the type of crop to be grown, locally available materials and local climatic conditions. The provision for future expansion should be there.

Site selection

A shade house should be situated in such a way that it is well connected with market for input supplies and sale of its produces. This structure should be constructed away from buildings and trees, so also away from industrial or vehicular pollutants. The site should be free from drainage problem. There should be provision of electricity and good quality water. However, wind breakers may be located 30m away from the structure.

Orientation

There are mainly two criteria for shade house orientation. They are the uniformity of light intensity in the shade house and wind direction. Single span structure may be oriented either in east-west or north-south direction but multispan structure should be oriented in north-south direction to ensure uniform light intensity.

Structural Materials

A shade house structure composed of two basic components i.e., frame and cladding material. The shade house frame provides support for cladding material and designed to protect against wind, rain, and crop loud. The shade house mild steel (ms) angle frame lasts up to 20 to 25 years, if anti rust treatment is done at regular interval, whereas bamboo structure can last up to 3 years. The agro shade net lasts for 3 to 5 years depending on the climatic condition. Shade nets are available in different colours with wide range of shade percentages viz. 25%, 30%, 35%, 50%, 60%, 75% and 90%.

The design of shade house frames depends on the need and engineering skill. Structural frames of Quonset, gable, or gothic arch shape or with minor modification suitable to local condition are recommended in high rainfall areas like Orissa.

Design and Construction of shade house

Two types of shade house designs have been developed at Precision Farming Development Centre, Orissa University of Agriculture and Technology, Bhubaneswar. The principal advantage of these shade houses is that these structures do not require any welding at the site. Another advantage is that foundation posts have been chosen to protect these structures against termite attack.

Different types of protected structures

	
Natural ventilated polyhouse	**Green shade net house**
	
Insect proof net house	**Mist chamber**
	
Hardening chamber	**Walk-in-tunnel**

	
Low tunnel	**Tomato seedlings under low tunnel**
	
High tunnel	**Mulching**

Draw the Sketches of Different Types of Poly House and Shade Net House

	

Question1: Write down the major differences between polyhouse and shade net with diagram.

Polyhouse	**Shade net house**

Question 2: Write about types greenhouse according to shape

1. Lean-to type greenhouse

2. Qunonset type:

3. Gable type:

4. Ridge and furrow type greenhouse:

5. Even span type greenhouse:

6. Uneven span type green house:

7. Saw Tooth Type Green House:

Experiment No. 2

Intercultural operations

Weeding

Removal of weeds is known as weeding. Weed is a plant grown where it is not desired.

Objectives

1. To reduce the competition of weeds to crop plants for light, space, water, and nutrients.
2. To get expected output (yield) from crop cultivation.
3. Weeding in dry condition fulfils the objective of natural mulching.

Mulching

Mulching is a method of conserving soil moisture. It is a very important intercultural operation for rabi and rainfed crops. It is done by making a covering on the soil surface which reduces the evaporation of soil water. Inorganic and organic materials used for mulching.

Objectives

1. To conserve soil moisture.
2. To reduce excess evaporation loss of soil moisture.
3. To ensure economic use of irrigation water.

Advantages

1. It keeps the soil moist during the dry season.
2. It suppresses weed growth and population.
3. Keeps the soil cool during dry and hot season.
4. Use of mulches like water hyacinth or straw adds significant amount of organic matter to the soil after decomposition.
5. Natural mulching aerates the soil which helps better respiration of plant roots.
6. Mulching becomes essential for some crops to prevent contact of product with soil as for example fruits of straw berry plants if come in direct contact with the soil then the fruits rot. So, mulching becomes essential for strawberry.

Types of mulch

1. Natural mulch (water hyacinth, straw, leaves etc.)
2. Artificial mulch (polythene, paper etc.)

Natural mulching

It is a method of breaking the surface of dry soil and generally done by stirring the soil surface with the help of some implements like niri, khurpi etc. Weeding in dry condition with the help of niri or khurpi results in natural mulching. When the soil becomes drier, water vapour moves upward towards the soil surface through capillary tubes and escapes into the atmosphere. Natural mulching breaks the soil crust and thereby, opening of capillary tubes gets broken and blocked which results in prevention of upward movement of water vapour. Hence, upward movement of capillary water is restricted and soil moisture is conserved.

Artificial mulching

This includes application of plant leaves, straw, water hyacinth, polythene, sawdust etc. to provide a covering on the surface soil which can check the evaporation of soil moisture. Mulch crops may also be grown to conserve soil moisture in bare ground by their thick and multilayered foliage, trailing habit and sometimes, self-seeding nature, for instance cow pea, Alylosia.

Earthing up

Earthing up consists of lifting or shifting the soil from the central portion of the space between rows towards the base of plants to cover the plant base or certain plant organs grown from below or at the soil surface. Earthing up may be done both under wet and dry conditions of soil.

Objectives

1. Earthing up creates ridges and furrows in the crop field which later serves the purpose of irrigation channel.
2. Earthing up reduces weed growth and population.
3. Earthing up closes the spreading tillers in sugarcane which makes the tying of canes easier.
4. Earthing up increasing the number of tubers in potato and prevents solarization of developing tubers.

Thinning

Removal of excess plants after germination from the crop field or seed bed is called thinning. Excess plants in a crop field reduce crop yield due to intra crop competition. As a result, there occurs shortage of space, nutrients, light, air and moisture for individual crop plant which ultimately reduce yield. So, if required, excess seedlings are removed leaving the strongest ones.

Gap filling

Several frugivorous and granivorous animals and birds feed on many seeds after they are sown in the field. Moreover, after transplanting many seedlings fail to establish them in the new environment and dies. Then, gap filling with seeds staggers the period of germination and emergence. As a result, ripening periods extend over time and affect the harvesting which is scheduled once for most crops; and this seriously impairs the quality of produce.

Objectives of thinning and gap filling

The mainly goal is to ensure the optimum plant population in the crop field. Plant population more than optimum creates competitive condition whereas that less than optimum results in misuse of space, irrigation water and other inputs.

Advantages

Both thinning and gap filling ensures ideal plant population and optimum utilization of sunlight, space, nutrients, moisture, and other inputs which ultimately increases yield.

Different intercultural operation under protected cultivation

Question No. 1: Define inter cultural operations and write about the special cultural practices adopted in vegetable crop under polyhouse.

Question NO. 2: Defined Mulch and its type.

Experiment No. 3:

Identification of tools and equipment and their applications

1. Axe

Features

The axe is a simple hand tool, which consists of cutting edge and an eye for fixing of a handle. It is forged to shape from a single piece. Axes are available in various sizes and shapes. The common types are hand felling, felling estate pattern and felling trade pattern. For operation, the operator holds the handle with both hands at convenient position and the tool is raised to suitable position and struck with force against the work.

Uses

Axe is multipurpose cutting tool used for felling and delimbing of trees, splitting of logs for firewood and dressing of logs for timber conversion. Small axes are also used for clearing of bushes.

2. Sickle

Features

The sickle is a simple manually operated hand tool, which consists of a cutting blade and tang made in single piece by forging. The cross-section of the cutting blade is tapered towards cutting edge, like knife. The tang is inserted into the wooden handle and fastened by riveting.

Uses

The dah is used for cutting of small trees, shrubs, and clearance of jungle growth.

	
Axe	**Sickle**

3. Billhook

Features

The billhook is a manually operated hand tool, which consists of a curved blade in hook shape and a tang to which a wooden or plastic handle is attached. The billhooks are available with single or double cutting edges. The cross section of the blade tapers down towards cutting edges. For operation, the tool is held in one hand and struck against the work.

Uses

The billhook is used for lopping of branches, cutting of shrubs and other hard vegetative material.

4.Budding knife

Features

The budding knife is an important hand tool of a gardener, which consists of a folding blade and a handle. The blade has two edges. One of the edges is sharpened all along its length; whereas the blunt or the other edge is sharpened on the tip and is slightly curved. This sharpened curved portion is used to create a "T opening or slot on the bark of the mother branch or twig for the insertion of the bud.

Uses

The budding knife is used for the budding operation, cutting of scion stick, defoliation of leaves and removing or cutting of unwanted thin twigs of the plants.

	
Billhook	**Budding Knife**

5. Grafting knife

Features

The grafting knife is another important plant propagation hand tool, which resembles a household knife. The principal parts of the knife are blade and the handle. The cutting edge the blade is sharpened all along its length and the other edge is blunt. The blade of the knife can be folded into the handle While not in use. A nail mark is provided in the blade to pull the blade from the handle. The blade is made from high carbon steel, tool steel of alloy steel and hardened to 460-510 HB.

Uses

For cutting and defoliation of scion stick, making of chisel point and "V" grooves for grafting and slashing of thin twigs and for general-purpose cutting.

6. Budding and grafting knife

Features

The budding and grafting knife is a multipurpose knife to accomplish both the budding and grafting jobs. It consists two blades each for budding and grafting, which are either joined to a common hinge or are fixed to the ends of the handle. A plastic budder is provided to the other end of the knife in which both the blades are joined to a common hinge or end of the handle.

Uses

For budding and grafting in vegetables, nurseries and fruit gardens. The knife is also used for cutting of thin unwanted twigs, defoliation of leaves and general cutting works in nurseries and orchards.

	
Grafting Knife	**Budding and grafting knife**

7. Pruning and slashing knives

Features

Pruning is a process of removing unwanted branches or twigs of a plant or tree for providing aeration, lighting and frame work which help in obtaining higher yields. Pruning and slashing knives are hand tools, which consists of a blade and tang joined rigidly to the handle.

Uses

For cutting and slashing of thin branches and twigs of plantation crops and orchards.

8. Medium chopping knife

Features

Medium chopping knife is an important tool of bamboo craftsmen, fish/meat shopkeepers and farmers. The tool is used for agricultural and domestic purposes. The cutting blade is made from old leaf spring steel or mild steel flat and angle sections by forging operation. The cutting edge is drawn from the back to form a sharp edge.

Uses

It is used for cutting wood, bamboo, fish, and meat. It is also used for clearing of jungle growth and forest vegetation.

	
Pruning and slashing knives	**Medium chopping knife**

Question No 1: Describe the use of secateurs and draw the equipment required for budding.

Question No.2: What is pruning? Method of pruning use in indeterminate tomato.

Experiment No 4:

Micro propagation

Definition

Asexual reproduction through multiplication of vegetative parts is the only method for the in vivo propagation of certain plants, as they do not produce viable seeds e.g., banana, grape, fig, and chrysanthemum. Clonal propagation has been successfully applied for the propagation of apple, potato, tuberous and several ornamental plants.

The various applications of micro propagation are:

1. Rapid rate of multiplication of a plant clonally
2. Production of disease-free and disease resistant plants
3. Induction of mutants and selection of mutants
4. Production of haploids through anther culture
5. Wide hybridization through excised embryo and ovule culture
6. Somatic hybrids and cybrids through protoplast fusion
7. Transformation through uptake of foreign genome
8. Nitrogen fixation
9. Cryopreservation of germplasm types

Advantages of Vegetative Propagation:

Asexual (vegetative) propagation of plants has certain advantages over sexual propagation.

1. Seed-raised plants pass through an undesirable juvenile phase which is asexual propagation.
2. Sexually-derived sterile hybrids can be propagated.
3. Possible to produce genetically identical plants.
4. Gene banks can be more easily established by clonally propagated plants.
5. Faster multiplication

Disadvantages

1. Expensive and sophisticated facilities, trained personnel and specialized techniques are required.
2. High cost of production results from expensive facilities and high labour input
3. Contamination or insect infestation can cause high losses in a short time
4. Higher level of somatic variation
5. Poor establishment of the plantlets in the field

In Vitro Clonal Propagation: The in vivo clonal propagation of plants is tedious, expensive, and frequently unsuccessful. In vitro clonal propagation through tissue culture is referred to as micro propagation. Use of tissue culture technique for micro propagation was first started by Morel (1960) for propagation of orchids, and is now applied to several plants. Micro propagation is a handy technique for rapid multiplication of plants.

Technique of Micro propagation: Micro propagation is a complicated process and mainly involves 3 stages (I, II and III). Some authors add two more stages (stage 0 and IV) for more

comprehensive representation of micro- propagation. All these stages are represented in Fig. 47.1, and briefly described hereunder. Stages Involved in Micropropagation

Stage 0: Selection of mother plant for explants isolation

This is the initial step in micro- propagation, and involves the selection and growth of stock plants for about 3 months under controlled conditions.

Stage 1: Explant establishment in culture medium

In this stage, the initiation and establishment of culture in a suitable medium is achieved. Selection of appropriate explants is important. The most commonly used explants are organs, shoot tips and axillary buds. The chosen explant is surface sterilized and washed before use.

Stage II: Proliferation and multiplication

It is in this stage; the major activity of micro propagation occurs in a defined culture medium. Stage II mainly involves multiplication of shoots or rapid embryo formation from the explant.

Stage III: Plant establishment and rooting

This stage involves the transfer of shoots to a medium for rapid development into shoots. Sometimes, the shoots are directly planted in soil to develop roots. In vitro rooting of shoots is preferred while simultaneously handling a large number of species. This stage involves the establishment of plantlets in soil.

Stage IV: Acclimatization or hardening

The plantlets of stage III from the laboratory to the environment of greenhouse. For some plant species, stage III is skipped, and un-rooted stage II shoots are planted in pots or in suitable compost mixture. The different stages described above for micro propagation are particularly useful for comparison between two or more plant systems, besides better understanding. It may however, be noted that not all plant species need to be propagated in vitro through all the five stages referred above.

Culture Techniques

Various culture techniques such as

1. Meristem culture
2. Callus culture
3. Shoot bud regeneration
4. Somatic embryogenesis
5. Ovule culture
6. Embryo culture
7. Anther culture
8. Protoplast culture are employed in micropropagation.

1. Meristem culture:

Meristem culture involves culture of both shoot-tip and axillary-bud. The use of small shoot-tips comprising of the apical dome with one or two leaf primordia (0.1-0.5mm) is the basis for the technique known as meristem-tip-culture, pioneered by Morel in the 1950s. Meristem tip culture is now being routinely used, mainly in horticultural crops, for the elimination of virus

from infected material. Virus apparently either does not easily invade or rapidly multiply in the young meristematic tissue. A simple nutrient medium consisting only of salts, sucrose and vitamins is used in order to minimize the formation of callus. Gibberellic acid is often needed to promote adequate growth and NAA may be required to stimulate root formation.

2. Callus culture:

A piece of sterile plant tissue with living cells is transferred to a culture medium to induce callus proliferation. Sub-culturing is then done onto a medium with or without altered growth regulator concentrations, ultimately resulting in the induction of adventitious organs or embryos. In the last stage, regenerated plants are removed from in vitro culture and slowly exposed to outer environment so that the plants can be fully autotrophic.

3. Cell culture:

The cells are maintained in suspension cultures to produce free cells and are then sub cultured to regenerate complete plant from single cells. This technique is now useful to induce variability in plant cells and to select desirable cell variants and regenerate complete plants from these variants.

4. Embryo culture:

It involves aseptic excision of the embryo and its transfer to a suitable medium for development under optimum culture conditions. After the embryo has grown into a plantlet in vitro, it is transferred to sterile soil or vermiculite and grown to maturity in a green house. This technique is useful in the production of interspecific and intergeneric hybrids which could not be otherwise accomplished and in overcoming embryo abortion.

5. Protoplast culture:

From different sources, protoplasts (the plant without any rigid cellulose wall but with plasma membrane only allowed to fuse to form a somatic hybrid) are cultured in suitable media to regenerate the cell wall and are again cultured in suitable medium for differentiation and morphogenesis.

6. Anther culture:

The culture of anthers is of considerable value to breeders as it is possible to produce haploid plants which reveal recessive alleles. These haploid plants can be used to produce homozygous diploids, thus avoiding generations of inbreeding. Added benefits, such as small flowers and prolonged flowering time, might be ensured from the use of haploid plants as they are usually smaller than their diploid counterparts and being sterile there will be no pollination induced senescence. Anther culture has been used in Pelargonium spp. to eliminate virus, in Lilium spp. to produce haploid plants and in Gerbera to obtain different flower colour.

7. Somatic embryogenesis:

The greatest potential for clonal multiplication is through somatic embryogenesis, where technically a single isolated cell can produce first an embryo, then a complete plant. Somatic embryogenesis and plantlet regeneration has been reported in various species of horticultural plants by using mid-rib, leaf, and stem callus on modified MS basal medium supplemented with 1.0 – 2.0 mg/l 2,4-D and 0.25-0.50 mg/l BA or kinetin.

Micro propagation of banana

Question No. 1: Defined micropropagation and its advantage and disadvantage.

Question No. 2: Illustrate the steps involved in plant tissue culture.

Experiment No.5:

Nursery Portrays

Introduction:

Vegetable nursery is now accepted as a specialized enterprise and is gradually changing from open field nurseries to protected raised bed or pro tray productions.

The portrays are generally kept under net house which is cost effective and practical. The height of the structure should be 3mm while length and breadth depend upon the requirement of nursery.

Generally, 50% Ultraviolet stabilized HDPE shade net is used. It is recommended to cover the sides with 40 mesh UV stabilized nylon insect proof net.

Portrays:

Portrays are shallow plugs in which germination media remains warm and provides better aeration. Seed are sown directly into plugs. Weeding and thinning is easily carried out in such portrays.Plugs per tray varies from 48-96 per tray. Trays are made of soft plastic to facilitate removal of seedling without damaging its roots96 celled trays which are 54 cm X 27 cm and 4 cm deep are commonly used for tomato seedling. Life of the tray depends on the handling and quality of trays.

Growing Media for Portrays:

1. Coco peat, a by-product of coir industry having high water holding capacity is commonly used as media in portrays. Cocopeat has 6 times water holding capacity to its weight.
2. Coco peat should be supplemented with nutrients. Sterilizing the growing media reduces diseases and pest introduction and attack.
3. Other recommended media are Coco peat + vermi-compost or vermi-compost + sand or soil loam + FYM in equal proportion.

Filling and Sowing:

1. Portrays are filled with appropriate growing media.
2. Small depressions (0.5 cm) are made at the centre of the plugs with finger tips. One seed is sown in each cell and covered with medium containing 300-400 percent moisture.
3. The trays are covered with polyethylene sheet to ensure conservation of moisture until germination.

After Care:

1. Light irrigation is provided to trays with a fine rose spray depending upon the weather conditions. Over irrigation results in nutrient leaching and fungal attack
2. Coco peat is deficient in nutrients and therefore needs nutrient supplementation. Water soluble fertilizer (19:19:19) is sprayed a 3 grams/liter of water on 12" and 20" days after sowing.
3. Manual weeding should be carried out as and when necessary.

Plant Protection:

Disease:

1. Occurrence of damping off disease is more in crowded seedlings due to poor ventilation. Sterilizing media, good drainage, seed treatment with Thiram 0.3% and drenching of Bavistin @ 0.3% are recommended for avoiding damping off-disease.
2. Fungal diseases are prevented by maintaining sanitation and drenching of copper fungicide (0.3%) or Carbendazim (0.1%).

Pricking of Seedlings:

1. Pricking is done when seedlings are at 2-4 leaf stage. Pricking is shifting of seedlings to comparatively bigger size trays or containers to accommodate seedlings in better growing condition.
2. Seedling trays are bigger and seedlings get appropriate quantity of nutrients and moisture. Trays have pre-punched holes at the bottom for proper drainage and have the appropriate spacing.
3. The Portray nursery is an upcoming technique for quality vegetable seedling production, where seedlings are produced under shade net and such seedlings have better germination. appears healthy and are protected from pest and diseases and build up well developed root system within 25-30 days.

Advantages-

The benefits of portray nursery includes production of pest free quality seedlings, having independent area for each seed, improved seed germination, better root development, minimized seedling mortality and damping off disease, provides uniform, healthy and early maturity, easy handling, and cheaper transportation.

	
Cocopeat, vermiculite and perlite	**Filling of pro-tray with cocopeat, vermiculite and perlite**
	
Seed sown in pro-tray with media of cocopeat, vermiculite and perlite	**Healthy seed germination**
	
Healthy seedlings	**Large scale seedlings production**

Question No. 1: What is growing media and describe its types.

Question No. 2: How pro-tray helps to the farmers.

Experiment No.6:

Micro-irrigation

Introduction

Irrigation advancements within the last decade have been astounding. Micro-irrigation is one of the latest innovations for applying water and it represents a definite advancement in irrigation technology. It can be defined as the frequent application of small quantities of water on or below the soil surface as drops, tiny streams or miniature sprays through emitters or applicators placed along a water delivery lateral line. It differs from sprinkler irrigation by the fact that only part of the soil surface is wetted. Micro-irrigation encompasses a few methods or concepts such as bubblers, drip, trickle, mist or spray and subsurface irrigation.

Micro irrigation Systems

Micro irrigation is the slow application of continuous drips, tiny streams, or miniature sprays of water above or below the soil surface. Micro irrigation system is effective in saving water and increasing water use efficiency as compared to the conventional surface irrigation method. Besides, it helps reduce water consumption, growth of unwanted plants (weeds), soil erosion and cost of cultivation. Micro irrigation can be adopted in all kinds of land, especiallywhere it is not possible to effectively use flooding method for irrigation. In flooding method of irrigation, a field is flooded with water.

This results in significant run-off, anaerobic conditions in the soil and around the root zone, and deep irrigation below the root zone, which does not supply sufficient water to the plants. It is, therefore, one of the most inefficient surface irrigation methods. Micro irrigation can be useful in undulating terrain, rolling topography, hilly areas,barren land, and areas having shallow soils. According to depth, soil types can be classified asshallow (depth less than 22.5 cm), medium deep (22.5–45 cm) and deep soil (more than 45 cm).

Feature of micro irrigation system

1. Water is applied via pressurised piping system. Micro irrigation requires pumps for developing the required pressure for delivering water through pipelines, regardless of whether the source of water is surface or underground.
2. Water is applied drop-by-drop for a long period in case of drip irrigation system.
3. Water is applied at a low rate to maintain the optimum air–water balance within the root zone.
4. Water is applied at frequent intervals as per the requirement of plants.
5. Water is supplied directly to the plants and not to the other areas of the field, thus, reducing wastage.
6. Soil moisture content is always maintained at field capacity of the soil. Hence, crops grow ata faster rate, consistently and uniformly.

Classification of micro irrigation system

Micro irrigation system can be broadly classified into two categories:

1. Drip irrigation system
2. Sprinkler irrigation system

Drip irrigation system

Drip irrigation system, also known as trickle irrigation system is a method of applying the required amount of water directly to the root zones of plants through drippers or emitters atfrequent intervals. In this system, water is applied drop-by-drop or by a micro jet on the soil surface or sub-surface at a rate lower than the infiltration rate of the soil.

Types of drip irrigation system

Drip irrigation system can be classified into the following:

1. Surface drip irrigation
2. Sub-surface drip irrigation
3. Family drip
4. Online drip
5. In-line drip

Benefits of Drip System

1. More efficient water use.
2. More efficient use of fertilizers.
3. Less pumping cost.
4. Less chemical usage.
5. Less labour required.
6. Significantly higher yield.
7. Better crop quality.
8. Better uniformity of application

Sprinkler irrigation system

Sprinkler irrigation is a method of applying water in a manner like rain. It is suited for most row, field, and tree crops. Water can be sprayed over or under the crop canopy. If a site is known to be windy most of the time, sprinkler irrigation will not be suitable. The sprinkler breaks up the water into droplets sized 0.5–4 mm. The drop size is controlled by pressure and nozzle size of the sprinklers. The average rate at which water is sprayed onto the crops is measured in mm/hour.

Types of sprinkler irrigation system

1. Linear move sprinkler
2. Pop up sprinkler
3. Impact sprinkler
4. Rain gun
5. Towable pivot
6. Centre pivot

Sub -surface Drip Irrigation

The application of water below the soil surface through emitters, with discharge rate generally in the range of 0.6 to 4 1/h. This method of water application is different from and not to be confused with the method where the root zone is irrigated by water table control, herein referred to as sub irrigation.

Spray Irrigation

The application of water by a small spray or mist to the soil surface, water travel through the air becomes instrumental in the distribution of water. In these category two types of equipment are in use viz. micro-sprayers and micro-sprinklers. Micro-sprayers and static micro jets are non-rotating type with flow rates ranging from 20 to 150 l/h, whereas, micro- sprinklers are rotating type with flow rates ranging from 100 to 300 l/h.

Bubbler Irrigation

The application of water to the surface at a small stream or fountain where the discharge rate for point source bubbler emitters is greater than the drip or subsurface emitters but generally less than 225 l/h. Since the emitter discharge rate generally exceeds the infiltration rate of the soil, a small basin is usually required to contain or control the water. Present developments and expansion of micro-irrigation.

1. High value crops are produced.
2. Steep slopes and undulated topography.
3. Soils are sandy, rocky, or difficult to level.
4. Water is of marginal quality viz., saline.
5. Water and labour are expensive or scarce.

The principal crops under micro-irrigation are commercial field crops (sugarcane. cotton, tobacco etc), horticultural crops-fruit & orchard crops, vegetables, flowers, spices & condiments, bulb & tuber crops, plantation crops and silviculture/forestry plantations. This method of irrigation continues to be important in the protected agriculture viz., greenhouses shade nets, shallow & walking tunnels etc. for production of vegetables & flowers. The drip irrigation system with its controlled application of water makes possible the task of maintaining the soil moisture close to the field capacity, thus resulting in noticeable increase in growth and yield.

Components

Much significant advancement has occurred in the design of components and micro-irrigation systems. The basic components of a micro-irrigation system can be grouped into three subsystems viz., control head unit, water carrier system and water distribution system besides a pumping station.

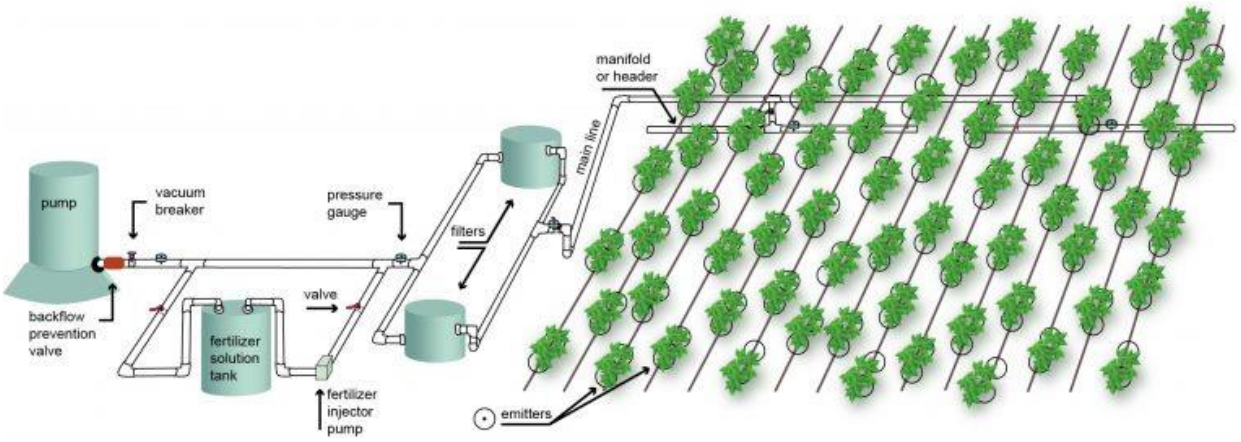

Fig. Layout of drip system

Head control unit

1. Non return valve
2. Air release valve
3. Vacuum breaker

Filtration unit

1. Fertigation unit.
2. Throttle valve.
3. Pressure gauge.
4. Water meter.
5. Pressure regulator.
6. Pressure relief valve

Water carrier system

1. PVC main pipeline.
2. PVC sub main pipeline.
3. Control valve.
4. Flush valve and other fittings.

Water distribution system

Drip lateral, Emitters, Micro sprinklers, Grommet, start connector, Nipple, End Cap The water distribution system components vary depending upon the type of emitter device selected by the farmer to suit his soil and crop requirement.

For example, if the farmer is growing citrus or mango at wider spacing, drip system with online emitters is recommended. On the other hand, if he is growing vegetable or field crop like sugarcane or cotton crop with narrow spacing, integral dripline with line source emitters would be appropriate.

Emitters

Many different emitters have been devised and manufactured within the last decade. Some of the more distinctive designs are the short-path, long-path, short-orifice, vortex. Pressure compensating, self-flushing, perforated single and double-chamber tubing, as well as porous-tubing emitters. These designs can be classified into two types, point source and line source.

Point-source systems discharge water from individual or multiple outlets that are spaced at least 1 m apart.

Hydraulics:

The flow regime throughout a trickle irrigation system is hydraulically steady. spatially varied pipe flow with lateral outflows. The total discharge in the distribution network (Lateral, sub main and main lines) decreases with respect to distance from the pump. The lateral and sub-main have similar hydraulic characteristics and are designed to maintain a small pressure variation along the lateral line. The main line is designed in terms of input pressures and minimal required pressures at any sub- main line.

Question No. 1: Defined micro-irrigation and enlist its component.

Question No.2: Write down the basic differences between drip and sprinkler irrigation.

Experiment No.7

Canopy Management

Canopy management is the manipulation of tree canopies to optimize the production of quality fruits. The canopy management, particularly its components like tree training and pruning, affects the quantity of sunlight intercepted by trees, as tree shape determines the presentation of leaf area to incoming radiation. An ideal training strategy centers around the arrangement of plant parts, especially, to develop a better plant architecture that optimizes the utilization of sunlight and promotes productivity.

Necessity of Canopy Management

Fruit trees produce fruit regardless of human intervention. Fruits house the seeds needed for trees to reproduce - when birds and animals eat the fruits, they distribute the seeds to start new growth optimize the balance between vegetative growth and fruit production, and to keep fruit picking manageable. An unmanaged canopy will grow all its fruit 25-30 feet in the air. which is difficult and just plain dangerous to get at Managing a canopy will help to develop a strong tree that will support heavy crop loads, while increasing fruit production and improving fruit quality in the long-term.

Some of the Basic Principles in Canopy Management are

1. Maximum utilization of light.
2. Avoidance of built-up microclimate congenial for diseases and pest infestation.
3. Convenience in carrying out the cultural practices.
4. Maximizing productivity with quality fruit production.
5. Economy in obtaining the required canopy architecture.

Lack of Canopy Management Leads To....

1. Larger height and stature
2. Higher cost of management
3. Low photosynthetic efficiency
4. Low productivity
5. High pest and disease incidence

There Are Three Primary Methods for Managing Fruit Tree Canopies

Pruning: The removal of limbs or branches from the tree. This is what most of us think of as canopy management, but it is only one part of a larger process.

Types of Pruning

1. Thinning out: removed entirely without leaving any stub.

2. Heading back: branches and shoots are removed leaving its basal portion intact.

Objectives

1. Remove surplus branches.
2. Fruit colour will improve.
3. To remove dead and diseased limbs.
4. 4.Improve fruiting wood and to regulate production of floral or buds.
5. Maintain a balance between vegetative growth and fruiting.

Special Pruning Techniques

Root Pruning

1. Dwarf fruit trees
2. Circular trench 45cm away & roots are cut off every year.
3. Deccan Vidarbha -induce flowering in oranges.

Ringing

1. Complete removal of the bark from the branch or trunk
2. Increase fruit bud formation.
3. Interrupts the downward passage of carbohydrates
4. Mango -force flowering over vegetative tree.
5. Grape -promote fruit set and large size fruit.

Notching

1. Partial ringing above the dormant lateral bud.
2. Increases yield of fig trees in Pune.
3. Produce strong shoots in apple.

Smudging

1. Smoking of trees
2. Mango: Philippines to produce off season crop
3. Done for a week – centre of the crown of tree
4. India-mango trees induce early blossom.

Pollarding: Removing growing point in shade trees-silver oak.

Lopping: Reduce canopy cover in shade trees.

Pinching: Removal of terminal growing point. Ex. Flower crops: carnation, chrysanthemum.

Disbudding

1. Removal of unwanted flower bud
2. Cut flowers: rose, carnation, dahlia, chrysanthemum

Bending

1. Bend to a 45-to-60-degree angle
2. Increase lateral branching
3. Decrease terminal growth
4. Decreases amount of auxin moving to tip
5. Increasing fruit production in guava.

Coppicing

1. Complete removal of trunk: Eucalyptus, Cinchona
2. 30 -35cm stumps are alone left.
3. Produce vigorous shoots in 6 months

Training: Positioning limbs in specific ways to manage growth, rather than removing them. Train rather than prune when poss.

Objectives

1. Admit lighter and air to the centre of the tree.
2. Expose maximum leaf surface to the sun.
3. To protect tree from sunburn and damage.
4. Facilitates easy maintenance.

Methods of Training

Open Centre System

1. Main stem is allowed to grow only to a certain height.
2. Leader stem is pruned and scaffold branches are encouraged.
3. Vase shaped system.

Central Leader System

1. Main stem extends from surface of soil to top of tree
2. Closed centre- e.g., Apple, Cherry, Pear, Pecan, Plum

Modified Leader System

1. Intermediate between open centre and central leader.

Bower System

1. Pandal or pergola e.g., grapes and cucurbitaceous vegetables

Espalier System

Kniffin System

Telephone System: Overhead Trellis System

Head System

1. Followed in grapes.
2. Wines are allowed to grow as a single stem with the help of stakes.
3. After 1.2m side shoots are allowed.

Horticultural Practice:

Addition of nutrients, water, etc. E.g., Rather than cutting limbs, cut back on water and nitrogen to stop excessive tree growth.

Timing For the Canopy Management

1. You can see the shape and structure of the tree, as there are no leaves-this gives you a better idea of what you are working with.
2. The tree's physiological response to pruning will be predictable throughout the dormant season-whether you prune in November or February, the tree's growth response will be the same. The metabolic processes are slow to non-existent.

3. If you prune during the growing season (spring through fall), it is impossible to know what stage growth the tree is in, and so its growth response is unpredictable.
4. Microorganisms (e.g., bacterial, and fungal infections) are plentiful during the summer months. Pruning in the summer creates wounds that make trees more susceptible to infections.Toolkit for Canopy Management Rather than cutting away limbs, we can learn to manipulate trees based on our understanding of how they grow and develop.

Mechanisms For Growth of Trees

Trees have a set amount of energy (created through photosynthesis) that they can use to grow. Based on external and internal cues, they will produce either reproductive growth or vegetative growth. Canopy management manipulates the allocation of the tree's resources to favour one kind of growth over another-creating the right balance is crucial.

Maintaining The Balance

We want as much fruit as possible, but too much emphasis on fruit will prevent good structure. If a tree bears too much fruit too early, it can become 'runted out, or unable to grow adequately, and will produce far less fruit in the long run. It is important that enough vegetative growth occurs in roots, branches, etc. to ensure that the tree is healthy and sturdy. Because one form of growth occurs at the expense of the other, the best way to control overly vigorous vegetative growth is to let the tree fruit. Pruning can delay fruiting - if you want more fruit, sooner, do not prune.

Appearance for Growth of Good Vegetation

Current season growth should be between 18-20 inches. More than that is excessive and should be controlled. Less than that will not be enough to support fruit.

Trees Grow in Two Ways:

Primary Growth:

Growth in length of limbs. This form of growth results from the activity of the "apical meristem" which creates undifferentiated cells (cells which have no function, but will eventually be differentiated to become blossoms, bark, etc.)

Secondary Growth:

Growth outwards and in diameter (i.e., thickening of the limbs). When managing the canopy, it is important to know what age of wood you are working with. This is referred to in years, e.g., one year old wood, two-year old wood, etc.

Current Season Growth:

It is the new shoot growth expanding from the last terminal bud. At the end of the season, when the tree goes dormant, it sets up a new terminal bud at the end of the growth. That growth then becomes one-year-old wood. Over time you will be able to recognize old terminal buds (bud scale scars) and the age of the wood stemming from them.

Tree Habits:

Every tree has tendencies towards certain shapes of growth knowing and understanding these tendencies can make canopy management much more efficient.

Growth Habit:

The growth habit of a tree is its natural inclination towards a certain canopy shape. There are two basic growth habits;

1. Acro tonic: Strong growth at the top of the tree, at the expense of weaker growth on lower levels. Red Delicious apple has this tendency.

2. Basi tonic: Lower branches are stronger and outgrow the top of the tree. Braeburn apple trees have this tendency. There are also several growth habits in between, such as columnar or conical shaped canopies.

Mechanisms For Growth of Trees

Trees have a set amount of energy (created through photosynthesis) that they can use to grow. Based on external and internal cues, they will produce either reproductive growth or vegetative growth. Canopy management manipulates the allocation of the tree's resources.

Question No. 1: Describe plant canopy and its principles.

Question No. 2: Illustrate the different training systems utilized in hi-tech horticulture and explain about its advantage.

Experiment No.8

EC, pH-Based Fertilizer Scheduling

Preserving environment in farming is now becoming main concern since use of inputs like fertilizers & pesticides has been widely employed. Site-specific application of agricultural

chemicals is an effective way of resource saving and environmental protection. Precise farming implementation is now gaining popularity and widely accepted as one of smart solutions to sustain agriculture production without ignoring environment. In appropriate nutrient inputs has affected environment and human's health. Indiscriminate use of nitrogen and phosphorus fertilizers has lead to ground water pollution.

The pH and EC (electrical conductivity) are the two important indices of fertilization. They represent the whole quality and characteristics of fertilizers and water. It varies for different plants and soils.

(A) pH Gives the Information of Acidity or Alkalinity of Solution

A pH reading of 7 is neutral because there are equal concentrations of (H+) and (OH-) is ideal for many plants and spray materials. pH log [H+] (neg. log of the H+ conc.) pH level gives the availability of nutrients in the soil or fertilizer solution. pH range of fertilizers solution delivered in soil effects the soil properties. Calcium, Phosphorus, potassium, and magnesium are unavailable to plants in acidic soil. Plants have difficulty in absorbing micro-nutrients like copper, zinc. boron, manganese, and iron in basic soils; however, their presence in soil can also be excessive and become toxic to plants. A higher quantity of bicarbonate ions is contained in basic soil which affects the optimum growth in plants by interfering with the normal uptake of other ions.

(B) Electrical Conductivity

Salinity of solution is measured by common way using electrical conductivity (EC) sensor. This sensor measures the electricity moves through a saltier solution; the electricity moves through it is directly proportional to the conductivity readings. EC is measured in dS/cm (Deci siemens per centimetre). In all soils salts are naturally present additional salts build up in the soil by higher concentration of fertilizers applied.

Fertilizers Selection

The main factors affecting fertilizers composition are the plant characteristics, soil characteristics, irrigation water quality and growing place. Major nutrients nitrogen (N). phosphorus (P) and potassium (K) are supplied to plant through fertigation process. However, calcium (Ca) and magnesium (Mg) are sometimes supplied in the field. When potassium sulphate and magnesium sulphate are used to supply K and Mg respectively, soil also gets Sulphur (S) in addition.

A. Measuring pH

Fertilizer's pH is measured using pH electrode. The output signal of ph electrode is in milli-volts (mV). The working of pH electrode is based on the principle that a potential is developed when two solutions of different pH come in contact through a thin glass membrane. The pH electrode is consisting of glass electrode and reference electrode the potential between these two electrodes.

B. Measuring EC

The electrical conductivity of a solution is measured by determining the resistance of the solution between two flat or cylindrical electrode separated by a fixed distance. The resistance is measured by a conductivity cell. An alternating voltage is used in to avoid electrolysis.

Question No. 1: What you understand about fertigation and fertilizer scheduling.

Question No. 2: How to maintain pH and EC under polyhouses.

Experiment No. 9

Visit To Hi-Tech Orchard/Nursery

India is endowed with a remarkably heterogeneous area characterized by a great diversity of agro climatic zones, allowing for production of a variety of horticultural crops such as fruits, vegetables, flowers, spices, plantation crops, root and tuber crops, and medicinal and aromatic crops. Agriculture is the backbone of our country.

Nursery's Role in Indian Economy

Agricultural sector provides livelihood to more than 65 percent of the labour force. Under agriculture sector horticultural crops play very important role to economy. It ranks second in fruits and vegetables production in the world, after China. As per National Horticulture Database published by National Horticulture Board, during 2014-15 India produced 86.602 million metric tonnes of fruits and 169.478 million metric tonnes of vegetables.

Horticulture is the science or art of cultivating fruits, vegetables, flowers, or ornamental plants. Etymologically, "horticulture" can be broken down into two Latin words: *hortus* (garden and *cultus*(tilling). As William L. George explains in his definition as "Horticulture involves five areas of study".

These areas are floriculture (includes production and marketing of floral crops), landscape horticulture (includes production, marketing, and maintenance of landscape plants), floriculture (includes production and marketing of vegetables), pomology (includes production and marketing of fruits), and postharvest physiology which involves maintaining quality and preventing spoilage of horticultural crops. "Horticulture is the cultivation of garden plants, fruits, berries, nuts, vegetables. Flowers, trees, shrubs, and turf. Horticulturists work for plant propagation, crop production. plant breeding, genetic engineering, plant biochemistry, plant physiology, storage, processing, and transportation. They work to better crop yield, quality, nutritional value and resistance to insects, diseases, and environmental pollution. Horticulturalists use modern nurseries to produce seedlings and mother plants. These plants are propagated through different methods such as seeds, inarching, budding, veneer grafting, patch budding and soft wood grafting.

Horticulture exports have helped the country to earn Rs 14,000 crore in 2011-12. Horticulture accounts for 30% of India's agricultural GDP from 8.5% of the cropped area. India's major exports include onion, mango pulp, fresh mangoes, dried walnuts, fresh grapes. India's biggest export markets are South Asian and Middle East Countries. India's share in the global market is insignificant - it accounts for 1.7% of the global trade in vegetables and 0.5% in fruits. Twenty-two types of fruits (e.g., banana, mango, citrus, apple, guava, grapes, pineapple, papaya, pomegranate etc.), 20 types of vegetables (e.g. potato, brinjal, tomato, tapioca, onion, cabbage, cauliflower, okra etc.), flowers (loose and cut) plantation crops (coconut, cashew nut, areca nut, cocoa), spices (e.g., mustard seed, chilli, turmeric, garlic, ginger, tamarind, coriander, cumin, pepper, fenugreek etc.) and some aromatic and medicinal plants are being produced.

Nursery is defined as an area where plants are raised for eventual planting out. It comprises of nursery beds, paths irrigated channels etc.

Nursery bed is defined as a prepared area in a nursery, where seed is sown or into which seedlings or cuttings are raised. On the bases of kind of plants growing in them nursery beds are classified into seedling beds and transplant beds, seedlings, beds are those nursery beds in which seedlings are raised either for, transplanting in other beds or for planting out. The aim of good nursery management is to provide planting material of the highest possible quality for new development areas and replanting. This aim is of the greatest important as the areas planted are likely to have a productive life span of 25 years or more. Poor planting materials will lead to low yield and unnecessary thinning cost top rid of runts in planted field. So, the selection of good planting materials and strict culling in nursery are the important step. The importance of the best quality planting material as an initial investment is a well realized factor for persons in Horticulture field.

Different vegetable crop under protected cultivation

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<tr><td>  </td><td>  </td></tr>
<tr><td>Green Capsicum</td><td>Red Capsicum</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Green, Red and Yellow Capsicum</td><td>Yellow Capsicum</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Cucumber fruits on plant</td><td>Fresh Fruits of Cucumber</td></tr>
<tr><td>  </td><td> 
</td></tr>
<tr><td colspan="2">Cucumber fruits</td></tr>
</table>

Question No. 1: Visit to your university orchard/polyhouse and work out economics of any horticultural crop suitable for cultivating in high-cost greenhouse.

Question No. 2: What is nursery ? write about basic characteristics of ideal nursery.