COURSE NO. : ELE. HORT-368 COURSE TITLE: HI-TECH

HORTICULTURE CREDIT: 3(2+1) SEMESTER VI

Syllabus

1. Introduction, importance & scope of hi-tech horticulture in India

2. Hi-tech nursery management & mechanization of horticultural crops

3. Micropropagation of horticultural crops

4. hi-tech field preparation and planting methods

5. Protected cultivation: Advantage & constraints

6-7. Environmental control in green house- temperature, light, Co2, relative humidity and ventilation methods & techniques.

8. Micro irrigation systems & its components

9. EC/pH based irrigation/ fertigation scheduling

10-11. Hi-tech canopy management of horticultural crops

12-16.High density orcharding in Mango, guava,papaya, citrus, pineapple etc

17. Remote sensing & geographical information system

18. Differential geo-positioning system (DGPS)

19-30. Component of precision farming & application of precision farming in horticultural crops (fruit, vegetables & ornamental crops 2 crops each)

31. Mechanized harvesting produce

32. Post harvest management for export.

Reference book:

Hi-tech Horticulture- T.A.More, MPKV,Rahuri Balraj Singh,2005: Protected cultivation of vegetable crops.Kalyani publication

Patil M.T. & Patil,P.V.,2004 Commercial Protected Floriculture.MPKV,Rahuri

Commercial floriculture- Prasad & kumar

Green house operation & Management: Paul V. Nelson

Background of Hi-tech Horticulture

It is now widely employed for the profitable commercial production of horticultural products. Hi-tech horticultural practices include Integrated Pest Management (IPM), Integrated Nutrient management (INM), Plasticulture, Greenhouse Cultivation or Protected Cultivation, Hydroponics, Micro irrigation or Drip irrigation, Fertigation, Sub-surface Drainage System; Precision Farming; High Density Planting; Hi-Tech Mechanization; Molecular Diagnostics etc.

Integrated Pest Management (IPM)

Integrated Pest Management (IPM) has become a widely practiced Hi-tech horticulture practice now. Integrated Pest Management in horticultural production is one of the key requirements for promoting sustainable agriculture and rural development. Integrated Pest Management aims at a judicious use of cultural, biological and chemical control of pests and diseases.

Integrated Nutrient Management (INM)

Integrated Nutrient Management (INM) also has become a widely practiced Hi-tech horticulture practice now. Integrated Nutrient Management (INM) refers to maintenance of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of the benefits from all possible sources of plant nutrients in an integrated manner. Another important aspect of INM is the enhancing of the fertilizer use efficiency (FUE) by proper placement of fertilizer in close proximity to the rhizosphere of the highest root activity. Integrated Nutrient Management has become one of the common practices among progressive horticulture producers today.

Plasticulture

Plasticulture has become a popular hi-tech horticulture technology today. Plastics have various applications in commercial horticultural production. The practice of using plastics for commercial horticultural production is termed as ‘Plasticulture’. Various applications of plastics in horticulture include Protected Cultivation (greenhouse structures; high and low tunnels etc); Plastic Mulching, and Plastic Lining. Plasticulture improves the economic efficiency of production systems and helps in efficient water and energy management. Plasticulture reduces temperature fluctuations and moisture fluctuations and also helps in controlling pest and disease infestations. Plasticulture plays a dominant role in precise irrigation and nutrient applications by reducing wastage of water and nutrients and by

reducing soil erosion. Use of plastics has proved beneficial to promote the judicious utilization of natural resources like soil, water, sunlight and temperature.

Greenhouse Cultivation

Greenhouse cultivation or protected cultivation is now quite popular among progressive horticultural producers. This hi-tech horticulture technology offers several advantages over traditional production techniques such as in greenhouse cultivation, horticultural products mainly fruits, vegetables and flowers can be produced under protected cultivation even during their off-seasons.

Advantages of Greenhouse are—

Production of vegetable crops.
Production of off-season flowers, vegetables.
Production of Roses, Carnation, cut-flowers etc.
Plant propagation, raising of seedlings.
Primary and secondary hardening nursery of Tissue cultured plant.
Growth / Production of rare plants, orchids / herbs, medicinal plants.

Hydroponics

Hydroponics, another hi-tech horticulture technology offers great scope for horticultural producers worldwide. Hydroponics is also known as soilless cultivation. Hydroponics helps producers grow plants in nutrient solution, without using the standard soil medium.

Micro-irrigation or Drip irrigation

Drip irrigation is now a widely used irrigation practice worldwide. Drip irrigation has many advantages over a standard irrigational procedure. These advantages include optimum utilization of irrigational water, maximum water use efficiency by supplying water within the root system of the plants, and minimum evaporative loss of soil moisture.

Fertigation

The practice of supplying plant fertilizers and nutrients via irrigational water is known as fertigation. Fertigation is usually practiced with drip irrigation.

Horticulture business mainly comprises of horticulture food processing, fruit and vegetable retailing and floriculture industry.

Horticulture Food Processing

Spoilage of fresh fruits and vegetables due to their short shelf life and subsequent wastage of large quantities of fruits and vegetables is a major issue even today. There is only one way to minimize this food wastage, that is horticulture food processing. Fruit and vegetable processing holds the key to curtail food wastage down to the possible minimum level. Another major advantage of horticulture food processing is its value-addition.

Horticulture food processing forms a major percent of the entire food processing industry. Horticulture foods like fruits and vegetables are processed into various value-added products such as pickles, jams, squashes, concentrates, marmalade, fruit mixes, canned vegetables, and canned fruits for long-term consumption

Fruit and Vegetable Retailing

Fruit and Vegetable Retailing is a major horticulture business that employs millions of small time entrepreneurs. Retail market of fruits and vegetables has tremendous growth potential in the immediate future. Due to the increased health awareness of the consumers, consumption of fresh fruits and vegetables are also increasing day by day.

Hi-tech Horticulture - Defination

Use of advance technologies like integrated pest management, integrated nutrient management, hybrids seeds, genetic modified planting materials, protected cultivation , plasticulture, micropropagation, microirrigation, ferigation, hydroponics, precision farming, high density planting, advance mechanization etc for the management & qualitative production of horticulture produce for high economic return is called as hi-tech horticulture.

Importance & scope of Hi-tech horticulture

1. Production of qualitative produce –
   Qualitative production of fruits, vegetables, flowers & value added products can be produce as per the requirement of market or consumes by using hi- tech horticulture technologies
2. Higher production per unit area
   Productivity of fruits , vegetables , flowers, medicinal, plantation & spices crops per unit area can be achieves by using hi-tech horticulture technologies.
3. Higher income or high return
   Higher income or high return from horticulture produce can be achieved by using hi-tech horticulture technologies
4. Use of biotechnologies for shelf life of crop
   Use of Genetic Modified technologies (GM) in crops like tomato & capsicum have increased shelf life of crops in great extent.
5. Use of biotechnologies for controlling the pest & disease problems
   Use of Genetic Modified technologies in crop like brinjal have controlled the problem of pest like shoot & fruit borer and hence increased the productivity .
6. Use of tissue culture technologies in micro propagation
   Use of tissue culture technology have give a way of availability of true to type, qualitative & disease free planting materials .e.g. Banana
7. Efficient use of nutrient
   By using fertigation technology , the efficient use of nutrient management is possible for higher production in horticultural crops.
8. Efficient use of water
   By using drip irrigation & underground irrigation system , the efficient use of water is possible for higher production of horticultural crops
9. Use of hydroponics
   By using water ,nutrient & other soiless media technology i.e. hydroponics, higher production of vegetable crops can be obtained.
10. Weed management
    By using plasticulture technology in horticultural crop production, the efficient weed & water management can be achieved for higher production.

11. High density planting technology in fruit as well as in plantation, spices, vegatables & flower crops have increased the productivity & income of cultivators.
12. Protected cultivation technologies in flowers like roses, gerbera, carnarion etc; vegetables like tomato, capsicum, cucumber etc; and in nursery management have not only increase the higher production & income but also the off season availability of horticultural produce.

13. Export quality produce in horticultural crops like capsicum, tomato, cucumber, rose, carnation, gerbera, planting materials etc can be achieved by using the hi-tech technology.

14. Hardening of planting material can be successfully achieved by using protected cultivation technology.

15. Government subsidies for polyhouses, drip irrigation, plasticultures & also for advance equipment for advance mechanization have tremendous scope for hi-tech horticulture production

16. There is heavy demand in Domestic as well as foreign market for export type qualitative horticultural produce.

17. Chimate change, off season availability & export quality material are the basic requirement for the hi-tech horticulture produce.

18. More availability of advance technologies in horiculture as well as in agriculture sector have tremendous scope in its utilization for higher production resulting in higher net income.

High Tech Nursery Management in Horticultural Crops

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 and has a prime 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 for the production of 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. A nursery which has only seedling beds i.e. in which seedlings are only raised for transplanting is called seedlings nursery. Transplant beds are those nursery beds in which seedlings raised in seedling beds are transplanted before planting out in forest. A nursery that has only transplant beds i.e. in which seedlings are transplanted in preparation for forest planting is called transplant nursery. In India separate seedling and transplant nurseries

are seldom made in the same nursery. Generally whatever is grown in nursery for planting out is called nursery stock.

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 off 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 engaged in Horticulture field. So nurseries have great demand for the production of plants, bulbs, rhizomes, suckers and grafts. But in general good quality and assured planting material at reasonable price is not available. So persons having a skill of propagation of plants can go for this avenue as an agro-business of future. Seedling production is a major expense of afforestation and every effort should be made to produce good quality seedlings at a reasonable cost. To this end mastering the techniques of nursery operations is essential means high tech nursery management is very essential. State of Indian Agriculture 2011-12 reported the increase in per capita availability of fruit (from 115 gram to 172 gram per day) and vegetables (from 236 gram to 312 gram per day) between 2001-02 and 2010-11. As per FSI (2011), the total forest cover increased and reached 692027 km2 (21.05% of geographic area) while the total tree cover has been estimated to be 90,844 km2 (2.76% of geographic area). Even though the agriculture production is in an upward trend, the increase in population, inflation and climate uncertainty warrants efforts towards sustainable agriculture.

The main suppliers of perennial tree seedlings are the departmental/government and industrial nurseries. They are producing seedlings and vegetative propagules to meet their own seedling demand and also supply them to public to meet their raw material demand. Mostly the vegetable and ornamental seedlings are produced by the farmers themselves, due to the market availability of improved seed and requirement of minimum inputs to establish them. Since the price of ornamental seedlings mainly depends on the buyer's interest, size of planting material, the small private nurseries mostly concentrate on the ornamental seedling/propagule production to fetch more profit.

The industrial nurseries are well equipped with infrastructure, manpower, automation and target to produce seedling/propagules of short rotation tree species to meet their factory raw material demand such as pulp and paper, plywood, small timber for furniture, juice, jam and pickle making. Hence, different kind of nurseries targets various end products. But nursery is pre requisite for meeting the quality seedlings demand and nursery management is a potential tool to execute the activity in successful way.

Meaning, objectives and types of nursery

Meaning

A nursery is a place where plants are propagated and grown to usable size. They include retail nurseries which sell to the general public, wholesale nurseries which sell only to businesses such as other nurseries and to commercial gardeners, and private nurseries which supply the needs of institutions or private estates. Some retail and wholesale nurseries sell by mail. Nurseries may supply plants for gardens, for agriculture, for forestry and for conservation biology. Some nurseries specialize in one phase of the process: propagation, growing out, or retail sale; or in one type of plant: e.g., groundcovers, shade plants, or rock garden plants. Some produce bulk stock, whether seedlings or grafted, of particular varieties for purposes such as fruit trees for orchards, or timber trees for forestry. Some produce stock seasonally, ready in springtime for export to colder regions where propagation could not have been started so early, or to regions where seasonal pests prevent profitable growing early in the season

Definition of nursery

A nursery is a place where plants are grown, nurtured and sold out. Generally, various commercial crop growers require a good quality saplings or grafts of genuine type. It can also defined nursery is a place or an establishment for raising or handling of young vegetable or fruit seedlings until they are ready for more permanent planting."

Objectives of nursery

It occupies an important place in artificial regeneration.

The following objectives for which nursery is generally made, clearly bring out its importance.

1. Some important species do not seed ever year. Plantations of these species can be raised annually, only by sowing all available seeds in nursery to raise seedlings to be planted out various years.

2. Some species grow very slowly and if the seeds of these species are sown directly in plantation, the seedlings are most likely tobe suppressed by weeds and ultimately killed. Therefore, slow growing spices are generally raised in nursery and planted out, only when the seedlings are not liable to be damaged by weeds.

3. Success of road side avenue plantations depends largely on planting tall and sturdy plants which can be only obtained from nursery.

4. Plantations of some species, when raised by direct sowing are not so successful when raised by transplanting their seedlings. In such cases, nursery is an essential part of artificial regeneration to these species.

5. The best method for introduction of exotics, tropical Pines, Poplars Eucalyptus etc. is only by, planting and therefore nursery is very essential for them.

6. Planting of nursery grown plants is the surest method of artificial regeneration on poor and barren sites.

7. Causalities in plantations have to be replaced either for the year of planting or in the next year. Sowing done in the gaps is liable to be unsuccessful as a result of suppression from weeds and cannot catch up the growth as from, original sowing. Therefore, replacement of causalities is always done by planting nursery grown plants or stumps and so nursery is very essential for causality replacement also.

Benefit of raising seedlings in nursery

1. It is very convenient to look after the tender seedlings

2. It is easy to protect the seedlings from pests and diseases

3. Economy of land usage (duration in the main field is reduced)

4. Valuable and very small seeds can be raised effectively without any wastage

5. Uniform crop stand in the main field can be maintained by selecting healthy, uniform and vigorous seedlings in the nursery itself.

Types of nurseries

Nurseries are categorized in different ways.

Based on time duration

Temporary nursery

This type of nursery is established in or near the planting site. Once the seedlings for planting are raised, the nursery becomes part of the planted site. There are sometimes called "flying nurseries". This type of nursery is developed only to fulfil the requirement of the season or a targeted project. The nurseries for production of seedlings of transplanted vegetables and flower crops are of temporary nature. Likewise temporary arrangement for growing forest seedlings for planting in particular area can also be done in temporary nursery.

Permanent nursery

This type of the nursery is placed permanently so as to produce plants continuously. These nurseries have all the permanent features. permanent nursery has permanent mother plants. The work goes on continuously all the year round in this nursery. These can be large or small depending on the objective and the number of seedlings raised annually. Small nurseries contain less than 100,000 seedlings at a time while large nurseries contain more than this number. In all cases permanent nurseries must be well-designed, properly sited and with adequate water supply.

Based on type of plants produced

Fruit plant nurseries

In this nursery, seedlings and grafts of fruit crops are developed.

Vegetable nurseries

In this nursery, seedlings of cauliflower, cabbage, brinjal and tomato are prepared.

Flowers plants nurseries

The seedlings of flowering plants like gerbera, carnation, petunia, salvia, rose, chrysanthemum, coleus, aster, dianthus are developed in this nurseries.

Forest nurseries

The seedlings of plants useful for forestation like pine, oak, teak, eucalyptus, casuarinas are prepared and sold.

Miscellaneous nurseries

In such type of nurseries plants with great economic value, rare and medicinal, herbal plants are propagated. In this nursery plants like geranium, rose, calendula, and marigold are propagated. Planning of nursery one has to decide which type of nursery is to be started. At the same time the durations and type of plants propagated should be finalized.

Selection of site

Site is the basic requirement of a nursery.

Site is a place upon which one can produce seedlings of plants.

Qualities of a good site are

1 Nearness of road or Near a habitat
2. Suitable climate Neither shady nor exposed area
3. Sufficient sunlight
4. Good irrigation facilities

5. Good soil condition
6. Good transport facility

Management of Nursery.

Layout of Model Nursery

- 1.Fence
- 2.Road & Paths
- 3.Progeny block/ mother plant block
- 4.Irrigation system
- 5.Office cum stores
- 6.Seed bed
- 7.Nursery bed
- 8.Potting mixture & potting yard
- 9.Structures for model nursery
- A. Shade house
- B. Green house/ polyhouse
- C. Hot beds
- D. Lathhouses
- E. Miscellaneous
- i. Mist chamber
- ii. Fluorescent light boxes
- iii. plastic mulch
- iv. light chamber
- v. High humidity chamber

Improved Nursery Management

- A. Hi-tech Nursery- Environment fully controlled

B. Net house- environment partially modified

C. Open field – Naturally modified

Hi-tech Nursery- Environment fully

- Hi-tech nursery where the entire device , controlling the environment parameters, are supported to function automatically. To propagate the plants around the years the hi- tech nursery are used. The use of hi-tech nursery is also essential to mass multiply the plants through the tissue culture. The main cause of promoting optimum growth in hi-tech nursery is high relative humidity and temperature control, adequate day length and light intensity. Good light condition are essential for the sturdy growth of seedling. High tech nursery is well equipped with elaborate structures and has precise control on temperature, light intensity and humidity. The size and type of hi-tech nursery is primarily depends upon the need of the plant propagator.

Major components of hi-tech nursery

- Temperature control
- Relative humidity control
- Light intensity control
- Quality of light

Management of Hi-tech nursery

Soil and soil preparation

Soil treatment

Soil contains harmful fungi, bacteria, nematodes and even weeds seeds, which affect the growth and further development of plant. These can be eliminated by soil solarization, chemical treatment, physical treatment & biological treatment. For that soil is disinfected by heating to the temperature of about 60 0C for 30 minutes.

Soil solarization

It is is done with trasparent polythene of 200 guage during the hot & dry period.

Chemical treatment

The chemicals like formaldehyde, methyl bromide, chloropicrin, vapam are used. Other diseases like rust, powdery mildew, leaf spot, bacterial blight, yellow vein mosaic are also observed. For control of these diseases Bordeaux mixture, Carbendazime, Redomil can be used. Tricoderma viride a biofungicide can also be tried out.

Nursery bed preparation

- Types of nursery beds
- A. Flat bed
- B. Raised bed
- C. Sunken bed
- Poly bag nursery
- Protray nursery

Seed treatment

It is done by using the following methods as per the species of plants

a. Mechanical treatment

b. Hot water treatment.

C. Acid pre treatment

d. Cold water treatment

e. Growth regulators

Plants require due care and attention after having either emerged from the seeds or have been raised from other sources like rootstock or through tissue culture technique. Generally they are grown in the open field under the protection of Mother Nature where, they should be able to face the local environment. It is the duty and main objective of a commercial nursery grower to supply the nursery plants with suitable conditions necessary for their development and growth. This is the major work of management in the nursery which includes all such operations right from the emergence of young plantlet till them are fully grown-up or are ready for uprooting and transplanting in the main fields.

Potting the seedling

Before planting of sapling in the pots, the pots should be filled up with proper potting mixture. Now a day's different sizes of earthen pots or plastic containers are used for propagation. For filling of pots loamy soil, sand and compost can be used in 1:1:1 proportion. Sprouted cuttings, bulbs, corms or polythene bag grown plants can be transferred in earthen pots for further growth. All the necessary precautions are taken before filling the pots and planting of sapling in it.

Manuring and irrigation

Generally sufficient quantity of nutrients is not available in the soil used for seedbed. Hence, well rotten F.Y.M / compost and leaf mould is added to soil. Rooted cuttings, layers or grafted plants till they are transferred to the permanent location, require fertilizers. Addition of fertilizers will give healthy and vigorous plants with good root and shoot system. It is recommended that each nursery bed of 10 X 10m area should be given 300 gm of ammonium sulphate, 500 gm of Single super phosphate and 100 gm of Muriate of potash. Irrigation either in the nursery beds or watering the pots is an important operation. For potted plants hand watering is done and for beds low pressure irrigation by hose pipe is usually given. Heavy irrigation should be avoided.

Plant protection measures

Adoption of plant protection measures, well in advance and in a planned manner is necessary for the efficient raising of nursery plants. For better protection from pest and diseases regular observation is essential. Disease control in seedbed:- The major disease of nursery stage plant is "damping off". For its control good sanitation conditions are necessary. Preventive measures like treatment with 50% ethyl alcohol, 0.2% calcium hypo chloride and 0.01% mercury chloride is done. These treatments are given for 5 to 30 minutes. Some of the seed treatments are as follows:

Disinfection

The infection within the seed is eliminated by use of formaldehyde, hot water or mercuric chloride.

Hot water treatment

Dry seeds are placed in hot water having a temperature of 480C – 550C for 10-30 minutes.

Protection

In dry seed treatment organo mercuric and non-mercuric compounds like agallal, aretan –6, and tafasan-6. For this the seeds are shaken within the seed container. While in wet method, the seeds are immersed for certain period in liquid suspension.

Soil treatment

Soil contains harmful fungi, bacteria, nematodes and even weeds seeds, which affect the growth and further development of plant. These can be eliminated by heat, chemical treatment. For that soil is disinfected by heating to the temperature of about 600C for 30 minutes**.**

Chemical treatment

The chemicals like formaldehyde, methyl bromide, chloropicrin, vapam are used. Other diseases like rust, powdery mildew, leaf spot, bacterial blight, yellow vein mosaic are also observed. For control of these diseases Bordeaux mixture, Carbendazime, Redomil can be used. Tricoderma viride a biofungicide can also be tried out.

Weed control

Weeds compete with plants for food, space and other essentials, so timely control of weeds is necessary. For weed control weeding, uses of cover crops, mulching and use of chemicals (weedicides) are practiced. Pre-emergence weedicides like basaline or post-emergence weedicide like 2; 4-D and roundup are useful.

Measures against heat and cold

The younger seedling is susceptible to strong sun and low temperature. For protection from strong sun, shading with the help of timber framework of 1 meter height may be used. Net house and green house structures can also be used.

Packing of nursery plants

Packing is the method or way in which the young plants are tied or kept together till they are transplanted. So they have to be packed in such a way that they do not lose their turgidity and are able to establish themselves on the new site. At the same time, good packing ensures their success on transplanting. For packing, baskets, wooden boxes, plastic bags are used. In some parts of the country banana leaves are also used for packing the plants with their earth ball. This is useful for local transportation.

Sale management

In general the main demand for nursery plants is during rainy season. A proper strategy should be followed for sale of nursery plants. For that advertisement in local daily

newspapers, posters, hand bills, catalogue and appointment of commission agents can be followed.

Management of mother plants

Care of mother plants is necessary so as to get good quality propagules and scion. A. Labeling and records B. Certification C. Irrigation D. Fertilization E. Pruning F. Protection from pests and diseases G.Collection and development of new mother plants for Fruit Nurseries

Another best way to manage hi-tech nursery

A vital part of nursery management is planning the production schedules and data collection. As we know that whole agriculture sector is seasonal and perishable in nature and in agriculture nursery production is highly seasonal. This is particularly marked when producing trees for agro forestry research, as the demand for species or numbers of seedlings will vary considerably depending on current research priorities. Flexibility and planning are therefore essential.

There are four main tools for planning nursery operations

A nursery calendar to help plan necessary actions and purchases of seed, supplies and equipment.

A plant development register for collecting species-specific information about seed treatment, germination requirements and duration, plant development, special requirements for potting substrate, watering, shading or disease control.

A nursery inventory to keep track of the species and numbers of seedlings in different stages of development.

A record of ongoing nursery experiments.

All four can be maintained in tabular form designed for ease of data capture on to computer programs. Computerized systems have increased the flexibility of data collection and analysis, making it easy for a nursery manager to correlate the collected information to necessary actions rapidly.

Tools for high-tech nursery management

1. Nursery calendars

2. Plant development registers

3. Nursery inventories

4. Records of nursery experiments

These are needed for production management as well as for research. We also discuss the significance of staff training, particularly in the use of pesticides, plant protection and general safety issues regarding to nursery management.

Planning tools nursery calendar

A nursery calendar is a very essential tool in nursery planning. The date for sowing seeds can be calculated by counting backwards from the anticipated date of planting, taking into consideration the number of days needed for germination and further seedling development until the right stage for planting. Different species have different requirements for the planting out period (before or during the rains). The time in the nursery also depends on the site on which the seedlings are to be planted. Seedlings for drier sites may need to be larger and need more time in the nursery. Customers might need to be reminded of this when they order plant material to meet certain deadlines. It is also worth anticipating problems with poor germination and/or damping-off to allow time to sow a second time. Once a nursery calendar has been developed, it will help greatly in making decisions about the need for extra labour and requisition of supplies. Consider the likely delays in procuring and shipment of goods, especially when ordering from abroad. Place orders early enough to allow timely arrival.

Plant development register

For plant development register, we should keep a register for each species by seed lot, with information about seed sources used, pre-treatment's, sowing date, time to germination, percentage of germination, percentage of germinants, pricked out, potting substrate, microsymbionts used with its origin and type, plant development and condition under which produced. Include pests encountered and control treatments, if any, as well as data of plant and/or substrate nutrient analyses. All this information is important for nursery research and might later help explain unexpected results. It can also be used to compare results with published information and alert you to possible problems originating in the nursery, for example if the development is much slower than is reported elsewhere. It might open additional research areas, for example it might lead to trying different substrates, shading or fertilizer treatments. Good documentation about species handling and development is also necessary when staff changes.

Nursery inventory

A well-kept and up-to-date nursery inventory helps to assess whether the nursery is operating as planned, and whether demands are being met. Your inventory should list all plants currently in the nursery by bed or frame number, and details of delivery of seedlings, including the site, name of owner and site conditions. It can be an important tool to record feedback from the planting sites and can then help to determine whether seedlings have the right quality for the sites on which they are planted.

Record of experiments

An up-to-date record of past and ongoing nursery experiments is advisable. Simple experiments testing new potting mixtures, watering regimes, seed pretreatments etc. should be part of normal nursery management and, without accurate records of these, valuable information is likely to get lost.

Micropropagation in horticultural crops

Vegetative or clonal propagation for mass multiplication in controlled condition of laboratories by using biotechnological methods is called as micropropagation

Micropropagation is the development of new plants in an artificial medium under aseptic conditions. You do not have to start with seeds but you can use different parts of a plant as starting materials to establish an *in vitro* culture. These will include embryos, pollen grains and parts such as stems, shoot tips, nodes, root tips, callus and single cells

Advantages of micropropagation

1. Millions of plants of elite type can be produced

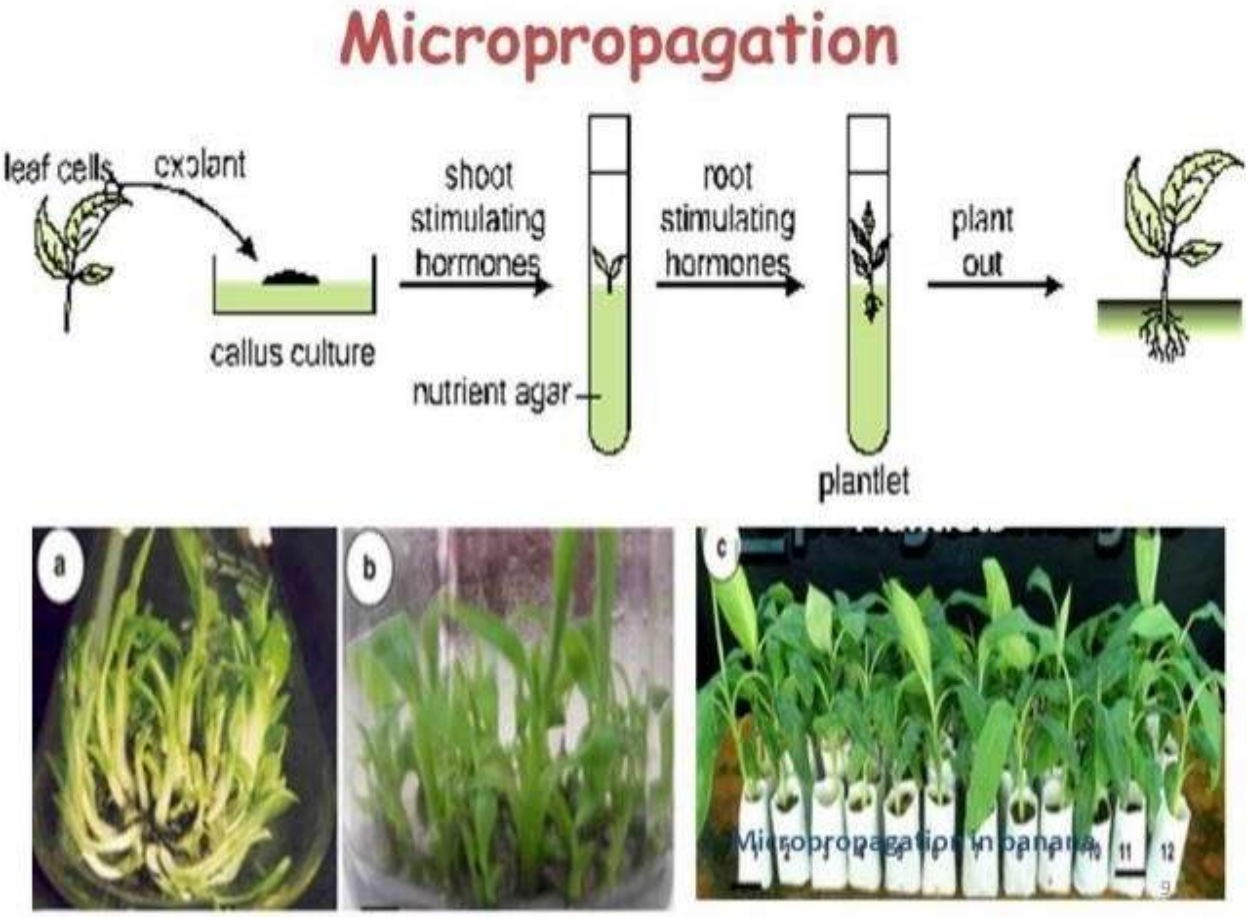
2. All the plants are of the same physiological age and hence of uniform growth.

3. Planting material can be made free from viral & bacterial diseases.

4. A large numbers of plants can be produced in a short time & space.

5. It is the continuous & reliable source of plants round the year irrespective of seasonal variation.

6. Genetic and phenotypic uniformity can be maintained.



Disadvantages of micropropagation

1. It requires advanced skills of production

2. It is highly expensive due to requirement of controlled condition

3. The chances of producing genetically aberrant plants may be increased.

4. The young plants are more susceptible and hence require hardening.

Crops

Banana,Cactus,Orchids,Maranta,Narcissus,Eucalyptus,Tamarind,Coffee,Dalbegia,Bambusa ,Gerbera,Iris,Gladiolus, Lilies etc.

General Methods of Micro propagation

- **Shoot tip** is the starting material for micropropagation which is surface sterilized then trimmed and remaining material place on one of a variety of different media.
- Selection of special medium is necessary with special reference to concentration of particular **growth regulators**.
- This is the phase of **acclimatization of the tissue to the in-vitro condition** which requires about 3 or 4 months and varies from species to species.
- Under the suitable laboratory conditions the small shoot tip grows well in a normal fashion, **giving rise to a small, unrooted shoot** in culture.
- The initiated shoot can, after a suitable period on the initiation medium, be sub-cultured so that the nodal section of the shoot is placed onto a multiplication medium.
- This medium differ from the initiation medium in that it contains higher level of cytokinnins which are likely to give rise to precocious shooting of axiliary buds.
- The normal period between subculture is 3 weeks and during this time the number of shoot tip available for subculture will multiply as a result of breaking of nodal axillary buds anywhere from 2 to 12 times.
- After 3 weeks on multiplication medium, somewhere on an average of about 5 shoot tips can be placed onto fresh medium, and these in turn will multiply 5 times in subsequent 3 weeks, and thus micropropagation has led to a 25-fold increase in plant material available over a total of 6 weeks

Stages of Micropropagation

- 1. Selection and sterilization of elite plants
- 2. Establishment of axillary buds in culture
- 3. Multiplication in culture
- 4. Rooting of in vitro plants and transfer to compost

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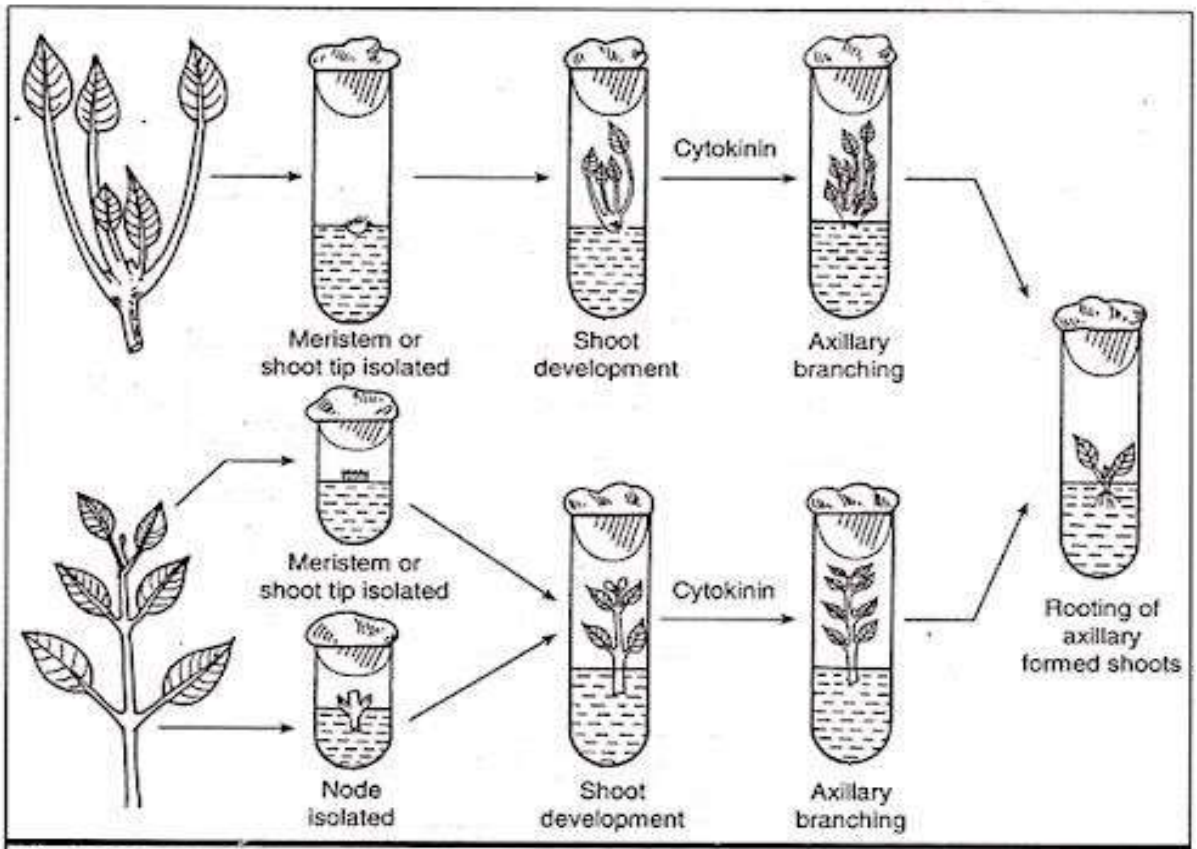

Fig. 18.9A: Scheme showing the *in vitro* micropropagation of plants by the axillary bud method. Upper row: as applied to rosette plants; bottom row: applied to plants which elongate

- **Materials**

Stage-I: Selection and Sterilization of Elite plant

1. The selected **elite stock plant** should be visible free from any sign of disease, stress or surface blemishes.

2. It should be tested for the presence of specific viruses by using ELISA techniques.

3. Sterilization is used by using 70% ethanol plus four drops of surfactants (manoxol

Stage-II: Establishment of Axillary buds in culture

1.1 mm dia. sterile petri dishes containing approximately 10 ml of medium

2. 85 mm sterile petri dishes containing approximately 25 ml medium should be used

3. Use incubator or environmentally controlled chamber allowing environmental condition of 20-24 0c temperature , a 16 hr photoperiod and a light intensity of 4000-6000 lux

Stage III : Multiplication in culture

1 ml sterile jar containing approximately 30 ml of medium2 or medium 3. Environmental condition as describe in stage II

- **Stage IV: Rooting of In Vitro plants and transfer to compost**
- 1 ml sterile jars containing approx. 50 ml of medium 4, Propagation trays, plastic bags, or seed trays covered with glass sheet or a misting or fogging systems, 50mm dia. Pots containing compost (3:2 peat : sand) supplemented with nutrients.
- **Methods**
- **Stage-I: Selection and Sterilization of Elite plant**

1. Use a clean sharp blade, carefully excise axillary buds of the desired variety and stored in distilled water until enough buds have been obtained.
2. commercial preparation of M & S and B5 salt are available in pockets that make up a 1 l of media

   a) pH adjusted using 1 M HCL and 0.1M KOH before agar added and prior to autoclaving.

b) The amount of agar added is depending upon the brand used.

c) Varying the hormones allows the media to be used for axillary bud culture of a wide range of species.

3 The practical should be conducted in a laminar air flow bench.

4. Put a maximum of 20 buds into a sterile test tube

5. Fill to brim with ethanol solution and leave for 1-1.5 min

6. Decant the ethanol

7. Fill the brim with chloros solution, replace the top, and agitate at 120 strokes/ min for 12 min, either manually or with a shaker.

8. Decant the chloros solution and refill with the sterile distilled water.

9. Rinse in sterile distilled water 3x.

10. Store in sterile distilled water until ready to continue.(not longer than 2 h)

- **Stage-II: Establishment of Axillary buds in culture**

1. Empty the water plus axillary buds into an empty sterile petri dish, for ease of handling.

2. Place upto 4 buds in a 50 mm petri dish containing medium 1

3. Make sure that the base of the bud is stuck firmly in the medium.

4. Take care that the bud is not buried.

5. Seal the petri dish with laboratory sealing film, enduring adequate gaseous exchange by puncturing the film 2-4 x with a fine sterile needle.

6. Transfer to growth room or incubator and leave for between 1 week and 2 months depending upon the variety.

- **Stage III : Multiplication in culture**

- 1. When shoot extends, cut internodes, and transfer apical cutting and internodal cuttings to sterile jars containing medium 2 or 3.

- 2. Make sure that the base portion of the stem is firmly pressed into the medium without burying the explant.

- **Stage IV: Rooting of In Vitro plants and transfer to compost**

1. Cut off the 5 mm of in vitro plants

2. Transfer to medium 4

3. Leave for 3-5 days until 3 or 4 small roots approx. 5 mm long are visible

4. Remove each plantlet carefully from the jar, removing as much agar as is possible without harming the root structure

5. Transfer to damp compost in 50 mm pots

6. Keep in high humidity conditions, for 12-24 hrs

7. Transfer to glass house, preferably placing on top of capillary matting, Shade from direct sunlight.

8. When the plants are approximately 70 mm high and have begun to lose their juvenile characteristics, they should be hardened off and transferred to larger pots or to the field.

Plant Tissue Culture

The technique of in vitro cultivation of plant cells or organs is called plant tissue culture

Stages and basic requirement for plant tissue culture techniques

1. **Explant :** The plant tissue or organ excised and used for in vitro culture known as explant.

2. **Surface sterilization:**

It required to eliminate the bacteria and fungi present on their surface.
It is achieved by treating it with 1-2% solution of sodium or calcium hypochloride.
Then rise several times with sterilized distilled water to remove the disinfectant.

3. **Sterilization:**

Plant tissue culture media is very rich and they readily support the microorganism growth in a culture tube and is called as contamination. Contamination of plant tissue culture must be avoided otherwise the culture will over run by contaminations. Therefore, microbes present in the culture media, culture

vessels, instruments, etc. are inactivated by a suitable treatment, this is called sterilization.

It may be done by following ways

i. Flame sterilization

Instruments like forceps, scalpels, needles etc are usually dipped in 95% alchohol and flamed just before use.

ii. Dry heat: Mouth of test tubes, culture flask are ordinarily heated on a burner of spirit lamp

iii. Ethanol (70%): Laminar air flow surface cabinet bench surface, outer surface of culture vessels, hands of the workers, are wiped with70% ethanol.

iv. Autoclaving: Culture media, empty culture vessels, etc. are autoclaved at 121 o C and 15 p.s.i. usually 15-20 minutes

4. Nutrient Medium:

- The medium on which plant cells and organs are cultured is known as nutrient medium or culture medium or medium.
- Nutrient medium contains inorganic salts to provide 12 elements, excluding C,H,O. like N,P,K,Ca,Mg,S,Fe,Mn,Cu,B,Zn and Mo , certain vitamins, a carbon source generally sucrose, and where needed growth regulators like auxins or cytokinins.
- The pH of the medium generally adjusted to about 5.5 using 1 N KOH or HCL as per need
- The medium may be solidified by using agar (6g/l)or may be used as liquid.
- The cells on agar medium developed into an unorganized mass known as callus and hence called as callus culture.
- The medium is distributed into appropriate culture vessels, eg. Test tubes, culture flasks, petriplates, etc. and then autoclaved at 25 p.s.i. (pound per square inch) for 15-20min. To free from microbes.
- Sterilized plants then placed on or into nutrient medium, this operation is done under aseptic condition.
- Well known medium are B5 medium(Gamborg et al.1965) and MS medium(Murashige & Skoog 1962)

Environmental conditions:

Proper temperature (18-24 Oc) and light should be provided.

5. Subculturing:

After a period of time it required to transfer the organs and tissue to fresh media. This is particularly true of tissue and cell cultures where a portion of tisue used to inoculate new culture tubes or flasks. This is known as subculturing.

6. Plant regeneration and transfer to soil

- The ultimate object is to obtain the full plants and to transfer then successfully to soil.
- The regenerated plants may be transferred to small pots and covered with a suitable materials /vessels e.g. inverted beakers to prevent excess transpiration
- After 3-4 days the covers are removed but pots are still kept in diffuse light for 5-10 days.
- Hardening on large scale is done in mist chambers and then transferred to green house for 1-2 weeks and then may be available for field.
-

Classification of plant tissue culture:

On the basis of plant part used as explant

- 1.Embryo culture
- 2. Meristem culture
- 3. Anther or pollen culture
- 4. Tissue and cell culture

- **Meristem culture:**

- The cultivation of axillary or apical meristem is known as meristem culture
- It involves the development of an already existing shoot apical meristem and the regeneration of shoots.
- It does not involve the regeneration of new shoot meristem.
- Meristem culture have been extensively use for quick vegetative propagation of a large number of plant species.
- Usually 5-10 mm shoot apices containing the shoot apical meristem along with leaf primordia.
- Shoot tip may be cut into fine pieces to obtained more than one plant from each shoot tip.
- Axillary buds and nodal cuttings may also be used for meristem culture.

Hi tech Field preparation & planting Methods

Hi-tech Field preparation

The soil or media used in hi-tech field as well in greenhouse generally should have required physical and chemical properties which are distinct from field soils.

- A desirable medium should be selected with a good balance between physical properties like water holding capacity and porosity.

- The medium should be well drained.
- Medium which is too compact creates problems of drainage and aeration which will lead to poor root growth and may harbour disease causing organisms.
- Highly porous medium will have low water and nutrient holding capacity, affects the plant growth and development.
- The media reaction (pH of 5.0 to 7.0 and the soluble salt (EC) level of 0.4 to 1.4 dS/m is optimum for most of the greenhouse crops.
- A low media pH (<5.0) leads to toxicity of micronutrients such as iron, zinc, manganese and copper and deficiency of major and secondary nutrients while a high pH (>7.5) causes deficiency of micronutrients including boron.
- A low pH of the growth media can be raised to a desired level by using amendments like lime (calcium carbonate) and dolomite (Ca-Mg carbonate) and basic, fertilizers like calcium nitrate, calcium cyanamide, sodium nitrate and potassium nitrate.
- A high pH of the media can be reduced by amendments like sulphur, gypsum and Epsom salts, acidic fertilizers like urea, ammonium sulphate, ammonium nitrate, mono ammonium phosphate and aqua ammonia and acids like phosphoric and sulphuric acids.
- It is essential to maintain a temperature of the plug mix between 70 to 75ºF. Irrigation through mist is a must in plug growing. Misting for 12 seconds every 12 minutes on cloudy days and 12 seconds every 6 minutes on sunny days is desirable.
- The pH of water and mix should be monitored regularly.

Media ingredients and Mix

- Commercially available materials like **Cocopeat, sphagnum moss, vermiculite, perlite and locally available materials like sand, red soil, common manure/ compost and rice husk** can be used in different proportions to grow horticultural crops. These ingredients should be of high quality to prepare a good mix. They should be free from undesirable toxic elements like nickel, chromium, cadmium, lead etc.

Temperature necessary to kill soil pests

- 115°F for water molds (*Pythium* and *Phytophthora*)

- 120°F for nematodes
- 135°F for worms, slugs and centipedes
- 140°F for most plant pathogenic bacteria
- 160°F for soil insects
- 180°F for most of weed seeds
- 200°F for few resistant weed seeds and plant viruses

Soil treatment

There are four soil treatment methods

1. Soil solarization

2. Soil pasteurization

3. Soil fumigation

4. Soil by fungicides or chemicals

Soil Solarization

is a method of heating soil by covering it with transparent polythene sheeting during hot periods to control soil borne diseases. The technique has been commercially exploited for growing high-value crops in diseased soils in environments with a hot summer (maximum daily air temperatures regularly exceeding 35°C). Examples include control of verticillium and fusarium diseases in vegetable crops in Israel, control of verticillium dahlias in pistachio orchards and control of chickpea and pigeon pea wilt in India. Although the major benefit of solarization is reduction of soil borne pathogens by soil heating effects, there are many other possible additional beneficial effects that can result in an increased growth response (IGR) of plants. Such additional effects include control of weeds and insect pests and release of plant nutrients.

Pasteurization of growing media

Greenhouse growing medium may contain harmful disease causing organisms, nematodes, insects and weed seeds, so it should be decontaminated by heat treatment or by treating with volatile chemicals like methyl bromide, chloropicrin etc

Fumigation of growing media

Physical propagation facilities such as the propagation room, containers, flats, knives, working surface, benches etc. can be disinfected using one part of formalin in fifty parts of water or one part sodium hypochlorite in nine parts of water. An insecticide such as dichlorvos sprayed regularly will take care of the insects present if any. Care should be taken to disinfect the seed or the planting materials before they are moved into the greenhouse with a recommended seed treatment chemical for seeds and a fungicide –insecticide combination for cuttings and plugs respectively. Disinfectant solution such as trisodium phosphate or potassium permanganate placed at the entry of the greenhouse would help to get rid off the pathogens from the personnel entering the greenhouses.

Disinfection of the growing media can also be achieved by fungicides or bactericides

- Captan
- 2 g/l of water
- *Pythium, Fusarium, Rhizoctonia and Phytophthora. Some extent to root and stem rot, white mold,black rot, crown rot and damping off.*
- Metalaxyl + Mancozeb (Ridomil MZ 72 WP)
- 1 g/l of water
- *Pythium, Phytophthora, Fusarium* and other soil borne pathogens

Hi- tech Planting Methods.

Planting of horticultural crops should be done after soil disinfection & media preparation

For Field purpose

1. Various beds should be prepared as per the requirement of crops like broad ridges & furrow beds, flat beds ,Ring beds etc.
2. Well drip irrigation system should be designed and layout.
3. The prepared beds should be mulched with plastics for water saving & weed management.
4. The mulched beds should be irrigated with sufficient water before planting.
5. The mulched beds should be holed at the time of planting.

6. The seedlings or seed material should be given required pre treatments for avoiding further diseases.
7. Care of seedlings with fertilizer & water application should be taken up to germination or plant stand.

For Green house

1. Prepared required beds
2. Fill the required pots with prepared disinfected media
3. Erect required different type of benches or tables & then fill the containers with prepared media.
4. Well drip irrigation system should be designed and layout.
5. The beds or containers should be irrigated with sufficient water before planting.
6. The seedlings or seed material should be given required pre treatments for avoiding further diseases.
7. Care of seedlings with fertilizer & water application should be taken up to germination or plant stand.

Protected Cultivation: Advantages & Constraints

Advantages:

1. Productivity of horticultural crops increases considerably therefore higher production & higher income.
2. Year round cultivation is possible in protected cultivation due to controlled environmental condition.
3. Off season production of horticultural crops is possible due to protected cultivation.
4. Nursery management & plant propagation becomes so easy & successful due to controlled condition of protected cultivation.
5. Effective control of pest & diseases is possible.
6. Protection against wind & other unfavorable condition is possible.
7. Reduction in water consumption
8. Reduction in time of growth & developmental phases of horticultural crops.
9. Getting export quality of produce of international standards.
10. Cultural operations are very easy under protected cultivation
11. It may be self employment for educated youth.

12. Cultivation of horticultural crops is possible in environmental problematic area.
13. A requirement of horticultural produce particularly vegetales & flowers of metropolitan or big cities can be successfully mitiogate with green house technology due to requirement of less area.
14. Rare and medicinal plants can be safely & m successfully grown in protected structures.
15. Government subsidies help to minimize the production economy of horticulture crops in green house and hence more returns from cultivation in green house.

Constraints:

1. Protected cultivation technology is high cost investment
2. It required skilled persons & labours also.
3. It required 24 hours electricity & water.
4. It required to manage the ideal environmental condition in protected structure which has become the tremendous problems in some hot area like Vidharbha.
5. Covering materials required to change as an torn or damage which becomes hectic and increase the input cost.
6. Local market prices & governmental export policies may sometimes affects on getting the profitable market rates.

Micro irrigation system & its components

Micro irrigation is a modern method of **irrigation**; by this method water is irrigated through drippers, **sprinklers**, foggers and by other emitters on surface or subsurface of the land.

Types of Micro Irrigation Systems

The micro irrigation system can be classified in respect to variety of parameters. The micro irrigation encompasses several ways of water application to plants: drip, spray, subsurface and bubbler irrigation.

Drip Irrigation

Drip or trickle irrigation is the newest of all commercial methods of water application. It is described as the frequent, slow application of water to soils through mechanical devices called emitters or applicators located at selected points along the delivery lines. The emitters dissipate the pressure from the distribution system by means of orifices, vortexes and tortuous or long flow paths, thus allowing a limited volume of water to discharge. Most emitters are placed on the ground, but they can also be buried (Fig 4.1). The emitted water moves within the soil system largely by unsaturated flow. The wetted soil area for widely spaced emitters will be normally elliptical in shape. Since the area wetted by each emitter is a function of the soil hydraulic properties, one or more emission points per plant may be necessary (Howell et al., 1980)

Spray Irrigation

Spray irrigation is a form of irrigation in which pressurized water is sprayed over plants to provide them with water. This type of irrigation is also sometimes called sprinkler irrigation, and it is very widely used all over the world. The spray irrigation sizes can be designed for all size of farms, ranging from a home sprinkler to keep a lawn green to industrial sized sprinklers used to irrigate crops.

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 this 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. Fig 4.2 shows operation of micro sprinkler for irrigating a flower bed.

Sub-Surface System

It is a system in which water is applied slowly below the land surface through emitters. Such systems are generally preferred in semi permanent/permanent installations.

Subsurface drip irrigation (SDI) is a low-pressure, high efficiency irrigation system that uses buried drip tubes or drip tape to meet crop water needs. SDI technologies have been a part of irrigated agriculture since the 1960s; with the technology advancing rapidly in the last two decades. A SDI system is a flexible and can provide frequent light irrigations. This is especially suitable for arid, semi-arid, hot, and windy areas with limited water supply. Farm operations also become free of impediments that normally exist above ground with any other pressurized irrigation system. Since the water is applied below the soil surface, the effect of surface infiltration characteristics, such as crusting, saturated condition of pounding water, and potential surface runoff (including soil erosion) are eliminated during irrigation. With an appropriately sized and well-maintained SDI system, water application is highly uniform and efficient. Wetting occurs around the tube and water moves out in all directions. Fig 4.3 shows moisture distribution through a sub surface drip system. Subsurface irrigation saves water and improves yields by eliminating surface water evaporation and reducing the incidence of disease and weeds. Water is applied directly to the root zone of the crop and not to the soil surface where most weed seeds winter over. As a result, germination of annual weed seed is greatly reduced, and lowers

weed pressure on beneficial crops. In addition, some crops may benefit from the additional heat provided by dry surface conditions, producing more crop biomass, provided water is sufficient in the root zone. When managed properly, water and fertilizer application efficiencies are enhanced, and labor needs are reduced. Field operations are also possible, even when irrigation is applied.

Bubbler System

In this system the water is applied to the soil surface in a small stream or fountain. 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. Bubbler systems do not require elaborate filtration systems. These are suitable in situations where large amount of water need to be applied in a short period of time and suitable for irrigating trees with wide root zones and high water requirements.

Components of Micro Irrigation System (MIS)

Micro irrigation systems components

Irrigation pipeline systems are generally described as branching systems. Various branches are given names such as main, submain, and lateral. Fig 5.1 shows a typical layout of micro-irrigation system. Choosing the right size main, submain, and lateral pipe to match the flow rates from the water source is important. Basic components include a pump and power unit, a backflow prevention device if chemicals are used with water, a filter, a water distribution system, and some devices for controlling the volume of water and pressure in the system. If the water source is from a city/municipal/rural water supply, a direct connection is possible.

Pumps and power unit

Micro-irrigation systems are typically designed to make the best use of the amount of water available. The type and size of pump selected will depend on the amount of water required, the desired pressure and the location of the pump relative to the distribution network. Electric power units or internal combustion engine driven pumps are equally adaptable. However, the electric power unit is preferred because it is easier to automate.

Filters

Filters remove sand and larger suspended particles before they enter the distribution network. However, the filters cannot remove dissolved minerals, bacteria and some algae. The three types generally used are screen, disk and sand filters.

Distribution lines

The water distribution system is a network of pipes and tubes that can range in size from 1/2 inch to 6 inches (12 mm to 150 mm) in diameter. Water from the pump may be carried

to the edge of the field by a single large main. Smaller submains may then carry the water to laterals and ultimately to the emitters.

5.1 Control Head

The head control unit of micro-irrigation system includes the following components.

1. Pump/Overhead tank: It is required to provide sufficient pressure in the system. Centrifugal pumps are generally used for low pressure trickle systems. Overhead tanks can be used for small areas or orchard crops with comparatively lesser water requirements.

2. Fertilizer applicator: Application of fertilizer into pressurized irrigation system is done by either a by-pass pressure tank, or by venturi injector or direct injection system.

3. Filters: The hazard of blocking or clogging necessitates the use of filters for efficient and trouble free operation of the micro-irrigation system. The different types of filters used in micro-irrigation system are described below.

a) Gravel or Media filter: Media filters consist of fine gravel or coarse quartz sand, of selected sizes (usually 1.5 – 4 mm in diameter) free of calcium carbonate placed in a cylindrical tank. These filters are effective in removing light suspended materials, such as algae and other organic materials, fine sand and silt particles. This type of filtration is essential for primary filtration of irrigation water from open water reservoirs, canals or reservoirs in which algae may develop. Water is introduced at the top, while a layer of coarse gravel is put near the outlet bottom. Reversing the direction of flow and opening the water drainage valve cleans the filter. Pressure gauges are placed at the inlet and at the outlet ends of the filter to measure the head loss across the filter. If the head loss exceeds more than 30 kPa, filter needs back washing. Different types of media filters are shown through Fig. 5.2

b) Screen filters: Screen filters are always installed for final filtration as an additional safeguard against clogging. While majority of impurities are filtered by sand filter, minute sand particles and other small impurities pass through it. The screen filter, containing screen strainer, which filters physical impurities and allows only clean water to enter into the micro-irrigation system. The screens are usually cylindrical and made of non-corrosive metal or plastic material. Steel wire mesh filter is shown in Fig. 5.3 These are available in a wide variety of types and flow rate capacities with screen sizes ranging from 20 mesh to 200 mesh. The aperture size of the screen opening should be between one seventh and one tenth of the orifice size of emission devices used.

c) Centrifugal filters: Centrifugal filters are effective in filtering sand, fine gravel and other high density materials from well or river water. Water is introduced tangentially at the top of a cone and creates a circular motion resulting in a centrifugal force, which throws the heavy suspended particles against the walls. The separated particles are collected in the narrow collecting vessel at the bottom (Fig. 5.4).

d) Disk filters: Disk filter contains stacks of grooved, ring shaped disks that capture debris and are very effective in the filtration of organic material and algae. Fig. 5.5 shows disk filters. During the filtration mode, the disks are pressed together. There is an angle in the alignment of two adjacent disks, resulting in cavities of varying size and partly turbulent flow. The sizes of the groove determine the filtration grade. Disk filters are available in a wide size range (25-400 microns). Back flushing can clean disk filters. However they require back flushing pressure as high as 2 to 3 kg/cm^2.

4. Pressure relief valves, regulators or bye pass arrangement: These valves may be installed at any point where possibility exists for excessively high pressures, either static or surge pressures to occur. A bye pass arrangement is simplest and cost effective means to avoid problems of high pressures instead of using costly pressure relief valves.

5. Check valves or non-return valves: These valves are used to prevent unwanted flow reversal. They are used to prevent damaging back flow from the system to avoid return flow of chemicals and fertilizers from the system into the water source itself to avoid contamination of water source.

Chemical injection equipment

Micro-irrigation's high distribution uniformity gives it great potential for uniformly and efficiently applying agricultural chemicals, a process called chemigation. The main components of a chemigation unit are a chemical solution tank, an injection system and chemigation safety devices.

Chemical Solution Tanks

Chemical solution tanks generally are constructed of poly or fibreglass. A conical form at the tank bottom facilitates flushing it completely so that no material is wasted. Tanks should have an easy-clean screen downstream of the valve to make them easier to clean.

Injection system

The main types of chemical injectors are the venturi injector, injection pump, and the differential tank. The different types of fertilizer / chemical injection system are shown through Fig. 5.6. Criteria for selecting the proper injection system include cost, ease of use/repair, durability and susceptibility to corrosion.

With venturi injectors, water is extracted from the main line, then (1) pressure is added with a centrifugal pump or (2) a pressure differential is created by a valve in the mainline forcing water through the injector at high velocity. The high-velocity water passing through the throat of the venturi creates a vacuum or negative pressure, generating suction to draw chemicals into the injector from the chemical tank. Although the venturi is cheaper than a positive displacement pump, its injection rate is more difficult to control.

With injection pumps, water is pumped into the system using pistons, diaphragms or gears. An injection pump has a small motor powered either by electricity or by energy from the water itself. The motor moves small pumps (diaphragms) or pistons to inject

fertilizer into the system. The advantage of injection pumps is that chemicals can be injected with high uniformity at rates easily be adjusted regardless of discharge pressure.

With differential tanks, water is forced through a tank containing the chemical to be injected. As water passes into the tank, fertilizer is injected into the irrigation system. One disadvantage of such a system is that the concentration of the chemical in the tank decreases over time.

5.2 Water Distribution Network

The water distribution network constitutes main line, submains line and laterals with drippers and other accessories (Fig. 5.7).

5.2.1. Mainline

he mainline transports water within the field and distribute to submains. Mainline is made of rigid PVC or High Density Polyethylene (HDPE). Pipelines of 65 mm diameter and above with a pressure rating 4 to 6 kg/cm^2 are used for main line pipes.

5.2.2. Submains

Submains distribute water evenly to a number of lateral lines. For sub main pipes, rigid PVC, HDPE or LDPE (Low Density Polyethylene) of diameter ranging from 32 mm to 75 mm having pressure rating of 2.5 kg/cm^2 are used.

5.2.3. Laterals

Laterals distribute the water uniformly along their length by means of drippers or emitters. These are normally manufactured from LDPE and LLDPE (Fig.5.8). Generally pipes having 10, 12 and 16 mm internal diameter with wall thickness varying from 1 to 3 mm are used as laterals.

Emission Devices

The actual application of water in a micro- irrigation system is through an emitter. The emitter is a metering device made from plastic that delivers a small but precise discharge. The quantity of water delivered from these emitters is usually expressed in liters per hour (Lh^{-1}). These emitters dissipate water pressure through the use of long-paths, small orifices or diaphragms. Some emitters are pressure compensating meaning they discharge water at a constant rate over a range of pressures. Emission devices deliver water in three different modes: drip, bubbler and micro-sprinkler. In drip mode, water is applied as droplets or trickles. In bubbler mode, water `bubbles out' from the emitters. Water is sprinkled, sprayed, or misted in the micro-sprinkler mode. Emitters for each of these modes are available in several discharge increments. Some emitters are adapted to apply water to closely spaced crops planted in rows. Other emitters are used to irrigate several plants at once. There are emitters that apply water to a single plant.

Emitters / Drippers

They function as energy dissipaters, reducing the inlet pressure head (0.5 to 1.5 atmospheres) to zero atmospheres at the outlet. The commonly used drippers are online pressure compensating or online non-pressure compensating, in-line dripper, adjustable discharge type drippers, vortex type drippers and micro tubing of 1 to 4 mm diameter. These are manufactured from Poly- propylene or LLDPE.

A) Online pressure compensating drippers: A pressure compensating type dripper supplies water uniformly on long rows and on uneven slopes. These are manufactured with high quality flexible rubber diaphragm or disc inside the emitter that it changes shape according to operating pressure and delivers uniform discharge (Fig. 5.9). These are most suitable on slopes and difficult topographic terrains.

B) Online non-pressure compensating drippers: In such type of drippers discharge tends to vary with operating pressure. They have simple thread type, labyrinth type, zigzag path, vortex type flow path or have float type arrangement to dissipate energy. However they are cheap and available in affordable price. Different types on line non-pressure compensating types of drippers are shown through Fig. 5.10.

Point source emitters

Point source emitters are typically installed on the outside of the distribution line. Point source emitters dissipate water pressure through a long narrow path and a vortex chamber or a small orifice before discharging into the air (Fig. 5.11). The emitters can take a predetermined water pressure at its inlet and reduce it to almost zero as the water exits. Some can be taken apart and manually cleaned. The typical flow rates range from 2 to 8 Lh^{-1}.

Line source emitter

Line source emitters are suitable for closely spaced row crops in fields and gardens.
Line source emitters are available in two variations:

- Thin wall drip line
- Thick wall drip hose.

A thin walled drip line has internal emitters molded or glued together at set distances within a thin plastic distribution line (Fig. 5.12). The drip line is available in a wide range of diameters, wall thickness, and emitter spacing and flow rates. The emitter spacing is selected to closely fit plant spacing for most row crops. The flow rate is typically expressed in gallons per minute (gpm) along a 100-foot section. Drip lines are either buried below the ground or laid on the surface. Burial of the drip line is preferred to avoid degradation from heat and ultraviolet rays and displacement from strong winds. However, some specialized equipment to install and extract the thin drip distribution line is required.

Bubblers

Bubblers typically apply water on a "per plant" basis. Bubblers are very similar to the point source external emitters in shape but differ in performance (Fig. 5.13). Water from the bubbler head either runs down from the emission device or spreads a few inches in an umbrella pattern. The bubbler emitters dissipate water pressure through a variety of diaphragm materials and deflect water through small orifices. Most bubbler emitters are marketed as pressure compensating. The bubblers are equipped with single or multiple port outlets. Most bubbler heads are used in planter boxes, tree wells, or specialized landscape applications where deep localized watering is preferred. The typical flow rate from bubbler emitters varies between 8 and 75 Lh^{-1}.

Micro sprinklers

Micro-sprinklers are emitters commonly known as sprinkler or spray heads (Fig. 5.14). These are of several types. The emitters operate by throwing water through in air, usually in predetermined patterns. Depending on the water throw patterns, the micro-sprinklers are referred to as mini-sprays, micro-sprays, jets, or spinners. The sprinkler heads are external emitters individually connected to the lateral pipe typically using "spaghetti tubing," which is very small (1/8 inch to 1/4 inch) diameter tubing. The sprinkler heads can be mounted on a support stake or connected to the supply pipe. Micro-sprinklers are desirable because fewer sprinkler heads are necessary to cover larger areas. The flow rates of micro-sprinkler emitters vary from 16 lph to 180 lph depending on the orifice size and line pressure

Emission devices selection

The selection of emission devices involves choosing the type of device to be used and then determining the capacity of the device. The type of emission device depends on such factors as the crop to be irrigated, filtration requirements, the need for a cover crop and/or frost protection, cost and grower preference. Micro sprinklers should be strongly considered when a cover crop is needed for erosion, pest or disease control or when frost protection is desired. Line-source emitters are especially well suited for row crops, although closely spaced point-source emitters, bubblers and micro sprinklers can also be used. In situations where filtration requirements are high, bubblers and micro sprinklers may be the most viable alternatives.

Hi-tech Canopy Management of Horticultural Crops

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.

Light is critical to growth and development of trees and their fruits. The green leaves harvest the sunlight to produce carbohydrates and sugars which are transported to the sites where they are needed –buds, flowers and fruits. Better light penetration into the tree canopy improves tree growth, productivity, yield and fruit quality. The density and orientation of planting also impact light penetration in an orchard.

Objectives

i) To remove the apical dominance for encouraging branching.
ii) To remove unproductive over crowded branches.
iii) To remove diseased and dead wood branches.
iv) To encourage vegetative growth.

Some of the basic principles in canopy management are:

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

Lack of canopy management leads to....

- •Larger height and stature
- •Higher cost of management
- •Low photosynthetic efficiency
- •Low productivity
- •High pest and disease incidence.

COMPONENTS

➢**Training**

➢**Pruning**

The goal of tree **training** is to direct tree growth. and minimize cutting.

Pruning is the proper and judicious removal of. plant parts such as shoots, spurs, leaves, roots or nipping away of terminal parts etc. to correct or maintain tree structure and increase its usefulness.

Training

- Development of frame work to a plant.

OBJECTIVES

- Admit more light and air to the centreof the tree
- .Expose maximum leaf surface to the sun.
- To protect tree from sunburn and damage.
- Facilitates easy maintainence

METHODS OF TRAINING

OPEN CENTRE

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

CENTRAL LEADER

- Main stem extends from surface of soil to top of tree
- Closed centre

e.g. Apple, Cherry, Pear, Pecan, Plum

MODIFIED LEADER

- Intermediate between open centre and central leader.

BOWER SYSTEM

- •Pandal or pergola
- •Eg, grapes and cucurbitaceous vegetables
- ESPALIER SYSTEM
- KNIFFIN SYSTEM

TELEPHONE SYSTEM

- Overhead trellis system

HEAD SYSTEM

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

PRUNING- Mainly two types

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. .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

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

RINGING

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

NOTCHING

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

SMUDGING

- Smoking of trees
- Mango : Philippines to produce off season crop
- Done for a week –centre of the crown of tree
- 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.
- Flower crops: carnation, chrysanthemum.

Disbudding

- Removal of unwanted flower bud
- Cut flowers:rose, carnation, dahlia, chrysanthemum

Bending

- Bend to a 45 to 60 degree angle

- Increase lateral branching
- Decrease terminal growth
- Decreases amount of auxin moving to tip
- Increasing fruit production in guava.

COPPICING

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

CANOPY MANAGEMENT IN HORTICULTURE CROPS

MANGO

Stepwise operations

- grafts to grow to a height of 1m from ground
- Head back the graft at 60-70 cm from the ground during October-November to induce primary branches
- formation of new primary branches (3-7) during March-April.
- Prune primary branches at 60-70 cm height to induce new secondary shoots (October-November)
- Thin the excessive secondary shoots retaining 2-3 shoots per primary branch
- Tertiary branches (2 to 3) can be obtained by pruning the secondary branches at 60-70 cm height

GUAVA

- Trees are topped to a uniform height of 60-70 cm from the ground level, 2-3 months after planting to induce the emergence of new growth below the cut points.
- pruning is performed in January and May-June every year

POMEGRANATE

- •Pruning of terminal portion of a branch lowers down the total flower production. •Pruning does not affect sex ratio and fruit quality.
- •Pruning affects production of total fruits, and marketable and unmarketable fruits significantly
- •Fruit size and yield of higher grade fruits are more with high intensity pruning.

GRAPES

- •The canopy is often managed on trellis by training, pruning and leaf removal

SAPOTA

- •regulation of vegetative growth to improve productivity and quality of fruits
- .•central leader system

ACID LIME

- Acid lime plants may be trained to modified central leader system, with a smooth trunk up to 75-100cm height from the ground level and 4-5 well spaced and well spread branches, as scaffolding branches
- Lightly pruned young trees make more development of roots and shoots, producing fruits earlier

High density orcharding in Mango, guava, papaya, citrus, pineapple etc.

HDP is defined as **planting** at a **density** in excess of that which gives maximum crop yield at maturity if the individual tree grows to its full natural size.

In other words, it is the **planting** of more number of plants than optimum through manipulation of tree size.

HDP is one of the improved production technologies to achieve the objective of enhanced productivity of fruit crops.

Yield and quality of the produce are two essential components of the productivity.

HDP aims to achieve the twin requisites of productivity by maintaining a balance between vegetative and reproductive load without impairing the plant health.

In India, HDP has been proved useful in many fruit crops e.g. Pineapple, banana, mango, apple and citrus.

Principle of HDP

- To make the best use of vertical and horizontal space per unit time and
- To harness maximum possible returns per unit of inputs and resources.

Advantages of HDP

- •Induces precocity, increases yield and improves fruit quality.
- •Reduces labour cost resulting in low cost of production
- .Enables the mechanization of fruit crop production
- .Facilitates more efficient use of fertilizers, water, solar radiation, fungicides, weedicides and pesticides

Plant Architecture in HDP

- Fruiting branches-more and structural branches-minimum
- Arrangement –minimum shade on other branches
- Plant architecture is influenced by
- –the method of propagation,

- –rootstock and
- –spacing

Factors Affecting HDP

- •Cultivar
- •System of Planting
- •Planting material
- •Nutrition and moisture
- •Economics of production

Methods of HDP

- •Control of tree size
- •Planting systems

Tree Size Control

- •Use of genetically dwarf scion cultivars
  e.g. Mango- Amrapalli,Sapota-PKM-1 & PKM-2,Papaya- Pusa Nanha, Banana-Dwarf Cavendish
- •Use of dwarfing rootstocks and interstock e.g. Apple-M9,M-26 & M-27
- •Training and Pruning
- •Use of growth retardants
- •Induction of viral infection
- •Use of incompatible rootstock

High Density Planting in Mango

- High density orcharding appears to be the most appropriate answer to overcome low productivity and long gestation period for early returns and export quality mangoes
  .
- To meet the challenge of high productivity, optimization of growth parameters and minimization of the unproductive components of trees without sacrificing the overall health of the tree and quality of the product are required.

- Dwarfing rootstock like Amprapalli is useful for controlling the tree size of Mango The moderate planting density at a spacing of 7 x 7 m which accommodates 204 plants/ha (82 plants/acre) and high density planting at a spacing of 5 x 5 m which accommodates 400 plants/ha (160 plants/acre) should be followed.

- To develop a strong trunk in mango, the trees training are allowed to grow to over 1 m height initially and then cut back to a height of between 0.6 and 0.7 m
- Unwanted new shoots should be regularly removed to maintain the tree canopy and to avoid re-crowding of branches.

- For maintenance of bearing mango trees, pruning at pre flowering stage & after harvesting is useful for higher yield.

Remote Sensing Techniques in Horticulture

In India, Fruits and vegetables comprises nearly 90% of the total horticulture production. India is now the second largest producer of fruits and vegetables in the world and leader in several horticultural crops, namely mango, banana, papaya, cashewnut, arecanut, potato, and okra (National Horticulture Board, 2015). Different horticultural crops like fruits, vegetables, spices, medicinal plants and plantation crops comprises a large chunk of the total crop sales value of the country and also secures nutritional security of the persons of the country. For systematic and efficient management of existing crops and to bring more area of the country under the cultivation of horticultural crops to increase overall horticultural production in term of time and area, a database must be created for decision making and planning. Remote sensing is a proven tool that can play an important role to achieve the goal.

Remote sensing

Remote sensing can be defined as the science of obtaining information about objects or areas from a distance, typically from aircraft or satellites (NOAA). It is a process of detecting and monitoring physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the targeted area. Remote Sensing Systems offer four basic components to measure and record data about an area from a distance. These components include the energy source, the transmission path, the target and the satellite sensor. The propagated signal is detected by sensors placed in aircraft or satellites and then analyzing the electromagnetic radiation, particular land form or objects on earth is classified. In case when the signal is emitted by the carrier of the sensor and the reflection is detected by the sensor, it is called active remote sensing on the other hand if the reflection of sunlight is detected by the sensor; it is called passive remote sensing (Schowengerdt, 2007; Schott 2007). Remote sensing has a great use in estimation of area coverage, mapping and classification of land use and land cover features like vegetation, soil, water, forests and manmade activities etc. (Singh et al., 2014).

Applications in horticulture

1. **Crop insurance:** Insurance companies can use the red and infrared bands of satellite images in combination of NDVI (Normalized Difference Vegetation Index) and verify seeded crops to catch fraud.
2. **Crop stands**: Remote sensing is very useful to identify crop stands and thus totally the area under crop stand and its production.
3. **Crop conditions:** Remote sensing can be a helpful tool to identify the crop condition using NDVI. Near-infrared radiation is being used to detect healthy vegetation in horticulture.
4. **Crop area estimation**: Horticultural crops usually face big ups and down both in its production and consumption as a result, it has a very unstable market and price. That's why reliable statistics regarding area and production of horticulture products

is essential for market planning and export of produces. Remote sensing here plays a very important role to assess the supply scenario.

5. **Crop canopy measurement**: Crop canopy of horticultural crops is very important as its volume determines the amount of fertilizer, pesticide and any other chemicals to be applied besides canopy volume also indicates crop health condition as well as about the expected yield .It is possible by remote sensing techniques.
6. **Yield estimation**: Remote sensing is a very useful tool to estimate the yield of different annual crops but again so far its use has been very limited for fruit trees and vegetables.
7. **Detecting pest and disease occurrence**: Pest and diseases are the two main causes of production and consequently economic losses in horticultural industry. It has been proved that remote sensing can be a useful tool for early detection of diseases and identifying, managing pests and nematodes by detecting changes in plant pigments, leaf skeletonising caused by pest damage and identifying plant susceptible areas.

PRECISION FARMING

Precision farming or precision agriculture is about doing the right thing, in the right place, in the right way, at the right time. Managing crop production inputs such as water, seed, fertilizer etc to increase yield, quality, profit, reduce waste and becomes eco-friendly. The intent of precision farming is to match agricultural inputs and practices as per crop and agro-climatic conditions to improve the accuracy of their applications.

Precision farming is a comprehensive information based farm management system to identify, analyse and manage variability within fields for optimum profitability, sustainability and protection of land resources. It basically means adding the right amount of treatment at the right time and the right location within a field. Precision farming calls for an efficient management of resources through location specific high tech interventions which includes fertigation, protected/ greenhouse cultivation, soil and leaf nutrient based fertilizer management, mulching for in-situ moisture conservation, micro-propagation, high density planting, drip irrigation etc. Precision farming integrates environmental health, economic profitability and social and economic equity by giving emphasis on crop management using technologies like GIS, GPS, remote sensing (RS) along with ground equipment like variable rate applicators (VRA), yield monitors and computers along with appropriate software. Thus, precision agriculture is conceptualized by a system approach to re-organize the total system of agriculture towards a low-input, high-efficiency, and sustainable agriculture. Looking to the pressure arising population and erratic climatic variation, more attention required towards the development of technology driven horticulture precision farming is being reviewed as a promise in this regard.

Objectives of Precision Farming.

1. To enhance productivity in agriculture
2. Prevents soil degradation in cultivable land.
3. Reduction of chemical use in crop production
4. Efficient use of water resources
5. Dissemination of modern farm practices to improve quality, quantity & reduced cost of production in agricultural crop