

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.

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.

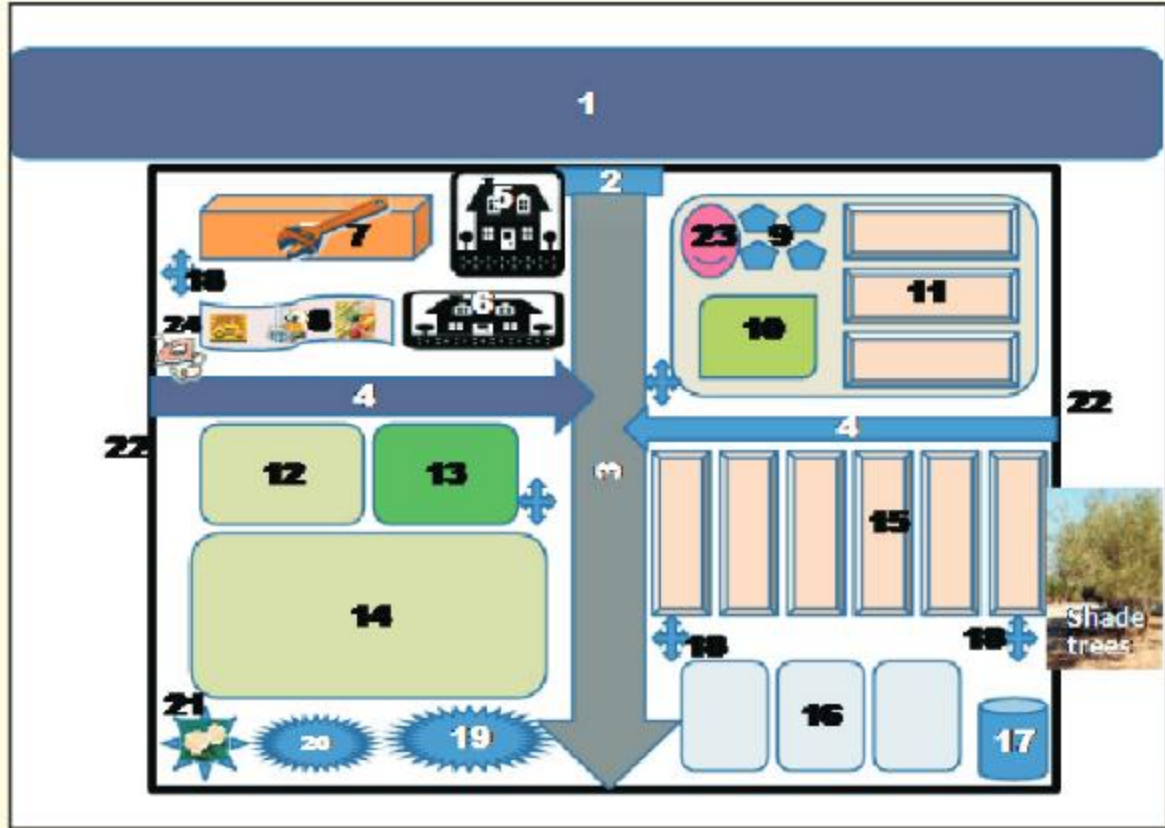
As per National Horticulture Database published by National Horticulture Board, during 2014-15 India produced 86.602 million metric tonnes of fruits and 169.478 million metric tonnes of vegetables.

#### Yearly demand of fruit, vegetable seedlings and seeds in India

Crop	Seedling (millions)	Seed (kgs)
Banana	3151	*
Mango	10	*
Papaya	576	*
Grapes	80	*
Cashew nut	31	*
Pomegranate	21	*
Gauva	20	*
Coconut	2.5	*
Sapota	1.6	*
Arecanut	1	*
Tomato	13028	600
Brinjal	200000	635
Chilli	14157	195
Onion	695000	2779
Cabbage	22963	101
Cauliflower	12669	87

(\* - No data available)

(Source: *Resource Book on Horticulture Nursery Management, NAIP, ICAR, 2012*)



**General layout of nursery**

(1: Main road, 2: Gate, 3: Nursery road, 4: Path, 5: Office, 6: Labor shed, 7: Store rooms, 8: Vehicle shed, 9: Potted plants, 10: Saplings, 11: Seedlings, 12: Propagation/mist chamber, 13: Shade net house, 14: Poly house, 15: Seedling beds, 16: Mother beds, 17: Well/water source, 18: Water pipeline, 19: Soil dumping, 20: Compost area, 21: Mother plants, 22: Fencing, 23: Plant library, 24: Generator/Electricity room).

## **Role of Nurseries in Horticulture Development**

### **1. Production of Genetically Pure Nursery Stock**

Genetically pure planting material is essential for healthy and vigorous plant growth. Both stock and scion should be genetically pure. The planting material should be satisfactory in quantity and quality and easily available for further multiplication.

### **2. Export of Nursery Stock**

Globalization has improved the chances of export of quality planting material to other countries. Special techniques and care is required for exporting the nursery material. Similarly, great care is necessary while importing nursery material from outside.

### 3. Employment Generation

There is a huge demand of skilled professionals for grafting, budding, potting, repotting and other nursery operations. Nursery provides employment opportunities for technical, skilled, semi-skilled, and unskilled labor. Nursery can itself be a very remunerative enterprise in the changing national scenario.

### 4. Role of Nurseries in Dry Land Horticulture

Like India, there are many countries in this world, which face droughts every other year. Growing drought tolerant fruit crops provide assured income to farmers. Horticultural plantations play an essential part in afforestation and thereby help to reduce the global warming.

### Types of Plant Propagation Nurseries

It has been estimated that manpower accounts for 70 per cent of the production costs of a horticultural nursery.

#### State-wise details of nurseries

State	Number of nurseries under			
	Public Sector	SAUs/ ICAR Institutes	Private sector	Total
Andhra Pradesh	57	-	913	970
Arunachal Pradesh	20	-	37	57
Assam	4	-	82	86
Bihar	127	27	126	280
Chhattisgarh	106	1	-	107
Gujarat	23	14	335	372
Haryana	25	1	36	62
Himachal Pradesh	78	-	648	726
Jammu & Kashmir	77	-	348	425
Jharkhand	157	2	-	159
Karnataka	28	-	15	43
Kerala	64	26	30	120
Maharashtra	136	42	1300	1470
Madhya Pradesh	270	-	-	270
Manipur	12	-	41	53
Meghalaya	31	-	-	31
Mizoram	9	-	8	17
Nagaland	2	-	15	17
Orissa	92	-	62	154
Punjab	24	7	39	70
Rajasthan	27	6	22	55
Tamil Nadu	76	-	285	361
Tripura	41	-	9	50
Uttar Pradesh	79	-	-	79
Uttarakhand	23	12	176	211
West Bengal	6	-	80	86
<b>Total</b>	<b>159</b>	<b>138</b>	<b>4,607</b>	<b>6,330</b>

(- no data available)

## **Types of Nurseries According to Type of Plants Grown**

### **1. Fruit Plant Nurseries**

Fruit crops are mainly propagated vegetatively and need special techniques for propagations as well as maintenance. Mango, Guava, Pomegranate, Sapota, Oranges etc. are propagated with vegetative means. Fruit nurseries are essential for production of grafts as well as the mother plants of scions and rootstocks.

### **2. Vegetable Nurseries**

All vegetables except few like potatoes, sweet potato, bulbous vegetables and some other are raised by seedlings. Very few vegetables are perennials like, little gourd, drumsticks, Alocasia etc. Seedlings are to be produced on a large scale in short period.

### **3. Ornamental Plant Nurseries**

Ornamental and floricultural crops are numerous and are propagated vegetatively, like gladiolus, carnation, roses, lilies etc. There is a large group of ornamental plants, which is propagated by seeds and seedling; Asters, Marigolds, Salvias, etc. are some of them.

### **4. Medicinal and Aromatic Plant Nurseries**

There is considerable increase in people adopting ayurvedic medicines with the changing life style. It is also necessary to conserve the fast depleting precious medicinal and aromatic plants. To save and multiply the valuable medicinal and other auspicious plants, nurseries specializing in these plants have begun to flourish. These plants are also demanded by the Ayurvedic medicinal practitioners.

### **5. Hi-Tech Nurseries**

There is sudden increase in the demand for certain commercial plants. For example Tissue cultured banana, gerbera and carnation etc. It is not possible to fulfill this requirement by ordinary or common nursery practices. There is necessity to have special techniques and methods to meet the demand and only Hi-tech nurseries can satisfy this type of demand. These nurseries grow plants in greenhouse, building of glass or a plastic tunnel, designed to protect young plants from harsh weather, while allowing access to light and ventilation. Modern greenhouses allow automated control of temperature, ventilation, light, watering and feeding. Some also have fold-back roofs to allow "hardening-off" of plants without the need for manual transfer of plants to the outdoor beds.

## **Types of Nurseries According to the Type of Sale**

**1. Retail Nurseries:** Retail nurseries raise plants for sale to the general public. These places are small, locally owned nurseries that sell seasonal, annuals, ornamental trees, other landscaping plants and garden decoration to the general public or companies that specialize in a particular type of plant, such as tropical plants, citrus trees, bulbs or roses.

**2. Wholesale Nurseries:** Wholesale nurseries usually grow plants in bulk for the purpose of selling to large clients. These clients may include florists, garden centers or departmental stores. A wholesale nursery may fill a niche for particular types of plants, such as vegetables or

houseplants, or they may grow a general selection of plants to sell such as fruits, vegetables and landscaping plants.

**3. Private Nurseries:** A private nursery grows plants exclusively for a single client. The private nursery may be owned by the client or it may be under contract for use by the client. Clients for private nurseries include large estates, corporations and institutions. These nurseries are concerned with raising documented historical plants for the historic preservation of the estates.

**4. Mail Order:** Privately owned, retail and wholesale businesses may all be involved in mail order businesses. As shipping technology improved, it became possible to ship dormant ornamental trees and bedding plants via mail. The internet has largely shifted mail order from catalog to online shopping. Bedding plants may be shipped via postal carrier, but are primarily handled through third-party shipping agents.

### **On the basis of structure used**

#### **Open field nursery**

Such a nursery is established in open areas without any permanent structure. Usually, raised, flat or sunken seedbeds are prepared. These are vulnerable to natural environmental conditions.

#### **Hi-tech nursery**

Such a nursery is established under protected structures. The protected structures in which the nursery can be successfully raised are as follows. Thatched roof: In this type of nursery, a thatched roof is constructed over the nursery beds, which protects the seedlings from damage caused by extreme wind, rain, heat, etc.

**Shade-net:** Such a nursery is raised under shade-net houses. To give different amount of shade to plants based on their requirements, shade-nets of different colours and mesh sizes are used as covering material.

**Poly-tunnel:** The nursery is covered with a plastic film or sheet to form a tunnel. It is miniature structure, which produces greenhouse-like effect. Besides not being expensive, it is easy to construct and dismantle. The seedlings are protected from cold, wind, storm, rain and frost. Due to modified conditions, there is better germination and plant growth.

**Greenhouse or poly-house:** It is a framed structure covered by poly-film or shade-net so that the plants can grow under partially or completely modified environment. Such structures are ventilated and may have temperature and humidity controlling devices. The seedlings are raised inside the structure on raised beds or in plug-trays, and also for hardening of tissue cultural plants.

### **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

Nearness of road

Near a habitat

Suitable climate

Neither shady nor exposed area

Sufficient sunlight  
Good irrigation facilities  
Good soil condition  
Good transport facility

### **Physical Resources for Nursery**

Nursery like any other enterprise requires certain resources. The criteria for selection of products also depend on these resources. These resources thus play a very important role in determining the type of nursery enterprise. These physical resources are enlisted below,

#### **1. Land**

Land is the basic and fundamental physical resource for plant nursery. The area available must be considered before planning the nursery and the products. Soil sample testing should be done to avoid problematic and unmanageable soils. Soil should be well drained, porous and light to medium in texture. Soil pH should be 6.5 – 7.5. Heavy, black cotton soil, sandy, ill drained and soils having high pH more than 8 are strictly avoided.

Low lying land should not be selected. The soils should be free from salts and other harmful elements. The selected site should be close to railway station or bus station. Wind breaks and shelter belts should be raised prior to planting nursery plants.

#### **2. Irrigation Facilities**

Required land with sufficient and assured supply of irrigation is the most important basic resource. Quality of irrigation water should be at prescribed level. Harmful factors can be tested by water testing in laboratory. The pH and electrical conductivity (EC) of irrigation water should be tested.

#### **3. Labour**

Labour is another important resource. Degree of mechanization must be considered before estimating the labor requirement. Skilled as well as unskilled man power is necessary for grafting, budding, weeding, irrigation, spraying, dusting, training, pruning, etc. Technically sound gardeners are also necessary. Labour should be available at reasonable rates.

#### **4. Electricity**

The availability of power or electricity is also very important and is in accordance with the man power available. Load shedding should be minimum possible. Regular supply of electricity is very essential. Electricity is required for water pumps, spraying, dusting and many other operations.

#### **5. Road and Transport**

Once the nursery stock is ready for sale, there should be good roads and transport facilities. These facilities are also required for timely importing of stock and other material for the nursery.

#### **6. Mother Plants**

Mother plants are the most important factor for successful nursery. Separate planting of mother plants is necessary. Different varieties of mother plants are planted in different plots. Pests and diseases are controlled regularly by spraying pesticides and fungicides. Mother plants should be

authentic and selected from Government nurseries or from Agricultural Universities. Mother plants should be selected very carefully as the sale of the nursery stock depends on the mother plants used for the propagation.

### **Mother Bed**

They are seed sowing beds prepared with fertile and clean nursery mixtures (Soil, sand and FYM). Generally they are rectangular in shape with 1 to 1.8 m width and 1.8 (in hills) to 12 m (in plains) length. The lengthy side of the bed should be oriented towards the sun (east-west) so that shading can be done.

#### **Types of mother beds:**

**Raised bed:** They are prepared by dumping soil about 10 to 15 cm above ground level. They are common in high rainfall areas to prevent water logging. These beds Inputs Management are good for the species which don't require more moisture for germination as Teak, Fir, Spruce, vegetable seedling, etc.

**Sunken bed:** They are prepared by excavating the soil in bed area. These beds are usually 10-15 cm deeper than the normal ground level. It prevents the out flow of water and conserves moisture. Seeds with hard coat (Acacias, Acer, Karonda, etc.) are sown in these beds.



**Level/Flat beds:** The surface of this bed is perfectly flat or has a slight camber. Stones, wood or a line of pucca bricks are placed at the edges of bed to prevent crumbling in dry season. Germination bed, transplant bed, storage bed, seedling bed and cutting bed are the other kind of beds used in nursery for seedling stock preparation. For propagation, framed structures such as green house, poly tunnels, culture room, hardening chamber and mist chamber are some important structures.

A greenhouse is a framed, infrastructure covered with a transparent material in which crops can be grown under at least partially controlled environment. Various designs of greenhouse viz., shade net house, plastic film green house, glass house and natural green houses may be designed according to the need and resource availability. A shade net nursery usually has 20 m x 10 m dimensions. It is erected using GI pipes as a support. UV stabilized HDPE green or black colour shade net of 50 to 75% shade intensity is used to cover the nursery area at a height of 6.5 feet. Wire grid is provided at the top of the structure as support for shade net. To prevent insect entry, 40 mesh UV stabilized nylon insect proof net is fitted on all the four sides of the nursery. Provision is also made to pull polythene sheet over the pro-trays in the event of rainfall by way of making low tunnel structure.

For preparing low cost polytunnel structure, 3/4" LDPE pipes and 400 gauge UV stabilized polyethylene sheet are used. Sometime bamboo poles and polysheets may also be used.

Glass house is preferred when the greenhouse is to be placed against the side of an existing building. It makes best use of sunlight and minimizes the requirements for roof supports. Consolidation of interior space reduces labor, lowers the cost of automation, improves personnel management, and reduces energy consumption. Glass greenhouse is seldom used today because they are not adaptable to automation. The construction cost of glass house is more than that of plastic film greenhouses. Several styles of glass greenhouses are designed to meet specific needs.

## **Mother Plant Selection and Maintenance**

Mother plant is the most important factor of plant nursery. Mother plants provide bud sticks and scions for budding and grafting operations. Criteria for Selection of Mother Plants

1. Mother plants should be vigorous, healthy and high yielding. It should have a regular bearing habit.
2. It should be free from pests, diseases and viruses.
3. The mother plants must necessarily be genetically pure and superior in quality. They must be obtained from Registered Farms, Agriculture Universities or Government Nurseries.
4. The purchase receipt of mother plant should be preserved to prove the origin and authenticity of the mother plants.
5. Mother plants should be selected corresponding to the regional demand of the nursery plants.
6. Ornamental mother plants are planted under protected conditions either under shade net or semi-shade conditions. Planting of Mother Plants Proper selection is very necessary for mother plants.

By considering its quantitative and qualitative characters, mother plants are selected and planted in nursery. They are planted according to the recommended planting distance. Care should be taken that the mother plants attain optimum vegetative growth. Mother plant plantation must be well classified according to the types and varieties. Ornamental mother plants are planted under poly house or shed nets.

### **7. Propagation Structures:**

Propagation structures are very essential for production of grafts or seedlings. They are useful for multiplication of grafts and seedlings. Hardening of plants is done with the help of propagation structures.

### **8. Hedges and Compound**

Thorny plants like Chilar (thorny creeper), golden duranta (thorny shrub), and agave are used as hedges in nurseries. Barbed wire fencing is also used. Hedges protect the nursery plants from wild and stray animals, theft, etc. They fix the borders of the nursery and are ornamental and decorative.

### **9. Space for Hardening of Nursery Plants**

Small shade net houses are required for hardening of nursery plants. Young, pampered seedlings that were grown either indoors or in a greenhouse will need a period to adjust and acclimatize to outdoor conditions, prior to planting. This transition period is called "hardening off". Hardening off gradually exposes the tender plants to wind, sun and rain and toughens them up by thickening the cuticle on the leaves so that the leaves lose less water. This helps prevent transplant shock in which the seedlings have a stunted growth or they die from sudden changes in



temperature. Hardenings off time depend on the type of plants grown and the temperature fluctuations.

### **10. Store and Office**

Garden tools, implements, raw materials, insecticides, fungicides, manures, fertilizers, boards, polythene bags etc are stored in store house. An ideal nursery has at least one well managed office for keeping all registers, notebooks, information books and for instructing the team. The record of mother plants, progeny, Stock of plants, etc is preserved in office.

### **Growing medium**

The material in which plants grow in pots is known as 'potting material', while the substrate or medium used to grow plants is called 'growing medium'. The choice of the type of potting material is important as the growth of plants largely depends on it.

Functions of growing medium

- It supplies nutrients, air and water to the roots of plants.
- It retains necessary water in the soil, while excess is drained out.
- It provides physical support to plants
- It facilitates maximum root growth. characteristics of growing medium
- The medium must have adequate aeration, drainage and water-holding capacity
- It must not be too heavy to lift.
- The medium must be slightly acidic to neutral, i.e., pH of 6 – 6.5 being satisfactory in most cases.
- It must be free of weeds, pests and pathogens.
- It must be easily available.
- It must not be too expensive.

The main function of growing medium is to supply nutrients, air and water to the roots of a plant. It supports the plant physically and holds it in upright position, allowing growth against the gravitational force. For the above two functions, it is necessary that the medium facilitates the growth of roots within it. The chemical composition, as well as, physical structure of the medium favours the growth of the plant. Different types of growing medium are used as per the requirement of plants.

#### **Garden soil**

Light and sandy loam soil must be used as growing medium, while silty or clayey soils are not preferred due to poor aeration and stickiness. The soil contains both organic and inorganic matter. When the soil is used as a medium, it may contain disease-causing pathogens, along with weed seeds, which is a serious problem in growing crops. The soil is easily available and comparatively a cheaper medium used in a nursery.

#### **Sand**

Large particle size makes this medium more porous, aerated and well-drained. The water-holding capacity of this medium decreases with an increase in the size of the particles. The usual size of sand is 0.05–2 mm. Quartz sand is a useful growing medium but it lacks in nutrient content. It is relatively inexpensive and heavy. Generally, it is mixed with soil and used as a well-drained porous medium .

#### **Compost**

Compost is formed due to the decomposition of organic matter. Leaves, grass clippings, bagasse, litter, wood waste, rice husk, sawdust and farmyard manure are some of the common

ingredients used for preparing compost. Compost contains nutrients that plants need for growth. Vermicompost is a supplement that is added to a growing medium.

#### **Sphagnum moss**

Commercial sphagnum moss is a dehydrated by-product of bog plants of genus Sphagnum. Commonly used moss grass is comparatively light in weight, acidic in reaction, sterile in nature and has sufficient water-holding capacity. Hence, it is commercially used as a rooting medium in air layering.

#### **Peat**

Peat consists of residues from marsh swamp and organic nitrogen. It helps in fast vegetative growth and is commonly used for growing newly rooted cuttings or newly germinated seeds.

#### **Coir peat or coco peat**

Coir peat is obtained from coir's fibre dust. It is acidic in nature and has a pH of about 5. It has a high water retention capacity.

#### **Vermiculite**

Vermiculite is chemically hydrated magnesium aluminum iron silicate. It is produced by heat treatment of mica. It is porous in nature and light in weight. It has adequate water-holding capacity.

#### **Perlite**

Perlite is a natural mineral of volcanic origin, which is light in weight. Its pH is, usually, neutral to slightly alkaline.

#### **Sawdust**

It is the by-product of sawmills. It is easily available and cheap. It is poor in nutrient content but can be used after adding nitrogen.

### **Legal Authorizations for Starting Nursery Business**

A commercial nursery business requires a business license which is a rather lengthy process. In many cases zoning ordinances dictate possible uses for land. Normally, a nursery business would be considered an "agricultural use", but in some cases it may also be interpreted as commercial", "agribusiness", or some other classification. Permits regarding establishment of green houses must be taken before erection of a green house, storage building or warehouse for storing materials and equipment required in a nursery.

A nursery business may require a property hazard insurance, workmen's compensation if you have paid employees and general liability insurance if you expect visitors to your nursery.

Nurseries in some areas may have to fulfill the government agricultural inspection requirements as per the body governing the area. Permissions are also required from the local authorities for availing electricity, water and other facilities.

### **Investigation of Potential Market for Plant Nursery**

1. Nurseries under Horticulture Board Development Programs sponsored by State Agricultural Departments, Medicinal Boards, etc. produce plants for home gardens, landscaping, reforestation, and other uses. It should be decided as to which type of plants the nursery would produce, like the container grown, bare root, or root balled plants, etc.
2. Production of sufficient quantities of good quality material in order to satisfy the customer needs is essential. While producing more than the requirement may lead to unsold surplus which may cause losses to the nursery unit.

3. Advertising is costly but effective in horticulture nursery business. Marketing and advertising strategies must be preplanned to support each other and the business.

### **Financial Resources for Nursery**

#### **Bank Loans**

Terms and conditions differ from bank to bank, state to state and again the procedure for release of first installment is delayed. This may put the nursery unit in loss or trouble.

#### **Financial Resources from Government**

National Horticulture Mission (NHM) started in 2005 in India with an objective to establish ideal nurseries for production of genetically pure plant materials. Nurseries in the public sectors (on government establishments) are entitled to get 100 per cent subsidies on expenditure. The nurseries in the private sector get a subsidy of 50 per cent on their expenditures.

There are two types of nurseries based on their sizes. Big nurseries are those with size of 1 hectare area. Such nurseries are entitled to receive financial assistance up to 30 Lakh as subsidy. The small nurseries with size of 1 Acre are entitled for a subsidy up to 18 Lakhs. The subsidies are given as per the bank loans sanctioned.

#### **Financial Resources from Nationalized Banks**

There are different schemes under National Horticulture Mission for establishment of horticulture nurseries:

1. Development of Orchard with Tools and Implements
2. Establishment of New Orchards
3. Sources of Irrigation Facilities
4. Controlled Farming
5. Integrated Pest Management/ Integrated Disease Management
6. Organic Farming
7. Human Resource Development
8. Practical's on Technology
9. Honey Bee Keeping
10. Post-Harvest Handling of Fruits and Vegetables.
11. Self-Employment Program.

### **Hi-tech nursery raising techniques**

#### **1. Covering with polythene sheets**

In order to ensure early germination, thatching can be swapped with transparent/white polythene sheet (150 micron thickness). After seed sowing, irrigation water is applied in the nursery beds up to field capacity. Then the beds are covered with transparent/white polythene sheet and are made air tight by covering the sheet edges with soil. The polythene sheath is removed after the completion of germination process. Rest of the cultural practices is similar to conventional method of nursery raising.

#### **2 Poly tunnels for normal weather**

The nursery beds are covered with pre fabricated tunnels of size 3m long, 1.5m wide and central height of 1.0m. The semi circular structure is clad with UV-polythene sheath (200 micron) with 75 per cent transmittance. Once the seed sowing, covering and irrigation to field capacity is over, the bed can be covered with the tunnels. Both the openings can be closed if nursery is grown in winters.

### **3 Sunken nursery for weather extremes**

- Prepare a trench of any length, 1.2m wide and 50cm deep.
- Prepare a raised bed of 5-10 cm height at the bottom of the trench. The soil should not be imported from outside the trench. Albeit, FYM (25kg) and inorganic fertilizer mixture (100g) may be added as recommended earlier. Precautions must be observed in applying FYM. It may be treated with fungicide/Trichoderma (1kg/100kg dung) at least 15 days prior to bed preparation.
- Seed treated with Captan/bavistin may be sown in lines at 5cm width and cover the seed with the same soil.
- Drench the beds with water to the field capacity of the soil.
- Cover the trench with white, transparent polythene sheath, providing taper to both sides.
- Make the sheath air tight from all sides.
- Start observing the emergence of the seed through the poly sheath from tenth day onwards.
- Once the emergence is over, irrigation may be regulated, as required till the 4 leaf stage is achieved.
- Polythene cover may be removed in sunny days or converted into a roof in rainy days.

### **4 Naturally ventilated polyhouse**

For commercial nursery production, naturally ventilated polyhouses can be used. In a polyhouse of 100 m<sup>2</sup> area, 40,000 seedlings can be raised in one batch and we can have a total of five such batches per year.

#### **(i) Poly bags for cucurbits**

Most of the cucurbits are seed propagated and in situ sowing is practiced. In some cases where early crop is desired, seeds can be sown in alkathene bags and germinated under protected cover from low temperature. The seedlings are transplanted from the bags at 2-true-leaf stage. This practice is prevalent in Punjab, especially in the case of muskmelon and it can be done in the hills to get early crop in July. Normally, the cucurbits do not stand transplantation beyond this stage due to injury to tap root. There is considerable saving in seed quantity, nearly 50 to 60 per cent as compared to in situ sowing

#### **(ii) Plug tray technique**

Plastic trays or pro-trays having different sizes of cells are commonly used for raising vegetable seedlings. Mainly two kinds of plastic pro-trays are used for raising the seedlings in several European countries and Israel. In case cucumber, muskmelon, tomato and brinjal require plastic trays of 187 cells of 3.75 cm (1.5”) size, whereas lettuce, cabbage, cauliflower and capsicum require trays having 345 cells of 2.5 cm (1.0”) size. These trays help in proper germination, provide independent area for each seed to germinate, reduce the mortality rate, maintain uniform and healthy growth of seedlings easy to handle and store, reliable and economical in transportation.

- The seedling tray (pro-tray) is filled with the growing medium (coco peat, perlite and vermiculite).
- A small depression (0.5 cm) is made with fingertip in the center of the cell of the pro tray/ plug tray for sowing.
- One seed per cell is sown and covered with medium.
- Coco peat with 300 to 400 per cent moisture is used and hence no immediate irrigation is required until germination.
- After sowing 10 trays are kept one over other for 3 to 6 days, depending on the crops.
- The entire stack will be covered using polyethylene sheet to ensure conservation of moisture until germination. The stacked trays are spread once the germination commences to avoid etiolation.
- The trays are shifted to net house on germination of seedlings and spread over the beds.
- The trays are irrigated lightly every day depending upon the prevailing weather conditions by using a fine sprinkling rose can or with hose pipe fitted with rose.
- Drenching the trays with fungicides as a precautionary measure against seedling mortality is also being done.
- Spraying of 0.3 per cent (3g/litre) water soluble fertilizer using poly feed (19 all with trace elements) twice (12 and 20 days after sowing) is practiced to enhance the growth of the seedlings.
- The trays are provided with protective cover from rain by covering with polyethylene sheets in the form of low tunnel whenever it rains.
- The seedlings at right stage of planting are hardened by withholding irrigation and reducing the shade before transplanting or selling to the growers.
- Systemic insecticides are sprayed 7-10 days after germination and before transplanting for managing the insect vectors.

## **Care and management of nursery plants**

### **Handling of plants**

Since plants grown in a nursery are tender, care must be taken in nourishing them in order to ensure their growth and development. Timely and effective preventive measures against pests and diseases must also be taken. The production of quality seedlings depends on how well the following activities have been executed in the nursery.

### **Shading**

Newly grown saplings must be protected from adverse weather conditions. Shade can be provided by using shade-nets or polythene sheets.

### **Thinning**

It is important to maintain plant density in rows so as to ensure adequate light and air to the plants. During this process, weak, diseased or damaged plants are pulled out, allowing the growth of healthy seedlings.

### **Watering**

Nursery beds must be watered carefully with the help of a fine rosé can. After the establishment of plants, watering must be done as per the requirement of individual plants.

### **Weeding**

Weeding refers to the removal of all unwanted plants (weeds) from the nursery. Periodic removal of weeds is beneficial for the growth and development of seedlings as it prevents competition with the main plants for sunlight, water, air and nutrients. It also acts as secondary host for

insect-pests and disease-carrying organisms. Thus, the nursery area must be kept free from weeds. Hand weeding and hoeing are the most common practices to remove weeds. To control a large number of weed species, pre-emergence herbicides can also be sprayed just after the sowing of seeds.

### **Hardening of seedlings**

Seedlings must be hardened-off (acclimatized) in partial shade before being planted in the main field so that they can survive the harsh open climatic conditions. Generally, hardening is done before transplanting in the open field by gradually exposing the seedlings from lower to higher temperature. Over-hardening of the seedlings must be avoided.

### **Staking**

Staking is a practice to support plants growing straight and saving them from bending or lodging. This is done at a time when the plants are not too tall. It saves the plants from being blown over due to wind and rain, and also because of the weight of its stems when in bloom. It is useful in potted plants, as well as, grafted and budded plants. Bamboo is the most common plant where staking is used. Other than this, the branches of shrubs and trees, i.e., neem, subabool, phalsa, eucalyptus, etc., can also be used for this purpose.

### **De-shooting**

De-shooting refers to the removal of all side shoots (offshoots, offsets or keikis) emerging from the base of a plant. The main purpose of de-shooting is to divert the energy of the plant towards the development of its shoots or buds.

### **Disbudding**

Disbudding is the removal of floral buds when a large flower on a plant is desired, for example chrysanthemum and dahlia. The energy saved by disbudding is diverted towards the development of the retained bud so that the flowers become large and vigorous. Generally, it is followed in large flower varieties. In carnations, disbudding is practised to obtain long stalks with larger blooms.

### **Pinching**

It refers to the removal of growing tips of vegetative buds to promote bushy growth for more lateral formation and precocious flowering as in case of chrysanthemum. It is the removal of 3–5 cm growing tips when the plants are 8–10 cm tall, i.e., when they are about one-month old. The second pinching takes place about three weeks after the first pinching. Pinching is also a common practice in carnation and marigold.

### **Pruning**

The planned removal of twigs, branches, shoots, limbs or roots in plants is termed as 'pruning'. Pruning is done to increase the usefulness of the plants.

### **Application of manures and fertilizer**

#### **Types and methods of manure application**

Timely application of fertilizers and manures in adequate quantity is important for the growth of plants. The manner and method of manure application depends on the type of the plants.

#### **Bulky manures**

Farmyard Manure (FYM) or other bulky manures must be broadcast over the entire area and mixed well with the soil by harrowing. The application of manures depends on the season to avoid leaching of nutrients. In areas receiving light rainfall, the manures may be applied during monsoon, whereas, it must be done after the monsoon in areas receiving heavy rainfall.

#### **Concentrated manures**

Oil cakes, fish manure and blood meal are known as ‘concentrated organic manures’. These manures must be applied well in advance as they are not easily available and have to be broken down by soil microbes to be made available to plants.

### **Fertilizer application**

#### **Time of application**

Generally, organic manures are applied while preparing the land so that they improve the structure and water-holding capacity of the soil. Fertilizers are, normally, applied just before or soon after planting. The frequency and amount of fertilizer application depend on the crop, soil and season.

#### **Application of solid fertilizers**

##### **Broadcasting**

**Basal application:** Depending on the crop, broadcasting of fertilizer is carried out prior to sowing or planting just before the last ploughing is carried out in a field. **Top dressing:** When fertilizers are broadcast in a standing crop, it is known as ‘top dressing’. In this method, usually, nitrogenous fertilizers and micronutrients are applied in a dense sown flower crop.

##### **Placement**

Place the fertilizer in prepared soil before sowing, irrespective of the position of the seeds. There are three types of fertilizer placement. **Plough furrow or single band placement:** The application of fertilizers in narrow bands beneath and by the side of crop row or furrow is called ‘band placement’. This is done during the process of ploughing. This method can be adopted: (i) in case of low fertility of soil. (ii) when the fertilizer reacts with soil constituents, leading to the fixation of nutrients. (iii) in places where volatilization loss is high. **In single band placement,** fertilizers are applied on the side of the planted row. **Double band placement** happens when the fertiliser is applied in two bands, i.e., on both sides of the planted rows. **Deep placement:** It is, generally, practiced for the application of nitrogenous and phosphatic fertilizers and in fields. It is commonly recommended in dry land agriculture.

**Ring placement:** The quantity of fertilizer per plant is calculated and applied at some depth around the plant circle. This method is mostly practiced in case of orchard crops

#### **Application of liquid fertilizers**

##### **Foliar application**

This method can be used with fertilizer nutrients readily soluble in water. It is also used when there is a soil fixation problem. In this method, it is difficult to apply sufficient amounts of major elements. Nutrient concentration of 1–2 per cent can be applied without causing injury to the foliage. Foliar application, therefore, is commonly used only to apply minor elements or to supplement the major elements.

##### **Fertigation**

This refers to the application of fertilizers through irrigation water. Nitrogen is the principle nutrient that is commonly used. Potassium and highly soluble forms of zinc and iron can also be readily applied in this technique. When an element forms a precipitate with another substance commonly found in the irrigation water, it is not advisable to use this method. Phosphorus and anhydrous ammonia may form a precipitate in water with high calcium and magnesium content. So, they are not used in fertigation. Normally, this system is used through drip irrigation. Liquid fertilizers, containing all three major nutrients, are used.

### **Common diseases in nursery plants**

#### **Damping-off**

It is a common and serious disease in nursery plants, which can even cause their death. Damping-off is pre-emergence and seedling disease caused by fungi, such as *Pythium*, *Phytophthora*, *Rhizoctonia* and *Fusarium*. These fungi attack at the time of seed germination. Symptoms of damping-off, the necrotic, brown lesion girdles the stem and the seedling collapses (red circle) and soon dies. In this disease, girdling takes place near the base of the seedlings and the infected seedlings collapse due to rotting in the collar region. Damping-off is favoured by high humidity and damp soil surface, coupled with hot and cloudy weather, vis-a-vis, dense planting. One of the best preventive measures is to maintain a dry soil surface, which helps reduce the sowing density and thins out the seedlings, leading to improved aeration. Other methods include treating the nursery bed either by soil solarisation or soil sterilization with formalin @ 2 per cent, drenching with Copper oxychloride @ 2g/l or seed treatment with thiram or carbendazim @ 3g/kg.

### **Wilt**

Plants often show discoloured and wilted appearance. Leaves become yellow. The disease is controlled by drenching the soil with Copper oxychloride @ 2g/l or carbendazim @ 2g/l or by applying *Trichoderma harzianum*.

### **Leaf spot**

One can often notice small to big black or brown spots on leaves. The disease is controlled by spraying mancozeb @ 3g/l.

Insect-pests in nursery

Nursery plants are tender and vulnerable to attack by various insect-pests.

<b>Insects</b>	<b>Characteristics or symptoms</b>	<b>Control</b>
Aphids	Small green, brown or black sap-sucking insects, which secrete honey dew that attract ants and develop sooty mould	Dimethoate 2 ml/l Neem oil 4–5 ml/l
Thrips	Tiny black or yellow coloured sap-sucking insects, which infest young portions of plants and flowers	Dimethoate 2 ml/l Neem oil 4–5 ml/l
Scales	Small immobile sucking insects that are covered by wax mainly infesting the stems of plants	Dimethoate 2 ml/l
Mealy bugs	Small sucking pests covered by white filamentous hair	Chlorpyrifos 20 EC @ 2.5 ml/l 5% Malathion dust @ 25 kg/ha
Mites	Microscopic insects on the under surface of leaves producing webs and galls	Dicofol 18.5 EC @ 2.5 ml/l Wettable sulphur @ 5 g/l
Leaf miner	Leaf mining insect that produces serpentine (snake-like) white shining lines on leaves	Triazophos 0.25 ml/l
Termites	Tiny white ants that mainly infest dead parts of the plant and stay underground	Chlorpyrifos 0.3% (active ingredient) emulsion



## Container for propagation and growing young plants

### 1. Earthen pots

They are made of burnt porous clay in various sizes to provide requisite amount of soil and root space to different kinds and sizes of plants. They have straight sides and are made wider at the top than at the bottom to hold the greatest bulk of compost where the feeding roots are and also to facilitate easy removal of soil, intact with roots (ball of earth) at the time of planting or repotting. In our county, tube pots of varying sizes are used as follows

Tube pot sizes	Height (cm)	Diameter (cm)	Cost per pot (Rs.)
Tube pot	20	13	15.00
¼ size pot	18	22	15.00
½ size pot	20	27	30.00
¾ size pot	25	32	50.00
Full size pot	35	35	65.00
Tub size pots	35	50	90.00

### 2. Seed pan and seed boxes

Seeds pans are shallow earthen pots about 10 cm high and 35 cm in diameter at the top. They have one large hole for drainage in the centre or 3 holes at equidistant from each other. Seed boxes are made of wood, 40 cm wide and 60 cm long and 10 cm deep, with 6-8 properly spaced holes drilled in the bottom. Against each of the holes is placed a crock with its concave side down. Some large pieces of crock are put over it and also by the side of this crock, some coarse sand 2 or 3 handfuls are sprinkled on the crock pieces forming a thin layer to prevent fine soil from clogging the drainage. Over this, required soil mixture is added. Very delicate kinds of seeds like Cineraria, Begonia, etc. are best sown in these containers.

### 3. Polythene bags

Small polythene bags with holes punched in the bottom for drainage and filled with a porous rooting medium are used for propagation of cuttings like Jasmines, Duranta, Crotons etc. in the mist chamber. Sometimes, young seedlings which are raised in the nursery are subsequently transplanted in these polythene bags and kept there till they attain required growth for transplanting them to the main field (Papaya, Curry leaf etc.).

### 4. Plastic pots

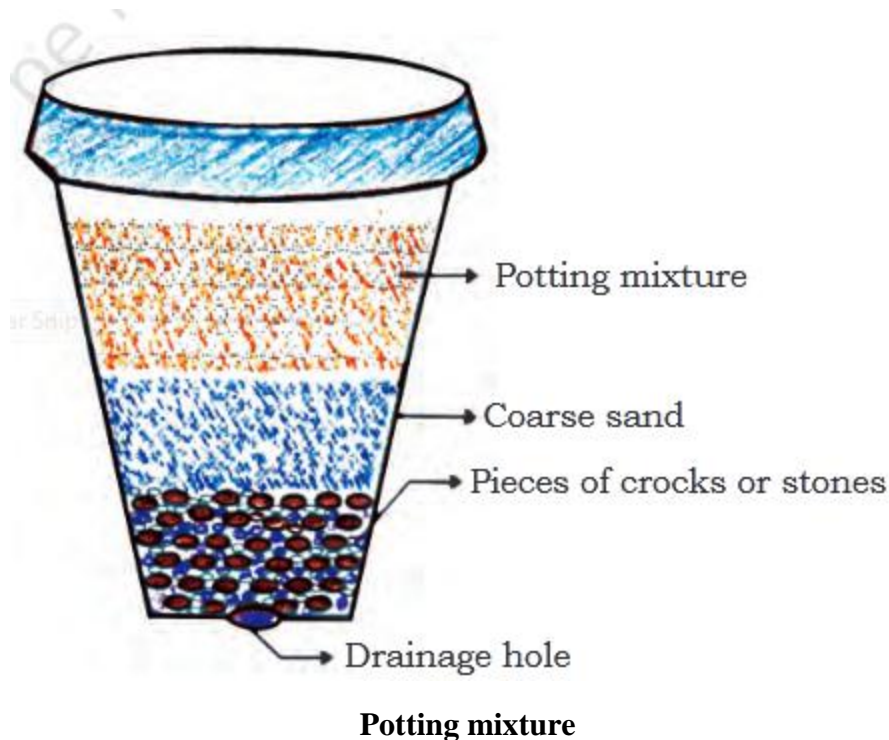
Plastic pots, round and square are used to keep mostly indoor plants. They are reusable, light weight, non-porous and they require only little storage space

### Potting, de-potting and re-potting Pots

Ornamental plants are grown in a variety of pots, depending on the choice of a person, including plastic, clay, cement, ceramic, etc. Pots are used for growing house plants (indoor and outdoor). Clay pots are the most popular, easily available, highly porous and cheaper than other type of pots. Size is an important factor while selecting pots. For specimen plant display, the pot size needs to be at least 30 cm in diameter. The size of the plant and its growth habit are to be considered before selecting a pot. Potting refers to transferring of plants from seedbed or poly-bags to pots, containing the potting mixture.

### Potting mixture

The potting mixture must be light in weight and have adequate water-holding capacity. It must allow drainage and supply adequate nutrients to plants. The mixture needs to be free from insect-pests and soil-borne pathogens. For ferns and bulbous plants, the mixture needs to be highly porous in nature, comprising coarse sand, light garden soil and leaf mould. Neem cake and bonemeal may also be used in small quantities as nutrients. Potting of rooted cutting and young seedlings: 1 or 2 part sand + 1 part loamy soil + 1 part peat moss or leaf mould Potting general container grown nursery stock: 2 part sand + 4 part loamy soil + 2 part peat moss or leaf mould + 1 part rotten FYM



### Potting

Potting is the process of planting new plants in pots containing suitable mixture for their growth and establishment. It is a simple operation but requires a certain degree of skill and practice. The following points must be taken care of while potting a plant. • The size of the pot must be suitable to set the plant. • Before filling the pots, crocks of 3–5 cm must be placed at the drainage hole to avoid clogging, followed by a 5–8 cm layer of coarse sand. • The pot is filled

with the potting mixture, leaving 2.5 cm from the rim, for holding water. • The pot can now be used for sowing seeds, potting of plants or cuttings. • For planting, a healthy and well-rooted plant is carefully dug out from a nursery bed. • The plant is placed with the ball of earth in the center of the pot. • Fill potting mixture all around the ball of earth, and press it firmly and uniformly. Care must be taken that the ball of earth is not pressed too hard as it will break and damage the roots. • Water the plant with a fine nozzle can immediately after planting. • Place the potted plant in a cool and shady place for establishment. • Staking is also provided, depending on the plant type, to support the plant. • Deciduous house plants are planted in February–March, while evergreens are planted in July–August.

### **De-potting**

De-potting is the removal of a plant from a pot for planting in soil, bed or another pot. As roots are sensitive and prone to injuries, care needs to be taken while de-potting the plant. It is better to de-pot the plant along with the soil attached to its root system. This soil, if needed, can be removed carefully after de-potting.

### **Procedure**

The pot needs to be watered before de-potting. The pot is lifted by the right hand palm spread over the top of the soil, holding the stem between the second and third finger, and the thumb along the side of pot. The pot is then turned upside down. If necessary, a gentle tap is given on the rim of the inverted pot against a solid base or on the edge of bench to loosen the earth ball. The whole earth ball with the intertwining roots of the plant will come out as a single piece and kept outside carefully. Before transferring the plant to a new pot, the lower old and finer roots along with some old potting mixture are removed.

### **Re-potting**

The first step in re-potting is de-potting. A de-potted plant needs to be re-potted in a fresh pot. For better growth of house plants, re-potting and transplanting of the established plants are done once in a year or two, depending on the type of plants and their growth habit. Re-potting is done when the plants have become pot-bound or overgrown, and also the potting mixture has become devoid of essential nutrients, resulting in poor growth of the plants. Depending on the plant type, it is done in February–March or September–October. During re-potting, the old potting mixture is replaced and the overgrown roots are pruned. Procedure • Prune the plant lightly before re-potting to remove excess shoot growth. • All adhering crocks along with some amount of the old mixture must be carefully removed from the base of the earth ball. • Decayed, dead, dried, twisted and unwanted roots are removed with a sharp knife or secateurs.

The plant is placed in a new pot at the same depth in soil at which it was in the old pot. The pot is filled with fresh potting mixture, and then watered.

### **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.

### **Bureau of Indian Standards (BIS-2008) Related to Nursery**

Different systems and standards of nursery are available for control the quality measures. Since agricultural practices are highly localized occupations they display a lot of variability in cultural

practices and varietal preferences across regions. Further, with the opening up of the world market, there is a flow of trade in the agricultural products. It is, therefore, necessary to define and assign certain common minimum standards to facilitate trade in these products and to win the confidence of the consumers within the country and outside. This draft Indian Standard (Part 1) (Doc: FAD 22 (1949) C) is first in a series of Indian Standards on Good Agricultural Practices (GAP) to be developed. Following table depicts some of the provisions mentioned in BIS specific to nursery.

Item	Level	India GAP requirements–related to nursery	Compliance criteria
Propagation	Minor	Has the recommended technology both in primary and secondary nursery, as applicable, followed in raising the seedlings in the open or under protected conditions? Is the source of technology documented?	Verify for quality control systems, viz., raised seedbeds, soil solarization, granular application of insecticides, drenching soil surface with fungicides etc. Documentation should be maintained to verify claim.
Nursery protection	Minor	Are the preventive measures against pests and diseases taken? Are crop protection treatments applied in the nursery or during plant propagation recorded? Is a record of approved products and treatment methodology used during seedling growth in the nursery, maintained?	Check if the planting material is protected against pests and diseases in the nursery before release. Necessary documentation should be maintained to verify the claim.
Stock scion compatibility	Recognition/ Critical	Is the selection of root stock and scion appropriate and graft compatible?	Check the records for appropriate age and growth of stock & scion used and the percentage graft taken in the nursery and visible compatibility.

(Source: India GAP Part 1 Crop Base, 2008, BIS, New Delhi, Doc: FAD 22 (1949) C, p 28).

At present, there is no legislation to regulate production and sale of seedling and vegetative propagules by nurseries. A mechanism to ensure the quality of planting material needs to be developed through registration and quality control.