NURSERY & GARDENING

S. ASIFA TABASSUM

&

M. JABEEN KOWSAR

Lab Coordinator

Department of Biotechnology

M.M.E.S Women's Arts and Science College

UNIT 1

NURSERY & GARDENING

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.

It occupies an important place in artificial regeneration. The following objects 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 to-be 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.

6. 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.

BUILDING UP OF INFRASTRUCTURE FOR NURSERY

Building up infrastructure for a nursery involves creating a controlled environment where plants can be started from seeds and nurtured until they are ready for transplantation. This infrastructure is critical for producing healthy and vigorous seedlings that will thrive when transplanted into the field. Here are the key components to consider when building nursery infrastructure:

1. **Location and Site Selection:**
    - Choose a site with good sunlight exposure, preferably receiving direct sunlight for a significant portion of the day.
    - Ensure access to water sources for irrigation and misting systems.
    - Consider proximity to the growing area to minimize transportation of seedlings.
2. **Greenhouse or Shade Structure:**
    - Greenhouses provide protection from adverse weather conditions, temperature control, and regulated light exposure.

- Shade structures are used to control light levels and protect young seedlings from excessive sun exposure.

3. **Irrigation System:**
    - Install an efficient irrigation system to ensure consistent and controlled watering for optimal plant growth.
    - Drip irrigation, misting systems, or overhead sprinklers are commonly used in nurseries.

Growing Medium and Containers:

- Choose appropriate growing media (potting mix) that provides good drainage and nutrient-holding capacity.
- Select containers of various sizes, such as trays, pots, or cell packs, based on the types of plants you plan to grow.

Climate Control:

- Install heating, cooling, and ventilation systems to regulate temperature and humidity.
- Automated systems can help maintain optimal conditions for seedling growth.

Lighting:

- Supplemental lighting may be necessary, especially in areas with limited sunlight or for year-round production.
- LED grow lights can mimic natural sunlight and promote healthy seedling development.

Shelving and Bench Systems:

- Efficient use of space is crucial. Shelving and bench systems optimize plant exposure to light and airflow.

- **Pest and Disease Management:**
- Implement integrated pest management (IPM) practices to prevent and control pests and diseases.
- Quarantine procedures can help prevent the introduction of pests from outside sources.
- Adjustable shelving allows for different plant heights.

Propagation Area:

- Designate an area for germination and initial growth of seeds.
- Consider using seedling trays or plug trays for efficient space utilization.

Hardening-off Area:

- Allocate space for gradually acclimating seedlings to outdoor conditions before transplanting.
- Gradual exposure to wind, sun, and temperature fluctuations helps reduce transplant

Work Area and Storage:

- Include a workspace for potting, transplanting, and maintenance tasks.
- Storage space for tools, equipment, and supplies is essential.

Sanitation and Hygiene:

- Maintain a clean and hygienic environment to minimize disease spread.
- Regularly disinfect tools, equipment, and growing surfaces.

Record-Keeping:

- Implement a system to track planting dates, cultivar details, growth progress, and other relevant information.

Accessibility and Infrastructure Maintenance:

- Ensure pathways and access points are well-designed for easy movement and maintenance.
- Building a nursery infrastructure requires careful planning, investment, and attention to detail. The goal is to create an environment that promotes healthy seedling growth, enables efficient workflow, and contributes to successful transplantation and plant establishment in the field.

- Take photos and notes during the activities. This not only provides memories but also helps you reflect on what worked well and what could be improved for future
- even the children themselves to make improvements for the next cycle.

PLANTING-DIRECT SEEDING AND TRANSPLANTS

Planting methods are essential in agriculture and gardening, as they can greatly influence the success and growth of crops. Two common planting methods are direct seeding and using transplants. Let's explore both methods:

1. **Direct Seeding:** Direct seeding, also known as sowing, involves planting seeds directly into the soil where the plants are intended to grow. This method is suitable for crops that have small seeds and can easily establish themselves in the growing environment. Here's how direct seeding works:

- **Advantages:**
    - Cost-effective: Direct seeding is generally less expensive than using transplants, as it eliminates the need for seedlings and nursery facilities.
    - Simplicity: It's a straightforward method, requiring less labor and equipment compared to transplanting.
    - Natural growth: Plants grown from direct-seeded seeds tend to develop a taproot system, which can enhance their ability to access nutrients and water from deeper soil layers.
- **Disadvantages:**

- Longer establishment time: Direct-seeded plants often take longer to establish and start growing vigorously compared to transplants, as they need to germinate and develop from seeds.
- Vulnerability: Young seedlings emerging from the soil are more susceptible to pests, diseases, and adverse weather conditions.
- Inconsistent spacing: Achieving uniform spacing between plants can be challenging, leading to competition for resources as plants grow.

2. **Transplants:** Transplants involve starting plants from seeds in a controlled environment, such as a greenhouse or nursery, and then transplanting the young seedlings into the final growing location. This method is particularly useful for crops with larger seeds or those that benefit from a head start in a protected environment. Here's how transplanting works:

- **Advantages:**
  - Early start: Transplants offer a head start to plants, as they can be grown indoors or in protected conditions, allowing for earlier planting in the field.
  - Controlled conditions: Seedlings are less exposed to pests, diseases, and harsh weather during their early stages.
  - Uniform spacing: Transplants are usually spaced consistently, optimizing resource utilization and growth.
- **Disadvantages:**
  - Cost: Transplanting can be more expensive due to the need for nursery facilities, containers, and labor for transplanting.
  - Skill required: Growing healthy seedlings requires expertise in managing greenhouse/nursery conditions and handling seedlings during transplantation.
  - Root disturbance: Transplanting can disrupt the root system of seedlings, leading to transplant shock if not done carefully.

The choice between direct seeding and using transplants depends on various factors, including the specific crop, local climate, available resources, labor, and the desired time to harvest. Some

crops are better suited for direct seeding, while others benefit from the advantages of transplants. Growers often consider these factors when deciding which planting method to use for each crop in their operation.

UNIT 2

SEED: STRUCTURE AND TYPES

What is the Seed?

A seed is a basic part of any plant. The ovules after fertilization, develop into seeds. A seed is made up of a seed coat and an embryo. The embryo is made up of a radicle, an embryonal axis and one (wheat, maize) or two cotyledons (gram and pea). A seed is found inside a fruit which converts into a new plant when we plant it. Hence, the seed is the most important part.

Types of Seeds

A Seed is primarily of two types. The two types are:

- Monocotyledonous Seed
- Dicotyledonous Seed

Let us now study about these types of seeds in brief.

Structure of a Monocotyledonous Seed

A Monocotyledonous seed, as the name suggests, has only one cotyledon. There is only one outer layering of the seed coat. A seed has the following parts:

- **Seed Coat:** In the seed of cereals such as maize, the seed coat is membranous and generally fused with the fruit wall, called Hull.
- **Endosperm:** The endosperm is bulky and stores food. Generally, monocotyledonous seeds are endospermic but some as in orchids are non-endospermic.
- **Aleuron layer:** The outer covering of endosperm separates the embryo by a proteinous layer called aleurone layer.
- **Embryo:** The embryo is small and situated in a groove at one end of the endosperm.
- **Scutellum:** This is one large and shield-shaped cotyledon.
- **Embryonal axis:** Plumule and radicle are the two ends.

- **Coleoptile and coleorhiza:** The plumule and radicle are enclosed in sheaths. They are coleoptile and coleorhiza.

Structure of a Dicotyledonous Seed

Unlike monocotyledonous seed, a dicotyledonous seed, as the name suggests, has two cotyledons. It has the following parts:

- **Seed coat:** This is the outermost covering of a seed. The seed coat has two layers, the outer testa and the inner tegmen.
- **Hilum:** The hilum is a scar on the seed coat through which the developing seed was attached to the fruit.
- **Micropyle:** It is a small pore present above the hilum.
- **Embryo:** It consists of an embryonal axis and two cotyledons.
- **Cotyledons:** These are often fleshy and full of reserve food materials.
- **Radicle and plumule:** They are present at the two ends of the embryonal axis.
- **Endosperm:** In some seeds such as castor, the endosperm formed as a result of double fertilisation, is a food storing tissue. In plants such as bean, gram and pea, the endosperm is not present in the matured seed. They are known as non-endospermous.

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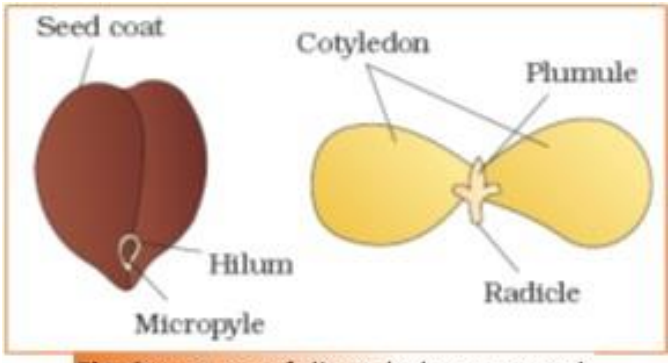


Fig: Structure of dicotyledonous seed

SEED BANKS

Seed banks

A seed bank is a type of gene bank where seeds of different crops and rare plant species are stored for future use. Seed banks are created to maintain and protect biodiversity, where samples of all species are collected and stored. In case seed reserves elsewhere are destroyed, the seed bank is opened to provide seeds to farmers at defined quantities for growing plants.

Most of the seeds can be stored for centuries without damaging their genetic properties. However, they should be replanted after a certain time period in order to avoid eventual DNA damage. The seeds are frozen at temperatures below -4 degrees centigrade and stored in seed vaults.

Seed banks primarily involve in selecting, collecting, and storing seed varieties. They also form seed exchange networks with government organizations, NGOs and community seed banks across the world. They also form ex-situ storage facilities. They help in seed exchange, on-farm conversation with experts and farmers, training and capacity building for farmers and continuous monitoring of cultivation. The Millennium Seed Bank and Svalbard Global Seed Vault are the largest seed banks in the world.

Well-known Seed Banks in India

The Indian government established the National Seeds Corporation in 1963 both at the national level and in every state. Working under the Ministry of Agriculture, NSC undertakes production, processing and marketing of agricultural seeds. It is also involved in formulation of seed certification standards done through seed testing laboratories by checking the compatibility of different seeds. State agricultural universities and the Indian Council for Agricultural Research

(ICAR) are involved in seed production and distribution. For each region or village there are community seed banks available for exchanging seeds.

Apart from government organizations, several private and voluntary organizations have also set up seed banks across India:

- **Navdanya** is a leading NGO advocating for biodiversity conservation through a large network of seed keepers and organic producers. Led by Vandana Shiva, it has created a women centered movement for protecting biological and cultural diversity. Navdanya has helped set up 54 community seed banks, as well as the largest direct marketing, fair trade organic network in the country.
- **Annadana Seed and Soil Savers** led by Sangita Sharma works toward conserving food plant diversity and support sustainable natural farming. The Annadana Seed Bank conserves and distributes 101 varieties of organic open-pollinated vegetable seeds.
- **Green Foundation** is a community based organization started in 1996, which works on conserving local seed diversity and promoting biodiversity-based ecological agriculture. It has a network of farmer associations spread across 109 villages in Karnataka and Tamilnadu for preserving and promoting agro-biodiversity through community seed banks.
- **Deccan Development Society** is another NGO involved in conserving agro-biodiversity, which works with voluntary associations to help women and agricultural laborers in Andhra Pradesh. It has initiated a community gene bank project to preserve agro-biodiversity, networking with a number of small organizations involved in seed bank activities.
- **Sahaja Samrudha** is an organic farmers' collective that works for preserving India's traditional farming practices and the rich biodiversity of its indigenous crop varieties. It has created a seed savers group in Karnataka, which has done some remarkable work in identifying rare varieties of paddy, millets, lentils, vegetables, etc.

By preserving biodiversity, we can make farming systems more stable and sustainable, which would help farmers to lead a stable life and reduce the number of suicides of farmers due to income loss and natural disasters. We can also increase income for farmers by diversifying their produce, improving human nutrition and protecting the ecosystem.

FACTORS AFFECTING SEED QUALITY

A variety of factors can affect seed viability such as **the ability of the plant to produce viable seeds, predator and pathogen damage, and environmental conditions like flooding or heat**. The age of the seed also affects its health and germination ability.

- Germination. The germination rate of seed is often the first characteristic growers will look at when measuring a seed's overall quality. ...
- Varietal purity. ...
- Physical purity. ...
- Optimum moisture content. ...
- Free from pest and disease. ...
- H2 certified seed.

FACTORS AFFECTING SEED VIABILITY

Seed viability refers to the ability of a seed to germinate and develop into a healthy plant under optimal conditions. Several factors can influence seed viability, and understanding these factors

is crucial for successful plant propagation and agriculture. Here are some of the key factors affecting seed viability:

1. **Age of the Seed**: As seeds age, their viability generally decreases. Over time, the metabolic processes within the seed can slow down, leading to reduced germination rates.

2. **Storage Conditions**: Proper storage conditions are critical for maintaining seed viability. Seeds should be stored in cool, dry, and dark environments to minimize deterioration. Moisture, light, and temperature fluctuations can all contribute to reduced viability.

3. **Temperature**: Extreme temperatures, either too high or too low, can adversely affect seed viability. High temperatures can cause damage to the seed's cellular structures and enzymes, while low temperatures can lead to freezing and cell rupture.

4. **Moisture Content**: Seeds contain varying levels of moisture, and maintaining the appropriate moisture content is crucial. If seeds are too dry, they can become dormant and lose viability. Conversely, if they are too wet, they can become prone to mold and other forms of deterioration.

5. **Seed Coat Integrity**: The seed coat or seed coat structure plays a role in protecting the embryo from external factors. Damage to the seed coat can expose the embryo to pathogens, dehydration, and other detrimental conditions.

6. **Seed Dormancy**: Some seeds have built-in dormancy mechanisms that prevent them from germinating immediately after maturity. This mechanism allows seeds to wait for favorable conditions. Breaking seed dormancy often requires specific conditions, such as exposure to cold temperatures or scarification (mechanical or chemical treatment to weaken the seed coat).

7. **Genetic Factors**: The genetic makeup of the seed can influence its viability. Some plant varieties naturally produce seeds with higher viability and better germination rates.

8. **Pathogens and Pests**: Seeds can be vulnerable to attack by pathogens (disease-causing microorganisms) and pests. Fungal or bacterial infections can significantly reduce viability.

9. **Oxygen Availability**: Oxygen is required for respiration, which provides energy for germination. Inadequate oxygen supply can lead to reduced viability and poor germination.

10.Seed Quality: The overall health and quality of the parent plant influence the viability of the seeds it produces. Plants that are stressed, malnourished, or genetically compromised are more likely to produce lower-quality seeds.

11.Harvesting Techniques: Improper harvesting techniques can damage seeds and reduce their viability. Using sharp and clean tools, as well as handling seeds with care, is important during the harvesting process.

12.Pollination and Fertilization: Successful pollination and fertilization are necessary for the production of viable seeds. Pollination issues, such as limited pollinator availability or cross-pollination with unrelated species, can affect seed viability.

13.Chemical Exposure: Seeds exposed to certain chemicals, such as herbicides or pollutants, can experience reduced viability. Chemical residues can interfere with the seed's metabolic processes.

To ensure the best possible seed viability, it's essential to consider these factors and provide appropriate care during seed collection, storage, and propagation processes. Different plant species may have specific requirements, so understanding the needs of the particular plants you're working with is key to successful seed management.

SEED TESTING AND SEED CERTIFICATION

Seed production technology involves various practices and processes aimed at producing high-quality seeds that are genetically pure, physically healthy, and have good germination potential. Seed testing and certification are integral components of seed production technology, ensuring that the seeds meet certain quality standards before they are distributed to farmers and growers for planting. Here's an overview of seed testing and certification:

Seed Testing: Seed testing involves evaluating the quality and viability of seeds through various laboratory tests and assessments. The goal is to determine whether the seeds meet specific standards for germination, purity, vigor, and other characteristics. Seed testing helps identify any issues that could affect the performance of the seeds when planted. The following are common tests conducted during seed testing:

1. **Germination Test:** This test determines the percentage of seeds that will germinate under optimal conditions. A sample of seeds is placed in controlled conditions, and germination rates are monitored over a specific period.

2. **Purity Test:** Purity testing assesses the presence of inert matter, other crop seeds, weed seeds, and undesirable contaminants in the seed lot.

3. **Seed Health Test:** This test checks for the presence of pathogens such as fungi, bacteria, and viruses that could potentially infect the plants grown from the seeds.

4. **Vigor Test:** Vigor testing assesses the overall health, strength, and potential for rapid, uniform germination and seedling establishment. It provides an indication of seed performance under less-than-ideal conditions.

5. **Moisture Content Test:** Measuring the moisture content of seeds is crucial to determine their storage stability and potential for germination.

6. **Physical Purity Test:** This test identifies the presence of other seeds, broken seeds, or inert materials in the seed lot.

Seed Certification:

Seed certification is a process through which seeds are officially tested, inspected, and certified to meet established quality standards before they are sold to farmers and growers. Seed certification helps maintain the integrity of seed varieties, ensures that seeds are true to type, and reduces the risk of introducing diseases and pests to new areas. The certification process involves the following steps:

Field Inspection: Certified seed production begins with inspecting the seed-producing fields to ensure that they meet the required standards for isolation from other crops, absence of contaminants, and adherence to good agricultural practices.

Sampling: Samples are collected from the seed lot and sent to accredited seed testing laboratories for analysis. The laboratory tests assess various quality parameters, as mentioned earlier.

Certification Decision: Based on the laboratory test results and field inspection reports, a certification authority decides whether the seed lot meets the certification standards.

Certification Labels: If the seed lot meets the standards, it is labeled as "certified seed" and may include information about its quality, purity, and germination percentage.

Certification Classes: Certified seeds are often categorized into different classes based on their quality. These classes may include "breeder seed," "foundation seed," "registered seed," and "certified seed," each representing a different level of genetic purity and quality.

Seed testing and certification are crucial for ensuring that farmers and growers have access to high-quality seeds that will result in healthy, productive crops. By following these practices, the agricultural industry can maintain the genetic integrity of plant varieties and contribute to improved crop yields and food security.

UNIT 3

"Hardening" in the context of plants refers to the process of gradually acclimating or toughening up young plants that have been grown in controlled environments, such as greenhouses or indoor setups, before they are transplanted into outdoor conditions. The goal of hardening is to prepare the plants for the often harsher environmental conditions they will face outside, including

changes in temperature, sunlight intensity, wind, and humidity. This process helps minimize transplant shock and allows plants to establish themselves more successfully in their new environment.

Here's how the hardening process typically works:

1. **Gradual Exposure:** Start by exposing the young plants to outdoor conditions for short periods of time, gradually increasing the duration over the course of several days to a week. This helps plants slowly adjust to the changes in temperature, wind, and sunlight.

2. **Shade Protection:** Initially, place the plants in a partially shaded area to prevent them from getting direct sunlight, which can be much stronger outdoors than in controlled indoor environments.

3. **Wind Exposure:** Gradually introduce the plants to wind or gentle breezes. This helps strengthen the stems and leaves, making them more resistant to wind damage.

4. **Temperature Fluctuations:** Expose the plants to cooler temperatures during the night and warmer temperatures during the day. This helps plants become more resilient to temperature fluctuations.

5. **Reduced Watering**: Reduce the frequency of watering slightly during the hardening process. This encourages the plants to develop deeper and stronger root systems as they search for moisture.

6. **Transplanting**: After the hardening period, when the plants have become accustomed to outdoor conditions, they can be transplanted into their final growing locations.

7. **Monitoring**: Keep a close eye on the plants during the hardening process. If you notice any signs of stress, such as wilting or yellowing leaves, adjust the exposure or conditions accordingly.

It's important to note that the specific duration and conditions for hardening can vary based on the type of plants you're working with and the local climate. Some plants may require longer or shorter hardening periods, and some may be more sensitive to changes in conditions. Understanding the specific needs of the plants you're hardening is crucial for a successful transition.

Hardening is a valuable practice to ensure that plants are well-prepared to thrive in their new outdoor environment. It reduces the risk of transplant shock, increases the plants' chances of survival, and promotes healthier growth and development.

GREEN HOUSE-MIST CHAMBER

A mist chamber is a specialized tool used in plant propagation and horticulture, often in combination with a greenhouse or controlled environment, to create a humid and controlled environment that promotes the successful rooting and growth of cuttings or seeds. The mist chamber provides a high humidity environment that reduces water loss through transpiration and encourages the development of roots and shoots.

Here's how a mist chamber works and its role in plant propagation:

1. Structure and Setup: A mist chamber is typically a covered structure, often made of transparent materials like plastic or glass, which allows sunlight to penetrate while maintaining high humidity. It can be a standalone structure or incorporated within a greenhouse. Inside the mist chamber, there are misting nozzles or systems that periodically release fine droplets of water into the air, creating a misty or foggy environment.

2. Humidity Control: The misting system in the chamber helps maintain high humidity levels. High humidity is crucial for plant cuttings and seeds because it reduces water loss

from leaves and promotes the absorption of water and nutrients through the plant's tissues. This encourages root development and minimizes stress on the young plants.

3. Plant Propagation: Mist chambers are commonly used for propagating plants from cuttings, where a piece of a parent plant is cut and encouraged to grow new roots. The cuttings are often placed in a rooting medium, such as a mixture of peat moss and perlite. The high humidity environment in the mist chamber helps prevent excessive water loss from the leaves of the cuttings while they develop new roots.

4. Seed Germination: Mist chambers can also be used for germinating seeds. The humid environment helps create optimal conditions for seed germination by providing consistent moisture to the seeds, promoting quicker and more successful sprouting.

5.Temperature and Light: Temperature and light are important factors in conjunction with humidity for successful propagation. Mist chambers are often placed within greenhouses where temperature and light can be controlled to suit the specific needs of the plants being propagated.

6. Transition to Normal Conditions: After a certain period of time and once the cuttings or seedlings have developed enough roots or shoots, they are gradually acclimated to normal conditions by reducing the misting frequency and increasing ventilation. This process, similar to the hardening process mentioned earlier, helps the plants transition to more typical growing conditions without stress.

Mist chambers play a significant role in enhancing the success of plant propagation by providing an environment that encourages root growth and minimizes transplant shock. They are particularly useful for delicate or sensitive plants that might struggle to establish themselves in less controlled environments.

SHED ROOT, SHED HOUSE AND GLASS HOUSE

1. Shade Cloth or Shade House: A shade cloth, also known as a shade net or shade screen, is a woven or knitted fabric that provides shade to plants. It is used to protect plants from excessive sunlight, reduce temperature stress, and prevent sunburn. A shade house is a structure covered with shade cloth and is designed to create a controlled

environment with reduced light intensity. Shade houses are commonly used for growing shade-loving plants, nursery seedlings, and delicate plants that require protection from intense sunlight.

2. Greenhouse: A greenhouse is a controlled environment structure made of transparent materials like glass or plastic. It is designed to create a microclimate that allows for year-round cultivation of plants, regardless of external weather conditions. Greenhouses capture and trap solar energy, creating warmer temperatures inside. This controlled environment is ideal for starting seeds, growing plants that require specific temperature and humidity levels, and extending the growing season. The transparency of the walls allows sunlight to enter and supports photosynthesis while maintaining a warmer interior.

3. Glass House: A glass house is essentially a type of greenhouse that specifically uses glass panels as its transparent covering. Glass houses provide excellent visibility and allow a significant amount of sunlight to enter. They offer advantages in terms of aesthetics and light transmission. However, they can also be more expensive to build and maintain compared to greenhouses covered with other materials.

When considering which structure to use for your plants, it's essential to consider factors such as the type of plants you're growing, the local climate, your budget, and your specific goals for plant cultivation. Different structures offer varying levels of control over temperature, humidity, and light conditions, which can greatly impact the success of your gardening or agricultural endeavours.

vegetative propagation: air layering, cutting, selection of cutting, collecting season, treatment of cutting

Introduction A large number of horticultural crops are raised through one or the other vegetative methods. Several methods of vegetative propagation have been standardized for different horticultural crops. However, one method of propagation may be suitable for a particular crop but may not be suitable for the others. Similarly, one crop may be propagated on large scale with different methods of propagation, whereas, the others may have only one method. Further, the success of different propagation methods is influenced by the environmental conditions. Hence, one method for a particular crop may

be highly successful in a particular locality, but cannot be of any value in the other. For instance, side veneer grafting is successful method of mango propagation in north India but in Konkan region of Maharashtra, epicotyl or stone grafting is more successful. The different methods of vegetative propagation
include:

1. Propagation by apomictic seedlings (mango, citrus etc)
2. Propagation by cuttings and layering (propagation on its own root system)
3. Propagation by grafting and budding (propagation on the root system of other plants

Importance and advantages of propagation by cuttings

- Now-a-days, propagation system are more market driven than production-driven, which means that propagators must first analyze market demands and then select and develop cultivar utilizing optimum propagation techniques to produce plants for the customers.
- Cuttings are still most important means of propagating ornamental shrub-deciduous species as well as broad and narrow leaved types of evergreen plants.

Cuttings are also widely used in commercial green house propagation of many floricultural crops.

Advantages

- Many new plants can be produced in a limited space.
- It is inexpensive, rapid and simple and does not require the special techniques necessary in grafting, budding or micropropagation.
- No problem of graft incompatibility with rootstock and poor graft union etc.
- No variation due to variable seedling rootstocks.

Disadvantages

The advantages of rootstock like induction of dwarfism, drought or disease resistance etc. cannot be utilized

Plants raised through cuttings have lesser longevity as they are susceptible to various diseases and insect-pests.

Types of cuttings On the basis of plant part used and relative positions on a plant, cuttings are classified in various groups.

a.) Stem cuttings: A stem cutting is any cutting taken from the main shoot of a plant or any side shoot growing from the same plant or stem. The shoots with high carbohydrate content usually root better. Broadly, there are four types of stem cuttings, namely hardwood, softwood, semi-hardwood and herbaceous cuttings.

i) Hardwood cuttings: Cutting from mature and lignified stem of shrubs and trees are called as hardwood cuttings. Hardwood cuttings are prepared during dormant season, usually from one-year-old shoots of previous season's growth. The size of cuttings varies from 10 to 45 cm in length and 0.5 to 2.5 cm in diameter, depending upon the species. Usually, the cuttings of 25-30 cm length, with pencil thickness are preferred. Each cutting should have at least three or more buds. While preparing the cutting, a straight cut is given at the base of shoot- below the node while a slanting cut, 1 to 2 cm above the bud is given at the top of cutting. However, in case of hollow pith species such as kiwifruit, top cut should also be close to bud to avoid drying up of top portion. For tropical and subtropical crops, straight cut is given at top in order to minimize transpiration loss and slant cut should be given at the base to expose more area for absorption of water and nutrients. This helps in maintaining the polarity of the shoot and if rain occurs, water does not accumulate on the tip of the cutting, which saves the cutting from fungal infection. A number of deciduous fruit plants like grape,

kiwifruit, hazel nut, chest nut, fig, quince, pomegranate, mulberry, plum, olive, and gooseberry etc. are commercially propagated by hardwood cuttings.

ii) Semi-hardwood (green wood) cuttings:

Semi-hard wood cuttings are those made from woody, broad-leaved evergreen species with partially matured wood. These types of cuttings are mostly used in evergreen fruit plants like mango, guava, lemon, jackfruit some shrubs and shrubby ornamental plants. The length of the cuttings varies from 7 to 20 cm. The cuttings are prepared by trimming the cuttings with a straight cut below the node and removing a few lower leaves. However, it is better to retain two-to-four leaves on the top of the cuttings. While planting 1/4th cutting should be inserted in the soil. The best time for taking such cuttings is summer, when new shoots have emerged and their wood is partially matured. It is

necessary that leafy cuttings should be rooted under conditions when water loss from the leaves is minimum. Commercially, such cuttings are rooted under intermittent mist, fog or under polyethylene sheets laid over the cuttings.

iii) Softwood cuttings: Cuttings prepared from the soft-succulent and non-lignified shoots, which are not hard or woody, are called as softwood cuttings. Such types of cuttings are very prone to desiccation. Therefore, proper arrangement for controlling humidity is required. Usually the size of cutting is 5-5.7 cm but it may vary from species-to-species. In general, some leaves should be retained with this type of cuttings. The best time for preparing softwood cuttings is late summer. Softwood cuttings generally root easier and quicker than other types, but require more attention and sophisticated equipments. Similarly, the temperature should be maintained 23 to 27oC during rooting at the base of cuttings.

iv) Herbaceous cuttings: Herbaceous cuttings are made from succulent non-woody plants like geranium, chrysanthemum, coleus, carnation and many foliage crops. These are usually 7-15 cm long with few leaves retained at the upper end. These are rooted under the same conditions as that of softwood cuttings, requiring high relative humidity. Bottom heat is also useful for initiation of rooting process. Herbaceous cuttings of some plants exclude a sticky sap (as in geranium, pineapple, cactus etc.) that interferes with root initiation process. In such cases, basal ends of cuttings should be allowed to dry for few hours before planting. Generally, fruit plants are not propagated by herbaceous cuttings.

b) Root cuttings: Propagation by means of root cuttings is also a simple and cheap method of vegetative propagation in species, which are difficult-to-propagate by other methods. In general, the plants, which produce suckers freely, are easily propagated by root cuttings. For preparation of root-cuttings, roots which are of 1cm thickness and 10-15 cm long are cut into pieces. The best time for taking root cutting is late winter or early spring, when roots are well supplied with stored food material. However, in temperate fruits, root cuttings are prepared in the month of December and are kept in warm place in moss grass or wet sand for callusing and are then transplanted in the nursery during February-March in the open beds. Blackberry and raspberry are

commercially propagated by this method. However, kiwifruit, breadfruit, fig, rose, mulberry, apple, pear, peach, cherry and persimmon are also propagated by root cuttings.

c) Leaf cuttings: Propagation through leaf bud cuttings is partially useful in species where leaves develop root system but die because of non-development of shoot system. Leaf bud cuttings are particularly useful when planting material is scarce because each node in leaf can be used as cutting. Leaf bud cutting should preferably be prepared during growing season because buds if enter into dormancy may be difficult to force to active stage, thereby inhibit the rooting in such cuttings.

d) Leaf bud cuttings: A leaf bud cutting consists of a leaf blade, petiole and short piece of stem with attached axiliary bud of actively growing leaves. In leaf bud cutting, 10-15 cm stem portion is used when propagating material is small. It is an useful method of propagation in blackberry, raspberry, lemon, camellia etc.

Layering techniques Layering is a form of rooting of cuttings in which adventitious roots are initiated on a stem while it is still attached to the plant. The rooted stem (layer) is then detached, transplanted, while later becomes a separate plant on its own roots. It is a natural mean of propagation in black raspberries and trailing blackberries or it may be induced artificially in many plants like clonal rootstocks of apple. In general, better rooting in the layers can be obtained by ringing or wounding, etiolation or by the use of rooting hormones like IBA, NAA and by providing favorable environmental conditions (temperature and humidity) .

Advantages

- It is an effective method of propagating species that usually do not root easily by cutting as in mango, litchi, filberts and kumquat etc.
- It is a natural method of propagation in blackberries and raspberries.
- It does not require precise control on water, relative humidity or temperature, as for other methods of propagation.
- Easy-to-perform and does not require much infrastructure. Disadvantages • Costlier in areas where labour availability is a problem.
- Limited number of plants can be produced.
- Plants produced through layering have usually small brittle roots.

- The mortality rate is particularly higher in air layered plants.

Types of layering

The most commonly used systems to layer plants include:

- Simple layering
- Compound/ serpentine layering
- Continuous/Trench Layering
- Air layering
- Mound/ Stool layering
- Of these, the most commercially important are mound layering for multiplication of rootstocks and air layering for some tropical fruits.

Simple Layering Simple layer consists of bending an intact shoot to the ground to cause adventitious roots to form .This method can be used to propagate a wide range of plants, indoor or outdoor on woody shrubs that produce numerous suckers. Layering is usually done in the early spring using flexible, dormant, one-year-old shoot-branches of the plant that can be bent easily to the ground. These shoots are bent and "pegged down" at a location 15 to 20 cm from the tip forming a "U"shape. Bending, twisting, cutting, or girdling at the bottom of the "U" stimulates rooting at that location. The base of the layer is covered with soil or other media, leaving the tip exposed.

Compound or serpentine layering

It is a modification of simple layering in which one-year-old branch is alternatively covered and exposed along its length. The stem is girdled at different points in the underground part. However, the exposed portion of the stem should have at least one bud to develop a new shoot. After rooting, the sections are cut and lined out in the field. In this way, many new plants can be made from one branch. It is also an easy plant propagation method, but is suitable only for plants producing slender, long and flexible shoots. Muscadine grape is commercially propagated by this method.

Continuous or trench layering

It is the most common method of propagation for woody plants, which produce long vines and are difficult-to-propagate by other methods of propagation. Vigorous rootstocks of apple like M-

16, and M-25 and walnut can easily be propagated by trench layering. In this method, it is important to establish a permanent row of plants to be propagated.

The method the mother plants are planted at the base of a trench at an angle of 450 in rows spaced 90 cm apart. The long and flexible stems of these plants are pegged down on the ground to form a continuous line of layered plants. The young shoots that arise from these plants are gradually mounded up to a depth of 15-20 cm in autumn, winter or at the end of the growing season, depending on the species to be propagated.

Air layering (Marcottage, Gootee, Pot layerage)

Air layering is an ancient method of layering, originally introduced from China and now commercially used for propagation of a number of tropical and subtropical trees and shrubs including litchi, guava, mango, longan, Persian lime (Citrus aurantifolia), ficus, croton etc. Air layers are made in the spring or summer on stems of the previous season's growth. The presence of active leaves on the layered shoot speeds root formation.

Layers are prepared by making an upward cut about 5 cm long at or about the centre of the shoot. The shoot is then girdled by removing a ring of bark about 2 cm wide. The upper part of wound is applied with IBA paste made in lanolin. The wound is covered with moist sphagnum moss in a way to provide complete cover to it. Polyethylene film is wrapped around the moss grass in such a way as to leave no opening, which could allow evaporation of moisture from the moss The rooted layers may be severed from mother plant and may be planted in the nursery under shade.

Mound /Stool layering or stooling The term stooling was first coined by Lynch in 1942 for mound layering. It is a method of propagation in which the shoots/plants are cut back to the ground and soil or rooting medium is mounded around new sprouts/shoots to stimulate roots to develop at their bases. This method is commercially used to propagate apple, pear, quince, currants, gooseberry and other fruit crops. In stooling, the mother plant is headed back to 15 to 20 cm above ground level during dormant season.

- The new sprouts will arise within 2 months. The sprouts are then girdled near the base and rooting hormone (IBA), made in lanolin paste, is applied to the upper portion of the ring.

• The concentration of IBA depends on species to species but generally; 3,000 to 5,000 ppm is commonly used. These shoots are left as such for two days for proper absorption of rooting hormone, before they are covered with moist soil.

• Care should be taken to keep the soil heaps moist all the times. It facilitates rooting in the stools. The roots in shoots may emerge within 30 to 40 days.

• However, the rooted shoots should be severed from the mother plants only after 60 to 70 days and then planted in the nursery or field.

Tip layering

It is the simplest form of layering, which often occurs naturally. The tips of shoots are buried 5 to 10cm deep in the soil .Rooting in buried shoots takes place within a month.The new plants (layers) may be detached and transplanted in the soil during spring. It is a natural method of propagation for black berries, raspberries etc. However, currants, gooseberries and rambling roses can also be propagated by tip layering easily.

- **Selection:** Choose a healthy, mature stem that is not too old. The stem should be pliable and capable of bending without breaking.
- **Procedure:**
    1. Make a slanting cut on the stem, removing a section of bark and exposing the cambium layer.
    2. Apply a rooting hormone to the exposed area (optional but can enhance rooting).
    3. Wrap the treated area with moist sphagnum moss or other suitable medium, then cover it with plastic wrap to create a sealed environment.
    4. Secure the plastic wrap with tape or string to keep the medium in place.
    5. Over time, roots will develop within the moist moss.
    6. Once roots are well-developed, cut the stem below the rooted section and pot it up as a new plant.

2. Cuttings: Cuttings involve taking a portion of a plant, typically a stem or a leaf, and encouraging it to develop roots and grow into a new plant. Different types of cuttings include stem cuttings, leaf cuttings, and root cuttings.

- **Selection:** Choose healthy parent plants that are disease-free and vigorous. For stem cuttings, select young, non-flowering stems with several nodes.
- **Collecting Season:** The best time to take cuttings can vary based on the plant species. Generally, take cuttings during the plant's active growth period. Softwood cuttings are taken from new, flexible growth, while hardwood cuttings are taken from mature, woody stems.
- **Treatment:**
    1. Remove leaves from the lower nodes of the cutting to prevent excess moisture loss.
    2. Dip the cut end of the cutting in a rooting hormone (if desired) to promote root development.
    3. Insert the cutting into a well-draining rooting medium, such as a mix of perlite and peat moss.
    4. Provide high humidity by covering the cuttings with a clear plastic dome or placing them in a plastic bag.
    5. Place the cuttings in bright, indirect light. Avoid direct sunlight.
    6. Keep the rooting medium consistently moist but not waterlogged.
    7. Once roots have developed and the new plant has grown, gradually acclimate it to normal conditions.

In both air layering and cuttings, creating a suitable environment with the right amount of humidity, light, and moisture is crucial for successful propagation. Additionally, using rooting hormones can often enhance the rooting process and increase the success rate of the propagated plants.

UNIT 4

GAREENING :OBJECTIVES AND SCOPE

Gardening: Gardening is the practice of cultivating and growing plants, typically for aesthetic, ornamental, recreational, or food purposes. It involves various activities such as planting, nurturing, and maintaining plants in outdoor spaces like gardens, yards,

balconies, and other suitable areas. Gardening can encompass a wide range of plant types, from flowers and ornamental plants to vegetables, fruits, herbs, and even trees.

Objectives of Gardening: The objectives of gardening can vary depending on the individual's preferences, goals, and the type of plants being cultivated. Some common objectives include:

1. **Aesthetic Enhancement:** Many people garden to create visually pleasing and beautiful outdoor spaces. Flowers, landscaping elements, and well-designed layouts contribute to the aesthetic appeal of gardens.
2. **Food Production:** Gardening can provide a source of fresh fruits, vegetables, and herbs, contributing to self-sufficiency and a healthier diet.
3. **Recreation and Relaxation:** Gardens offer spaces for relaxation, meditation, and recreation. People often find gardening to be a therapeutic and stress-relieving activity.
4. **Environmental Benefits:** Gardens can contribute to biodiversity by supporting various plant and insect species. They also improve air quality, reduce erosion, and provide habitat for wildlife.
5. **Education:** Gardens can serve as valuable educational tools, teaching people about plant growth, ecosystems, and sustainable practices.
6. **Community Engagement:** Community gardens bring people together, fostering social interactions and a sense of community.

Scope of Gardening: Gardening covers a wide range of activities, each with its own specific scope:

1. **Ornamental Gardening:** This focuses on growing flowers, ornamental plants, shrubs, and trees to enhance the visual appeal of outdoor spaces. Landscape design and elements like pathways, water features, and sculptures are often part of ornamental gardening.
2. **Vegetable Gardening:** This involves cultivating edible plants such as vegetables, herbs, and fruits for personal consumption. It can range from small-scale home gardens to larger plots.
3. **Fruit Gardening:** Fruit gardening concentrates on growing fruit-bearing trees, shrubs, and vines. Apples, citrus, berries, and grapes are examples of fruits commonly grown in gardens.

4. **Container Gardening:** This involves growing plants in containers like pots, planters, and hanging baskets. It's suitable for limited spaces like balconies and patios.
5. **Indoor Gardening:** Also known as houseplant care, this focuses on growing and maintaining plants indoors. It's popular for enhancing indoor air quality and bringing nature indoors.
6. **Herb Gardening:** Herb gardens are cultivated for culinary, medicinal, and aromatic purposes. Herbs like basil, mint, and rosemary are commonly grown.
7. **Sustainable and Organic Gardening:** These approaches focus on environmentally friendly practices, reducing chemical inputs and promoting soil health.
8. **Botanical and Specialty Gardens:** These gardens may showcase specific plant species, ecosystems, or themes. Examples include cactus gardens, butterfly gardens, and Japanese gardens.

   Gardening is a versatile and rewarding pursuit that can cater to various interests and goals. It allows individuals to connect with nature, create beauty, and contribute positively to their surroundings.

TYPES OF GARDENING:

The main concept of gardening was cultivating that plants fulfill the viable need of servants watched out for spices, fruits, and vegetables. It said that main gardening was invented by Egyptian people around 4000 years ago.

Also, the now day's different **Types of Gardens** are mostly used for mood booster activities like playing outdoor games, doing yoga, and relief from anxiety and frustration Levels.

Vegetable Garden

This vegetable garden gives fresh vegetables to your family, this is something that is very appealing to people who care about the environment.

Being able to avoid buying packaged food is a way in which you can reduce your carbon footprint while enjoying the freshest vegetable possible.

Taking care of these vegetable types of garden is too simple and easy, though, you will need to be careful with how you care for each type of vegetable that you decide to plant in your vegetable garden.

Different gardens will require different things and some vegetables need more water than others.

2. Container Gardens

This container garden is really convenient for those people who do not have enough space to plant. As the name suggests the container garden means you can plant different types of plants in a container.

This container types of garden can be tubs, Barrels, totes, pots, and many other types of containers, proper amounts of soil are put inside the container and then the planting is started.

3. Raised Garden

Raised Garden is important for those people who live in that areas where do not have fertile soil and it can be frustrating when you want to start planting or gardening and then find out your soil is simply not up to snuff.

So that you can prepare your soil according to your use building a raised garden is going to give you the space that you need in order for creating a garden area.

You can simply build a platform kind structure that will rest on top of the normal soil in your Back yard, and this will act as your garden.

Once you have built the Backyard area then you can purchase fertile soil which will work well for the different types of plants that you wish to put in your garden.

This fertile soil process is the most essential part of this gardening or planting plants, and another thing is that you need to have proper which gives your plants the nutrients that they need in order to thrive.

4. Greenhouse Gardens

You have usually heard of greenhouse garden areas, and this is amazingly convenient for when you want to be able for growing plants effectively. You are able for keeping things warm for

your plants or trees, no matter what time of the year it is. These are a method that people mostly use for growing plants when it is not normally the season for them to grow properly.

Setting up a greenhouse garden is not something that is going to be simple; it will take lots of equipment and a good amount of money in order to get everything going. This greenhouse garden method is mostly used by serious farmers and extreme gardening aficionados, if this is something that appeals to you then you may want to look into it further.

Small greenhouse area has started popping up on the market; you can buy these at a cheap rate and will be able to use them to keep plants safe when it is colder outside the garden area.

These mini greenhouses are easy to use but they are not as very complex as a large greenhouse is, they are still very useful.

5. Botanical Garden

Types of Garden: Explore the Most Popular Gardening Types with Pictures 17

This botanical garden displays as many different plant species as possible, they are dedicated to caring for plants and cultivating the plants.

A lot of the time, you will find that this types of garden area is able to be toured by the public. Sometimes, you will even see impressive species of plants that do not normally grow in the area where the garden is located.

6. Therapeutic Gardens

This therapeutic garden is highly beneficial for sick people to get well or stimulate their senses, their focus of interest on their legs, and hands to improve their feels and also help to make their mind fresh.

Also, this garden is widely used by elder people, and patients who suffer longtime illnesses such as Alzheimer, are autistic patients or are psychologically fragile.

Mostly this Therapeutic garden is located in Health centers such as Mental Homes or hospitals, wellness centers, Retirement homes, and many more.

7. Tropical Gardens

As the name suggests it is mostly planting tropical plants and those plants require heavy rainfall or a decent irrigation or sprinkler system for watering, also gardening needs fertilizer and heavy mulching.

If you can set up a good irrigation system then everything should be short, and then your only worry about the temperature.

You could also consider growing in a controlled temperature; this will allow you for maintaining the proper temperature at all times and your tropical plants will easily thrive.

8. Indoor Gardens

People who live in cooler areas where colder climates and heavy Snowfall have in that case only option that indoor gardening.

The colder atmosphere can present difficulties to outdoor gardening and you will only have so many months out of the year where you can viably plant things.

Also, this indoor type of garden makes your house and farm more beautiful.

9. Community Garden

Many communities across North America have begun for creating community garden areas, this area is places where people can grow vegetables and other plants on community property.

Basically, this community garden is used for providing vegetables and fruits for people who need help; everyone in the community is allowed to take a certain amount of food from this garden on a monthly basis in certain areas.

Also, this can be very beneficial for those people who enjoy gardening and it is a relaxing hobby that can help you to focus and eliminate a certain amount of stress from your daily life.

10. Vertical Garden

This vertical garden is the best choice for those people who have limited space because it requires small space as compared to other outdoor or indoor gardens, also setting up a vertical garden is a straightforward process.

This vertical types of garden gives a number of benefits to people such as easy mobility, adding an aesthetic look to your house, apartment, or any structure, good space saver, improved air quality, and many more.

11. Herb Garden

As the name suggests this herb types of garden is a specialized garden for planting or cultivation of medicinal plants, which include the following types of garden plants

- Basil Plants
- Oregano Plants
- Rosemary Plants
- Parsley Plants
- Thyme Plants
- Sage Plants
- Mint PHlants

12. Flower Garden

This flower garden name suggests it only cultivated flowers planted, usually, flower gardens are so colorful and exotic. In these types of gardens, you can literally see thousands or millions of different garden, but in some gardens, they harvest only a single or just one type of flower like above mention three examples.

But on the other side, they harvest most is a mix of different flowers. The most common plants for a making flower garden are,

- Tulip Flower Garden
- Daisy Flower Garden
- Lilac Flower Garden
- Rose Garden
- Orchids Flower Garden
- Sunflower Garden
- Gardenia Flower

SOIL TYPES

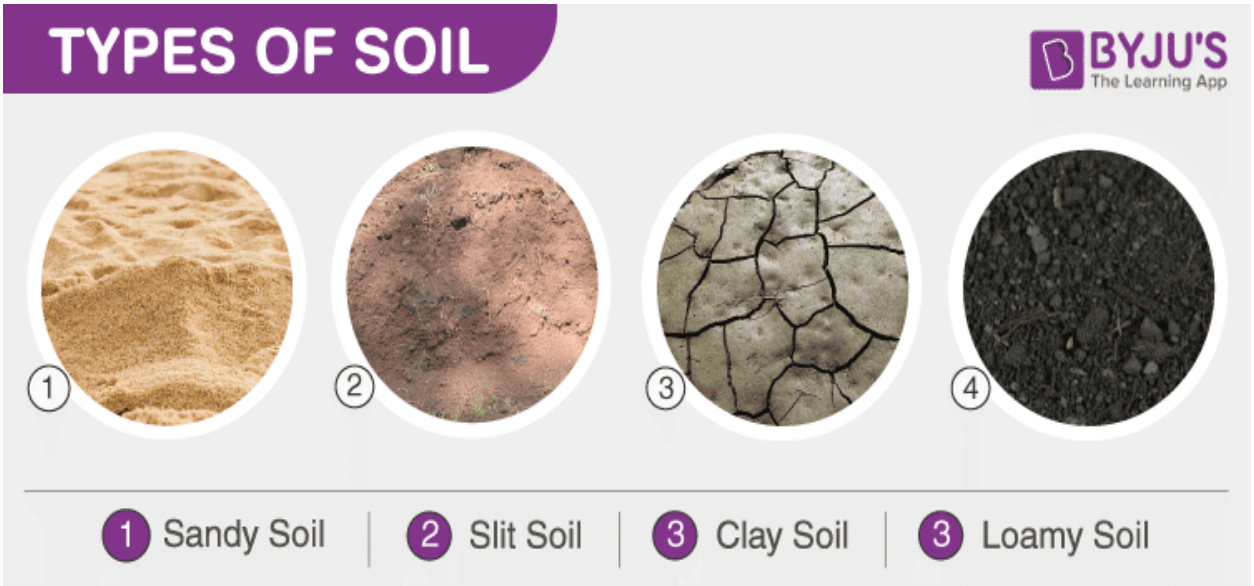
soil" is a very broad term and refers to the loose layer of earth that covers the surface of the planet. The soil is the part of the earth's surface, which includes disintegrated rock, humus, inorganic and organic materials. For soil to form from rocks, it takes an average of 500 years or more. The soil is usually formed when rocks break up into their constituent parts. When a range of different forces acts on the rocks, they break into smaller parts to form the soil. These forces also include the impact of wind, water, and salts' reaction.

There are three stages of soil:

- Solid soil
- Soil with air in the pores
- Soil with water in the pores

Various types of soil undergo diverse environmental pressures. Soil is mainly classified by its texture, proportions and different forms of organic and mineral compositions.

Types of soils



Soil is classified into four types:

- Sandy soil.
- Silt Soil.
- Clay Soil.
- Loamy Soil.

Sandy Soil

The first type of soil is sand. It consists of small particles of weathered rock. Sandy soils are one of the poorest types of soil for growing plants because it has very low nutrients and poor water holding capacity, which makes it hard for the plant's roots to absorb water. This type of soil is very good for the drainage system. Sandy soil is usually formed by the breakdown or fragmentation of rocks like granite, limestone and quartz.

Silt Soil

Silt, which is known to have much smaller particles compared to sandy soil and is made up of rock and other mineral particles, which are smaller than sand and larger than clay. It is the

smooth and fine quality of the soil that holds water better than sand. Silt is easily transported by moving currents and it is mainly found near the river, lakes and other water bodies. The silt soil is more fertile compared to the other three types of soil. Therefore, it is also used in agricultural practices to improve soil fertility.

Clay Soil

Clay is the smallest particle among the other two types of soil. The particles in this soil are tightly packed together with each other with very little or no airspace. This soil has very good water storage qualities and makes it hard for moisture and air to penetrate into it. It is very sticky to the touch when wet but smooth when dried. Clay is the densest and heaviest type of soil which does not drain well or provide space for plant roots to flourish.

Loamy Soil

Loam is the fourth type of soil. It is a combination of sand, silt and clay such that the beneficial properties of each are included. For instance, it has the ability to retain moisture and nutrients; hence, it is more suitable for farming. This soil is also referred to as agricultural soil as it includes an equilibrium of all three types of soil materials, being sandy, clay, and silt, and it also

happens to have humus. Apart from these, it also has higher calcium and pH levels because of its inorganic origins.

MANURING

Manure can be obtained from various sources. The different sources of manure are mentioned below:

- Cattle dung, urine, and slurry from biogas plants.
- Wastes from human habitation such as human urine, night soil, sludge, sewage, domestic waste.
- Droppings of goat and sheep
- Waste from the slaughterhouses such as bones, meat, horn and hoof meal, fish waste
- By-products of agricultural industries
- Crop waste
- Weeds, water hyacinth

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Types of Manure

Manure can be grouped as farmyard manure, green manure and compost manure. Following are the different types of manure used by the farmers:

Green Manure

Green manure increases the percentage of organic matter in the soil. The roots of such manures go deep into the soil. These help in the suppression of weeds and the prevention of soil erosion.

Farmyard Manure

Farmyard manure improves the soil structure and is used as a natural fertilizer in farming. It increases the soil capacity to hold more water and nutrients. It also increases the microbial activity of the soil to improve its mineral supply and also the plant nutrients.

Compost Manure

It improves the soil structure and water and nutrient holding capacity of the soil. Thus, it increases the nutrient value and thereby improves the health of the plants.

Advantages of Manure

- These are a good source of macronutrients.
- Improves soil fertility.
- Cost-effective
- Reduces soil erosion and leaching.
- Improves the physical properties of the soil and aerates the soil.
- Improves the water and nutrient holding capacity of the soil.
- It can be transported easily.
- Methane gas is evolved as the by-product of manure that can be used for cooking and heating purposes.
- The crops grown on the land treated with manure produces healthy crops.

Manure is an ideal soil amendment. When it is applied to the agricultural fields it acts as a field residue. Farmers can sell the manure to people who need to improve their soil fertility. Thus, it can bring income to farmers. They add to the overall soil ability and sustainability. Manure increases the water holding capacity of the soil. The organic content of the soil can also be improved by applying raw manure like biochar, compost, etc.

Different types of manure contain about 26% solid. The solid and liquid portions are segregated and the solids are used for bedding. The carbon content and other elements can be used to

produce different biofuels. Manure also contains a large number of fibres. The undigested animal feed, straw, sawdust, or other bedding contains a lot of fibre.

Manure is environment-friendly and has contributed a great deal in increasing food production. It was very difficult to feed a growing population. Use of manure improved the fertility of the soil and increased the yield of the crops.

LAYING

The layout of the orchard is a very important operation. Under this, the arrangement of fruit plants in the plot is carefully done to put the plants at a suitable distance for proper development and for accommodating the requisite number of plants per unit area in addition to improving the aesthetic look of the orchard. Hence, the factors which are considered important for proper layout of the orchard are (i) system of planting and (ii) planting distance of individual fruit species which again would provide the following advantages:

1. Allow equidistance for each tree for uniform growth.
2. Allow easy orchard operations like cultivation, intercropping, irrigation, spraying of plant protection chemicals and growth regulators, harvesting etc.
3. Proper utilization of orchard space avoiding wastage of land.
4. Help in proper supervision and management of the orchard.
5. Aloe further extension of area from time to time so that subsequent planting would match with the existing orchard planting.

36.2 SYSTEM OF PLANTING

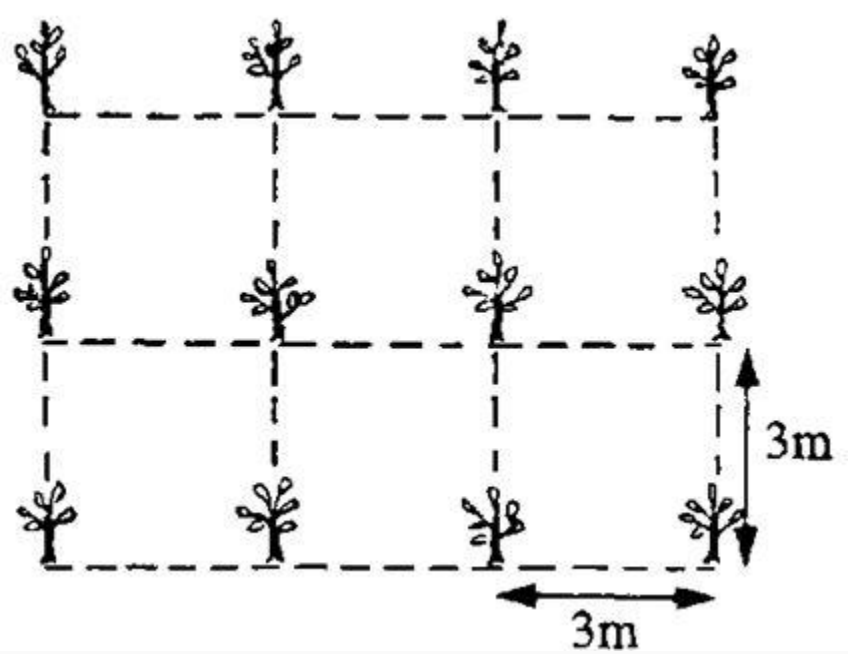
The system of planting to be adopted is selected after considering the slope of land, purpose of utilizing the orchard space, convenience etc. Generally, six systems of planting are recommended for fruit trees.

36.2.1 Square system

This system is considered to be the simplest of all the system and is adopted widely. In this system, the plot is divided into squares and trees are planted at the four corners of the square, in

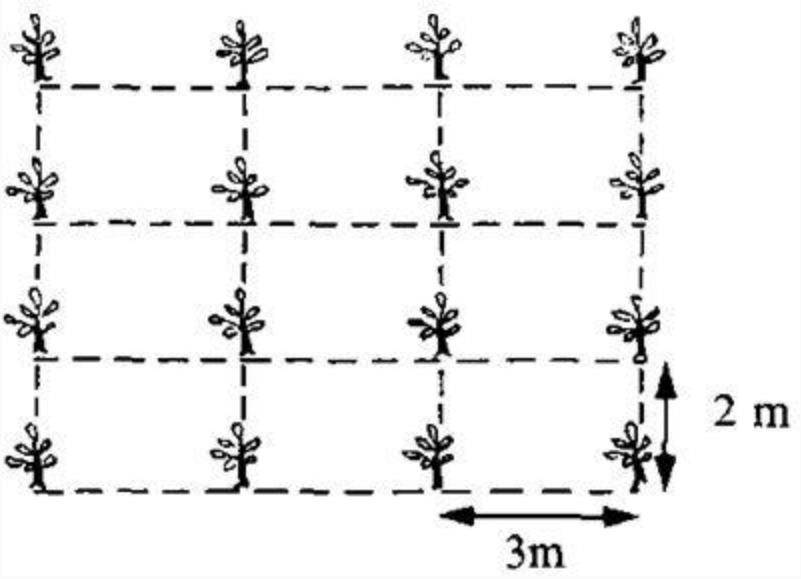
straight rows running at right angles. While laying out the plot a base line is first drawn parallel to the road, fence or adjacent orchard, at a distance equal to half the spacing to be given between the trees. Pegs are fixed on this line at the desired distances. At both ends of the base line right angles are drawn by following the simple carpenter's 3, 4, 5 meters system. After the formation of three lines it is easy to fix all the other pegs to mark the tree locations in between the lines at the required spacing by using ropes connecting the pegs of the lines in opposite directions.

Under this system, intercultural operations, spraying, harvesting etc., can be done conveniently and easily. Planting of quick growing fruit trees like papaya, banana, guava during the early life of the orchard is possible. Rising of inter-crops like vegetables, ginger, turmeric, cumin, coriander and such other spices can be done conveniently cultivation and irrigation can be done in two directions.



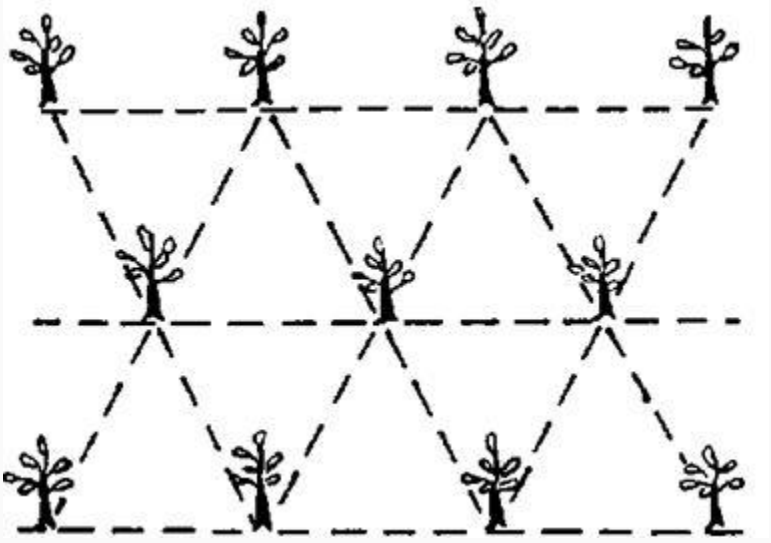
36.2.2 Rectangular system

In this system, the plot is divided into rectangles instead of squares and trees are planted at the four corners of the rectangle in straight rows running at right angles. The same advantages which have been mentioned in the square system are also enjoyed here. The only difference is that in this system more plants can be accommodated in the row keeping more space between the rows.



36.2.3 Triangular system

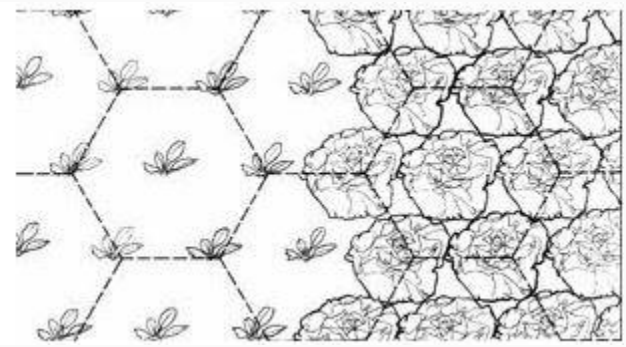
In this system, trees are planted as in the square system but the plants in the 2^{nd} , 4^{th}, 6^{th} and such other alternate rows are planted midway between the 1^{st}, 3^{rd}, 5^{th} and such other alternate rows. This system has no special advantage over the square system except providing more open space for the trees and for intercrops. It is not only a difficult layout but cultivation also in the plots under this system becomes difficult.



36.2.4 Hexagonal system

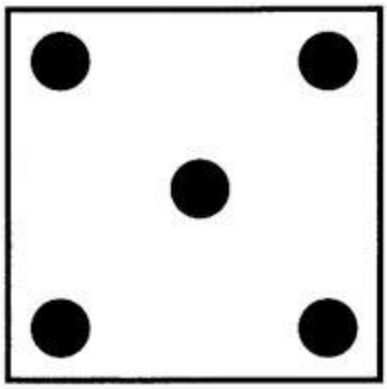
In this system, the trees are planted at the corners of an equilateral triangle and thus, six trees from a hexagon with the seventh tree at the centre. This system is generally followed where the land is costly and very fertile with ample provision of irrigation water. Though 15 per cent more trees can be planted in a unit area by this method over the square system, fruit growers usually do not adopt it, as it is difficult to layout and cultivation in the plot cannot be done so easily as in the square system.

For laying out the plot, a base line is drawn in one side as in the square system. Then an equilateral triangle having rings at each corner and with sides equal to the length of the required distance is made of heavy wire or chain. Two of these rings are then placed on the stakes of the base line and the position of the third ring indicates the position of a tree in the second row. This row is then used as the base line and pegs are set in the third row. In this way entire plot is laid out.



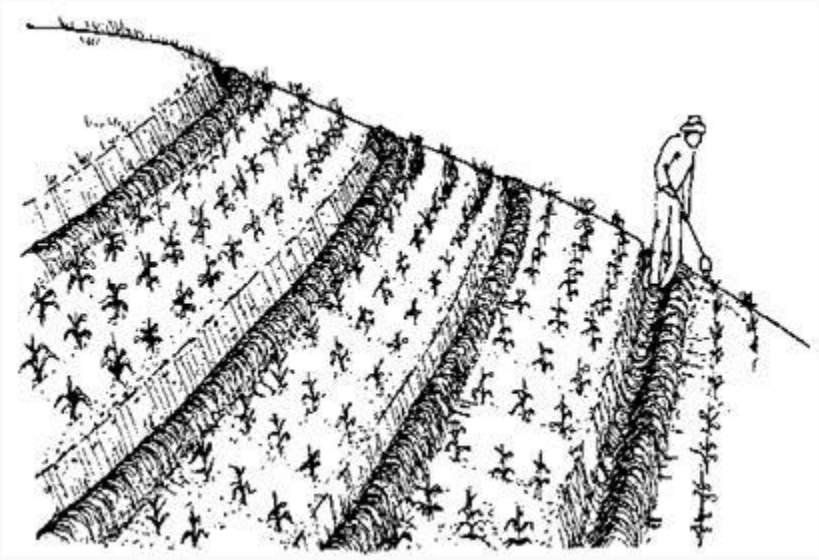
36.2.5 Quincunx system

This system of planting fruit trees is similar to square system, except that a fifth tree is planted at the centre of each square. As a result the tree number in an unit area becomes almost double the number in the square system. The additional tree in the centre is known as “filler”. The fillers are usually quick growing, early maturing and erect type fruit trees like banana, papaya, pomegranate, etc., which are removed as soon as the main fruit trees planted at the corner of the square come into bearing. The planting of filler trees provides an additional income to the grower in the early life of the orchard.



36.2.6 Contour system

It is generally followed on the hills with high slopes. It particularly suits to a land with undulated topography, where there is greater danger of erosion and irrigation of the orchard is difficult. The main purpose of this system is to minimize land erosion and to conserve soil moisture so as to make the slope fit for growing fruits. So, the contour line is designed and graded in such a way that the flow of water in the irrigation channel becomes slow and thus finds time to penetrate into the soil without causing erosion.



36.3 Spacing of Fruit Trees

Provision of optimum spacing to fruit trees is one of the most important aspects of successful fruit culture. If the spacing is inadequate, the fruit trees will grow poorly, produce small quantity of fruits of inferior quality, and suffer from various diseases and insect pests. The cultural

practices of the orchards are also greatly hindered. Weeds and grasses grow in abundance and rob off the vitality of the trees, resulting in their early decline and premature death. On the other hand, if the spacing is too wide, there will be wastage of valuable orchard land without having any direct benefit on the ultimate yield of the orchard. The optimum spacing is therefore, desired so that the fruit trees may grow and bear crops properly. The optimum spacing is one in which the tree on attaining its full size will not touch the branches of the neighbouring ones and the root-system of one tree must not encroach that of the adjoining tree. The spacing given to fruit trees is generally governed by the following factors:

1. Climate and soil
2. Varieties
3. Growth habit
4. Rootstocks
5. Nature of irrigation
6. Pruning

It is very difficult to suggest the exact spacing for fruit trees which will suit every locality or soil. However, the spacing given below for some of the important fruits may be considered as a safe guide for planting fruit orchards both in the hills and plains.

WATERING:

Top Ten Watering Tips

These watering tips apply to all areas of the landscape.

1. Check soil moisture frequently and water only when needed. Irrigation is needed when the soil feels dry to the touch down 1 or 2 inches.

2. Water the root zone, not the foliage. Roots absorb the water, and wetting the foliage doesn't provide moisture the plants can readily use. Plus, wet foliage is more likely to have disease issues!

3. Water slowly, deeply, and infrequently. Avoid a quick splash that can promote shallow rooting, leading to poor drought tolerance.

4. Water in the morning to allow wet foliage to dry quickly in the morning sun. Morning watering also ensures the plant is fully hydrated as it goes into the hottest part of the day.

5. Thoroughly wet the entire root zone. Apply water until the soil is moist to at least 5 or 6 inches. Unsure how deep it is? Water and dig a hole to see.

6. Use mulch to help conserve soil moisture and reduce the frequency of watering. Mulch can be used in nearly all garden settings, including vegetable gardens and containers.

7. Don't overwater. Check the soil moisture frequently, but only apply water when the soil is dry to the touch 1 or 2 inches down.

8. Set an alarm or timer on your phone so you don't forget to turn off sprinklers, drip irrigation systems, or soaker hoses. Water timers can also be purchased to avoid running water unnecessarily.

9. For garden areas such as annual beds, containers, hanging baskets, and vegetable gardens that require frequent watering, set up a watering system such as soaker hoses or drip irrigation systems. Assemble them in spring before plants get large. These systems can help save time and provide water directly to the root zone.

10. If you will be away from your garden for more than a couple of days, have a family member, friend, or neighbor water. Newly planted plants and containers cannot go for long periods without water.


A watering can with a wide opening makes filling and mixing fertilizers easier.

Tips for Watering Equipment & Systems

- Invest in a high-quality watering wand with a breaker at the end that gently showers plants but delivers a good volume of water.

- Use a watering wand with a local shut-off to make it easy to stop water flow in-between plants or containers.

- Use a long watering wand (24 to 36 inches long) to reduce bending and reaching.

- Avoid using spray nozzles. The powerful stream of water damages foliage and washes soil away. When adjustable spray nozzles are used on mist settings, they deliver a small amount of water, requiring more time to wet the soil thoroughly.
- Repair or replace leaky or broken hoses, sprinklers, and watering wands to avoid wasting water.
- Buy a watering can with a large opening to make filling and mixing water-soluble fertilizers easier.
- Install a rain gauge to know how much water Mother Nature has already provided for your garden.

Tips for Watering Trees & Shrubs

Consistent watering during the first year is the single most important task that will ensure long-term success when planting a tree

- Water trees and shrubs reguarly after planting. Every few days at first eventually tapering off to every 7 to 10 days. Woody plants will need regular watering the entire first growing season and supplemental water when conditions are dry in the second and third years.
- When watering newly planted woody plants, focus the water on both the original root ball and the surrounding soil. Most of the roots the first year after planting are still in the original root ball.

- Consistent watering when soil conditions are dry for the first year is the single most important task that will ensure long-term success when planting a tree.
- Consider using water bags or leaky buckets to water newly-planted trees slowly and deeply. These watering aids do not reduce the frequency of watering but can make the process easier and more efficient. Water bags will typically empty in 5 to 10 hours and need to be filled 1 to 2 times a week.
- Established trees rarely need supplemental irrigation. During extended dry periods supplemental water can be applied to reduce stress. The water should be applied to the entire root system. A spot, oscillating, or impact (also called pulsating) sprinkler can be used to apply water to large root zones.

Tips for Watering Perennials

- Water directly at the base of the plant focusing on the root zone. Avoid overhead sprinklers.
- The original root ball of newly planted perennials usually dries out faster than the surrounding soil. Be sure to check both and water when either one is dry.
- When watering garden plants that are really dry, apply water to the root zone of each plant and come back 15 to 30 minutes later and water again. The first watering wets the soil allowing the second watering to more easily and deeply soak in.
- Mark newly planted plants with a brightly colored golf tee, label, or flag to designate (and remind you) which plants need more frequent watering. This will also make the task easier for anyone watering for you while you're on vacation!
- If plants are wilting in the heat of the day, check the soil moisture before watering. Some plants wilt to conserve moisture and perk back up in the evening.

 To make watering easier, label newly planted plants with a flag, wooden label, or brightly colored golf tee.

Tips for Watering Annuals and Containers

- The soil in containers dries out much more quickly than soil in the ground. Containers will require more frequent watering.
- Check containers for water every day and water when dry. By mid-summer, they will likely need water every day. Set up a consistent schedule, so they don't dry out.
- Many hanging baskets will need water every day, and late in the season, they may need water twice a day in open, sunny, or exposed locations!
- Unglazed terracotta or clay pots are porous and will dry out more quickly than plastic or glazed containers.

Tips for Watering Lawns

- Avoid using overhead sprinklers that spray a lot of water high into the air because more water will be lost to evaporation. Instead, use sprinklers that keep water lower to the ground and can easily be adjusted to change the delivery pattern so water can be applied directly to the area that needs it.
- Orient sprinklers so they don't wet sidewalks or driveways where water will just run off.

- Consider using spot sprinklers rather than oscillating sprinklers to water small areas, such as patches of newly seeded lawn.
- To reduce watering needs, consider letting the lawn go dormant during summer. Cool-season lawns can typically go with minimal water for up to six weeks in summer with little long-term damage.

 Use a spot sprinkler to water only the areas of the lawn that need it, such as newly seeded patches.

Tips for Watering Vegetable Gardens

- Vegetable gardens should receive about 1 inch of water a week provided by the gardener when not provided by Mother Nature.
- Most vegetable gardens will need to be irrigated at some point during the growing season to be the most productive. Situate vegetable gardens near a water source to make watering easier.
- Whenever possible, avoid wetting areas outside of the plants' root zone to help reduce the germination and growth of weeds.
- Whenever possible, avoid overhead watering in the vegetable garden. Wetting the foliage and surrounding soil promotes disease and weed growth. Hand water or install soaker hoses to deliver water directly to the plant's root zone.

MANAGEMENT OF PEST AND DISEASES:

Managing pests and diseases is a critical aspect of agriculture, horticulture, and even home gardening to ensure the health and productivity of plants. Integrated Pest Management (IPM) is a holistic approach that combines various strategies to effectively control pests and diseases while minimizing environmental impact. Here's a general outline of pest and disease management:

1. **Preventive Measures:**
    - **Crop Selection:** Choose plant varieties that are resistant or tolerant to common pests and diseases in your region.
    - **Sanitation:** Keep the growing area clean by removing weeds, fallen leaves, and other debris that can harbor pests and diseases.
    - **Crop Rotation:** Avoid planting the same crop in the same location year after year, as this can help break the pest and disease cycle.
    - **Quarantine:** Inspect new plants before introducing them to your garden to prevent the spread of pests and diseases.
2. **Cultural Practices:**
    - **Proper Watering:** Avoid overwatering, as it can lead to conditions favorable for disease development. Use drip irrigation to keep foliage dry.
    - **Mulching:** Apply organic mulch to the soil surface to prevent weed growth, maintain soil moisture, and reduce the splash of soil-borne pathogens onto plants.
    - **Pruning:** Remove infected or infested plant parts promptly to prevent the spread of diseases.
    - **Spacing:** Plant crops at appropriate distances to provide good air circulation, which can reduce the chances of disease development.
3. **Biological Control:**

- **Predators and Parasitoids:** Introduce natural predators and parasites that feed on pests. Ladybugs, lacewings, and predatory mites are examples.
- **Beneficial Nematodes:** These microscopic organisms can control soil-dwelling pests like grubs and root maggots.
- **Microbial Inoculants:** Use beneficial microorganisms like bacteria and fungi that compete with or attack disease-causing pathogens.

4. **Mechanical Control:**
    - **Handpicking:** Physically remove pests from plants. This method is effective for larger insects like caterpillars and beetles.
    - **Traps:** Set up traps to attract and capture pests. Sticky traps, pheromone traps, and light traps are commonly used.
5. **Chemical Control (as a last resort):**
    - **Pesticides:** Use chemical pesticides only when other methods are insufficient. Choose selective pesticides that target specific pests to minimize harm to non-target organisms.
    - **Follow Instructions:** Always read and follow the label instructions of pesticides carefully. Use protective clothing and equipment during application.
6. **Monitoring and Decision-Making:**
    - Regularly inspect plants for signs of pests and diseases.
    - Use threshold levels to decide when action is necessary. Not all pests or diseases require intervention.
7. **Education and Record Keeping:**
    - Stay informed about local pests, diseases, and best practices for management.

- Maintain records of pest and disease outbreaks, control methods used, and their effectiveness. This helps refine your management approach over time.

Remember that a combination of these approaches, tailored to your specific situation, is the most effective way to manage pests and diseases while minimizing environmental impact.

UNIT 5

Transplanting seedlings is a crucial step in the gardening and farming process. It involves moving young plants from their initial seedling trays or pots into their final growing location, whether that's in a garden bed, a larger pot, or a field. Here's a guide on how to transplant seedlings effectively:

1. Timing: Transplant seedlings when they have developed enough roots and are strong enough to handle the stress of transplantation. This typically occurs when they have at least two to four true leaves.

2. Preparation:

- Prepare the transplant site in advance by ensuring the soil is well-prepared, weed-free, and adequately watered.
- If you're moving seedlings into larger containers, make sure the new containers are clean and have drainage holes.

3. Steps for Transplanting:

- Water the seedlings in their original containers a day before transplanting. Moist soil makes it easier to remove the seedlings without damaging their roots.
- Gently tap the bottom of the container to loosen the soil and roots. If using trays, carefully push up from the bottom to lift the seedling out.
- Handle seedlings by their leaves, not the delicate stems, to avoid damaging them.
- Create a hole in the transplant site slightly larger than the root ball of the seedling. The depth should be such that the seedling is planted at the same depth it was in its original container.
- Place the seedling in the hole and fill in with soil, gently pressing down to eliminate air pockets. Water the newly transplanted seedlings immediately to help settle the soil around the roots.

4. Post-Transplant Care:

- Shade the transplanted seedlings for a few days, especially if transplanting during hot weather, to reduce stress.
- Mulch around the seedlings to help retain soil moisture and prevent weed growth.
- Water the seedlings regularly, keeping the soil consistently moist but not waterlogged.
- If transplanting into a garden bed, consider using row covers or other protective measures to shield the seedlings from pests and harsh weather.

5. Hardening Off:

- If you've been raising seedlings indoors or in a controlled environment, they may not be accustomed to direct sunlight, wind, and temperature fluctuations. Gradually expose them to outdoor conditions over the course of a week or two before transplanting to help them acclimate. This process is called "hardening off."

6. Transplant Shock:

- Transplanting can temporarily stress seedlings, leading to a period of slowed growth as they adjust to their new environment. This is normal and should not be a cause for concern.
- Providing proper care, including adequate water and protection from extreme conditions, will help minimize transplant shock.

By following these steps, you can increase the chances of successful transplanting and give your seedlings the best start in their new growing location.

Cultivation of Cabbage (Brassica oleracea)

Botanical Name:

Brassica oleracea Var. Capitata f. alba.

Family:

Cruciferaceae.

The peculiar flavor in the head is due to the glucocide Sinigrin, which carries sulphur also. The open green leaves are more nutritious than cabbage head.

Botany:

The word cabbage is derived from the French word ‘coboche’, meaning head. A cabbage head is made up of numerous thick, overlapping smooth leaves which cover smooth terminal bud. Sometimes small heads of 5 or 7.5 cm. In diameter are formed, which are known as ‘cabbage sprouts’ having no commercial importance. Normally it is biennial but it is grown in India as annual crop.

Season and Climate:

It grows best in cool moist climate and is very hardy to frost. In areas with comparatively dry atmospheres, its leaves tend to be more distinctly petiole than in the more humid areas. In hot dry

atmosphere, its quality becomes poor and much of its delicate flavor is lost. Its germination is best at a soil temperature of about 55 °F to 60 °F. Temperatures below this and above this are not suited for it. Well hardened seedlings can tolerate temperature of2Q °F to 25 "F. It is grown mainly as rabi crop during winter. But in and around Nasik (Maharashtra), Ootacamond (Madras), and in semi parts of Kerala, it is grown as kharif crop also.

Soil and its Preparation:

It can be grown almost in all types of soil ranging from sand to heavy soils. But small quick growing cabbage varieties do well in sandy soils, while targe and late maturing varieties in heavy soils. While large and late maturing varieties in heavy soils. Soils intended for cabbage growing, should have good drainage. Acid soils are not good for cabbage. The best PH range for cabbage is between pH 5.5 to 6.5. Lime may be added in acid soil to make it neutral or alkaline for growing good crop of cabbage. Land is prepared by ploughing it 3 to 4 times. The first ploughing should be done by soil turning plough, and the bulky organic manures should be spread in the field. Then the land should be ploughing and leveling the land, beds of suitable size and irrigation channels are made.

Seed Rate &Time of Sowing:

Cabbage is grown mainly as Rabi crop during winter (Sept.-Oct.), But around Nasik (Maharashtra) it is grown as kharif crop also. In cabbage for early crop (September) 500 gm & for late crop 373 gm. seed is required.

Layout & Spacing:

Ridges & furrow type of layout is used for crop. Before that seedlings are prepared in nursery bed (Raised bed) & transplanted in main field after 3-4 weeks. Spacing for early crop is 45×45 cm and late crop it is 60×60 cm.

Manures & Fertilizers:

150 kg N, 50 kg P2O5 should be applied per hectare.

Irrigation:

Irrigation at the time of transplanting is essential. Steady supply of moisture is necessary for god growth and development. Interval between two irrigations depends upon climate, soil and plant growth. In winter season irrigation at an interval of 8-10"days is sufficient.

Harvesting and Yield:

In cabbage harvesting is done depending on the maturity of the head and demand in market. Normally harvesting is done when heads are firm. If prices are high in the market harvesting is done earlier when heads are ax small and loose Heads are cut with a knife with little stalk arid some leaves. Proper grading is followed before heads are sent to market the yield of cabbage variety from 15 to 25 tons per hectare. The yield of cabbage depends upon the variety, growing season and management practices, Hybrid cabbage yields upto 50 tonner per hectare The yield of early varieties ranges between 12to 15 tones/ha. The yield of late season varieties is about 20 to 25 tones /ha.

CULTIVATION OF SPINACH

Spinach

Spinach is perennial vegetable. It is very good source of vitamins, iron and anti-oxidants. China is the largest producer of spinach. In India, it is popular as palak.

Common name: Spinach/ palak (India)

Botanical name: Spinacia oleraceae

Family: Amaranthaceae

Origin: Persia (Iran)

Introduction:

- Spinach is grown throughout the world it is perennial leaf vegetable.

- Name of spinach stands on equally with the term “health” as it has excellent nutritional value.

- It is very good source of vitamin A and C. It also contains sufficient amount of protein, calcium and iron.

- Comparatively, it is easy to grow. People grow spinach in pots, containers and in back yards.

- It is an annual and cross pollinated crop.

- The leading spinach producing states in India are Maharashtra, West Bengal, Gujarat, Andhra Pradesh, Telangana, Kerala, Tamil Nadu, Karnataka and Uttar Pradesh.

Climate:

Spinach is a rabi season crop but its cultivation is possible throughout the year with moderate temperature conditions.

- Leave of spinach is resistant to frost as compare to other crops.

- Spinach is also tolerant to warm weather but it can affect the productivity and premature bolting would occur.

Soil:

- We have wide range of variety of soil to cultivate spinach. Available soil should have good fertility and well drainage capacity.

- However sandy loam soil is comparatively best for the high yield.

- It is also resistant to slightly alkaline soils.

- For the best output, soil should have pH ranging from 6.0-7.5.

Fertilizer and manure:

Spinach comparatively requires more nitrogen as it is leafy vegetable. It is recommended that the soil must go through a clinical test. This would help to identify the right amount of fertilizers.

- It is recommended to mix well farm yard manure with phosphorus and half dose of nitrogen during land preparation.

- Generally, 25 t/ha of farmyard manure is sufficient with 90kg/ha of phosphorous and 30kg/ha of potassium oxide.

- Another half does of nitrogen should be applied in two divided doses, one after each cutting along with light irrigation.

Seed rates:

- For winter season seed rate: 4 to 6 kg per acre.

- For summer crop seed rate: 10 to 15 kg per acre.

Land preparation:

- Land should have soft soil and fine tilth and this can be done when field is being ploughed 5 to 6 times.

- Land should be weed free and leveled.
- We can also add micronutrients in case of nutrient deficiency in the soil.
- Proper irrigated channels should also be made in the field.

Plant spacing:

Broadcast and line sowing method are generally preferred by the farmers, as it facilitates weeding, harvesting and hoeing.

- Required space for row to row: 25-35cm.
- Required space for plant to plant: 10-12cm.
- Required depth for plantation: 1.5-2.0cm.

Irrigation:

- In cultivation of spinach, irrigation should be based on availability of moisture in the soil. Climatic conditions also play important role.
- Spinach crop should be irrigated at 10-12 days of interval in the winter season.
- Process of irrigation is not much required in the rainy season

Harvesting:

- Time of harvesting depends upon the adopted variety, soil and climatic conditions.
- Generally first cutting can be done in 25-30 days of sowing.
- Subsequent cutting can be done at interval of 20-25 days, depending on the variety of the spinach.

Yield:

Quality and quantity of the crop depends on the variety and adopted management practices. On an average 60-80 quintal/ha can be expected.

Lady Finger Cultivation

Okra is a multipurpose crop valued for its tender and delicious pods. It is the most important vegetable crop of the tropical and subtropical regions of the world. It belongs to the genus Abelmoschus and family Malvaceae.

Plant Name- Okra

Scientific Name - *Abelmoschus esculentus (L.)*

Family- Malvaceae

Hindi Common Name- Bhindi (भिंडी)

Marathi Common Name- Bhendi(भेंडी).

Introduction-

- Lady Finger or Okra is also known as 'Bhindi' and is an important vegetable crop in India.
- It is grown in both tropical and sub-tropical regions and also in the warmer parts of the moderate regions.
- 100g of edible okra's nutritional value gives 1.9g protein, 0.2g fat, 6.4g carbohydrate, 0.7g minerals and 1.2g fibres.
- As a foreign exchanger crop, Okra or Lady Finger has a good potential and it accounts for 65% of the export of fresh vegetables.

- It is cultivated in the area of about 0.35mt/ha and its production is 3.5mt/ha and productivity of 9.6mt/ha.

Location:

Uttar Pradesh, Bihar, Orissa, West Bengal, Andhra Pradesh, and Karnataka are the major Lady Finger /Okra producing states in India.

Season:

- It is grown in Kharif Season in the month of June-August
- It also grows in Zaid season in the month of January – March.

Climate:

- During the growing period, it requires long warm season.
- In humid condition, it gives good yield.
- It grows well within a temperature range of 22-35°c.
- It grows the best in rainy season and in heavy rainfall areas.
- It is highly receptive to frost injury.
- Below 20°c seeds will fail to germinate.

Varieties:

VARIETY	RELEASED BY	SPECIAL FEATURES
Pusa Makhmali	IARI	Produces light green fruits. Highly susceptible to Yellow Vein Mosaic Virus. (YVMV).
Punjab no.13	PAU	Suitable for cultivating in spring-summer season and fruits are light green and 5ridged and of medium length. Suspectible to mosaic.
Parbhani Kranti	MKV	Fruits are medium long with tender smooth surface at marketable stage. Average yield is 8.5-11.5 t/ha in 120 days.
Arka Anamika	IIHR	Fruits are borne in two flushes and they are borne on the first stem 45-50 days after sowing during second flush. Fruits are spineless with 5-6 ridges.

Soil Requirement:

- It grows well in all kind of soils.

- For its cultivation, Sandy loam and clay-loam soils are the best.
- The optimum pH range is 6-6.8.
- The soil should have good internal drainage.
- Soil with high organic matter is preferred so that cartful of FYM or compost should be assimilated during land preparation.

Land Preparation:

- 2-3 plowing is needed for well prepared land.
- At the time of land preparation, well decomposed FYM 25t/ha is integrated into the soil.
- It is sown on flat soil or on ridges.
- Sowing should be done on ridges if the soil is heavy.
- Neem cake and poultry manures helps in improving the growth of plant and the yield in this crop.
- By using neem cake and poultry manures or other compost it is possible to reduce the use of fertilizer.

Seed Rate & Sowing Time:

- During summer season, the seed rate is 5-5.5Kg seeds/ha.
- During rainy season, the seed rate is 8-10Kg seeds/ha.

- Seed rate normally depends on the germination percentage of spacing and season.
- Seeds should be soaked in a solution of Bavistin (0.2%) for 6 hours before sowing them.
- Then the seeds should be kept to dry in shade.
- The seeds are dibbled on both the sides of the furrows at a spacing of 60 x 30cm in Kharif season and 30 x30cm in summer season.

Spacing:

- In Okra, ridges and furrow type of arrangement is done.
- At a spacing of 75 x 30 cm and 60 x 45 cm hybrid varieties are planted.
- 3-4 days before sowing pre-soaking irrigation is very beneficial.
- The seeds germinate in about 4-5 days.

Irrigation:

- During summer, the crop requires appropriate moisture in the soil for faster growth.
- Drip irrigation is most useful to the crop as it provides consistent moisture throughout the season.
- The daily water demand of the crop is 2.4 liter for a day during the early growth stage.
- During the peak growth stage it demands 7.6 liter per day.

- During the initial growth stage irrigation should be done daily for 75 minutes and during peak growth stage it should be done for 228 minutes with a conductor capacity of 2lph.

Manures & Fertilizers:

- In order to maximize the yield in the rows before sowing for one hectare of land about 30 t of FYM (Field Yard Manure), 350 kg Super phosphate, 125 kg Murate of Potash and 300 kg Ammonium sulphate should be applied.
- Through fertigation, nitrogen should be applied in three split doses.

Harvesting:

- Flowering starts from 35-40 days after planting.
- Crop starts harvesting in 55-65 days after planting when pods are 2-3 inches long. Pods are tender at this stage.
- It should be harvested after every 2-3 days as the Okra pods grow very fast.
- The pods should not mature on the plant because this will hinder more pods from growing and will reduce the production of the plant.
- Okra should be handled carefully because the pods blemish easily.

Yield:

The yield differs from 5-7 t/ha in summer and 8-10 t/ha in the rainy season.

Storage:

- A fresh pod should be stored for 7-10 days in 7-10 degree temperature and 90-95% humidity.
- If the temperature will be below 7 degree, it would lead to chilling injury which will lead to discoloration of surface, pitting and decay.

ONION CULTIVATION:(Allium cepa)

Onion cultivation is a rewarding endeavor that requires attention to detail and proper care throughout the growing season. Here's a step-by-step guide to cultivating onions:

1. Soil Preparation:

- Choose a well-drained, fertile soil with a pH of 6.0 to 7.5.
- Incorporate organic matter like compost to improve soil structure and fertility.

2. Seed Selection and Starting:

- Choose onion varieties suitable for your climate and intended use (storage, fresh consumption, etc.).
- Start seeds indoors 8-10 weeks before the last frost or purchase onion sets (small bulbs) for direct planting.

3. Planting:

- Transplant onion seedlings or sets once the soil is workable and temperatures are appropriate.
- Plant sets about 1 inch deep and 4-6 inches apart in rows. For seedlings, follow recommended spacing on the seed packet.

4. Watering:

- Keep the soil consistently moist but not waterlogged, especially during the bulb formation stage.
- Water at the base of the plant to avoid wetting the foliage, which can lead to disease.

5. Fertilization:

- Onions benefit from nitrogen-rich fertilizer. Apply a balanced fertilizer at planting and again during bulb development.
- Avoid excessive nitrogen during late stages, as it can delay bulb maturation.

6. Mulching:

- Apply a layer of mulch to help retain soil moisture, control weeds, and maintain even soil temperatures.

7. Thinning and Spacing:

- If you've planted onion sets or started seeds in clusters, thin them to the recommended spacing once they are established to ensure proper bulb development.

8. Weeding:

- Keep the onion bed weed-free, as competition from weeds can affect onion growth and bulb size.

9. Bulb Formation:

- Onions develop bulbs in response to the length of daylight hours. Short-day onions are suited for southern regions with mild winters, while long-day onions are for northern regions with longer daylight hours.
- Maintain consistent watering and avoid stress during bulb formation for optimal growth.

10. Harvesting:

- Onions are ready for harvest when the tops start to yellow and fall over. This indicates that the bulbs have reached maturity.
- Carefully lift the bulbs from the soil using a fork or your hands. Allow them to dry in a well-ventilated, shaded area for a week or two.

11. Curing and Storage:

- After drying, trim the tops and roots, leaving about an inch of stem.
- Store cured onions in a cool, dry, and well-ventilated place. Braiding the tops together can aid in hanging storage.

12. Pest and Disease Management:

- Watch for common onion pests like thrips, onion maggots, and nematodes.
- Diseases like onion downy mildew and white rot can also affect onions. Practicing crop rotation and using disease-resistant varieties can help prevent these issues.

13. Crop Rotation:

- Avoid planting onions in the same spot or where other Allium family crops (garlic, leeks) have been grown recently to prevent disease buildup.

By following these steps and adjusting your practices based on your specific growing conditions, you can successfully cultivate onions and enjoy a bountiful harvest of flavorful bulbs.

CULTIVATION OF TOMATO

Tomato cultivation in India is one of the most profitable agribusiness. It is the second most important crop of world after potato. Fruits are eaten raw or in cooked form, and contain vitamins like ‘A’ and ‘C’ enriched with antioxidants in abundance. Due to these benefits, tomato demand remains high throughout the year.

Advantages of growing tomato over other crops

- Short duration vegetable crop.
- Tomato can be grown in outdoor as well as indoor conditions.
- Tomato cultivation is well-fitted in different cropping systems of cereals, grains, pulses and oilseeds.
- Cultivation gives more yields hence high economic value.
- Tomatoes are nutritionally valuable for their high mineral and vitamin content.
- Tomato is used widely in a number of processed items, prepared on large scale for consumption as well as for export purpose.

Climate Requirements for Tomato cultivation

The temperature range of 10-25 °C is considered ideal for tomato cultivation. The ideal sowing temperature is 10-15 °C coupled with 400-600 mm rainfall. The best quality tomato, red in colour is developed at 21-24 °C temperature.

Soil Requirements & Land Preparation

Tomato grows very well on a wide range of soils, but it grows particularly well on deep, well-drained soils with good drainage ability. Sandy loam, red soils and medium black

soils are considered most suitable for tomato cultivation. For good yield, the pH of soil must be at 7-8.5.

For tomato plantation, land can be prepared to a fine tilth by thorough ploughing 4-5 times and levelling. At time of last ploughing, add decomposed cow dung and Carbofuron (5kg) or Neem cake (8kg), per acre, for optimal soil preparation. **Transplanting & Management**

Soil solarization must be carried out for one month before sowing, to destroy harmful soil borne pathogen, pest and organism. This can be done by using transparent plastic film as mulch (the plastic sheet absorbs radiation and as a result increases soil temperature and kills pathogens). Following this, tomato seeds can be sown on raised beds of 80-90 cm width and of convenient length. After sowing covered bed with mulch, irrigate the bed with Rose-Can daily in morning.

Seedling is ready for transplantation 25-30 days after sowing. Water seedling beds 24 hours before transplanting so that seedlings can be easily uprooted. To protect crop from bacterial wilt, dip seedlings in 100 ppm Streptocycline solution for 5 minutes before transplanting.

Sowing

The major tomato producing states in India are Bihar, Karnataka, Uttar Pradesh, Orissa, Maharashtra, Andhra Pradesh, Madhya Pradesh and West Bengal. In Punjab state, Amritsar, Ropar, Jalandhar, Hoshiarpur are tomato growing districts.

- Time of sowing: For northern state, tomato cultivation for spring season is done in late November and transplanted in second fortnight of January. For autumn crop, sowing is done in July - August and transplanted in August - September. In hilly areas sowing is done in March- April and transplantation is done in April -May.

- Spacing: Depending upon the variety sowed and its growth habit, spacing of 60x30 cm or 75x60 cm or 75x75 cm should be maintained. In Punjab, for dwarf variety use spacing of 75 x 30 cm and for rainy season use spacing of 120-150 x 30 cm.

- Sowing depth: In nursery, seeds should be sown at depth of 4cm and then covered with soil.

- Method of sowing**:**Transplanting of seedling in main field.

Irrigation Requirements

Tomatoes need irrigation that is just sufficient at the right time, and thus it is necessary to maintain an even moisture supply to the crop. During summer season, irrigation at every 5 to 7 days interval is required, whereas in winter 10 to 15 days interval is sufficient.

Fertilizer & Nutrient Requirements for Tomato crop

At the time of land preparation mix rotten cow dung (10 ton/acre) in the soil. Apply fertilizer dose of N:P:K (60:25:25 kg/acre) in form of Urea (130kg/acre), Single Super Phosphate (155kg/acre) and MOP (45kg/acre). Apply half dose of Nitrogen, full dose of Phosphorus and Potash applied as basal dose, apply it before transplanting. 20 to 30 days after transplantation apply remaining 1/4th dose of nitrogen. Two month after transplantation, apply remaining dose of Urea.

10-15 days after transplanting, spray 19:19:19 along with micronutrient (2.5-3 gm/L) of water. If the temperature is low, the plant will absorb fewer nutrients and growth will get affected. In this case use foliar spray - in vegetative growth stage take spray of 19:19:19 or 12:61:00 (4-5 gm/L). For better growth and more yield, spray with 50 ml Brassinolide per acre in 150L of water at 40-50 days after transplanting for two times at 10 days intervals.

To obtain good quality along with good yield, take spray of 12:61:00 (Mono Ammonium Phosphate 10gm/L) before flowering. To control flower and fruit dropping, spray Boron (25gm/10L of water) as soon as flowering starts. To avoid black spots which are an indication of calcium deficiency, spray calcium nitrate (2gm/L of water). During high temperature if flower drop is witnessed, spray with NAA (50 ppm (50ml/10L water) when crop is in the flowering stage. Further, give one spray of sulphate of potash (00:00:50+18S) during fruit development stage (3-5 gm/L of water) to boost fruit development and colour. Finally, to improve plant growth, flowering and fruit set spray with sea weed extract Biozyme/Dhanzyme (3-4 ml/L water) twice a month.

CULTIVATION OF RADISH

adish is grown for its tender tuberous roots which are eaten raw as salad or as cooked vegetable. It has a unique pungent flavour. It is also used in *Parathas* which are taken with curd for breakfast in north India. It has a cooling effect, prevents constipation and increases appetite and is more nutritious when cooked with leaves. Young leaves are also cooked as vegetable. It is recommended for patients suffering from piles, liver troubles, jaundice etc. Juice of fresh leaves is sued as diuretic and laxative. Radish is a good source of vitamin-C and minerals. Rat-tail radish (*R. sativus* var. *caudatus*), which is similar to common radish, is grown for its long slender pods which are used as salad or cooked vegetable. It will not produce fleshy root as in radish.

Origin

Radish is originated in Europe and Asia. It is believed to have originated from *Raphanus raphanistrum,* which is widely distributed as a weed crop in Europe.

Botany

Radish is an annual or biennial depending on the ecotype / cultivar. The rosette leaves are lyrate, pinnatifid and vary in size from 10 cm to 15 cm in small rooted cultivars to 45 cm in large rooted cultivars. Edible portion develops from both the primary root and hypocotyls. Inflorescence is of racemose type with white flowers. Fruit is a siliqua. Seeds are yellowish when mature and turn reddish brown with age. Radish is cross-pollinated due to sporophytic self

incompatibility. Pollination is by honey bees and flies. Stigma receptivity is maintained up to 4 days after anthesis. Selfing is by bud pollination. Flower buds are pollinated two days prior to opening of flower by collecting pollen grains of previously bagged flowers of the same plant.

Varieties

Radish varieties vary in shape, sized and skin colour of roots and duration of cop. The varieties can be divided into three groups – European or temperate types. Asiatic or tropical types and Indian types. Temperate types are of small size, with excellent quality and mainly used for salad purpose. Tropical types are more pungent than temperate types and have large roots. An indigenous type, Jaunpuri Giant, cultivated Jaunpur in Uttar Pradesh, has roots of 75-90 cm length, 50-60 cm girth and weight up to 5-15 kg.

Climate

Ideal temperature for growth and development of quality roots in radish is 10-15.5oC. Though it can tolerate high temperature, roots develop pungency under hot weather. Hence, it should be harvested when roots are small and tender during hot periods.

Soil

Being a root crop, radish requires loose and friable soil, rich in organic matter.

Land preparation and sowing

In plains of North India, radish can be grown throughout the year. Since temperate radish tolerates frost, it is successfully grown between September and January in plains. Tropical types are sown from middle of September onwards. If sowing is done later than November, it bolts earlier.

Land is ploughed to a fine tilth and ridges of 25 cm height and furrows are prepared at 30-45 cm distance. Seeds are sown continuously in ridges. Spacing depends on type of varieties. Indian tropical cultivars take longer time and grow larger. Distance between two rows is kept at 45 cm and seeds are sown continuously on ridges. Later they are thinned to keep a distance of 6-8 cm in a row. European types will be ready in 25-30 days and are sown at a closer spacing of 5-10 cm x 3 cm. Accordingly, seed rate varies from 10.0 kg for large varieties to 12.0 kg for temperate European types. For round cultivars, sow seeds on soil surface and put a layer of soil above it. Seeds of large cultivars are sown 1.5-3.0 cm deep. Usually seeds are sown in

phased manner to get continuous supply of roots.

Hafeez and Hudson (1967) narrated beneficial effects of hardening radish seeds by subjecting them to 2 cycles of wetting and drying in which they are allowed to absorb water equivalent to 25% of weight and alter dried at 2.2oC.

Irrigation

Radish requires plenty of water from sowing to harvest. For rapid germination and subsequent production of roots, soil should be moist and loose. So irrigate immediately after sowing. If irrigation is restricted, roots will be tougher and pungent, making it unfit for marketing.

Inter-culture

In radish, the epicotyl's grows up and develops into root tubers. As it grows in size, there is a tendency to bulge out. These roots are to be covered by way of one earthing up, which will take care of weeds also.

Harvesting

Depending up on the cultivar, roots will be ready for harvest in 25-55 days after sowing. If harvesting is delayed, roots will become bitter and pithy. Harvesting is done manually. A light irrigation is given before pulling out roots. After harvesting, roots are washed, made into bundles and marketed along with a few leaves.

Yield

European varieties yield 5-7 t/ha while in Indian cultivars, it varies from 15-20 t/ha. Radish roots can be stored for 2-3 days under room temperature without impairing quality. Roots can be stored for about 2 months at 0oC and 90-95% RH.

Seed production

Seeds of European varieties an produced in hills and tropical types in plains. As it belongs to family Cruciferae, it is cross-pollinated and pollination is done by bees. Hence, provide isolation distance as in cabbage or cauliflower. Wild mustard, wild turnip and wild radish should also be removed from field. Roots left in *situ*, without harvesting, produce maximum quantity of seeds. One additional earthing up is required during flowering and fruiting stages to prevent lodging of plants. For producing quality seeds, roots are pulled out and true-to-type roots alone are replanted. Usual practice is to remove ½ to ¾ of lower root portion before planting. However, it reduces yield considerably. Hence, replanting roots with minimum injury

is advisable for high yield. Seed yield varies from 600-800 kg/ha.

Pests and diseases

A few of the important diseases of radish are *Alternaria* blight, white rust and radish mosaic.

Alternaria blight: It is caused by *Alternaria rapham.* Symptoms and control measures already discussed under Cole-crops.

White rust (*Albugo candida*): It produces white powdery substance in patches on under-surface of leaves. Disease symptoms appear on leaves and flowering shoots, which become deformed and produce malformed flowers. Use of resistant cultivars like Arka Nishant and regular sprayings with mancozeb (0.2-0.3%) are recommended.

CULTIVATION OF GREEN CHILLIES

Chilli is a spicy fruit used in cuisine preparations. It is mostly added as an ingredient in foods to make it spicy. As per the latest data, India tops the list in chilli production followed by China, Peru, Spain and Mexico. Indian chillies are known for their pungency and color, especially the ones grown in Guntur district of Andhra Pradesh. Some of the chillies that are bigger in size are called bell peppers and are used as a vegetable. Chilli has various local names in India like lanka, mirchi etc.

Ideal Conditions for Chilli Cultivation

Climatic Requirements

Chilli is a tropical and sub-tropical plant requiring a combination of warm, humid yet dry weather. During the growth stage it needs a warm and humid weather. However, a dry weather is suitable for fruit maturity. Range between 20^0 -25^0 C is ideal temperature range for chilli growth. At 37^0 C or higher the crop development is affected. Similarly in case of heavy rain the plant starts rotting. In case of low moisture conditions during fruiting time period the bud does not develop properly. Hence, flower and fruit may drop off. It means that, a high temperature and

relatively low humidity level would lead to deflowering and fruits if developed would be very small.

Soil for Chilli Cultivation

Chillies need moisture for growth. It has been found that black soil which retains moisture is ideal in case they are grown as rainfed crops. Under irrigated conditions, the crop needs well-drained sandy loam with rich organic content. They can also be grown in deltaic soil under irrigated conditions. In areas such as Uttarakhand, soil is mixed with gravel and coarse sand before undertaking chilli cultivation.

pH Requirement

pH of soil should be between 6.5 and 7.5 (neutral soil). It cannot tolrate acidic nor alkaline soil.

In which Season Chilli Farming Should be done

Chillies can be grown both as Kharif and Rabi crop. In addition they are also planted at other times. Sowing months are May to June for Kharif crop, September to October for Rabi crops. If they are grown as summer crops then January-February months are chosen.

Water for Green Chilli Cultivation

Chillies are crops that cannot resist a lot of water. Heavy rainfall and stagnated water would result in rotting of the plants. In case of irrigated crops, watering should be only when it is necessary. A frequent watering would result in shedding of flowers and a spurt of vegetative growth. The amount of water to be irrigated, the number of irrigations and its frequency highly depends on the climatic conditions and the soil type. If the leaves start drooping during day time it is an indication of water requirement. If the flowers are weak then irrigating the crop would be helpful. Some farmers irrigate the field once the soil moisture content falls below 25%.

Want Planting Material for Chilli Plantation

Chillies are propagated from seeds. At the time of cultivation, disease- free, good quality seeds must be chosen. Various high yielding, disease resistant varieties have been developed by research institutes and different organizations. In case of organic farming, they must be obtained from farms certified by the central authority.

Chilli Varieties

Jwala

- Highly pungent variety with small
- The fruits have a red color.
- They are harvested from September to December.
- It is Grown in parts of Gujarat.

Kanthari

- Fruits are short with high level of pungency.
- Color is ivory-white.
- Grown as a homestead crop, they are available all year round.
- Grown in Kerala and parts of Tamil Nadu.

Kashmiri Chilli

- Fruits are long and have a deep red color.
- They are harvested from November to February months.
- These are grown in North Indian states like Jammu-Kashmir and Himachal Pradesh.

Bhagya Lakshmi

- It is also known as G-4 this variety is grown in irrigated areas of Andhra Pradesh.
- The fruits are olive green in colour, which turns dark red when ripe.
- The variety is tolerant towards pests and diseases.

TNAU Hybrid Chilli Co1

- Developed by TNAU, Coimbatore the fruits are 12 cm long.
- The raw fruits are light green in color and tapering at the tip.
- Moderately resistant to fruit rot.
- Yields 11 tonnes per acre of green chilli and 2 tonnes of dry pods per acre.
- These Chillies are ready for harvest within 200 days of plantation.

KI

- It is developed through pure line selection from Assam typeB72A.

- They are suitable for cultivation in rainfed areas.
- Plants are tall with fruits spread out.
- Yields about 700 Kg of fruits per acre.

PLR1

- This variety is from Kandangadu type chillies.
- The fruits are medium-sized with a bulging base.
- The tip is dull and the chillies appear glossy.
- It is most widely used for pickling purposes using buttermilk.
- These crops are ready to be harvested within 210 days and they yield around 7 tonnes per acre.

Land Preparation for Chilli Cultivation

The land needed for chillies farming are ploughed 2-3 times and brought to a fine tilth. The gravel, stones and other such unwanted material present in the soil are removed. If the seeds are sown directly in the soil then it is carried out along with the last ploughing cycle. However, at the time of ploughing, the soil must be sterilized properly so that diseases affecting the plants are kept in check.

Soil Treatment for Organic Farming

- The soil is treated with Azotobacter or AzospirillumIf, if chillies are being planted in an organic farm.

- Around 1 Kg of Azotobacter or Azospirillum is mixed with 50 Kg of farm yard manure.
- We can also add 2 tonnes of vermicompost is added on per acre basis.

Soil Treatment for Conventional Farming

- In case of conventional farming, soil sterilization is done with the help of
- Around 20 mL of formalin is mixed with a liter of water before applying on soil.
- After applying, it is covered with polyethylene sheet of 25 micron thickness for 1-1.5 days.
- For 15 days, they are aerated.
- Around 8-10 Aldrin per acre is applied to the soil, during the time of last ploughing. This protect crop from pests like white ants.
- Ridges and furrows are dug with a spacing of 60 x 45 cm and 75 x 60 cm for hybrids.
- Raised beds are built at a distance of 30 cm from each other and are 120 cm wide.

Sowing Chilli or Mirchi Plant

Seed Treatment

- This is first steps on sowing.
- Chilli seeds are never ever pre-treated with chemicals, instead they are treated with herbal fungicides.

- Around 80 grams of seeds are required for sowing in one acre of land.

- The seeds are treated with Pseudomonas fluorescens. It is a bio-fungicide which protects the crop from fungal attacks and pests.

- The seeds are then mixed with Azospirillum and for half hour they are shade dried.

Chilli seedlings in nursery

- The seeds of chilli are commonly grown in nurseries and then the seedlings are transplanted.

- After sowing the seeds are covered with coco peat and it is watered everyday till it germinates.

- Around 3% Panchagavya spray is done after 15 days or a micronutrient spray is done after 18 days.

- Once they are 35 days old, the seedlings are transplanted.

Transplanting

- For half an hour, the seedlings are dipped in 0.5% Pseudomonas fluorescens solution and then it is transplanted in the main field.

- The intercrop distance is at 45 cm during plantation.

Intercropping in Chilli Cultivation

- Chillies are intercropped with onions in rows at some places.

- It is done in this way that two rows of chillies are followed by one row of onion.

Diseases Management in Chilli Plantation

- Chillies suffer from a various diseases like anthracnose, fruit rot, dieback, bacterial wilt, mosaic diseases, powdery mildew, leaf spot, etc.

- Spraying Trichoderma and Pseudomonas species would help prevent disease spread.

Pest Management

- Pod borers, Thrips, grubs, nematodes, aphids, mites, etc. are the major pests of chilli farming.

- At the time of farm yard manure application only well-rotted manure is sued.

- Growing onions with chillies would help prevent pest attack.

Chilli Production per Acre

- Fresh chilli yield varies from 30-40 quintal per acre.

- We get 25-35 Kg of dried chilli from 100 Kg of fresh chilli.

- Average yield of dry chilli varies from 7.5 to 10 quintals per acre.

Harvesting in Chilli Cultivation

- The harvesting of chilli is done according to the intended use of chillies.

- For making powdered chilli and dry chilli, fruits are harvested when the chilli turns dark red in color.
- The green chilli is plucked for preparing pickles.
- Plucking should be done at regular intervals.
- Keeping them on the plant for a longer period of time can cause color fading and wrinkles.
- The chilli in green colour or green chillies can be plucked 8-10 times while ripe ones are plucked 5-6 time **Land Preparation for Chilli Cultivation**
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