Plant Science

Floriculture and Nursery Management

Government of Nepal
Ministry of Education, Science and Technology
Curriculum Development Centre
Sanothimi, Bhaktapur
Phone : 5639122/6634373/6635046/6630088
Website- https://www.moecdc.gov.np
Email- info@moecdc.gov.np

Grade 10

Technical and Vocational Stream
Learning Resource Material

Floriculture and Nursery Management

(Grade 10)

Plant Science

Government of Nepal
Ministry of Education, Science and Technology
Curriculum Development Centre
Sanothimi, Bhaktapur

Publisher: Government of Nepal
Ministry of Education, Science and Technology
Curriculum Development Centre
Sanothimi, Bhaktapur

Layout by Santosh Dahal

Preface

The curriculum and curricular materials have been developed and revised on a regular basis with the aim of making education objective-oriented, practical, relevant and job oriented. It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in students and equip them with morality, discipline, self-reliance, creativity and thoughtfulness. It is essential to develop linguistic and mathematical skills, knowledge of science, information and communication technology, environment, health and population and life skills in students. It is also necessary to bring the feeling of preserving and promoting arts and aesthetics, humanistic norms, values and ideals. It has become the need of the present time to make them aware of respect for ethnicity, gender, disabilities, languages, religions, cultures, regional diversity, human rights and social values to make them capable of playing the role of responsible citizens with applied technical and vocational knowledge and skills. This learning resource material for Plant Science has been developed in line with the Secondary Level Plant Science Curriculum with an aim to facilitate the students in their study and learning on the subject by incorporating the recommendations and feedback obtained from various schools, workshops, seminars and interaction programs attended by teachers, students and parents.

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Mr. Yubaraj Paudel and members of the subject committee Pro.Dr. Kaniya Prasad Singh, Pro.Dr. Gyan Kumar Shrestha, Dr. Kishorchandra Dahal, Anita Bolakhe is highly acknowledged. The learning resource material is written by Rikhiram Neupane, Santosh Koirala, Niraj Belbase, Purnima Paudel, Mahesh Poudel, Dayamond Pokharel the subject matter of the materials, was edited by Mr. Badrinath Timsina and Mr. Khilanath Dhamala and language was edited by Mr. Binod Raj Bhatta. CDC extends sincere thanks to all those who have contributed to developing this material in this form.

This learning resource material contains a wide coverage of subject matters and sample exercises which will help the learners to achieve the competencies and learning outcomes set in the curriculum. Each chapter in the material clearly and concisely deals with the subject matters required for the accomplishment of the learning outcomes. The Curriculum Development Centre always welcomes constructive feedback for the betterment of the material.

2082 BS

Ministry of Education, Science and Technology
Curriculum Development Centre

Table of Content

Guidelines to Teachers

A. Facilitation Methods

The goal of this course is to combine the theoretical and practical aspects of the contents needed for the subject. The nature of contents included in this course demands the use of practical or learner focused facilitation processes. Therefore, the practical side of the facilitation process has been focused much. The instructor is expected to design and conduct a variety of practical methods, strategies or techniques which encourage students engage in the process of reflection, sharing, collaboration, exploration and innovation new ideas or learning. For this, the following teaching methods, strategies or techniques are suggested to adopt as per the course content nature and context.

Brainstorming

Brainstorming is a technique of teaching which is creative thinking process. In this technique, students freely speak or share their ideas on a given topic. The instructor does not judge students' ideas as being right or wrong, but rather encourages them to think and speak creatively and innovatively. In brainstorming time, the instructor expects students to generate their tentative and rough ideas on a given topic which are not judgmental. It is, therefore, brainstorming is free-wheeling, non-judgmental and unstructured in nature. Students or participants are encouraged to freely express their ideas throughout the brainstorming time. Whiteboard and other visual aids can be used to help organize the ideas as they are developed. Following the brainstorming session, concepts are examined and ranked in order of importance, opening the door for more development and execution. Brainstorming is an effective technique for problem-solving, invention, and decision-making because it taps into the group's combined knowledge and creative ideas.

Demonstration

Demonstration is a practical method of teaching in which the instructor shows

or demonstrates the actions, materials, or processes. While demonstrating something the students in the class see, observe, discuss and share ideas on a given topic. Most importantly, abstract and complicated concepts can be presented into visible form through demonstration. Visualization bridges the gap between abstract ideas and concrete manifestations by utilizing the innate human ability to think visually. This enables students to make better decisions, develop their creative potential, and obtain deeper insights across a variety of subject areas.

Peer Discussion

Peer conversation is a cooperative process where students converse with their peers to exchange viewpoints, share ideas, and jointly investigate subjects that are relevant or of mutual interest. Peer discussion is an effective teaching strategy used in the classroom to encourage critical thinking, active learning, and knowledge development. Peer discussions encourage students to express their ideas clearly, listen to opposing points of view, and participate in debate or dialogue, all of which contribute to a deeper comprehension and memory of the course material. Peer discussions also help participants develop critical communication and teamwork skills by teaching them how to effectively articulate their views, persuasively defend their positions, and constructively respond to criticism.

Peer conversation is essential for professional growth and community building outside of the classroom because it allows practitioners to share best practices, work together, and solve problems as a group. In addition to expanding their knowledge horizon and deepening their understanding, peer discussions help students build lasting relationships and a feeling of community within their peer networks.

Group Work

Group work is a technique of teaching where more than two students or participants work together to complete a task, solve a problem or discuss on a

given topic collaboratively. Group work is also a cooperative working process where students join and share their perspectives, abilities, and knowledge to take on challenging job or project. Group work in academic contexts promotes active learning, peer teaching, and the development of collaboration and communication skills. Group work helps individuals to do more together than they might individually do or achieve.

Gallery Walk

Gallery walk is a critical thinking strategy. It creates interactive learning environment in the classroom. It offers participants or students a structured way to observe exhibition or presentation and also provides opportunity to share ideas. It promotes peer-to-peer or group-to-group engagement by encouraging participants to observe, evaluate and comment on each other's work or ideas. Students who engage in this process improve their communication and critical thinking abilities in addition to their comprehension of the subject matter, which leads to a deeper and more sophisticated investigation of the subjects at hand.

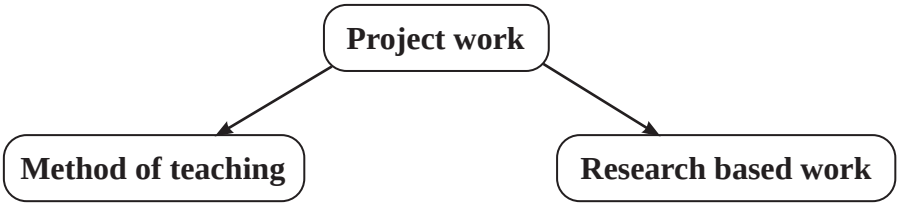
Interaction

The dynamic sharing of ideas, knowledge, and experiences between people or things is referred to as interaction, and it frequently takes place in social, academic, or professional settings. It includes a broad range of activities such as dialogue, collaboration or team work, negotiation, problem solving, etc. Mutual understanding, knowledge sharing, and interpersonal relationships are all facilitated by effective interaction. Interaction is essential for building relationships, encouraging learning, and stimulating creativity in both in-person and virtual contexts. Students can broaden their viewpoints, hone their abilities, and jointly achieve solutions to difficult problems by actively interacting with others.

Project Work

Project work is a special kind of work that consists of a problematic situation which requires systematic investigation to explore innovative ideas and solutions.

Project work can be used in two senses. First, it is a method of teaching in regular class. The next is: it is a research work that requires planned investigation to explore something new. This concept can be presented in the following figure.



Project work entails individuals or teams working together to achieve particular educational objectives. It consists of a number of organized tasks, activities, and deliverables. The end product is important for project work. Generally, project work will be carried out in three stages. They are:

- Planning
- Investigation
- Reporting

B. Instructional Materials

Instructional materials are the tools and resources that teachers use to help students. These resources/materials engage students, strengthen learning, and improve conceptual comprehension while supporting the educational goals of a course or program. Different learning styles and preferences can be accommodated by the variety of instructional resources available. Here are a few examples of typical educational resource types:

- Daily used materials
- Related Pictures
- Reference books
- **Slides and Presentation:** PowerPoint slides, keynote presentations, or other visual aids that help convey information in a visually appealing and organized manner.
- **Audiovisual Materials:** Videos, animations, podcasts, and other

multimedia resources that bring concepts to life and cater to auditory and visual learners.

- **Online Resources:** Websites, online articles, e-books, and other web-based materials that can be accessed for further reading and research.

Maps, Charts, and Graphs: Visual representations that help learners understand relationships, patterns, and trends in different subjects.

Real-life Examples and Case Studies: Stories, examples, or case studies that illustrate the practical application of theoretical concepts and principles.

C. Assessment

Formative Test

Classroom discussions: Engage students in discussions to assess their understanding of concepts.

Quizzes and polls: Use short quizzes or polls to check comprehension during or after a lesson.

Homework exercises: Assign tasks that provide ongoing feedback on individual progress.

Peer review: Have students review and provide feedback on each other's work.

Summative Test

Exams: Conduct comprehensive exams at the end of a unit or semester.

Final projects: Assign projects that demonstrate overall understanding of the subject.

Peer Assessment

Group projects: Evaluate individual contributions within a group project.

Peer feedback forms: Provide structured forms for students to assess their peers.

Classroom presentations: Have students assess each other's presentations.

Objective Test

Multiple-choice tests: Use multiple-choice questions to assess knowledge.
True/False questions: Assess factual understanding with true/false questions.

Matching exercises: Evaluate associations between concepts or terms.

Portfolio Assessment

Compilation of work: Collect and assess a variety of student work samples.

Reflection statements: Ask students to write reflective statements about their work.

Showcase events: Organize events where students present their portfolios to peers or instructors.

Observational Assessment

Classroom observations: Observe students' behavior and engagement during class.

Performance observations: Assess practical skills through direct observation.

Field trips: Evaluate students' ability to apply knowledge in real-world settings.

Introduction

Unit 1

1.1 Meaning, Importance, Scope, and Challenges of Floriculture in Nepal

1.1.1 Meaning of Floriculture

Floriculture is a specialized branch of horticulture that deals with the cultivation, marketing, and use of flowering and ornamental plants for various purposes, including aesthetics, economy, and environment. It involves the production of flowers, foliage, climbers, shrubs, succulents, and other plants.

Floriculture can also be defined as the science and art of growing flowering and ornamental plants for gardens, landscaping, and the floral industry. It includes producing cut flowers, potted plants, bedding plants, and foliage plants.

1.1.2 Importance of Floriculture

a. **Economic Value**: Floriculture generates significant income through the sale of flowers, seeds, and saplings. High-value crops like roses, gladiolus, and gerbera fetch premium prices in both domestic and international markets, boosting the economic condition of growers.

b. **Cultural and Social Value**: Flowers hold immense cultural importance in Nepal, being integral to festivals like Tihar, weddings, and other ceremonies. Growing flowers is also a symbol of pride and high social status in society.

c. **Medicinal Value**: Certain flowers like marigolds and chrysanthemums are used for medicinal purposes. For example, marigold extracts help cure stomach ailments, while chrysanthemum tea is known to reduce fever.

4. **Aesthetic Value**: Flowers and ornamental plants significantly enhance the visual appeal of homes, gardens, parks, and public spaces, making them more attractive and pleasant.
5. **Environmental Value**: Ornamental plants contribute to environmental conservation by improving air quality, reducing soil erosion, and maintaining ecological balance. Their presence promotes a healthier and greener environment.

1.1.3 Scope of Floriculture in Nepal

a. **Diverse Climatic Conditions**: Nepal's varied climatic zones, ranging from tropical to alpine, enable the cultivation of a wide variety of flowers, such as roses, gladiolus, and chrysanthemums, enhancing the scope of floriculture.
b. **Rising Demand for Floral Products**: The increasing use of flowers in landscaping, tourism, and hospitality has boosted demand for floral products like cut flowers, ornamental plants, and essential oils, both domestically and internationally.
c. **Potential for Export**: There is immense potential for exporting floricultural products like seeds, bulbs, and ornamental plants, providing opportunities to earn foreign currency and strengthen the economy.
d. **Underutilized Land**: Nepal has abundant underutilized fertile land that can be effectively used for flower production, creating additional income opportunities for farmers.
e. **Increasing Urbanization**: The rapid urbanization in Nepal has led to a growing demand for ornamental plants, houseplants, and landscaping services, further expanding the scope of floriculture.

1.1.4 Challenges of Floriculture in Nepal

a. **Lack of Infrastructure**: Nepal faces a lack of modern infrastructure, including cold storage and transportation facilities, which hinders the efficient marketing of floral products.

b. **Limited Technical Knowledge**: Farmers and entrepreneurs often lack proper training and technical expertise in advanced floriculture practices, reducing productivity and profitability.

c. **Low Investment Priority**: Floriculture receives less attention and financial investment compared to other agricultural sectors, limiting its potential for growth.

d. **Dominance of Food Crops**: Agricultural practices in Nepal are dominated by food crops, leaving limited land and resources for the cultivation of flowers and ornamental plants.

e. **Market Accessibility Issues**: The absence of systematic marketing systems and reliable networks affects the sale and distribution of floricultural products, reducing the economic benefits for growers.

1.2 Current Status of Floriculture in Nepal

a. **Steady Growth**: Floriculture businesses in Nepal have been growing steadily, with an annual growth rate of 6-9% over the past two decades, reflecting increasing demand for flowers.

b. **Regional Presence**: Floriculture is practised in 44 districts, with Madhesh and Bagamati being major hubs. Districts like Kathmandu, Lalitpur, and Chitwan are key centers of floriculture.

c. **Land Utilization**: Around 141 hectares of agricultural land is dedicated to flower cultivation, directly benefiting over 41,000 individuals in terms of employment and income.

d. **Import Dependency**: While domestic production fulfills about 30% of the demand, the remaining 70% of floral products, such as cut flowers and ornamental plants, are imported to meet rising demand.

e. **Institutional Support**: Organizations like Floriculture Association Nepal (FAN), Nepal Agricultural Research Council (NARC), and Floriculture Development Centre (FDC) are actively promoting research and development in floriculture.

1.3 Classification of Ornamental Plants

Ornamental plants are cultivated primarily for their aesthetic appeal and are used in gardens, parks, landscaping, and decoration. These plants can be classified based on various factors, including their flowering season, growth habit, life span, economic use, habitat, reproduction method, and environmental adaptation. This classification helps in understanding the plants better and managing them effectively for different purposes.

1. Classification Based on Flowering Season

Ornamental plants are classified based on the time of year they bloom:

a. **Summer Season Plants**: These plants flower during the summer months (Jestha–Shrawan). They thrive in warm temperatures and add color to gardens during the hot season.

- **Examples**: Gulmohar, Nil Mohar, Petunia, and Phlox.

b. **Winter Season Plants**: These plants flower during the winter months (Mangsir–Magh). They are hardy and can withstand cooler temperatures.

- **Examples**: Poinsettia, Euphorbia, Bougainvillea, Chrysanthemum, and Gerbera.

c. **Rainy Season Plants**: These plants bloom during the rainy season (Ashad–Bhadra). They thrive in moist and humid conditions.

- **Examples**: Sano Asare *(Lagerstroemia indica)*, *Thulo Asare (Lagerstroemia flos-regime)*, and Gomphrena (Makhmali).

2. Classification Based on Growth Habit

This classification is based on the physical structure and growth patterns of plants.

a. **Herbs**: These are plants with soft, green, and non-woody stems. They are usually short and easy to cultivate.

- **Examples**: Petunia and Makhamali

b. **Shrubs**: These are semi-woody plants with multiple stems arising from the base. They grow up to 3 meters in height and are often used for hedges

or borders.

- **Examples**: Rose and Lalupatey

c. **Trees**: Trees are large woody plants with a single trunk and height exceeding 3 meters. They provide shade and enhance landscapes.

- **Examples**: Gold Mohar and Peepal

d. **Climbers**: Climbers are plants with weak stems that grow upward with the help of tendrils or other support structures

- **Examples**: Money Plant and Peas

e. **Creepers**: These plants spread across the ground as they have fragile, long, and thin stems that cannot support vertical growth.

- **Examples**: Strawberry, Melons and Pumpkins.

f. **Vines**: These are climbing or trailing plants that need support to grow upright. They can be woody or herbaceous.

- **Examples**: Clematis, Wisteria, Morning Glory, and Grapevine.

g. **Succulents**: Succulents have thick, fleshy leaves or stems that store water. They are well-adapted to dry conditions and require minimal care.

- **Examples**: Aloe Vera, Jade Plant, Sedum, and Agave.

h. **Grasses**: Ornamental grasses are grown for their attractive foliage. They come in various heights and textures, adding movement and interest to landscapes.

- **Examples**: Reed Grass and Pampas Grass.

3. Classification Based on Life Span

This classification is based on how long a plant lives.

a. **Annuals**: Annual plants complete their life cycle, from germination to flowering and seed production, within one growing season. They die after producing seeds and are commonly grown for their vibrant flowers.

- **Examples**: Hollyhock, Sweet Pea, Annual Chrysanthemum, Carnation, Marigold, Calendula etc.

b. **Perennials**: Perennial plants live for more than two years. They flower every season and add lasting beauty to gardens. Some perennials also produce flowers year-round.

- **Examples**: Rose, Jasmine, Orchids, Chrysanthemum, Gerbera, Hibiscus etc.

4. **Based on Economic Use**

a. **Cut Flowers**: Cut flowers are flowers harvested with their stems, primarily used for floral arrangements, bouquets, and decorations. They are cultivated for their aesthetic value and are widely used in events, ceremonies, and gifting.

- **Examples**: Roses, Gladiolus, and Gerbera.

b. **Loose Flowers**: Loose flowers are flowers harvested without stems and used in bulk for garlands, decorations, and religious rituals. They are commonly used in Nepalese festivals, weddings, and other cultural events.

- **Examples**: Marigold and Chrysanthemum.

c. **Foliage Plants**: Foliage plants are grown for their attractive leaves rather than their flowers. These plants are widely used for indoor decoration, landscaping, and enhancing the aesthetic value of homes and offices.

- **Examples**: Ferns and Crotons.

d. **Medicinal Plants**: Medicinal plants are cultivated for their therapeutic properties and are used in traditional medicine and pharmaceutical industries. Their flowers or other parts are processed into herbal remedies and medicines.

- **Examples**: Marigold (used for wound healing) and China Rose (used for stomach relief).

e. **Aromatic Plants**: Aromatic plants are grown for their fragrant flowers, which are used to extract essential oils and manufacture perfumes and scented products. These plants are highly valued in the cosmetic and aromatherapy industries.

- **Examples**: Jasmine and Tuberose.

5. Based on Habitat and Environmental Adaptation

Ornamental plants are classified based on their natural growing environments and their ability to adapt to various environmental conditions. This classification helps in selecting plants suitable for specific locations and climates, ensuring optimal growth and aesthetic value.

1. **Aquatic Plants:** Aquatic plants grow in water or very moist environments like ponds, lakes, wetlands, or aquariums. They have adaptations such as air-filled cavities to help them float and absorb nutrients directly from water. These plants enhance the beauty of water gardens and also contribute to oxygenation in aquatic ecosystems.
    - Examples: Lotus, Water Lily, and Water Hyacinth etc..
2. **Terrestrial Plants:** Terrestrial plants grow on land and depend on soil for nutrients and water. These are the most common plants found in gardens, landscapes, and agricultural fields. They can adapt to a wide range of land conditions and climates, making them highly versatile.
    - Examples: Roses, Marigolds, and Jasmine
3. **Epiphytes**: Epiphytes are plants that grow on other plants or surfaces, using them as physical support but not as a source of nutrients. They absorb moisture and nutrients from the air, rain, or organic debris. Epiphytes are well-suited to humid environments and are valued for their exotic and ornamental appeal.
    - Examples: Orchids, Ferns, and Bromeliads
4. **Xerophytes:** Xerophytes are plants that thrive in arid and dry conditions where water is scarce. These plants have adaptations like thick, fleshy leaves or stems for water storage, waxy coatings to minimize water loss, and deep root systems to access underground moisture. They are ideal for drought-prone regions and xeriscaping.
    - Examples: Cactus, Agave, and Aloe Vera.
5. **Hydrophytes:** Hydrophytes are water-loving plants that grow in or

near water bodies. They are adapted to waterlogged soils or submerged conditions with features like hollow stems and air spaces for buoyancy and oxygen exchange. Hydrophytes are commonly used in aquatic landscaping.

- Examples: Water Lily, Lotus, and Hydrilla.

6. **Mesophytes:** Mesophytes thrive in moderate environmental conditions, requiring neither excessive moisture nor extreme dryness. They grow well in fertile soil with adequate water and sunlight and are widely used in ornamental gardening.

- Examples: Roses, Chrysanthemums, and Jasmine

6. **Based on Mode of Reproduction**

a. **Sexual Reproduction**: Plants reproducing through sexual means produce seeds after pollination and fertilization. This method contributes to genetic diversity and is widely used for propagating flowering plants.

- **Examples**: Marigold and Calendula

b. **Asexual Reproduction**: Asexual reproduction involves the propagation of plants through vegetative parts like stems, cuttings, bulbs, or tubers. This method ensures uniformity in plants and is faster than seed propagation.

- **Examples**: Roses (cuttings) and Gladiolus (bulbs)

Exercise

Choose the correct answer from the given alternatives.

1. What is the primary focus of floriculture?
   a. Cultivation of food crops
   b. Cultivation of flowering and ornamental plants
   c. Cultivation of medicinal herbs
   d. Soil conservation

2. Which flower is widely used in Nepal during Tihar?
   a. Rose b. Marigold
   c. Tulip d. Chrysanthemum

3. Which of the following is an aquatic plant used in ornamental gardening?
   a. Marigold b. Lotus
   c. Cactus d. Peepal

4. Which district in Nepal is a major hub for floriculture?
   a. Chitwan b. Jhapa
   c. Mustang d. Doti

5. What classification category does Aloe Vera belong to?
   a. Herb b. Succulent
   c. Climber d. Grass

6. Which ornamental plant thrives in arid conditions?
   a. Cactus b. Lotus
   c. Water Hyacinth d. Rose

7. Which of the following is an example of a perennial plant?
   a. Marigold b. Rose
   c. Petunia d. Sweet Pea

8. What is the most common economic use of cut flowers?

   a. Fertilizer production b. Landscaping

   c. Bouquets and decorations d. Medicinal purposes

9. Which of these is an example of a xerophyte?

   a. Jasmine b. Water Lily

   c. Cactus d. Marigold

Write short answer to the following questions.

1. Define floriculture and its importance in Nepal.
2. List two major challenges in the floriculture industry in Nepal.
3. Name three types of ornamental plants based on growth habit.
4. Why is floriculture considered an eco-friendly practice?
5. Mention two examples each of summer and winter season plants.
6. What are the primary environmental benefits of ornamental plants?

Write long answer to the following questions.

1. Discuss the meaning, importance, scope, and challenges of floriculture in Nepal with examples.
2. Explain the classification of ornamental plants based on growth habits and economic use, providing examples.
3. Evaluate the current status of floriculture in Nepal, including its regional presence, growth rate, and institutional support.

Project Work

1. **Field Visit:** Visit a local nursery or floriculture farm and observe the classification and care of ornamental plants. Prepare a report on the types of plants grown and their uses.
2. **Practical Exercise:** Classify five ornamental plants in your area based on

growth habits, flowering seasons, and environmental adaptations.

3. **Awareness Campaign:** Create a poster or brochure highlighting the benefits of floriculture for the environment and economy in Nepal.
4. **Case Study Analysis:** Visit a successful floriculture enterprise in local area and analyze its business model, challenges, and contributions to the local economy.
5. **Group Discussion:** Organize a discussion on the challenges faced by Nepalese floriculture and propose solutions to overcome them.

Unit 2

Garden

2.1 Introduction, Scope and Importance

2.1.1 Garden

A garden is a planned outdoor space designed for cultivating and enjoying plants and nature. It combines both natural and man made elements to create an aesthetically pleasing environment. Alternatively, a garden is defined as a thoughtfully organized area where plants and decorative materials are arranged for aesthetic and functional purposes.

2.1.2 Scope of Gardens

Gardens have a broad scope that extends beyond aesthetics, covering economic, environmental, cultural, and social dimensions. Here is a detailed explanation of the scope of gardens:

1. **Economic Scope**: Gardens contribute significantly to the economy through various avenues such as landscaping services, sale of ornamental plants, and floriculture. They create opportunities for businesses like nurseries, garden design firms, and maintenance services.
2. **Environmental Conservation**: Gardens play a vital role in enhancing air quality, reducing soil erosion, and conserving biodiversity. They act as green belts, helping to mitigate the urban heat island effect and supporting ecological balance.
3. **Educational Scope**: Gardens serve as outdoor classrooms for students and researchers to study plant species, ecosystems, and environmental sustainability. Botanical gardens are particularly valuable for conservation education and scientific research.

4. **Tourism and Recreation**: Public gardens, botanical gardens, and historical landscapes attract tourists, generating income for local communities. They also provide spaces for recreation, leisure, and family outings.
5. **Community Development**: Gardens enhance urban spaces, improve the quality of life, and foster community interaction. Community gardens in urban areas encourage collective responsibility and engagement among residents.
6. **Productive Use of Unused Land**: Gardens utilize barren and unused lands by transforming them into productive green spaces. This not only enhances the beauty of the area but also prevents land degradation.

2.1.3 Importance of Gardens

Gardens hold immense importance in human life, contributing to physical, mental, social, and cultural well-being. Below are the key aspects of their importance:

1. **Environmental Benefits**: Gardens improve the environment by purifying the air, reducing noise pollution, and providing habitats for various species. They help in maintaining ecological balance and mitigating the effects of climate change.
2. **Aesthetic Value**: Gardens beautify surroundings, making them more visually appealing and enjoyable. They provide a sense of relaxation and are a source of inspiration for creativity.
3. **Health and Well-being**: Gardening is a therapeutic activity that improves mental health by reducing stress and anxiety. Spending time in gardens promotes physical activity and enhances overall well-being.
4. **Economic Contribution**: Gardens contribute to economic growth through the sale of plants, seeds, and gardening equipment. They generate employment opportunities in sectors such as landscaping, nursery management, and garden maintenance.
5. **Cultural Significance**: Gardens are an integral part of cultural and

religious ceremonies in Nepal. They play a crucial role in festivals like Tihar and weddings, symbolizing prosperity and celebration.

6. **Educational and Research Value**: Gardens provide a platform for learning about plants, their growth habits, and their role in the ecosystem. They are also sites for research in horticulture, floriculture, and plant sciences.
7. **Social Interaction**: Gardens act as social spaces where people come together for events, gatherings, or relaxation, fostering a sense of community and belonging.
8. **Food and Medicinal Resources**: Some gardens, especially kitchen gardens, provide fresh fruits, vegetables, and herbs, while others grow medicinal plants like marigold and tulsi, which have therapeutic uses.

2.2 Garden Types

2.2.1 Formal Garden

Formal gardens are characterized by structured design, symmetrical layouts, and classical design elements, emphasizing geometric patterns and precise symmetry. These gardens are meticulously planned and maintained to showcase human control over nature through a balanced and orderly appearance.

Key Elements of Formal Garden Design

- **Symmetry**: Designs center around a main axis or central line, often a pathway or lawn, with the garden space divided into equal halves or quarters.
- **Prominent Focal Point**: Sculptures and statues, ranging from classical figures to modern abstract works, serve as central attractions.
- **Topiary**: Clipped hedging, typically of box or yew, is used to define spaces and create intricate patterns.
- **Ornamentation**: Features large, ornate urns often placed on plinths or balustrades, which may vary from elaborate to simpler modern designs.
- **Natural Stone Paving**: Pathways and terraces use natural stone to create regular patterns, enhancing architectural elements.

Maintenance and Locations

- Formal gardens require extensive maintenance, including regular pruning and shaping to preserve their precise appearance.
- Typically found in significant public and private spaces, examples include the Mughal Gardens in India and the Versailles Garden in France, often associated with grand residences or governmental buildings.

2.2.2 Informal Garden

In contrast, informal gardens, or naturalistic gardens, are designed to resemble natural habitats, featuring less structured layouts and more organic patterns. They prioritize a natural, relaxed aesthetic with varied plantings that blend seamlessly into the landscape.

Characteristics of Informal Gardens

- **Curved Lines**: Pathways and plant beds follow natural, curving shapes.
- **Mixed Plantings**: Utilizes a variety of plants, including native species that grow freely and require minimal grooming.
- **Relaxed Borders**: Borders and divisions between different garden areas are subtle and blend naturally.

Maintenance and Locations

- Informal gardens require less maintenance than formal gardens as they rely on plants' natural growth patterns and appearances.
- These gardens are typically smaller and found in more intimate settings such as private backyards or nature reserves, with examples including the English landscape gardens and various Japanese gardens.

2.2.3 Differences Between Formal and Informal Garden

Formal garden	Informal gardens
Formal gardens are designed with straight lines, geometrical shapes and symmetrical patterns.	Informal gardens have natural and relaxed design with curved lines, irregular shapes, and asymmetrical patterns.

Formal gardens are typically arranged in a structured layout, often with central axis or focal point.	Informal gardens are arranged in more organic and freer flowing layout, often without a central axis and focal point.
The style of this garden referred as classic design resembling artificial looking.	This style of garden is sometimes referred to as naturalistic. It may draw inspiration from natural habitats
Formal garden requires a lot of maintenance, including regular pruning and shaping of plants to maintain their formal appearances.	Informal garden requires lower maintenance as they rely more on natural growth and appearances of plants.
Formal gardens contain pergolas, hedges, topiary, fountains.	Informal gardens contain stones, mix of wild/native plants species arranged in naturalistic way.
Formal gardens are bigger and often found on the front of houses, parks.	Informal gardens are smaller and found inside houses, private backyards and nature reserves.

2.3 Concept of Landscape Gardening

Landscape gardening is the art and practice of designing the outdoor environment to achieve beautiful and harmonious effects. It involves the planned layout and management of gardens and estates to create a picturesque appearance. The primary goal is to integrate the man-made structures (like buildings and pathways) with the natural landscape in a way that is both aesthetically pleasing and functional.

Key Aspects of Landscape Gardening:

- **Harmony and Aesthetics**: Ensuring that the garden design complements the existing landscape and architectural style of any buildings.
- **Functionality**: Designing the landscape to serve intended uses, whether for private relaxation, public gatherings, or functional outdoor living spaces.

- **Ecological Balance**: Incorporating sustainable practices that support local wildlife, conserve water, and minimize the environmental impact.

2.4 Principles of Landscape Design

Effective landscape design is governed by several fundamental principles that ensure both beauty and functionality:

- **Balance**: This principle achieves visual equilibrium by evenly distributing elements either symmetrically or asymmetrically across the garden.
- **Proportion**: This involves maintaining the correct scale among the various components of the garden to ensure they fit harmoniously within the overall space.
- **Unity**: This principle integrates diverse structures and plantings to create a cohesive appearance that complements the main building or focal area.
- **Perspective**: This controls visual perception by positioning objects in a way that makes them appear smaller or larger based on their distance from the viewer.
- **Prospect**: This offers scenic views through strategic openings, such as windows or gaps in foliage, creating picturesque vistas.
- **Restraint**: This involves avoiding the overuse of any single element to maintain the aesthetic appeal of the garden.
- **Rhythm**: This introduces repeated patterns or colors to guide the eye and enhance the visual flow within the garden.
- **Harmony**: This coordinates different garden features to produce a pleasing and unified effect.
- **Scale**: This uses relative dimensions to ensure elements like trees and water features are proportionate to the size of the garden.
- **Space**: This aims to design the layout to make the garden appear larger and more open, often by minimizing central plantings and emphasizing the periphery.

2.5 Preparation and Maintenance of Lawn

A well-maintained lawn serves as the foundation of landscape gardening, providing a vibrant green backdrop for other garden features.

Preparation of Lawn

- **Site Selection**: Gardeners choose locations with ample sunlight and good drainage, ensuring the soil depth is between 25-30 cm with a pH of 5.5 to 6.5.
- **Soil Preparation**: Gardeners till the land thoroughly, remove weeds, incorporate plenty of organic matter, such as FYM at 500 kg per 100 sq. m., and level the ground.
- **Planting**: Gardeners sow seeds or lay turf, ensuring even coverage and good contact with the soil.

Methods of Planting

1. **Sowing Seeds**: Gardeners distribute seeds evenly across the prepared soil, lightly cover them with sifted soil, and roll the surface to firm it.
2. **Dibbling**: Gardeners place doob grass cuttings at regular intervals in moist soil and water them frequently until they are established.
3. **Turfing**: Gardeners lay squares of turf closely together on prepared soil, press them firmly, and water them generously.

Lawn Maintenance

- **Regular Mowing**: Gardeners cut the grass to a height of 1.5 to 2.5 cm to encourage dense growth.
- **Frequent Irrigation**: Gardeners water the lawn lightly at regular intervals, especially during dry periods.
- **Weeding and Rolling**: Gardeners perform regular weeding and rolling to maintain a smooth lawn surface.
- **Fertilization**: Gardeners apply compost and a balanced mix of nutrients to promote healthy grass growth.
- **Disease and Patch Management**: Gardeners treat yellow patches and other signs of distress with appropriate horticultural practices.

Exercise

Choose the correct answer from the given alternatives.

1. What is the primary purpose of a garden?
   a. Industrial development
   b. Aesthetic and functional purposes
   c. Soil testing
   d. Aquatic ecosystem management

2. Which of the following is a key principle of landscape design?
   a. Overuse of ornamental elements
   b. Avoiding any symmetrical patterns
   c. Maintaining balance and proportion
   d. Exclusive use of exotic plants

3. What is the recommended pH range for preparing a lawn?
   a. 3.0–4.5
   b. 5.5–6.5
   c. 7.5–8.5
   d. 6.5–7.5

4. Which type of garden prioritizes natural growth and curved pathways?
   a. Formal garden
   b. Informal garden
   c. Xerophyte garden
   d. Vertical garden

5. Which method is most commonly used for planting grass in a lawn?
   a. Mulching
   b. Dibbling
   c. Aerating
   d. Pruning

6. What does "rhythm" in landscape design achieve?
   a. Creates harmony by uniting all features
   b. Introduces repeated patterns to enhance visual flow
   c. Emphasizes a single focal point
   d. Prevents overuse of any single element

7. What is a key characteristic of an informal garden?

   a. Symmetrical design

   b. Geometrical layout

   c. Organic patterns and mixed planting

   d. Extensive use of pergolas and hedges

8. Which type of garden requires high maintenance?

   a. Informal garden b. Formal garden

   c. Aquatic garden d. Natural reserve

9. Which is an example of a formal garden?

   a. Mughal Garden b. Japanese Garden

   c. Rock Garden d. English Landscape Garden

10. What is the main goal of perspective in landscape design?

    a. Creating symmetrical layouts

    b. Making objects appear proportionate

    c. Offering scenic views

    d. Controlling visual perception

Write short answer to the following questions.

1. Define a garden and mention its key components.
2. Discuss the scope of gardens in economic and environmental terms.
3. Differentiate between formal and informal gardens with two examples of each.
4. List four principles of landscape design and explain their importance briefly.
5. Describe the steps involved in preparing a lawn before planting grass.
6. What are the advantages of community gardens in urban areas?
7. Explain the significance of "harmony" and "balance" in landscape design.

Write long answer to the following questions.

1. Explain the meaning, scope, and importance of gardens in detail. Provide examples of how gardens contribute to economic, social, and environmental development.
2. Compare formal and informal gardens, including their design elements, maintenance requirements, and cultural significance.
3. Discuss the principles of landscape design with examples of how each principle enhances the aesthetic value of a garden.
4. Outline the steps for lawn preparation and maintenance, highlighting the importance of each step for achieving a healthy lawn.

Project Work

1. **Observation Visit:** Visit a local formal and informal garden. Identify and compare the design elements, plant arrangements, and maintenance practices.
2. **Practical Exercise:** Prepare a small-scale lawn plot in a garden or backyard using either the dibbling or turfing method. Document the steps and outcomes.
3. **Group Activity:** Collaboratively design a landscape garden layout for a given space, incorporating key principles such as balance, perspective, and rhythm.
4. **Interactive Discussion:** Discuss the challenges of maintaining urban gardens and propose sustainable solutions to address them.

Unit 3

Ornamental Plants

3.1 Cultivation Practices of Flowers

3.1.1 Cultivation Practices of Flowers: Carnation

Introduction

- **Common Name:** Carnation
- **Botanic Name:** *Dianthus caryophyllus*
- **Family:** Caryophyllaceae

- **Origin:** Native to Mediterranean countries including Greece, Italy, and Spain.
- **Significance:** The genus name 'Dianthus' is from Greek 'dios' (divine) and 'anthos' (flower), meaning 'Divine Flower.' Carnations are popular for their role in traditional Greek ceremonial crowns and are Spain's national flower. They rank third in commercial importance among cut flowers globally.

Importance and Uses

Carnations are versatile in use, suitable for cut flowers, decorative bedding, potting, indoor settings, and rock gardens. Their long shelf life makes them ideal for vase decorations. They are popular in weddings and special events like Mother's Day. In France and the Netherlands, carnations are used in perfume production.

Cultivation Details

Soil Requirements: Best grown in sandy loam soils rich in organic matter with a pH of 5.5-6.5 and a minimum soil depth of 50 cm for optimal root growth. Good drainage is crucial to avoid diseases like fusarium wilt.

Climate: Carnations thrive in greenhouses where conditions such as light, temperature, and carbon dioxide levels can be optimized. They prefer cool climate with day temperature of 18-24^{0}C and night temperature of 10-15^{0}C; relative humidity of 70 -75 % require long day conditions with a critical photoperiod of about 13 hours for flowering.

Varieties: Carnations are cherished for their rich fragrance and vibrant colors. Varieties include:

- **Standard Carnations:** 'Acropolis', 'Firato', 'Exotica', 'Baltico', 'Noblesse', 'Java', 'Montezuma', 'Texas', 'White Tundra', 'Design'.
- **Spray Carnations:** 'Natila', 'Alliance', 'Rony', 'Reflection', 'Barbara'.

Propagation: Carnations are propagated through cuttings, which involve taking a segment of the stem from a mature plant. These cuttings are treated with a rooting hormone and planted in a suitable medium to initiate root development.

Nursery Raising

Carnations are propagated from cuttings placed in trays or polybags within greenhouse conditions to control temperature and humidity. The nursery phase lasts until the plants are well-rooted, usually about 4-8 weeks, before they are transplanted into the main production areas.

Land Preparation and Bed Preparation

Carnations thrive in sandy loam soil with good drainage. The land should be plowed to a depth of 25-30 cm and leveled before preparing raised beds. Beds should be 30 cm high, 1-1.2 m wide, and of suitable length for efficient management. Incorporate 25-30 tons/ha of FYM into the soil during preparation and mix basal doses of 50:50:50 kg/ha NPK before planting.

Manure and Fertilizer

Carnations require 20-25 tons of FYM/ha and additional NPK (100:80:100 kg/ha) applied in two splits. Micronutrients like boron and zinc can be applied as foliar sprays to enhance flowering and prevent physiological disorders.

Weeding

Manual weeding is necessary to maintain a weed-free environment during the growing season. Mulching with organic materials helps to reduce weed growth and conserve soil moisture.

Irrigation

Water carnations at regular intervals of 10-12 days, ensuring the soil remains moist but not waterlogged. Drip irrigation is highly effective for maintaining optimal soil moisture while minimizing disease risk.

Pinching and Disbudding

Pinching is performed 3-4 weeks after planting to promote lateral branching and increase flower production. Disbudding is practiced to remove secondary buds, ensuring larger and more uniform blooms.

Training and Pruning

Netting is commonly used to support carnation stems, preventing them from bending or breaking under the weight of flowers. Pruning involves removing old, damaged, or diseased shoots to maintain plant health.

PestS

1. **Aphids *(Myzus persicae)***
    - **Symptoms:** Aphids are small, soft-bodied insects that cluster on the undersides of leaves and stems. They suck plant sap, causing leaves to curl, wilt, and become yellow. Aphids also excrete a sticky substance known as honeydew, which can lead to the growth of sooty mold on the plants.
    - **Management:** Aphids can be managed by spraying insecticides like malathion or using natural predators such as ladybugs. Additionally, neem oil or insecticidal soaps can be effective for organic management. Regular monitoring and early intervention are key to preventing severe infestations.

2. **Thrips *(Thrips tabaci)***
    - **Symptoms:** Thrips are tiny insects that cause damage by piercing and sucking the cell contents from leaves, buds, and flowers. This results in stippling, discolored flecking, and silvery patches on leaves. Severely attacked flowers may fail to open.
    - **Management:** Managing thrips involves applying systemic insecticides like imidacloprid or spinosad. Good sanitation practices, such as removing plant debris and weeds, can reduce thrip populations. In greenhouse settings, blue sticky traps can help monitor and reduce their numbers.

3. **Red Spider Mites *(Tetranychus urticae)***
    - **Symptoms:** These mites are very small and can be difficult to see

without magnification. They suck sap from the plant, causing the leaves to become speckled with yellow and eventually turn bronze or gray before dropping off. Fine webs may be visible on heavily infested plants.

- **Management:** Increasing humidity can deter spider mite outbreaks, as they prefer dry conditions. Miticides or oils such as neem oil are often required to control severe infestations. Regular washing of leaves can also help prevent these pests.

Diseases

1. **Fusarium Wilt *(Fusarium oxysporum)***
   - **Symptoms:** This fungal disease causes leaves to turn yellow and wilt, starting typically at the base of the plant and progressing upward. The vascular system may become browned, which can be seen in a cross-section of the stem.
   - **Management:** Fusarium wilt is managed by ensuring good drainage and avoiding overwatering. Crop rotation and soil sterilization with fungicides can prevent disease establishment. Resistant cultivars should be selected when available.

2. **Alternaria Leaf Spot *(Alternaria spp.)***
   - **Symptoms:** This disease manifests as small, dark, water-soaked spots on leaves and stems, which enlarge and become ringed with yellow. Severe infections can lead to leaf drop.
   - **Management:** Effective control involves the use of fungicides containing copper or mancozeb. Cultural practices such as spacing plants to improve air circulation and removing infected plant debris can also help manage leaf spot diseases.

Common Disorders in Carnations

1. Calyx Splitting

- **Symptoms:** Calyx splitting occurs when the protective layer around the flower bud, the calyx, splits open prematurely. This can lead to poor flower quality and makes the blooms more susceptible to disease. The disorder is often exacerbated by environmental factors such as fluctuating temperatures and high humidity.
- **Management:** To manage calyx splitting, ensure consistent environmental conditions in the greenhouse. Use cultivars that are less prone to splitting. Providing adequate boron nutrition can help as boron strengthens the calyx. Avoid excessive nitrogen levels as it can exacerbate the issue. Some growers use mechanical means like placing rubber bands around the calyx to prevent it from splitting.

2. Curly Tip

- **Symptoms:** Curly tip is characterized by the curling or distortion of the growing tips of the plant. It can make the tips appear stunted or twisted. This disorder is often associated with adverse environmental conditions, such as poor light, water stress, or a deficiency in potassium.
- **Management:** Ensure that the plants are receiving adequate light, especially during the darker winter months, by using supplemental lighting if necessary. Maintain consistent watering practices to prevent water stress. Potassium supplementation can also help prevent this disorder, ensuring that fertilizer regimes supply sufficient potassium according to soil and tissue test recommendations.

Harvesting Techniques and Yield

- Flowers are harvested when the outer two whorls of florets have started opening but are not fully open.
- Cut the stems close to the base of the plant, ensuring a long stalk for floral arrangements.

- Yield: About 10-12 lakh cut flowers/ha with 7-10 flowers per plant.

Post-harvest Handling

- Immediately place harvested flowers in cold water (5-8°C) for 30 minutes to reduce field heat.
- Use floral preservatives like sucrose (5%) and 8-HQC (300 ppm) in vase solutions to prolong vase life.

Storage

- Store at 0-5°C with relative humidity of 90-95%. Properly treated flowers can last up to 2-3 weeks in storage.

3.1.2 Cultivation Practices of Flowers: Gladiolus

Introduction

- **Common Name:** Gladiolus
- **Botanic Name:** *Gladiolus spp.*
- **Family:** Iridaceae
- **Origin:** Native to South Africa and Mediterranean Europe.

- **Significance:** Known as the 'sword lily' due to its sword-shaped leaves, Gladiolus is a staple in cut flower arrangements for its striking, colorful spikes. It is also used in traditional healing practices in Africa for its medicinal properties.

Importance and Uses

- Gladiolus is primarily used as a cut flower due to its impressive height and variety of colors, making it perfect for vertical interest in arrangements and floral displays. It is also planted in home gardens for its aesthetic appeal and is used in ceremonies for its symbolic representation of strength and integrity.

Soil Requirements: Best grown in well-drained sandy loam soils that are moderately fertile. A soil pH between 6.0 and 6.5 and a depth of at least 30 cm are ideal for healthy corm development and root growth.

Climate: Gladiolus performs best in temperate climates with full sun exposure. They require temperatures between 18-25°C for optimal growth, with a relative humidity of 60-70%. They do not tolerate frost and need protection in colder climates.

Varieties: Gladiolus is known for its striking, tall floral spikes and is popular in a range of settings. Varieties include:

- Recommended: 'White Prosperity', 'American Beauty', 'Peter Pears'.
- Additional: 'Plum Tart', 'Green Star', 'Nova Lux', 'Oscar'.

Nursery Raising

Nursery raising for Gladiolus involves planting corms directly into raised beds or the open field. Corms are spaced about 10-15 cm apart to allow sufficient room for growth. The nursery period lasts until the corms sprout and are ready for transplantation, which typically happens within a few weeks. The soil must be well-drained and fertile, and the nursery should be positioned in full sun.

Propagation: Propagation of Gladiolus typically involves the use of corms,

which are specialized stem tissues. Plant these corms directly into the ground in a sunny location. Ensure that the corms are healthy and free from any signs of rot or damage for the best results.

Land Preparation and Bed Preparation

The land should be deeply plowed (25-30 cm) and harrowed to break clods and ensure a fine tilth. Raised beds, 15-20 cm high and 1 m wide, should be prepared to enhance drainage and aeration. Incorporate 20-25 tons of well-rotted farmyard manure (FYM) into the soil 2-3 weeks before planting. Additionally, mix basal doses of 80:40:40 kg/ha NPK into the soil during the final preparation.

Manure and Fertilizer

FYM at 20-25 tons/ha is essential for healthy growth and should be applied during bed preparation. Supplement the crop with 150:80:80 kg/ha of NPK, split into two doses—one at planting and the second 6 weeks after planting. Micronutrients like boron and zinc improve flower quality and should be applied as foliar sprays when necessary.

Weeding

Weeding is crucial during the early growth stages to reduce competition for nutrients and water. Manual weeding should be done 2-3 times during the growing season. Organic mulching with straw or dry grass is recommended to suppress weeds and conserve soil moisture.

Irrigation

Irrigation is vital for gladiolus, particularly during spike emergence and flowering. The first irrigation should be done immediately after planting, followed by regular watering every 7-10 days depending on soil moisture. Furrow or drip irrigation is recommended to prevent waterlogging, which can lead to corm rot.

Pinching and Disbudding

Pinching is not typically practiced in gladiolus, but disbudding may be done to remove excess buds and improve the quality of spikes.

Training and Pruning

Training involves staking tall plants to prevent breakage from wind or the weight of flowers.

Earthing Up

Earthing up is done 4-6 weeks after planting to cover exposed corms and provide better anchorage.

Pests

1. **Thrips *(Thrips tabaci)***
    - **Symptoms:** Thrips attack flower buds and leaves, causing silver streaks and discoloration. Infested flowers fail to open properly, and leaves may appear distorted or curled.
    - **Management:** Regularly monitor crops using blue sticky traps. Apply imidacloprid 17.8% SL at 1 ml/liter or spinosad at 0.5 ml/liter. Maintain good sanitation by removing weeds and debris.
2. **Aphids *(Aphis spp.)***
    - **Symptoms:** Aphids cluster on young shoots and flower buds, sucking sap and causing stunted growth, leaf yellowing, and curling. They excrete honeydew, which attracts sooty mold.
    - **Management:** Spray neem oil at 3 ml/liter or malathion 50 EC at 2 ml/liter. Introduce natural predators such as lady beetles to reduce aphid populations.
3. **Cutworms *(Agrotis spp.)***
    - **Symptoms:** Cutworms cut young shoots at the base, leading to significant losses in newly transplanted crops.
    - **Management:** Apply chlorpyrifos 20 EC at 2 ml/liter to the soil before planting. Remove weeds, which can harbor larvae.

Diseases

1. **Fusarium Wilt *(Fusarium oxysporum f.sp. gladioli)***
    - **Symptoms:** The disease causes yellowing and wilting of leaves, discoloration of the vascular tissue, and rotting of corms. Infected plants often fail to flower.
    - **Management:** Treat corms with carbendazim 50 WP at 0.2% before planting. Ensure good drainage to avoid waterlogging, and practice crop rotation with non-host plants.

2. **Botrytis Blight *(Botrytis cinerea)***
    - **Symptoms:** Flower buds and leaves develop brown, water-soaked spots, which may be covered by gray fungal growth in humid conditions.
    - **Management:** Apply captan 50 WP at 2 g/liter. Improve air circulation in the planting area and avoid overhead irrigation.

Disorders

1. **Floret Blast**
    - **Symptoms:** Flower buds drop prematurely, often due to sudden changes in temperature, water stress, or nutrient deficiency.
    - **Management:** Ensure consistent irrigation and provide balanced fertilization, including potassium at 150 kg/ha.

Harvesting Techniques and Yield

- Harvest spikes when the lower 1-2 florets show full color but are still in bud stage for distant markets; for local markets, when 2-3 florets bloom.
- Cut spikes early in the morning with sharp tools, leaving a few leaves on the plant for future growth.
- Yield: Approximately 2-3 lakh spikes/ha and 20,000 kg of corms/ha.

Post-harvest Handling

- Place spikes in water immediately after cutting to prevent dehydration.

- Use preservative solutions (8-HQC and sucrose 4%) to improve vase life.

Storage

- Spikes: Store at 4°C and 90-95% RH.
- Corms: Corms are dried, treated with fungicides, and stored at 4-8°C with good ventilation.

3.1.3 Cultivation Practices of Flowers: Rose

Introduction

- **Common Name:** Rose
- **Botanic Name:** *Rosa spp.*
- **Family:** Rosaceae
- **Origin:** Native to Asia, Europe, North America, and northwest Africa.
- **Significance:** The rose is universally recognized as the symbol of love, beauty, and passion. Roses are culturally significant in many societies across the world and are used extensively in cosmetics, perfumes, and medicines.

Types of Rose

Roses are categorized into several types based on their growth habits, flower forms, and historical breeding. Here are the main types:

1. **Hybrid Tea Roses**: These are the most popular roses for their large, colorful, and often fragrant blooms that grow singly on long stems. Ideal for cut flowers, they come in a wide variety of colors and are known for their repeated blooming.
2. **Floribunda Roses**: Known for their bountiful clusters of flowers, Floribunda roses combine the hardiness of polyantha species with the beauty of hybrid teas. They are often smaller and bushier than hybrid teas, and they flower more prolifically.
3. **Grandiflora Roses**: Developed by crossing hybrid teas with floribundas, Grandiflora roses are characterized by their large flowers arranged in clusters on tall stems, combining the best traits of both groups.
4. **Miniature Roses**: As the name suggests, these roses are smaller in form, growing to a maximum of 15 inches tall. They are popular for growing in containers and for edging borders, and they replicate the forms and colors of larger roses.
5. **Climbing Roses**: These roses have long, arching canes that can be trained along supports such as arbors or fences. Climbers may bloom once per season or continuously, depending on the variety.
6. **Shrub Roses**: Including a wide range of roses that don't fit into the other categories, shrub roses are generally hardy, easy-care plants with diverse forms that can be used for hedges, ground cover, or as stand-alone plants.
7. **Old Garden Roses**: This group includes varieties developed before 1867, featuring lush fragrances and beautiful blooms. They are known for their resilience and disease resistance, often blooming only once a season.

Importance and Uses

- Roses are widely cherished for their beauty and fragrance, utilized in public

and private gardens, and essential in the floral industry for bouquets and decoration. Rose hips (the fruit of the rose) are high in vitamin C and are used to make jams, jellies, and herbal teas.

Soil Requirements: Roses thrive in fertile, loamy, well-drained soil with a pH of 6.5-7.0. Soil depth should be at least 40 cm to accommodate the extensive root systems and facilitate proper drainage.

Climate: Requires a temperate climate with at least 6 hours of direct sunlight daily. Optimal growth temperatures range from 15-25°C. Roses benefit from cool nights and moderate humidity to reduce disease incidence.

Varieties: Roses are highly prized for their beauty and fragrance. Varieties include:

- Recommended: 'Banarasi', 'Raktima', 'Golden Trophy'.
- Additional: 'Black Baccara', 'Blue Moon', 'Desert Rose'.

Propagation: Roses are primarily propagated through cuttings and budding. Stem cuttings are prepared by cutting a healthy, disease-free branch into segments, which are then planted in a propagating medium.

Nursery Raising

Rose nursery raising commonly utilizes cuttings, which are planted in polybags or directly in a specially prepared nursery bed with rich, loose soil. The cuttings are spaced to allow ample air circulation, crucial for preventing fungal infections. Nurseries usually maintain these plants for several months until they are hardy enough for transplantation, typically in the cooler months to reduce transplant shock.

Land Preparation and Bed Preparation

Deep plowing (30-40 cm) and thorough harrowing are essential to achieve a fine tilth. Raised beds, 30 cm high and 1 m wide, are recommended for proper drainage and aeration. During land preparation, incorporate 30-40 tons/ha of FYM into the soil to improve fertility.

Manure and Fertilizer

Apply 100:50:50 kg/ha of NPK as a basal dose during planting, supplemented with 50 kg/ha of nitrogen applied in two split doses after pruning and during the flowering stage. Roses benefit from micronutrient applications, especially boron and magnesium, to improve flower quality and plant vigor.

Weeding

Frequent hand weeding is required during the initial growth phase to control competition from weeds. Mulching with organic materials like straw helps in weed suppression and moisture conservation.

Irrigation

Roses require regular irrigation to maintain consistent soil moisture. Watering intervals of 5-7 days are ideal, especially during dry spells. Drip irrigation is highly effective in maintaining optimal moisture levels without waterlogging.

Pinching and Disbudding

Pinching is done in young rose plants (20-30 cm tall) to promote bushier growth. Disbudding, which involves removing secondary buds, is practiced to obtain larger blooms and enhance flower quality.

Training and Pruning

Pruning is essential in roses to remove dead, diseased, and unproductive growth. It is done annually during the dormant season to stimulate healthy shoots and maximize flowering. Climbers and ramblers require support structures for training.

Pests

1. **Aphids *(Macrosiphum rosae)***
    - **Symptoms:** Aphids infest young shoots and flower buds, causing deformation, leaf curling, and stunted growth. The presence of honeydew promotes sooty mold development.

- **Management:** Apply imidacloprid 17.8% SL at 0.5-1 ml/liter or neem oil at 3 ml/liter. Regular pruning of infested shoots is also effective.

2. **Spider Mites *(Tetranychus urticae)***
   - **Symptoms:** Leaves develop yellow or bronze specks and eventually turn brown and fall off. Fine webs may be visible on the undersides of leaves.
   - **Management:** Spray abamectin 1.9 EC at 0.4 ml/liter. Increase humidity and regularly wash leaves with water to deter mite infestations.

3. **Thrips *(Thrips tabaci)***
   - **Symptoms:** Thrips damage flowers, causing discoloration, flecking, and distortion of petals. Severely affected flowers may fail to open.
   - **Management:** Use blue sticky traps for monitoring and spray spinosad at 0.5 ml/liter.

Diseases

1. **Black Spot *(Diplocarpon rosae)***
   - **Symptoms:** Circular black spots with yellow halos appear on leaves, leading to premature defoliation and reduced flowering.
   - **Management:** Remove and destroy infected leaves. Spray chlorothalonil or mancozeb at 2 g/liter at regular intervals.

2. **Powdery Mildew *(Sphaerotheca pannosa)***
   - **Symptoms:** A white powdery coating develops on leaves, stems, and buds, causing deformation and reduced growth.
   - **Management:** Apply wettable sulfur at 2 g/liter or potassium bicarbonate at 1 g/liter. Avoid high humidity and overcrowding.

Harvesting Techniques and Yield

- Harvest buds at the tight bud stage with 2-3 sepals separated for distant markets; for local markets, when 1-2 petals partially open.

- Use sharp knives to cut stems at an angle to ensure better water absorption.
- Yield: 30-40 flowers/plant/year from the second year, increasing to 50-65 flowers/plant/year after the third year.

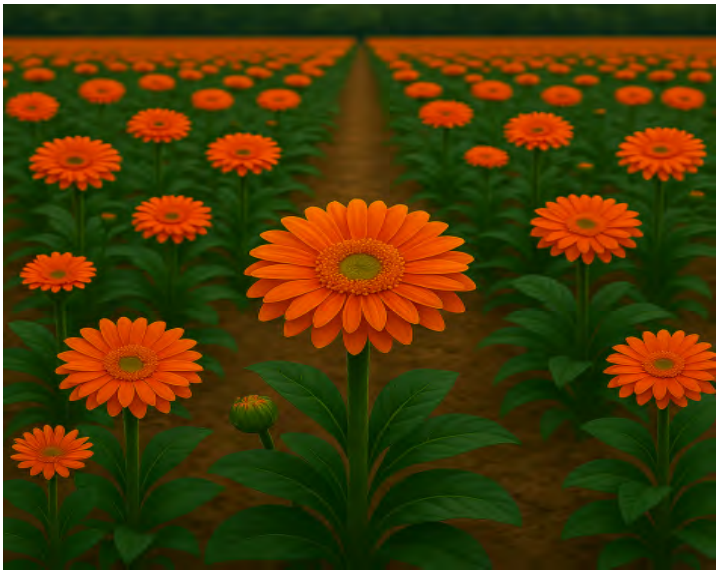
Post-harvest Handling

- Immediately place cut flowers in a preservative solution containing 300 ppm 8-HQC and 4% sucrose.
- Grade flowers by stem length (e.g., 60 cm, 45 cm).

Storage

- Store at 2-4°C with 90-95% RH. Use packaging like corrugated boxes for transportation.

3.1.4 Cultivation Practices of Flowers: Gerbera



Introduction

- **Common Name:** Gerbera
- **Botanic Name:** *Gerbera jamesonii*
- **Family:** Asteraceae
- **Origin:** Native to South Africa.

- **Significance:** Known for its vividly colored flowers, Gerbera is popular in the cut flower industry due to its wide color range and long vase life, symbolizing innocence and purity.

Importance and Uses

- Gerberas are extensively used in bouquets and flower arrangements for their cheerful and bright appearance. They are also popular potted plants due to their ability to purify the air by removing toxins.

Soil Requirements

Requires well-drained soil rich in organic matter, with a pH of 5.5 to 6.5 and a soil depth of at least 30 cm to promote healthy root systems.

Climate

Gerberas prefer a mild climate with moderate humidity and protection from direct midday sun. They thrive in temperatures between 18-24°C, with night temperatures not dropping below 12°C.

Varieties: Known for their bright and cheerful daisy-like flowers, Gerbera varieties include:

- **Recommended:** 'Salmon Queen', 'Dune', 'Jaguar'.
- **Additional:** 'Sakura', 'Everglades', 'Monte Carlo'.

Propagation

Gerbera can be propagated through seeds or division. Seeds require a well-aerated growing medium, whereas division involves separating the mother plant into smaller units.

Nursery Raising

Gerbera is typically propagated through division and tissue culture, with seedlings or plantlets being raised in trays under greenhouse conditions. The nursery media often includes peat or a peat-perlite mixture to ensure sterility and good drainage. Plants remain in the nursery until they develop a robust root

system and are ready for transplanting, generally around 8-12 weeks.

Land Preparation and Bed Preparation

The land should be deeply plowed, leveled, and prepared with raised beds. Beds should be 15-20 cm high and 1 m wide to ensure good drainage. During bed preparation, apply 25-30 tons/ha of FYM evenly to enrich the soil.

Manure and Fertilizer

Gerberas require 20 tons of FYM/ha and NPK (100:80:100 kg/ha), with micronutrient supplementation for optimal growth. Split the application of nitrogen into three doses—one at planting, the second during vegetative growth, and the third during flowering.

Weeding

Manual weeding should be done at least twice during the vegetative phase. Organic mulching with materials like straw is effective in suppressing weeds and conserving soil moisture.

Irrigation

Irrigate gerberas regularly, with intervals of 5-7 days depending on weather and soil moisture. Drip irrigation is recommended for precise water delivery and to avoid overwatering.

Pinching and Disbudding

Pinching is not commonly practiced in gerberas. However, removing spent blooms and old leaves improves air circulation and reduces the risk of disease.

Training and Pruning

Gerberas do not require staking but benefit from regular removal of diseased and senescent leaves. Proper sanitation practices help maintain plant vigor and flower quality.

Pests

1. **Whiteflies *(Bemisia tabaci)***
    - **Symptoms:** Whiteflies suck sap from leaves, causing yellowing, stunted growth, and reduced flowering. They also transmit viral diseases.
    - **Management:** Use yellow sticky traps to monitor and spray imidacloprid 17.8% SL at 0.5-1 ml/liter.
2. **Thrips *(Thrips palmi)***
    - **Symptoms:** Thrips feed on flower petals and leaves, leading to silver streaks and deformation.
    - **Management:** Apply spinosad at 0.5 ml/liter or fipronil at 2 ml/liter. Regular weeding and debris removal can reduce thrip populations.

Diseases

1. **Botrytis Blight *(Botrytis cinerea)***
    - **Symptoms:** Flowers and leaves develop water-soaked brown spots, which may turn gray due to fungal growth.
    - **Management:** Spray carbendazim 50 WP at 1 g/liter. Improve ventilation and reduce humidity in greenhouses.
2. **Phytophthora Root Rot *(Phytophthora spp.)***
    - **Symptoms:** Leaves turn yellow and wilt, and roots show signs of decay.
    - **Management:** Use well-drained soil and treat soil with metalaxyl at 2 g/liter.

Harvesting Techniques and Yield

- Harvest flowers when the outer rows of disc florets are perpendicular to the stem, ensuring good maturity.
- Gently twist or cut the stalk at the base to avoid damaging the plant.
- Yield: 250-270 flowers/m^2 annually.

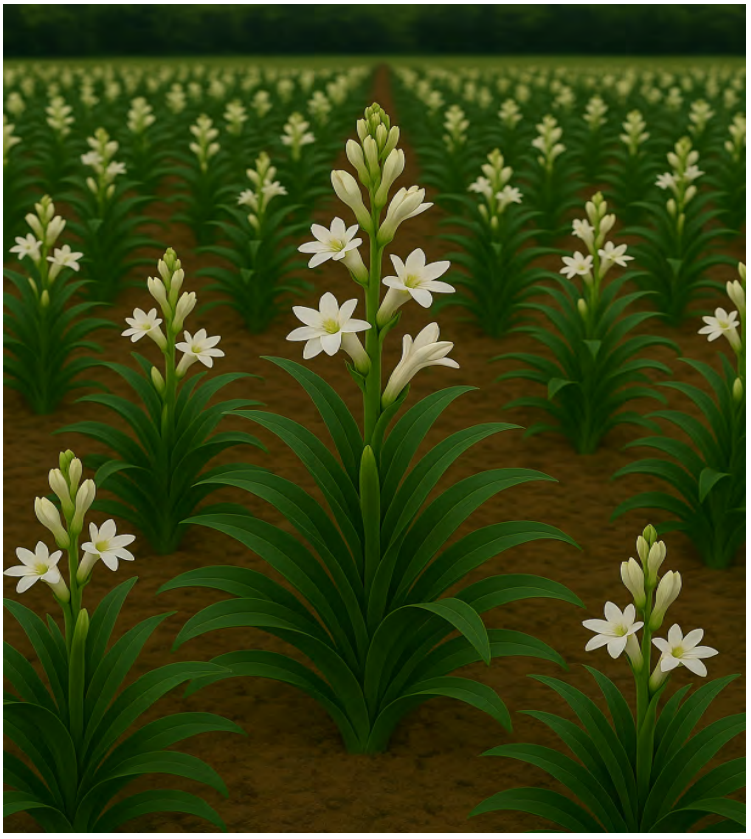
Post-harvest Handling

- Place harvested flowers in a vase solution of 5% sucrose and 200 ppm 8-HQC.
- Avoid direct sunlight during handling to prevent wilting.

Storage

- Store at 2-4°C with 85-90% RH. Use upright storage to prevent stem bending.

3.1.5 Cultivation Practices of Flowers: Tuberose



Introduction

- **Common Name:** Tuberose
- **Botanic Name:** *Polianthes tuberosa*
- **Family:** Asparagaceae

- **Origin:** Native to Mexico.
- **Significance:** Tuberose is highly valued for its heady fragrance and elegant white blooms, often used in perfumery and traditional wedding ceremonies in many cultures.

Importance and Uses

- Known for its strong and appealing scent, Tuberose is predominantly used in the perfume industry and in floristry for wedding arrangements, celebrated for its deep, intoxicating floral notes and long-lasting fragrance in cut flower form.

Soil Requirements

Tuberose prefers a well-drained sandy loam soil with high organic content, a pH of 6.5 to 7.5, and a soil depth of at least 30 cm to support its root system.

Climate

It requires a warm climate with full sunlight. Tuberose thrives in temperatures ranging from 20-30°C and prefers high humidity environments to promote flowering.

Varieties: This highly fragrant flower is available in several forms:

- **Single Flowered:** 'Calcutta Single', 'Coimbatore Single', 'Bangalore Single'.
- **Double:** 'Pearl Double', 'Mexican Single'.
- **Variegated:** 'Rajat Rekha', 'Dhawal'.

Propagation

Tuberose is propagated from bulbs. It is crucial to select disease-free bulbs for planting to ensure healthy growth.

Nursery Raising

Tuberose bulbs are planted directly in the soil in nursery beds or sometimes in larger containers if relocation is necessary. The spacing in the nursery should

allow for individual growth, generally about 15 cm apart. The nursery period for tuberose can last until the bulbs are mature enough to flower, which can take several months depending on the variety.

Land Preparation and Bed Preparation

The land should be plowed to a depth of 25-30 cm and leveled. Raised beds, 20-25 cm high and 1 m wide, should be prepared to avoid waterlogging. Incorporate 20-25 tons/ha of well-rotted farmyard manure (FYM) during land preparation to enrich the soil.

Manure and Fertilizer

Apply 100:50:50 kg/ha of NPK as a basal dose during planting, and top-dress with 50 kg of nitrogen at 30 and 60 days after planting. Micronutrients such as boron and zinc can be applied as foliar sprays to enhance flowering and prevent physiological disorders.

Weeding

Regular weeding should be carried out to prevent competition for nutrients and moisture. Manual weeding is recommended at least twice during the growing season. Organic mulching with straw or dry grass helps suppress weeds and retain soil moisture.

Irrigation

Tuberose requires regular irrigation to maintain soil moisture. The first irrigation should be applied immediately after planting, followed by subsequent irrigation every 7-10 days, depending on weather conditions. Drip irrigation is highly recommended for water efficiency and disease prevention.

Pinching and Disbudding

Pinching and disbudding are not commonly practiced in tuberose cultivation. However, removing older flowers and leaves helps maintain plant vigor and improve the quality of the flower spikes.

Training and Pruning

Tuberose does not require staking or training. Regular removal of dried or diseased leaves ensures better air circulation and reduces disease incidence.

Pests

1. **Bud Borer *(Helicoverpa armigera)***
    - **Symptoms:** Caterpillars bore into flower buds, causing them to wither and fail to open.
    - **Management:** Apply Bacillus thuringiensis (Bt) at 2 g/liter or emamectin benzoate at 0.4 g/liter.
2. **Thrips *(Thrips tabaci)***
    - **Symptoms:** Thrips feed on leaves and flowers, causing discoloration, silver streaks, and deformed blooms.
    - **Management:** Spray spinosad at 0.5 ml/liter or neem-based insecticides.

Diseases

1. **Stem Rot *(Sclerotium rolfsii)***
    - **Symptoms:** The base of the plant develops watery lesions, leading to wilting and death.
    - **Management:** Treat the soil with carbendazim 50 WP at 0.2% and avoid overwatering.
2. **Leaf Blight *(Alternaria polianthi)***
    - **Symptoms:** Dark spots with yellow halos develop on leaves, which may lead to defoliation.
    - **Management:** Spray mancozeb 75 WP at 2 g/liter.

Harvesting Techniques and Yield

- For cut flowers, harvest spikes when the lower 1-2 florets have opened.

- For loose flowers, pluck fully developed unopened florets early in the morning.
- Yield: 6,000-8,000 kg of flowers/ha annually.

Post-harvest Handling

- Place spikes in cool water immediately after harvesting to reduce field heat.
- Use preservative solutions of 300 ppm 8-HQC with sucrose to enhance longevity.

Storage

- Store at 5-8°C with 90-95% RH for spikes. Loose flowers should be stored in moist cloth bags.

3.1.6 Cultivation Practices of Flowers: Marigold

Introduction

- **Common Name:** Marigold
- **Botanic Name:** *Tagetes spp.*
- **Family:** Asteraceae
- **Origin:** Native to the Americas.
- **Significance:** Marigold is associated with cultural ceremonies such as Day of the Dead in Mexico and religious events in India, valued for its vibrant

color and protective properties.

Types of Marigold

Marigolds are generally divided into two main types based on their origin and flower characteristics:

1. ***Tagetes erecta* (African Marigold):** Despite their name, these marigolds are native to Mexico and Central America. They are known for their large, full flowers which can be yellow, orange, or white. African marigolds are taller and more upright, often reaching up to 3 feet in height.
2. ***Tagetes patula* (French Marigold):** These are smaller and bushier than their African counterparts, with a more sprawling habit and flowers that can include shades of yellow, gold, and mahogany. The blooms are smaller and may have a more detailed pattern than those of African marigolds.

Importance and Uses

- Marigold is widely used in gardens for its ability to repel pests and its ease of growing. The flowers are used to make natural dyes and are often planted in vegetable gardens to prevent nematode infestation.

Soil Requirements

Grows well in a variety of soils but prefers well-drained sandy or loamy soil with moderate fertility, a pH of 6.0-7.5, and a minimum soil depth of 20 cm.

Climate

Marigolds are sun-loving plants that thrive in full sun and can handle high temperatures, preferring an environment of 18-30°C. They are relatively drought-tolerant but perform best with regular watering in dry climates.

Varieties: Marigolds are divided into two main types based on their origin and flower size:

- **African Marigold (*Tagetes erecta*):** Known for larger blooms, popular varieties include 'Pusa Narangi Gainda', 'Pusa Basanti Gainda', and 'Inca'.

- **French Marigold (*Tagetes patula*):** Smaller and more delicate, varieties include 'Bonanza', 'Harmony', and 'Janie'.

Propagation

Marigolds are typically propagated through seeds. They germinate quickly under warm conditions and are easy to handle, making them excellent for novice gardeners.

Nursery Raising

Marigold seeds are sown directly into the soil or in seedling trays in the nursery. The seeds typically germinate within a week, and seedlings are grown until they reach transplanting size, about 6-8 weeks. Space seedlings adequately to allow for growth and air circulation, which helps prevent disease.

Land Preparation and Bed Preparation

Marigolds grow well in well-drained, fertile loamy soils. The land should be deeply plowed and harrowed to a fine tilth. Raised beds of 15-20 cm height and 1 m width are ideal for planting. Incorporate 20-25 tons/ha of FYM into the soil during preparation to improve fertility.

Manure and Fertilizer

Apply 100:50:50 kg/ha of NPK at planting and supplement with nitrogen (50 kg/ha) at 30 days after transplanting. Marigold plants also benefit from micronutrients like boron and zinc to improve flower quality.

Weeding

Weeding is essential during the initial growth stages and should be carried out manually or mechanically. A weed-free environment is crucial to avoid nutrient competition. Mulching can be used to suppress weed growth and conserve soil moisture.

Irrigation

Marigolds require consistent soil moisture but are sensitive to waterlogging. The first irrigation should be done after transplanting, followed by watering

every 7-10 days, depending on the season. Drip irrigation is highly effective in maintaining optimum soil moisture.

Pinching and Disbudding

Pinching is a common practice in marigold cultivation. It involves removing the terminal bud 30-35 days after planting to encourage lateral branching and improve flower yield. Disbudding is not typically required for marigold.

Training and Pruning

Training is not necessary for marigolds. However, removing old flowers and damaged foliage ensures better plant health and continuous flowering.

Pests

1. **Aphids *(Aphis craccivora)***
    - **Symptoms:** Aphids cluster on the undersides of leaves, sucking sap and causing yellowing and curling.
    - **Management:** Spray dimethoate 30 EC at 2 ml/liter or neem oil at 3 ml/liter.
2. **Cutworms *(Agrotis ipsilon)***
    - **Symptoms:** Cutworms sever young stems at ground level, causing plant mortality.
    - **Management:** Apply chlorpyrifos 20 EC at 2 ml/liter to the soil and practice deep plowing before planting.

Diseases

1. **Powdery Mildew *(Oidium spp.)***
    - **Symptoms:** White, powdery fungal growth appears on leaves and stems.
    - **Management:** Spray wettable sulfur at 2 g/liter or potassium bicarbonate at 1 g/liter.

2. **Leaf Spot *(Alternaria tagetica)***

- **Symptoms:** Circular to irregular brown spots appear on leaves, causing defoliation.
- **Management:** Apply copper oxychloride or mancozeb at 2 g/liter.

Harvesting Techniques and Yield

- Harvest flowers when they are fully opened, preferably in the evening to reduce field heat.
- Use sharp scissors or knives to harvest flowers without damaging the plant.
- Yield: 12-15 tons/ha for African marigolds; 8-12 tons/ha for French marigolds.

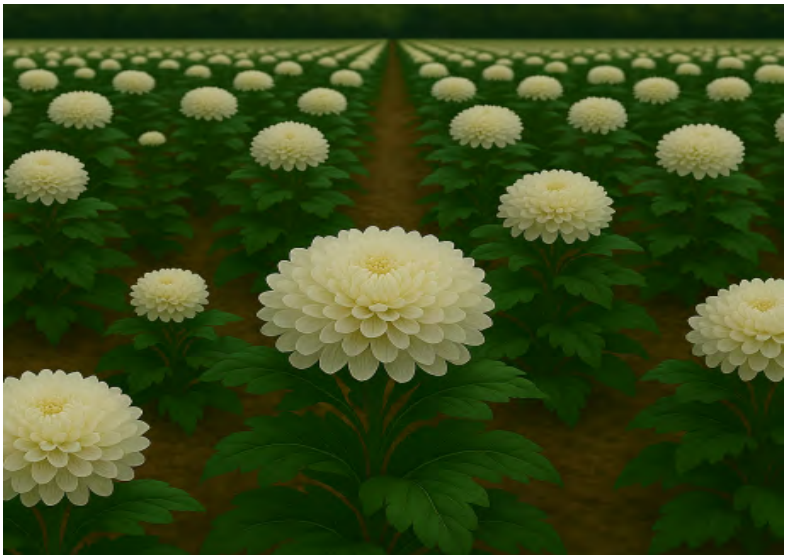
Post harvest Handling

- Remove stalks and grade flowers by size and quality.
- Pack flowers loosely in ventilated containers for transportation.

Storage

- Store at 10-12°C with 85-90% RH for short-term storage. Flowers are best used fresh due to limited shelf life.

3.1.7 Cultivation Practices of Flowers: Chrysanthemum



Introduction

- **Common Name:** Chrysanthemum
- **Botanic Name:** *Chrysanthemum spp*.
- **Family:** Asteraceae
- **Origin:** Native to Asia and northeastern Europe.
- **Significance:** Chrysanthemum is celebrated in Asia for its beauty and medicinal properties, symbolizing longevity and rejuvenation in Japanese culture.

Importance and Uses

- Chrysanthemums are popular for their bright blooms and as autumnal garden plants. They are used in teas in Asia for their health benefits, including reducing inflammation and improving bone health.

Soil Requirements

Requires fertile, well-drained soil rich in organic matter, with a pH of 6.0-7.0 and a minimum soil depth of 30 cm for effective root growth.

Climate

Chrysanthemums thrive in cooler climates with plenty of sunlight. They prefer temperatures between 15-20°C and require short day conditions for bud formation and flowering.

Varieties: Known for their vibrant blossoms and extensive use in festivals:

- **Large-Flowered Varieties:** 'Chandrama', 'Snowball', 'Pink Floyd'.
- **Small-Flowered Varieties:** 'Baby Doll', 'Tinkerbell', 'Button Gold'.

Propagation

Propagation is typically done through cuttings or by division, ensuring that the mother plants are healthy and disease-free to provide the best start for new plants.

Nursery Raising

Chrysanthemum cuttings are planted in polybags or directly in raised nursery

beds. The nursery environment requires controlled humidity and often shade to encourage rooting. Cuttings take about 4-6 weeks to establish enough for transplanting into the garden or field.

Land Preparation and Bed Preparation

The land should be plowed to a depth of 30-40 cm and leveled. Raised beds of 20-25 cm height and 1 m width are ideal. Incorporate 20-25 tons/ha of FYM into the soil along with basal doses of 100:50:50 kg/ha of NPK during bed preparation.

Manure and Fertilizer

Apply 100:50:50 kg/ha of NPK as a basal dose. Top-dress with 50 kg/ha of nitrogen in two split doses at 30 and 60 days after planting. Micronutrient supplementation with boron and magnesium improves flower quality and plant health.

Weeding

Manual weeding should be done 2-3 times during the growing season to keep the field weed-free. Organic mulching can be used to suppress weed growth and conserve moisture.

Irrigation

Irrigation is critical during the vegetative growth stage, bud formation, and flowering. Watering should be done at intervals of 7-10 days, depending on soil and weather conditions. Drip irrigation is preferred to avoid waterlogging and fungal diseases.

Pinching and Disbudding

Pinching is performed 30-40 days after planting to encourage lateral branching and increase flower yield. Disbudding is done to remove excess buds, allowing the plant to focus its energy on producing larger blooms.

Training and Pruning

Chrysanthemums may require staking or netting for support in taller varieties.

Pruning involves removing old, diseased, or damaged shoots to promote healthy growth and enhance flowering.

Pests

1. **Aphids *(Macrosiphoniella sanborni)***
   - **Symptoms:** Aphids infest tender shoots and flower buds, causing curling, yellowing, and stunted growth. The excreted honeydew promotes sooty mold.
   - **Management:** Spray neem oil at 3 ml/liter or malathion 50 EC at 2 ml/liter. Introduce natural predators like lady beetles and lacewings.
2. **Thrips I**
   - **Symptoms:** Thrips feed on leaves and petals, causing silver streaks, discoloration, and malformed flowers.
   - **Management:** Apply spinosad at 0.5 ml/liter or fipronil at 2 ml/liter. Use blue sticky traps for monitoring and reduce weeds around the crop.
3. **Leaf Miners *(Liriomyza trifolii)***
   - **Symptoms:** Leaf miners create serpentine mines on leaves, reducing photosynthesis and overall plant health.
   - **Management:** Spray abamectin 1.9 EC at 0.4 ml/liter or cyromazine at 1 g/liter. Remove and destroy affected leaves.
4. **Red Spider Mites *(Tetranychus urticae)***
   - **Symptoms:** Infested leaves develop yellow specks and turn bronze before drying. Fine webs are visible on the plant.
   - **Management:** Spray sulfur 80% WP at 2 g/liter or abamectin at 0.4 ml/liter. Increase humidity to deter mites.

Diseases

1. **Powdery Mildew *(Erysiphe cichoracearum)***
   - **Symptoms:** White, powdery growth appears on leaves, stems, and flowers, causing stunted growth and reduced flowering.

- **Management:** Apply wettable sulfur at 2 g/liter or potassium bicarbonate at 1 g/liter. Ensure good air circulation around plants.

2. **Leaf Spot *(Alternaria chrysanthemi)***
   - **Symptoms:** Dark brown circular spots appear on leaves, leading to premature defoliation.
   - **Management:** Spray mancozeb 75 WP at 2 g/liter. Remove infected leaves to prevent the spread.

3. **Stem Rot (Sclerotinia sclerotiorum)**
   - **Symptoms:** Soft, water-soaked lesions develop on the stem base, leading to plant collapse.
   - **Management:** Treat soil with carbendazim 50 WP at 0.2% before planting. Ensure proper drainage and avoid overwatering.

Disorders

1. **Chlorosis**
   - **Symptoms:** Leaves turn yellow due to iron deficiency, often seen in alkaline soils.
   - **Management:** Apply chelated iron at 0.2% as a foliar spray. Adjust soil pH to 6.5-7.0.

2. **Flower Malformation**
   - **Symptoms:** Flowers develop uneven or distorted petals due to improper nutrition or temperature fluctuations.
   - **Management:** Ensure balanced fertilization, especially potassium and phosphorus, and maintain consistent temperatures during the flowering phase.

Harvesting Techniques and Yield

- Harvest flowers when they are fully opened for loose flower purposes. For cut flowers, stems are harvested when 2-3 blooms per stem have opened.

- Use sharp tools to cut stems, leaving enough foliage for plant recovery.
- Yield: 10-12 tons of flowers/ha.

Post-harvest Handling

- Place cut flowers in water immediately and grade them according to size and quality.
- Use preservative solutions containing sucrose and 8-HQC to extend vase life.

Storage

- Store at 3-8°C with 85-90% RH. Loose flowers are best transported in bamboo baskets or ventilated cartons.

3.1.8 Cultivation Practices of Flowers: Orchid

Introduction

- **Common Name:** Orchid
- **Botanic Name:** *Orchidaceae spp.*
- **Family:** Orchidaceae
- **Origin:** Cosmopolitan distribution, found from tropical rainforests to arctic tundra.
- **Significance:** Orchids are known for their exotic appearance and are symbolic of luxury and delicate beauty. They are highly prized in horticulture for their unique and diverse structures.

Importance and Uses

- Orchids are primarily decorative, used both as indoor and outdoor plants. They are also studied for their fascinating pollination strategies and are used in the perfume industry for certain species' fragrances.

Soil Requirements

Orchids generally grow in loose, well-draining media like bark or specialized orchid mix, not traditional soil. The medium must be aerated and have a pH around 5.5-6.5.

Climate Requirements

Orchids require specific climatic conditions:

- Temperature: Orchids thrive in a temperature range of 15-30°C, with optimal growth occurring at 20-25°C.
- Light: Bright, indirect sunlight is essential. Too much direct sunlight can cause leaf scorch, while too little light results in poor flowering.
- Humidity: Orchids require 60-80% relative humidity. Humidity trays, misting, or greenhouse humidifiers can help maintain these conditions.
- Air Circulation: Proper ventilation is crucial to prevent fungal diseases and ensure healthy growth.

Varieties: With thousands of species, orchids have a diversity unmatched in the floral world. Popular cultivated varieties include:

- **Cymbidium Orchids:** Often seen in cooler climates.
- **Phalaenopsis Orchids:** Known for their moth-shaped flowers and suited for indoor environments.

Propagation

Orchids are propagated using seeds, division, or tissue culture:

- **Seed Propagation:** Orchid seeds are tiny and require sterile conditions with a nutrient-rich medium to germinate. This is usually done in a laboratory.
- **Division:** Mature plants are divided into sections, each containing 2-3

pseudobulbs and roots. This is a common method for commercial propagation.

- **Tissue Culture (Meristem Culture):** This is the most efficient method for large-scale propagation, producing uniform plants quickly.

Nursery Raising

Orchids are usually propagated from seed or tissue culture in sterile laboratory conditions, then transferred to small pots or baskets with a specific orchid-growing medium like bark chips or sphagnum moss. Nursery raising can be lengthy, often extending over several months to years, as orchids grow slowly and require careful environmental control to thrive.

Land Preparation and Growing Media

Orchids are typically not grown in soil like other flowers. Instead, they are cultivated using specialized growing media that simulate their natural habitats. The media may include tree bark, coconut husks, charcoal, bricks, coarse sand, and sphagnum moss. This ensures good aeration and drainage for the roots. For terrestrial orchids, soil should be well-drained and rich in organic matter with a pH of 5.5-6.5. For epiphytic orchids, wooden baskets, clay pots, or tree fern slabs are often used.

Planting and Potting

Orchids are planted in pots, baskets, or mounted on wooden slabs, depending on the variety. The roots should be placed gently into the chosen medium, ensuring they are not buried too deep to prevent rot. Repotting is necessary every 2-3 years or when the medium decomposes.

Manure and Fertilizer

Orchids have low nutrient requirements but benefit from regular feeding. Apply a balanced fertilizer (e.g., NPK 19:19:19) at 0.2% concentration every 15 days. Foliar feeding is also beneficial. Micronutrients like magnesium and calcium improve flower quality and plant health. Over-fertilization should be avoided, as it can damage the roots.

Irrigation

Orchids require careful watering to prevent root rot. They should be watered thoroughly but allowed to dry out slightly between watering. Rainwater or distilled water is preferred, as tap water can contain harmful salts. Drip irrigation systems can be used for commercial setups.

Weeding and Mulching

Weeding is minimal in orchid cultivation as they are typically grown in pots or baskets. Mulching is not required for orchids but can be used for terrestrial species to retain moisture.

Training and Pruning

Orchids do not require training, but staking is necessary to support flower spikes and prevent them from bending or breaking. Pruning involves removing old, damaged, or diseased leaves and spent flower spikes to encourage new growth.

Special Cultural Practices

- Humidity Control: Use humidity trays or misting to maintain appropriate moisture levels in the growing environment.
- Flowering Induction: Adjusting temperature and light can help induce flowering in orchids. For example, cooler temperatures at night are known to trigger flowering in many varieties.

Pests

1. **Thrips *(Thrips palmi)***
    - **Symptoms:** Thrips feed on leaves, causing silvery streaks and tiny black fecal spots. Flowers may become discolored and deformed.
    - **Management:** Spray spinosad at 0.5 ml/liter or neem oil at 3 ml/liter. Remove affected flowers and leaves.
2. **Aphids *(Aphis gossypii)***
    - **Symptoms:** Aphids attack young shoots and buds, causing leaf curling

and distortion. They excrete honeydew, encouraging mold growth.

- **Management:** Apply imidacloprid 17.8% SL at 0.5 ml/liter or use natural predators like lady beetles.

3. **Scale Insects *(Coccus hesperidum)***
   - **Symptoms:** Scales appear as small, rounded bumps on leaves and stems, sucking sap and weakening the plant.
   - **Management:** Spray horticultural oil at 3 ml/liter or imidacloprid at 0.5 ml/liter. Manually scrape off scales for small infestations.

4. **Mealybugs *(Planococcus citri)***
   - **Symptoms:** Mealybugs cluster at leaf nodes and roots, excreting honeydew that leads to sooty mold and reduced plant vigor.
   - **Management:** Apply neem oil at 3 ml/liter or systemic insecticides like dimethoate at 2 ml/liter.

Diseases

1. **Black Rot *(Pythium spp. and Phytophthora spp.)***
   - **Symptoms:** Affected roots and leaves turn black and soft, leading to plant collapse. The disease spreads rapidly in waterlogged conditions.
   - **Management:** Ensure well-draining potting media. Treat infected plants with metalaxyl at 2 g/liter.

2. **Leaf Spot *(Cercospora spp.)***
   - **Symptoms:** Small, circular spots appear on leaves, which enlarge and cause defoliation.
   - **Management:** Spray copper oxychloride at 2 g/liter. Remove and destroy infected leaves.

3. **Fusarium Wilt *(Fusarium oxysporum)***
   - **Symptoms:** Leaves turn yellow and wilt, and roots show signs of decay. Infected plants often die.

- **Management:** Treat potting media with carbendazim 50 WP at 0.2%. Disinfect tools to prevent spreading.

Disorders

1. Yellowing of Leaves

- **Symptoms:** Leaves turn yellow due to excessive watering, low light, or nutrient imbalance.
- **Management:** Ensure proper watering intervals and provide adequate light. Apply balanced fertilizers like 20:20:20 NPK at 0.2%.

2. Bud Drop

- **Symptoms:** Buds fall off prematurely due to sudden temperature changes, overwatering, or low humidity.
- **Management:** Maintain stable temperature and humidity levels. Avoid water stress and excessive fertilization.

Harvesting

Orchids are harvested when the flowers are fully developed but still in the bud stage. This ensures maximum vase life. For cut flowers, the spikes should be cut at the base using a sharp knife or scissors.

Post-Harvest Management

- Flowers should be immediately placed in water to prevent dehydration.
- Store cut flowers at 5-7°C to extend their shelf life.
- Packaging should be done in sturdy, ventilated boxes with moist paper around the flowers to retain freshness during transport.

3.1.9 Post-Harvest Management of Flowers and Vase Life

Proper post-harvest management of flowers is essential to maintain their quality, freshness, and vase life. Flowers are highly perishable and require careful handling from the moment they are harvested to their final destination. The following are detailed steps for effective post-harvest management:

Post-Harvest Management of Flowers

1. Harvesting

Flowers should be harvested during the cool parts of the day, such as early morning or late evening, to minimize heat stress. The appropriate maturity stage should be considered during harvesting. For instance, roses should be harvested at the tight bud stage, while marigolds are best harvested at full bloom. It is essential to use sharp and sterilized tools to make clean cuts and avoid damage to the stems.

2. Removal of Excess Foliage

Excess foliage, especially leaves that would be submerged in water, should be removed after harvesting. This step helps prevent bacterial growth and keeps the water clean. Leaves remaining on the stems should be healthy and free from pests or diseases to ensure the flowers' longevity.

3. Grading and Sorting

Flowers should be graded based on their size, quality, and stage of bloom. Grading ensures uniformity in bundles, which is important for market requirements. Sorting the flowers into similar quality groups helps in proper packaging and presentation.

4. Pre-Cooling

Immediately after harvesting, flowers should be placed in a bucket containing cool water at a temperature of 5–7°C. This process, known as pre-cooling, removes field heat, reduces respiration rates, and delays ethylene production, which extends the shelf life of flowers.

5. Pulsing

Pulsing involves treating flowers with a chemical solution to improve their freshness and vase life. Flowers are dipped in a 20% sucrose solution for 30 minutes to supply energy and prevent dehydration. Other pulsing solutions, such as silver nitrate or aluminum sulfate, can be used to inhibit microbial growth and reduce the effects of ethylene.

6. Packaging

After pulsing, flowers should be carefully packaged in corrugated cardboard boxes lined with moisture-resistant material. Proper cushioning should be used to prevent mechanical damage during transportation. Perforated plastic liners or film wraps can be added to maintain humidity and reduce water loss.

7. Storage

Flowers should be stored at temperatures between 3–8°C with a relative humidity of 65–85%. Proper storage conditions minimize water loss and maintain freshness. Ethylene-sensitive flowers, such as carnations and orchids, should be stored with ethylene absorbers or inhibitors.

8. Transportation

Flowers should be transported in refrigerated vans to maintain the cold chain and prevent heat damage. Flowers should be stacked properly to avoid crushing and to allow good air circulation within the transport vehicle.

Vase Life Management

Vase life refers to the duration flowers remain fresh and attractive in a vase. Proper care and handling after purchase can significantly enhance their display quality and longevity.

1. Hydration

Stems should be recut at an angle under water to remove air bubbles and improve water uptake. Immediately after cutting, flowers should be placed in clean, fresh water to prevent wilting.

2. Use of Floral Preservatives

Commercial floral preservatives should be added to the vase water. These preservatives typically contain sugars to provide energy, biocides to

prevent bacterial and fungal growth, and acidifiers to maintain the pH of the solution, which improves water uptake.

3. **Maintenance of Vase Water**

   The water in the vase should be changed every 2–3 days. The vase should be cleaned thoroughly during each water change to prevent microbial growth. Stems should also be recut every few days to ensure efficient water absorption.

4. **Temperature and Light**

   Vases should be kept in cool locations, away from direct sunlight, drafts, and ripening fruits, which release ethylene gas. The ideal temperature for most flowers in vases is 18–22°C, which helps prolong freshness.

5. **Special Treatments**

   For flowers like roses, pre-treatment with hot water (40–50°C) for 10–15 seconds can improve water uptake. For ethylene-sensitive flowers, such as carnations and lilies, anti-ethylene treatments like silver thiosulfate (STS) can be applied.

Common Post-Harvest Problems and Solutions

1. **Wilting:** Wilting occurs due to dehydration. Constant hydration and removing air bubbles from stems can prevent this issue.
2. **Bent Necks:** Bent necks, common in roses, occur due to poor water uptake. This problem can be solved by recutting stems and placing them in deep water.
3. **Fungal Growth:** Fungal growth is often caused by unclean tools or water. Cleaning all tools, vases, and water sources, and using biocides in water, can address this issue.
4. **Ethylene Damage:** Ethylene gas accelerates aging in flowers. Ethylene-sensitive flowers should be stored away from ethylene-producing materials, and ethylene inhibitors should be used.

Vase solution

Constituent	Concentration
Carbohydrates	Sucrose and dextrose (5%)
Germicides	8-HQS,8-HQC (200-600ppm)
Growth regulators	Cytokinin, gibberellic acid
Ethylene inhibitors	Silver–thiosulphate(10-200ppm)
Mineral salt	Aluminum sulphate, silver nitrate (200-400 ppm)
Organic acids	Citric acid, benzoic acid

3.2 Indoor Gardening

Indoor gardening refers to beautifying the areas inside the house with plants. Unlike outdoor gardening, the house plants are grown generally in containers made of earthen pots, ceramic pots or any container of cheap cost.

Selection and maintenance

Shade loving plants are generally preferred as house plants. The pots should be raised off the ground and placed on neatly arranged and concealed bricks or on wooden panels. The indoor garden can be established in the following zones of the houses:

1. **Open Zone**

   This is available in roof terraces. This zone is very warm especially during summer in inland plains. Plants like Agave and Catci, which can tolerate reflected heat, can be selected for the above purpose.

2. **Shade of a Tree in Front of a House**

   Such places near the eastern side of the building may be considered for growing certain house plants which can easily come up under shade. Foliage plants like Crotons,Graptophyllum, Chrysanthemum, Dracaena, Asparagus are preferred as potted plants in the area.

3. Verandah of a House

This area normally gets only diffused light and the air movement is also good. The plants best suited for growing in verandahs are palms such as Thrinax, Caryota, Areca tubscens, Ferns and Begonias etc.

4. Living Room

In this places, we can keep the plants either near the window or away from it. Near a window plant with brighter foliage and occasionally herbaceous flowering plants are preferred, while plants with dropping foliage like Zebrina, Sedum, Mesembryanthemum are preferred.

Care of Indoor Plants

1. Repotting

The house plants soon fill the pot with its roots and often need a large pot for satisfactorily continuing its growth. It is then shifted to a pot a little larger on size with its root and soil intact. This process is known as repotting. Plants should never be repotted when the soil is in a dry state.

2. Watering

Pot plants require to be watered much more carefully than those growing in the ground. Applying too little or too much of water is undesirable. When the leaves droop it is a sign that the plant is either in need of water or suffering from soil stagnation at the root always use soft water for watering the potted plants.

3. Syringing/Spraying

It refers to the operation of spraying the plant surfaces through a fine syringe nose. It is essential to the health of plants, growing under cover where the natural rain does not reach them. Syringing creates amoist atmosphere, cleans the leaves and thus assist in promoting their functions.

4. Sun Light

The plants growing in a verandah should be frequently turned round in

their position so as to equalize the effect of the light otherwise their growth will be top sided.

5. Solar Radiation

Too much light is just as detrimental as too little and the majority of indoor plants should not be placed in full sun. Sun scorch or leaf burn will soon make them very unattractive. Requirements for light vary with the individual plants. Most flowering plants require considerable light to bloom, while most foliage plants need diffused light. The only exception to this rule is plants that have variegated leaves. When a variegated plant is placed in a dark corner, the few green cells present in the leaves cannot manufacture enough food to maintain a healthy growing condition. Flowering plants since require more sunlight for profuse flowering can be better located near the windows.

6. Humidity

The humidity of air in the house or room is very low. Many house plants require a higher humidity than is normally present it is often difficult to provide the necessary humidity in the room. The humidity around the plants can be increased by the following ways:

i) Use trays of pebbles in which water is poured to just below the tops of the pebbles. Place the pots on the pebbles, being certain that the bottoms are not sitting in the water.

ii) Another method is the single plant may be top dressed with sphagnum moss and the moss kept nicely damp.

Pot Culture and Hanging Basket

1. Pot Culture

Pot culture is the method of growing ornamental plants on pot by providing nutrient medium. Purposes of pot culture are:

1. Preparing plants for sale such as rooted cuttings of grapes

2. Growing plants for decoration like crotons
3. Growing plants for experimental studies like pot -culture studies

2. Hanging Basket

Hanging basket is the practice of growing ornamental plants in a suspended container. Hanging baskets are usually made of galvanized wire, wood,plastic pots. Those plants which are erect growing, intermediate in size with graceful foliage may be selected. Similarly, plants which are intermediate or dwarf in growth habit with dropping graceful foliage with or without bloom are also a fitting material for massing in these baskets. Selected plants should have an ability to grow and bloom in hanging basket.

Introduction of Bonsai Making

Bonsai is a fascination art which has thrived in Japan for hundreds of years and has become an integral part of Japanese culture.The word Bonsai is a combination of two Japanese words Bon (meaning shallow pan) and Sai (meaning plant). Bonsai is natural plant in miniature form. The height of bonsai should not exceed 1 m.

Criterion for Selecting Plants for Bonsai

- Plant must be hardy in nature that can tolerate severe pruning of roots and shoots.
- Must have some aesthetic value (leaf, flower, aroma).
- Woody perennial plants having trunk such as pine, juniper are used.
- Evergreen plants favored more than deciduous plants.
- Plants with slow growth are suitable over vigorous growth having plants.
- Some shrubs can also be used as bonsai e.g.*adeniumobesum,* zade ***(****Crassula ovata****)***

Types of Bonsai

1. **Upright or chokkan style:** In this style a single specimen is grown with a straight and upright stem.

2. **Gnarled or hankan style:** Seems like winding style but the trunk is twisted near the ground once or twice to form a knob or loop.
3. **Cascade or kengai style:** The trunk hangs over the edge of the container as if it was hanging over the edge of a mountain.
4. **Ikadi-buki style:** Trees are laid or trained horizontally and many branches are allowed to grow vertically at intervals resembling individual trees.
5. **Clasped or stone style:** A single tree is grown with its root trained over a stone.
6. **Winding or kyokkuk style:** A single trunk is twisted once or several times showing as if it has struggled for existence in the wild.
7. **Oblique or shakan style:** Plant is grown in an oblique position as if swept by wind and consequently having more branches on one side.

Exercise

Choose the correct answer from the given alternatives.

1. What is the ideal pH range for growing carnations?
   a. 4.5–5.0 b. 5.5–6.5
   c. 6.5–7.5 d. 7.0–8.0

2. Which of the following is a common pest of gladiolus?
   a. Red spider mites b. Aphids
   c. Thrips d. Cutworms

3. Which rose variety is primarily grown for its large and colorful blooms?
   a. Floribunda b. Hybrid Tea
   c. Shrub Rose d. Miniature Rose

4. Gerberas prefer which type of soil?
   a. Heavy clay b. Well-drained sandy loam
   c. Acidic peat d. Waterlogged silty clay

5. What is the recommended planting material for tuberose propagation?
   a. Seeds b. Bulbs
   c. Cuttings d. Tissue cultures

6. Which type of marigold is commonly used for making garlands?
   a. French Marigold b. African Marigold
   c. Pot Marigold d. Wild Marigold

7. What is the primary use of chrysanthemums in Nepalese culture?
   a. Medicinal uses b. Food coloring
   c. Festival decorations d. Industrial dyes

8. Which of the following is not a major type of orchid propagation?

a. Division
b. Grafting
c. Seed propagation
d. Tissue culture

9. What is the optimal storage temperature for orchids?
   a. 10–12°C
   b. 5–7°C
   c. 15–20°C
   d. 0–2°C

10. Which of the following floral preservatives enhances vase life?
    a. Neem oil
    b. 8-HQC
    c. Urea
    d. Copper oxychloride

Write short answer to the following questions.

1. Explain the significance of carnations in the floral industry.
2. What are the key steps in post-harvest handling of gladiolus?
3. List three pests and their management practices in rose cultivation.
4. Differentiate between African and French marigolds based on flower size and uses.
5. Describe the propagation methods used for orchids.
6. What are the common disorders in tuberose cultivation, and how can they be managed?
7. Explain the importance of vase life management in the cut flower industry.
8. Name three diseases affecting chrysanthemums and their control measures.
9. How is bonsai classified based on style? Provide two examples.
10. What are the key maintenance practices for indoor plants?

Write long answer to the following questions.

1. Describe the cultivation practices for carnations, including soil and climate requirements, pest and disease management, and post-harvest techniques.
2. Explain the steps for growing gladiolus from nursery raising to harvesting, including its pest and disease management practices.

3. Compare the characteristics and cultivation of roses and gerberas, focusing on their climate requirements, propagation, and economic importance.
4. Discuss the significance of post-harvest management in floriculture, focusing on pre-cooling, grading, pulsing, and vase life.
5. Explain the concept of indoor gardening, including selection, maintenance practices, and the use of pot culture and hanging baskets.
6. What are the critical considerations for successful bonsai preparation, and how do different styles reflect natural forms?

Project Work

1. **Practical Exercise:** Perform propagation of marigolds and tuberoses using seeds and bulbs respectively. Document germination rates and early growth stages.
2. **Field Visit:** Visit a commercial orchid farm and observe propagation, cultivation, and post-harvest management practices. Prepare a detailed report.
3. **Hands-on Workshop:** Create a small bonsai tree, focusing on pruning, shaping, and pot selection techniques.
4. **Demonstration:** Set up a pot culture and hanging basket garden using indoor plants. Explain the maintenance techniques to the group.
5. **Research Task:** Investigate the market trends for cut flowers like carnations, gladiolus, and orchids in Nepal. Present the findings in a group discussion.

Unit 4

Introduction to Nursery

4.1. Definition of Nursery with its Types

Meaning and Concept Of Nursery

A nursery is a specially designated area where young plants are grown and nurtured under controlled conditions before being transplanted to their permanent locations. It serves as a place for raising healthy and vigorous seedlings that are better equipped to survive in the field. The purpose of a nursery is to ensure optimal growth during the critical initial stages of a plant's life, providing care that minimizes losses and enhances productivity. Nurseries are widely used in horticulture, forestry, and ornamental gardening.

Advantages of a Nursery

1. **Intensive Care:** Young plants in a nursery receive close monitoring and protection, ensuring healthy growth.
2. **Cost Reduction:** Raising seedlings in a controlled area reduces costs compared to direct sowing in the field.

3. **Opportunity for Selection:** Nurseries enable the selection of disease-free and robust seedlings.
4. **Extended Growing Season:** Late-maturing crops or species in short-growing season areas can be started early in nurseries.
5. **Space Efficiency:** A large number of plants can be cultivated in a small area, maximizing land use.
6. **Controlled Environment:** Parameters like temperature, light, and humidity can be manipulated for optimal plant growth.
7. **Off-Season Production:** Nurseries facilitate the cultivation of plants for off-season markets, increasing profitability.

Disadvantages of a Nursery

1. **High Initial Investment:** Setting up and maintaining a nursery requires significant resources and infrastructure.
2. **Specialized Labor:** Skilled personnel are needed for tasks like grafting, budding, and transplanting.
3. **Root Damage:** Seedlings are prone to root injury during transplanting, which can affect survival rates.
4. **Risk of Transplant Shock:** Plants may experience stress and reduced survival rates after transplantation.
5. **Need for Advanced Equipment:** Some nurseries require high-tech tools and systems, adding to operational costs.

Types of Nurseries

1. **Based on Lifespan**
    - **Temporary or Shifting Nurseries:** These nurseries are established for short-term use and are smaller in scale with limited facilities. They are often set up for specific projects or temporary purposes.
    - **Permanent or Central Nurseries:** These nurseries are established for long-term use and are larger, well-equipped, and intensively managed.

They provide consistent production of plant materials and support larger agricultural or forestry projects.

2. **Based on Production**

- **Wholesale Nurseries:** These nurseries produce large quantities of seedlings primarily for commercial purposes, catering to large-scale plantations and landscaping projects.
- **Retail Nurseries:** These nurseries focus on producing smaller quantities of diverse plant varieties for local sales, often catering to individual gardeners or smaller projects.

3. **Based on Irrigation Facilities**

- **Wet Nurseries:** Equipped with irrigation systems to maintain adequate moisture for plant growth, these nurseries are essential in dry or arid regions.
- **Dry Nurseries:** Operate without irrigation facilities, relying on natural rainfall. These are suitable in areas with reliable precipitation.

4.2 Scope and Importance of Nursery in Nepal

Importance of Nursery

Nurseries play an indispensable role in Nepal's agricultural and environmental sectors. They ensure the availability of healthy seedlings for reforestation, horticultural development, and urban landscaping. In a country with diverse climatic zones ranging from the tropical Terai to the cold Himalayan regions, nurseries provide tailored solutions for raising plants suited to specific conditions. They are especially important for propagating species that require specialized care during their early stages, such as slow-growing trees or exotic plants. Nurseries also serve as a reliable source for replacing casualties in plantations and creating a buffer stock of plants for emergencies.

Scope of Nursery in Nepal

1. **Reforestation and Afforestation:** Nurseries are vital for raising seedlings

of native and exotic tree species to combat deforestation and restore degraded lands.

2. **Commercial Horticulture:** They supply quality seedlings for high-value crops such as fruits, vegetables, and ornamental flowers, supporting the growing demand for commercial agriculture.
3. **Urban Landscaping:** Nurseries provide plants for beautifying cities and urban areas, contributing to ecological balance and aesthetic appeal.
4. **Roadside Plantations:** To ensure sustainable roadside vegetation, nurseries supply hardy and suitable species that can thrive in challenging conditions.
5. **Introduction of Exotic Species:** Nurseries are the primary method for acclimatizing and propagating exotic plants, enabling their successful introduction into Nepal's diverse ecosystems.
6. **Casualty Replacement:** Nurseries make it possible to replace damaged or dead plants in established plantations, ensuring continuity in greening efforts.

Exercise

Choose the correct answer from the given alternatives.

1. What is a nursery?
   a. A place where children are taken care of
   b. A designated area for growing young plants
   c. A place to buy plants
   d. A greenhouse for mature plants

2. Which type of nursery operates without irrigation facilities?
   a. Wet nursery
   b. Dry nursery
   c. Wholesale nursery
   d. Retail nursery

3. Which of the following is an advantage of using a nursery?
   a. Decreases initial investment
   b. Reduces the need for skilled labor
   c. Provides controlled growing conditions
   d. Avoids transplant shock completely

4. In Nepal, nurseries are critical for:
   a. Urban landscaping
   b. Reforestation
   c. Commercial horticulture
   d. All of the above

5. What is the main disadvantage of a temporary nursery?
   a. High investment cost
   b. Limited facilities
   c. Risk of transplant shock
   d. Requires skilled labor

Write short answer to the following questions.

1. Define a nursery and mention its primary purpose.
2. List any four advantages of nurseries.
3. Differentiate between wet and dry nurseries.

4. What is the significance of a nursery in urban landscaping?
5. Explain the concept of temporary and permanent nurseries.

Write long answer to the following questions.

1. Define a nursery. Discuss the different types of nurseries based on their lifespan and production.
2. Explain the scope and importance of nurseries in Nepal, with relevant examples.
3. What are the key advantages and disadvantages of nursery practices? Discuss with examples.

Project Work

1. Field Visit to a Local Nursery

a. Arange a field visit to a local nursery. Guide student to prepare a report summarizing the types of plants grown, nursery layout, and key challenges faced by the nursery operators.

2. Practical Seedling Raising

a. Guide students to raise seedlings of a local plant species in a classroom or lab environment and ask student for weekly observation an record data.

Unit 5

Nursery Media

5.1. Characteristics of Media

Nursery media refers to the substrate used for growing seedlings or rooting cuttings. It serves as the base for plant growth, providing essential support, nutrients, water, and aeration. The choice of media is critical for ensuring healthy germination and vigorous growth of young plants. A suitable propagation medium should meet the following characteristics:

- It must be firm and dense enough to hold seeds and cuttings securely for germination and rooting.
- The medium should not shrink excessively when dry or swell disproportionately when wet.
- It should have a high moisture retention capacity while ensuring proper drainage.
- Porosity is essential to allow the excess water to drain and permit air circulation around the roots.
- The medium must be free from weed seeds, pathogens, and harmful organisms.
- It should be economical, easily available, and convenient to use.
- The pH of the medium should ideally be slightly acidic or neutral for most plants.

5.2. Properties and Uses of Nursery Media

5.2.1. Soil

Soil is a key component in nursery media, particularly when combined with other

materials. Light and sandy soils are preferred for rooting and germination due to their aeration and drainage properties. Loamy soils are suitable when mixed with sand in a 6:4 ratio. Fertile topsoil, rich in organic matter (OM) and free from contamination, is ideal for nursery use. It should have good drainage capacity and be free of undecomposed organic matter and harmful microorganisms.

5.2.2. Sand

Sand plays a vital role in improving the aeration and drainage properties of nursery media. Medium to coarse-textured sand, with particle sizes between 0.05 and 2.0 mm, enhances soil texture and prevents waterlogging. While sand drains quickly, it requires the addition of organic matter to improve water and nutrient retention. It is particularly effective when combined with compost or other organic amendments.

5.2.3. Compost

Compost is an organic material derived from decomposed plant and animal waste. It improves the physical properties of the soil by enhancing porosity, water retention, and aeration. Compost can retain water up to 20 times its weight, making it valuable for moisture management. It also suppresses weed growth and reduces the risk of pests and pathogens. The pH of compost ranges between 5.0 and 8.0, making it versatile for a variety of plants.

5.2.4. Vermiculite

Vermiculite is a lightweight, porous material derived from mica. It has a high water-holding capacity and can absorb significant amounts of water (13.5 to 18 liters per cubic foot). Its neutral to slightly alkaline pH (7.0-9.5) and ability to retain minerals like potassium, calcium, and magnesium make it ideal for seed germination and seedling growth. Vermiculite is also non-toxic, sterilized, and resistant to mold growth.

5.2.5. Sphagnum Moss

Sphagnum moss is a lightweight, fibrous material harvested from peat lands.

It is highly absorbent, retaining up to 20 times its weight in water. Its organic composition and excellent aeration properties make it a popular choice for soil-less media and hydroponics. Sphagnum moss also inhibits damping-off diseases in seedlings and maintains soil acidity, promoting fertility and healthy plant growth.

5.3 Mixtures for Container Growing

For container cultivation, the soil must be modified to ensure adequate aeration, drainage, and moisture retention. A common mix includes equal parts of garden soil, peat moss, and perlite or coarse sand. For a lighter medium with improved aeration, ingredients like sphagnum moss, coir fiber, and vermiculite can be added. Organic materials such as compost or vermicompost further enhance the medium's nutrient content. Mulching the surface of container media with straw or moss helps retain moisture. It is important to avoid using garden soil directly, as it may harbor pests, diseases, or poor drainage properties.

5.4 Treatment of Media and Mixes

To ensure the quality and safety of nursery media, proper treatment and handling practices must be followed:

- **Avoid compaction:** Growing media should be lightly filled into containers to maintain porosity. Stacking or pre-filling containers should be avoided.
- **Hydration:** Pre-moisten peat-based mixes before use to enhance wettability.
- **p^H and Conductivity Testing:** Test the pH and electrical conductivity of the media to ensure suitability for plant growth.
- **Mixing:** Thoroughly mix components to ensure uniformity, but avoid over-mixing to retain structure.
- **Storage:** Do not store moist media containing fertilizers to prevent contamination or nutrient leaching.
- **Contamination Prevention:** Keep amendments in sealed bags and protect media from dust and pests.

- **Protective Measures:** Use dust masks when handling materials like dry peat moss or vermiculite to avoid respiratory hazards.
- **Wetting Agents:** Occasionally use surfactants to improve the wettability of the media.

Exercise

Choose the correct answer from the given alternatives.

1. What is the primary role of nursery media?

   a. To hold mature plants

   b. To provide support, nutrients, and aeration to seedlings

   c. To attract pollinators

   d. To eliminate weeds

2. Which of the following is not a characteristic of good nursery media?

   a. High porosity

   b. High shrinkage when dry

   c. Free from pathogens

   d. Neutral or slightly acidic p^H

3. Which material is derived from mica and has high water retention capacity?

   a. Sand b. Vermiculite

   c. Compost d. Sphagnum moss

4. Sphagnum moss is particularly useful because.....

   a. It increases soil alkalinity.

   b. It prevents damping-off diseases.

   c. It compacts soil for better root anchorage.

   d. It eliminates the need for irrigation.

5. A common soil mix for container growing includes.....

   a. Only sand and garden soil

   b. Equal parts garden soil, peat moss, and perlite

   c. Sphagnum moss and sand only

   d. Vermiculite and clay soil

Write short answer to the following questions.

1. Define nursery media and mention two of its key characteristics.
2. What are the benefits of adding vermiculite to nursery media?
3. How does sphagnum moss contribute to healthy seedling growth?
4. Mention two essential treatments required for nursery media before use.
5. Why is compost considered a valuable addition to nursery media?

Write long answer to the following questions.

1. Discuss the characteristics and properties of nursery media essential for healthy plant growth.
2. Explain the properties, uses, and benefits of any three nursery media components: soil, sand, compost, vermiculite, or sphagnum moss.
3. Describe the preparation of a suitable mixture for container growing and the importance of treating nursery media before use.
4. Highlight the advantages and limitations of using sphagnum moss and vermiculite in nursery media.

Project Work

1. Media Comparison Experiment

a. Guide student to compare the water retention and drainage properties of various nursery media (soil, sand, compost, vermiculite, and sphagnum moss) by using containers with each medium and observe their behavior after watering. Ask student to prepare a report summarizing the results with a chart displaying the differences.

2. Prepare a Container Mixture

a. Guide students to prepare a container mixture using specified proportions of garden soil, sand, compost, and vermiculite and ask them to prepare a short demonstration or photo documentation of the preparation process.

Unit 6

Nursery Containers

6. Nursery Containers

Nursery containers are specially designed pots or vessels used for growing and nurturing seedlings or plants. These containers vary in shape, size, and material depending on the plant type, its growth habit, and the intended purpose. They ensure the proper propagation, rooting, and growth of plants in a controlled environment.

Characteristics of Good Nursery Containers

A good nursery container must have the following features:

- Sufficient depth and width to support the plant's root system.
- Proper drainage holes to prevent waterlogging and ensure aeration.
- Durability to withstand handling and environmental conditions.
- Lightweight and portable for ease of transportation.
- Non-toxic and free from harmful chemicals.
- Cost-effective and reusable where applicable.
- Available in various shapes and sizes to cater to different plant requirements.

6.1. Clay Pots

Clay pots are traditional containers made from red clay, typically round in shape. They are porous, allowing air circulation and moisture regulation, making them ideal for plant growth. However, they lose moisture readily and require soaking in water before use. These pots are heavy, durable, and capable of binding harmful

toxins and chemicals, which makes them particularly suitable for nursery plants. Their biodegradability is an added environmental advantage.

6.2. Plastic Pots

Plastic pots are lightweight, durable, and available in various shapes and sizes. They are widely used in nurseries for seedling propagation, rooting cuttings, and accommodating tissue culture plantlets. Plastic pots require less storage space and can be sterilized by immersing them in hot water at 70°C for 30 minutes. However, they lack the aeration and moisture regulation properties of clay pots. Their affordability and ease of handling make them a popular choice.

6.3. Polyethylene Bags

Polyethylene bags, commonly known as polybags, are lightweight, inexpensive, and easy to handle. These bags are often black and come in various sizes with holes for drainage and aeration. They are widely used for germination, rooting of cuttings, and growing individual seedlings. Although polybags prevent root spreading and are reusable, they deteriorate quickly and are less environmentally friendly than biodegradable options.

6.4. Jute Bags

Jute bags are eco-friendly, lightweight, and biodegradable containers. They have high porosity and excellent water-holding capacity, making them suitable for growing plants in an environmentally sustainable way. Jute bags are easy to transport and provide an excellent alternative to plastic containers, especially for short-term nursery operations.

6.5. Cemented Pots

Cemented pots are heavy, durable, and porous, offering good water-holding capacity. They are available in various shapes and sizes and are suitable for larger or long-term nursery plants. These pots are particularly useful in landscaping and ornamental gardening. However, their weight and non-biodegradable nature make them less portable and eco-friendly than other options.

Comparison of the Advantages Clay Pots and Plastic Pots

Advantages of Plastic Pots over Clay Pots:

- Lightweight and easy to transport.
- More durable and less prone to breakage.
- Require less storage space.
- Cost-effective and reusable.

Advantages of Clay Pots over Plastic Pots:

- Porous, allowing better aeration and moisture regulation.
- Biodegradable and eco-friendly.
- Absorbs and binds harmful toxins and chemicals.
- Retains water longer than plastic pots.

Exercise

Choose the correct answer from the given alternatives.

1. Which of the following is a characteristic of a good nursery container?
   a. Must be heavy for stability
   b. Should lack drainage holes
   c. Durable and cost-effective
   d. Non-porous and airtight

2. What is the primary advantage of clay pots over plastic pots?
   a. Lightweight and easy to transport
   b. Better aeration and moisture regulation
   c. Longer lifespan
   d. Lower cost

3. Which nursery container is eco-friendly and biodegradable?
   a. Plastic pots
   b. Polyethylene bags
   c. Jute bags
   d. Cemented pots

4. Polyethylene bags are commonly used in nurseries because:
   a. They are heavy and durable
   b. They are inexpensive and easy to handle
   c. They allow superior aeration
   d. They are biodegradable

5. Cemented pots are best suited for:
   a. Short-term nursery plants
   b. Long-term or large nursery plants
   c. Indoor ornamental plants
   d. Portable nursery operations

Write short answer to the following questions.

1. List three characteristics of good nursery containers.
2. What are the advantages of using plastic pots in nurseries?
3. Why are jute bags considered an environmentally sustainable option for nursery operations?
4. Mention two limitations of clay pots as nursery containers.
5. How can polyethylene bags be made more environmen friendly?

Write long answer to the following questions.

1. Compare and contrast clay pots, plastic pots, and jute bags as nursery containers in terms of their advantages, disadvantages, and environmental impact.
2. Discuss the characteristics and uses of cemented pots and polyethylene bags in nursery operations.
3. Explain the importance of nursery containers and describe the factors to consider when selecting a container for specific nursery plants.

Project Work

1. **Container Analysis Activity**
   a. Students compare the physical properties and suitability of clay pots, plastic pots, and jute bags for a specific plant and use plants of the same species in each container type, observe growth patterns, water retention, and root health over a month. Student should prepare a report highlighting which container performed best and why.

Nursery Structures

Unit 7

7. Nursery Structures

Nursery structures are essential for creating optimal environments to support plant growth, germination, and protection from adverse climatic conditions. These structures provide suitable microclimates to facilitate seed germination, rooting of cuttings, and hardening of seedlings. Various types of nursery structures, including greenhouses, hotbeds, plastic tunnels, cold frames, and glasshouses, serve distinct purposes depending on the crop requirements and environmental challenges.

7.1. Hotbed

A hotbed is a compact, fixed structure with three primary components: a frame, cover, and heating unit. It is specifically designed to provide additional heat to the soil, making it suitable for growing seedlings and rooting cuttings in colder climates and high-altitude areas where low temperatures hinder plant development. The cover is typically made of glass or transparent polythene, while the heating mechanism relies on decomposing organic matter like raw cow dung, which generates heat to maintain a warm environment.

Applications

- Early cultivation of tender seedlings and cuttings.
- Protecting young plants from frost and cold winds.
- Starting off-season crops in regions with harsh winters.

Advantages

- Cost-effective heating solution using organic materials.
- Ideal for areas with low winter temperatures.
- Promotes early germination and rooting.

Disadvantages

- Requires regular maintenance of the heating layer.
- Limited scalability and use for larger nurseries.
- High labor requirement for preparing and maintaining the structure.

7.2. Plastic Tunnel

Plastic tunnels, also known as low tunnels, are simple, low-cost structures designed for the off-season cultivation of vegetables and flowers. These miniature greenhouse-like structures are covered with polythene sheets (70–120 microns) and create a greenhouse effect by trapping CO_2 and heat. They protect plants from environmental factors such as hail, frost, and cold winds while also raising soil temperature for enhanced crop growth.

Applications

- Off-season cultivation of vegetables like tomatoes, cucumbers, and radish.
- Protection of crops from adverse weather conditions.
- Enhancing photosynthesis and crop yield by retaining heat and CO_2.

Advantages

- Cost-effective and easy to construct.
- Provides significant protection against frost and wind.
- Increases productivity and extends the growing season.

Disadvantages

- Limited lifespan of polythene sheets, requiring frequent replacement.
- Ineffective in extreme weather conditions.
- Needs regular monitoring to maintain proper ventilation.

7.3. Greenhouse

A greenhouse is a permanent, high-tech structure covered with glass or polycarbonate sheets. It provides a controlled environment for plant cultivation, allow-

ing for precise regulation of temperature, humidity, light, and ventilation. Greenhouses are used for growing high-value crops, rooting cuttings, and propagating exotic plants that cannot survive in outdoor conditions. Advanced greenhouses often include automated systems for irrigation, heating, and cooling.

Applications

- Year-round production of vegetables, flowers, and exotic plants.
- Cultivation of crops in extreme weather conditions.
- Propagation of seedlings and cuttings for commercial purposes.

Advantages

- Provides precise control over environmental conditions.
- Enables year-round production of crops.
- Protects plants from pests and diseases to a significant extent.

Disadvantages

- High initial investment and maintenance costs.
- Requires skilled labor to operate automated systems.
- Limited affordability for small-scale farmers.

7.4. Cold Frame

A cold frame is a transparent-roofed structure built low to the ground to protect plants from adverse weather conditions, particularly cold and excessive moisture. The roof traps solar heat, creating a warm and stable environment that functions as a miniature greenhouse. Cold frames are primarily used to extend the growing season and harden seedlings before transplanting.

Applications

- Hardening young plants before field transplantation.
- Protecting seedlings from frost in early spring or late fall.
- Growing cold-tolerant crops like lettuce and spinach.

Advantages

- Inexpensive and easy to construct.
- Requires no external power sources for heating.
- Enhances plant survival rates by providing gradual acclimatization.

Disadvantages

- Limited temperature regulation compared to greenhouses.
- Not suitable for large-scale production.
- Requires manual ventilation to prevent overheating.

7.5. Glasshouse

A glasshouse is a highly advanced structure built entirely of glass to maximize light transmission and create a warm environment for faster plant growth. Glasshouses are commonly used in commercial agriculture to cultivate vegetables, flowers, and high-value crops. These structures are equipped with automated systems for temperature control, irrigation, and ventilation.

Applications

- Large-scale commercial cultivation of vegetables and flowers.
- Propagation of plants requiring high light intensity and specific temperature ranges.
- Production of exotic plants and ornamental flowers.

Advantages

- Allows maximum light penetration for optimal plant growth.
- Suitable for large-scale and high-value crop production.
- Enhances plant productivity through controlled environmental conditions.

Disadvantages

- Expensive to construct and maintain.
- Fragile and prone to damage from hail or storms.

- Requires skilled labor for operation and management.

Comparison of Nursery Structures

Structure	Primary Use	Material	Advantages	Disadvantages
Hotbed	Seed germination and rooting of cuttings	Glass or polythene	Cost-effective, promotes early growth	Labor-intensive, limited scalability
Plastic Tunnel	Off-season cultivation and weather protection	Polythene (70–120 microns)	Low-cost, enhances productivity	Short lifespan, requires frequent replacement
Greenhouse	Year-round cultivation and plant propagation	Glass or polycarbonate	Precise control, year-round production	High cost, skilled labor needed
Cold Frame	Hardening seedlings and extending seasons	Transparent materials	Inexpensive, easy to build	Limited temperature regulation
Glasshouse	Commercial production of high-value crops	Glass	Maximum light penetration, high productivity	Expensive, requires skilled labor

Exercise

Choose the correct answer from the given alternatives.

1. What is the primary purpose of a hotbed?
   a. Protecting plants from pests
   b. Providing additional heat for seed germination and rooting
   c. Large-scale commercial cultivation
   d. Storing nursery materials

2. Which nursery structure is best suited for off-season cultivation of vegetables?
   a. Cold frame
   b. Plastic tunnel
   c. Greenhouse
   d. Glasshouse

3. What is the main advantage of a glasshouse over a greenhouse?
   a. Lower construction cost
   b. Higher light penetration
   c. Portability
   d. Lower maintenance requirements

4. Which material is commonly used for covering plastic tunnels?
   a. Glass
   b. Polythene
   c. Wood
   d. Metal

5. Which of the following is a limitation of using cold frames?
   a. High maintenance cost
   b. Limited scalability
   c. Overheating risk
   d. Inability to regulate temperature

Write short answer to the following questions.

1. Define a hotbed and explain its primary application in nursery operations.
2. List two advantages and two disadvantages of plastic tunnels.

3. What are the key differences between a greenhouse and a glasshouse?
4. Why is a cold frame suitable for hardening seedlings?
5. Describe two limitations of using a glasshouse for commercial cultivation.

Write long answer to the following questions.

1. Compare and contrast hotbeds, cold frames, and plastic tunnels in terms of their applications, advantages, and limitations.
2. Discuss the role of greenhouses in modern nursery management, including their advantages and challenges.
3. Explain how nursery structures contribute to year-round crop production and environmental protection.

Project Work

1. Plastic Tunnel Demonstration

a. Set up a small plastic tunnel and monitor its effectiveness in protecting plants from adverse weather. Present data on temperature and humidity variations inside and outside the tunnel.

Unit 8

Propagation from Seeds

8. Propagation from Seeds

Introduction to Seed Propagation

Propagation from seeds is a fundamental and widely used method for the reproduction of plants. A seed, which is a mature and ripened ovule, contains the essential components for plant growth, including a viable embryo, stored food, and a protective seed coat. This method is crucial in agriculture, horticulture, and forestry due to its simplicity, potential for genetic variation, and suitability for large-scale production. Understanding the principles, advantages, limitations, and techniques of seed propagation is essential for effective nursery and field practices.

8.1 Advantages and Disadvantages of Seed Propagation

Seed propagation involves sexual reproduction, where seeds form after successful pollination and fertilization. This method leads to genetic recombination and diversity, making it an invaluable tool for crop improvement.

Advantages

Seed propagation has several key benefits:

1. **Simplicity:** It is an easy and cost-effective technique suitable for a wide range of crops.
2. **Genetic Diversity:** It allows the selection of superior plants and the development of hybrids.
3. **Durability:** Seedlings are often long-lived and resilient to adverse environmental conditions.

4. **Application in Specific Crops:** It is the primary method for plants like papaya and coconut, where vegetative propagation is not feasible.
5. **Storage:** Seeds can be stored for extended periods under suitable conditions, ensuring a steady supply.

Disadvantages

Despite its advantages, seed propagation has limitations:

1. **Heterogeneity:** Plants grown from seeds may not replicate the parent plant's traits exactly.
2. **Delayed Maturity:** Seedling plants often have long juvenile phases, delaying fruiting or flowering.
3. **Management Challenges:** Seedlings may grow taller and require more maintenance, such as pruning and harvesting.
4. **Viability Concerns:** Some seeds lose their viability quickly and require immediate sowing.
5. **Inferior Quality:** Seedling plants may produce fruits or flowers of lower quality than those propagated vegetatively.

8.2 Collection of Seeds

In floriculture, the collection of seeds is a critical practice that ensures the propagation of high-quality ornamental plants. Since flowers are primarily cultivated for aesthetic purposes, the quality, health, and genetic attributes of seeds are paramount. Proper collection techniques are essential to maintain the genetic integrity, viability, and vigor of seeds. Floriculture crops, including annuals, perennials, and exotic ornamentals, often demand specific methods for seed collection to ensure optimal germination and plant growth.

Steps and Sequences for Seed Collection

1. **Selection of Parent Plants:** Seeds should be collected from healthy, disease-free, and high-performing parent plants with desirable traits such as vibrant color, size, shape, and fragrance. For hybrids, it is crucial to choose

parent plants with stable genetic characteristics to ensure uniformity in the offspring.

2. **Timing of Collection:** The timing of seed collection is critical in floriculture. Seeds should be collected at physiological maturity, which is indicated by changes in fruit or pod color (e.g., from green to brown or black) and the drying or dehiscence of seed heads. Collecting immature seeds can result in poor germination and weak seedlings.

3. **Method of Collection**

   - For **dry-fruited flowers** (e.g., marigold, zinnia, or cosmos), seeds can be collected by gently shaking the mature flower heads into a container or by hand-picking them from the dried heads.
   - For **wet-fruited flowers** (e.g., petunia or impatiens), seeds can be extracted from fleshy fruits by pulping and washing them in water to separate viable seeds from pulp and debris.
   - In **self-pollinated crops**, such as some orchids, care must be taken to avoid cross-pollination during seed collection. Isolation or bagging techniques are often used.

4. **Cleaning and Processing:** After collection, seeds should be cleaned to remove impurities like chaff, dirt, or damaged seeds. This ensures uniformity and enhances the seed quality. For small or delicate seeds, use sieves or air-blowing techniques to separate viable seeds from lighter, immature ones.

5. **Storage Before Processing:** If immediate processing is not possible, seeds should be stored temporarily in dry, cool, and ventilated conditions. Avoid direct sunlight, as it can damage seed viability. Containers should be placed on racks or shelves to prevent contamination by moisture, pests, or rodents.

6. **Labeling:** Accurate labeling of seeds is crucial. Each batch should be labeled with the name of the species or variety, date of collection, and location. For hybrid varieties, include the parentage details to ensure

traceability.

7. **Seed Viability Testing:** Before large-scale sowing, seeds should undergo viability tests to ensure they will germinate. Common tests include germination trials or chemical staining (e.g., tetrazolium test).
8. **Tools and Equipment:** Use appropriate tools like pruning shears, scissors, or collection bags to harvest seeds gently. For flowers with high seed dispersal rates, such as dandelions or poppies, use netting or cloth bags to capture seeds before they scatter.
9. **Avoiding Contamination:** Seeds should be collected during dry weather to prevent fungal contamination or rotting. It is essential to avoid mixing seeds from different varieties or species to maintain purity.
10. **Specialized Practices for Floriculture Crops**
    - For **orchids**, seeds are microscopic and collected from pods that mature over several months. The collection process often requires aseptic conditions as the seeds lack endosperm and need special germination techniques.
    - For **bulbous flowers** like gladiolus, seeds are often collected from seed pods if sexual reproduction is required. However, vegetative propagation is more common.

8.3 Seed Viability and Germination

Seed viability and germination are fundamental aspects of plant propagation, particularly in floriculture, where the quality and success of a crop depend heavily on the ability of seeds to sprout and grow into healthy plants. Viability ensures that seeds are capable of germinating under favorable conditions, while germination is the actual process through which a seed develops into a seedling. Understanding these concepts is crucial for successful seed propagation in ornamental crops.

Seed Viability

Seed viability refers to the ability of a seed to germinate and grow into a healthy

plant under suitable conditions. It is an essential parameter that determines the quality and usability of seeds in floriculture.

- **Factors Influencing Seed Viability**
  - **Genetic Makeup:** Some species naturally have higher viability than others.
  - **Storage Conditions:** Temperature, humidity, and light exposure significantly affect the longevity of seed viability.
  - **Seed Maturity:** Fully matured seeds have better viability compared to immature seeds.
  - **Seed Treatments:** Proper cleaning, drying, and treatments such as fungicide application improve viability.
- **Viability Testing Methods**
  - **Germination Test:** Seeds are placed in a controlled environment (e.g., moist blotters or sand) to observe germination rates.
  - **Tetrazolium Test:** Seeds are stained with tetrazolium chloride solution, which highlights live tissues, indicating viability.
  - **Float Test:** Seeds are placed in water, and viable seeds tend to sink, while non-viable ones float.
  - **Cut Test:** The seed is cut open to observe the condition of the embryo.

Seed Germination

Seed germination is the process by which a viable seed transforms into a seedling under favorable conditions. It is a critical stage in the life cycle of a plant, involving a series of physiological and biochemical changes.

- **Process of Germination**
  1. **Imbibition:** The seed absorbs water, causing it to swell and activate metabolic processes.
  2. **Enzyme Activation:** Enzymes break down stored food in the

endosperm or cotyledons into usable nutrients for the embryo.

3. **Emergence of Radicle:** The root emerges first, anchoring the seedling and beginning water and nutrient uptake.
4. **Emergence of Plumule:** The shoot emerges and grows upward towards light.

- **Types of Germination**
  1. **Epigeal Germination:** In this type, cotyledons are pushed above the soil, as seen in beans and sunflowers.
  2. **Hypogeal Germination:** The cotyledons remain below the soil surface, as seen in maize and peas.

- **Factors Affecting Germination**
  1. **Water:** Sufficient moisture is essential for imbibition and enzyme activation. Excess water, however, can cause seed rotting.
  2. **Temperature:** Germination occurs within an optimal temperature range, varying by species (e.g., marigold seeds germinate best at 20–25°C).
  3. **Oxygen:** Adequate aeration is necessary for respiration during germination.
  4. **Light:** Some seeds require light for germination (e.g., lettuce), while others may require darkness (e.g., onion).
  5. **Dormancy Status:** Dormant seeds may require pre-treatment to break dormancy before germination.

Importance in Floriculture

In floriculture, seed viability and germination are crucial for achieving uniformity, high-quality plants, and optimal yield. Viability testing and proper germination practices ensure successful propagation, especially for high-value ornamental species like marigold, petunia, and zinnia. Nursery managers often invest in germination chambers and seed treatment protocols to maximize success rates.

Practical Applications

- Regular viability testing helps to avoid wastage of seeds.
- Understanding specific germination requirements ensures uniform plant growth.
- Proper monitoring of germination conditions, such as temperature and moisture, helps prevent losses in commercial nurseries.

8.6 Preparation of Seedbed

A seedbed is a specially prepared area where seeds are sown to grow seedlings before transplanting them into the main field or pots. The preparation of the seedbed is critical for the successful germination of seeds and the healthy development of seedlings. In floriculture, where delicate ornamental plants like marigolds, gerberas, or petunias are grown, meticulous preparation ensures better results, minimizes losses, and enhances the quality of the plants.

Preparation of a Seedbed

Preparing a seedbed involves several steps to create an ideal environment for seed germination and seedling growth. The goal is to provide a loose, fertile, and pest-free medium with proper drainage and aeration.

1. **Site Selection**
    - Choose a site with good sunlight exposure, as most ornamental plant seeds require light for germination.
    - The site should be free from flooding or waterlogging. A slight slope can help in draining excess water.
2. **Removal of Debris**
    - Clear the site of all plant debris, stones, and weeds to reduce competition for nutrients and prevent diseases.
    - Remove any potential insect eggs or fungal spores that could harm the young seedlings.

3. **Soil Preparation**

- Loosen the soil to a depth of 15–20 cm using a spade or tiller. This improves aeration and root penetration.
- Break down large clumps of soil into smaller particles to create a fine tilth, which is essential for the small seeds of flowers like petunias and pansies.

4. **Incorporation of Organic Matter**

- Add well-rotted farmyard manure (FYM), compost, or vermicompost at the rate of 5–10 kg per square meter. This improves soil fertility, structure, and water-holding capacity.

5. **Leveling the Seedbed**

- Level the surface to ensure uniform water distribution and prevent water stagnation in low spots.
- Create slightly raised beds (10–15 cm high) in areas prone to waterlogging to improve drainage.

6. **Sterilization**

- Treat the seedbed soil to kill harmful pathogens, pests, and weed seeds. Methods include:
  - **Solarization:** Cover the soil with a transparent plastic sheet for 4–6 weeks during summer to trap heat and eliminate pests and pathogens.
  - **Chemical Treatment:** Apply formalin solution (1.5–2%) at the rate of 4–5 liters per square meter. Cover with plastic for 15–20 days, then expose the soil to sunlight to remove residues.
  - **Fungicide Application:** Mix Captan or Thiram at 2–3 g per kg of soil to control fungal diseases.

7. **Seedbed Design**

- **Size:** Beds are typically 1–1.5 meters wide and 3–5 meters long,

allowing easy access for management.

- **Pathways:** Leave 30–50 cm wide paths between beds for movement and watering.

8. Seedbed Cover

- Use a thin layer of fine compost, sand, or sieved soil to cover seeds after sowing. This protects seeds from drying out and ensures good seed-soil contact.
- For sensitive seeds, cover the bed with a mulch or shade net to protect it from direct sunlight, heavy rainfall, or strong winds.

9. Watering

- Irrigate the seedbed thoroughly before sowing to ensure uniform moisture availability. Use a fine spray to avoid washing away seeds after sowing.

8.7 Seed Bed Treatment and Sowing

Seed bed treatment and sowing are crucial steps in ensuring healthy germination and growth of seedlings. In floriculture, where ornamental plants are highly valued for their aesthetic appeal, proper treatment of the seedbed minimizes the risk of diseases, pests, and poor growth. Sowing methods further ensure optimal seed placement for uniform germination. These practices are especially important for delicate flower seeds, which require specific conditions for successful establishment.

Seed Bed Treatment

1. Objective

- To sterilize the soil and eliminate harmful pathogens, weed seeds, and pests.
- To create a conducive environment for seed germination and early seedling growth.

2. Methods of Seed Bed Treatment

Soil Solarization

- Spread a transparent polythene sheet over the moist seedbed during the hot months (May–June).
- Keep the sheet in place for 4–6 weeks to trap solar heat, raising the soil temperature to 45–50°C, which kills soil-borne pathogens, pests, and weed seeds.

Chemical Treatment

- Apply **Formalin** (1.5–2%) by drenching the soil at a rate of 4–5 liters per square meter.
- Cover the treated area with polythene for 15–20 days, then expose it to sunlight to allow formalin residues to evaporate.
- Alternatively, use fungicides like **Captan** or **Thiram** at 2–3 g per kg of soil to control fungal diseases.

Insecticide Application

- Treat the soil with **Chlorpyriphos** at 2 ml per liter of water to eliminate soil-borne insects.
- Ensure even drenching to a depth of 15–20 cm.

Steam Sterilization

- Apply hot steam to the soil for 4–6 hours to kill harmful microorganisms.
- This method is particularly useful in greenhouse setups.

Sowing of Seeds

1. Timing

- Choose the appropriate sowing time depending on the flower species and its growth cycle. For instance:
  - Winter flowers like pansies and petunias are sown in early autumn.
  - Summer flowers like marigolds are sown in spring.

2. Seed Sowing Methods

Broadcasting

- Seeds are evenly scattered over the prepared seedbed.
- Cover lightly with a thin layer of fine compost or sand (1–2 mm thick).
- This method is simple but may lead to uneven spacing and competition among seedlings.

Line Sowing

- Create shallow furrows (0.5–1.0 cm deep) at a spacing of 5 cm between rows.
- Place seeds individually in the furrows at a spacing of 1–2 cm.
- Cover the seeds with a fine layer of soil or compost and water gently.

Drilling

- Use a seed drill to sow seeds at uniform depth and spacing.
- This method is more precise and is commonly used for large-scale flower production.

Post-Sowing Care

- **Watering**
  - Provide light irrigation immediately after sowing using a fine spray or mist to avoid displacing seeds.
  - Maintain consistent moisture levels but avoid waterlogging.
- **Mulching**
  - Cover the seedbed with a thin layer of mulch or shade net to retain moisture and protect seeds from direct sunlight and heavy rain.

Shading

- For delicate flower seeds, provide shade to prevent heat stress and ensure optimal germination conditions.

Labeling

- Label each seedbed with the name and variety of the flower sown, along with the sowing date, for easy identification and monitoring.

Importance in Floriculture

Proper seed bed treatment and sowing techniques are critical in floriculture to ensure uniform germination, healthy seedling growth, and minimal losses. These practices not only enhance the quality of ornamental plants but also improve their market value, making them essential for commercial flower production.

8.8 Care and Maintenance of Seedlings

Care and maintenance of seedlings are essential to ensure their healthy growth and successful establishment in the nursery. Proper attention during the seedling stage minimizes losses due to pests, diseases, or unfavorable environmental conditions. In floriculture, where ornamental plant quality is crucial, meticulous care ensures uniform growth, better transplanting success, and aesthetically pleasing plants.

Care and Maintenance of Seedlings

1. Watering

- Seedlings require consistent but careful watering to maintain soil moisture without waterlogging.
- Use a fine spray or mist to avoid displacing the delicate seedlings or exposing roots.
- Watering is generally done early in the morning to reduce evaporation and avoid fungal diseases.
- Frequency depends on the type of flower, soil condition, and climate, but seedlings should never be allowed to wilt.

2. Shading

- Young seedlings are sensitive to direct sunlight, which can cause heat stress or drying out.

- Provide shade using polythene nets, jute mats, or naturally available materials like straw.
- Gradually reduce shading as seedlings grow to acclimate them to outdoor conditions before transplanting.

3. Weeding

- Regular removal of weeds is necessary to minimize competition for nutrients, water, and light.
- Weeds can also harbor pests and diseases; hence, manual weeding or light hoeing is recommended.
- Care should be taken not to disturb the seedlings' roots during weeding operations.

4. Thinning

- Overcrowded seedlings may compete for resources, leading to poor growth.
- Thinning involves removing weaker or surplus seedlings to allow adequate spacing for healthy ones.
- Perform thinning when seedlings develop their first true leaves, ensuring optimal growth conditions for the remaining plants.

5. Insect Pest and Disease Control

- Monitor seedlings regularly for signs of pests like aphids, whiteflies, or caterpillars, and diseases such as damping-off or leaf spots.
- Use neem oil, insecticidal soaps, or recommended chemical sprays for pest control.
- Apply fungicides like Captan or Thiram at recommended doses to control fungal infections.
- Maintain proper sanitation in the nursery to minimize the risk of infections.

6. Fertilization

- Young seedlings require balanced nutrition for healthy growth. Apply a diluted solution of water-soluble fertilizers like **19:19:19** NPK at 0.5 g/L every two weeks.
- Avoid over-fertilization, as it can lead to salt accumulation in the soil and damage tender roots.
- Organic supplements like compost tea or vermiwash can also be applied to enhance soil fertility.

7. Hardening-off

- Hardening is the process of gradually acclimating seedlings to outdoor conditions before transplanting.
- Begin by reducing the frequency of watering and exposing seedlings to increased sunlight and wind for a few hours daily.
- This process typically lasts for 7–14 days and helps reduce transplant shock, ensuring better survival and establishment in the field.

8. Staking and Support

- For taller seedlings, provide small stakes or support to prevent bending or lodging due to wind or watering.

9. Transplant Readiness

- Seedlings are ready for transplanting when they develop 3–5 true leaves, have a healthy root system, and a firm stem.
- Water the seedbed thoroughly before lifting seedlings to minimize root damage.

Importance in Floriculture

Proper care and maintenance of seedlings ensure uniform growth, high survival rates, and the production of high-quality ornamental plants. In commercial floriculture, healthy seedlings contribute to better productivity, marketability, and customer satisfaction, making these practices indispensable for successful cultivation.

8.9 Packaging and Marketing

The packaging and marketing of ornamental seeds are essential components of the floriculture industry. Proper packaging protects seeds from damage and ensures their quality, while effective marketing strategies create demand and increase sales. For ornamental plants, the aesthetic appeal, high germination rates, and quality assurance provided through packaging and branding significantly influence buyer decisions. This process plays a pivotal role in meeting consumer needs and supporting the growth of the floriculture sector.

Packaging of Ornamental Seeds

1. **Purpose of Packaging:** Packaging serves multiple purposes, including protecting seeds from physical damage, preventing contamination by moisture, pests, or pathogens, and maintaining seed viability. It also provides important information to the buyer, such as the variety name, sowing instructions, germination rates, and packaging date. Proper packaging is critical for enhancing seed shelf life and ensuring successful germination.
2. **Characteristics of Good Seed Packaging:** A good seed package must meet specific criteria:
    - It should be moisture-proof to prevent spoilage due to dampness.
    - The material must be durable enough to withstand handling and transportation.
    - Packaging should be attractive and informative to appeal to retail consumers.
    - It must include clear labeling with details such as the seed type, weight, lot number, germination percentage, and sowing instructions.
3. **Types of Packaging Materials:** Different materials are used for ornamental seed packaging based on the type of seeds and market needs:
    - **Plastic Pouches:** These are popular for their moisture resistance and durability, ensuring seeds remain viable for longer durations.

- **Aluminum Foil Packets:** These are often used for high-value seeds, offering superior protection against moisture and light exposure.
- **Paper Packets:** Eco-friendly and cost-effective options for short-term storage, widely used for small-scale retail.
- **Glassine Envelopes:** Transparent envelopes commonly used for small quantities, allowing buyers to view the seeds.

4. **Seed Packaging Process**
   - **Cleaning and Grading:** Seeds are cleaned to remove debris and graded for uniformity.
   - **Treatment:** Seeds are treated with fungicides or insecticides to enhance their shelf life and protect them from diseases and pests.
   - **Filling and Sealing:** The treated seeds are filled into appropriately sized containers and securely sealed to maintain freshness.
   - **Labeling:** Clear and concise labels are applied, providing essential details to guide consumers.

Marketing of Ornamental Seeds

1. **Importance of Marketing in Floriculture:** Marketing ornamental seeds is vital for raising awareness among consumers about the available varieties and their uses. It encourages the adoption of ornamental plants for gardening, landscaping, and decorative purposes. Effective marketing strategies help expand the market, catering to different customer segments such as hobbyists and commercial growers.
2. **Key Elements of Seed Marketing**
   - **Branding:** Establishing a recognizable brand builds trust and loyalty among consumers.
   - **Packaging Design:** Well-designed packaging attracts attention and communicates product quality.
   - **Advertising and Promotion:** Using online platforms, print media,

gardening expos, and trade fairs to promote seeds effectively.

- **Distribution Channels:** Ensuring seeds are available in nurseries, garden centers, agricultural cooperatives, and through e-commerce platforms.

3. **Market Segmentation:** The market for ornamental seeds can be segmented based on consumer needs:
   - **Retail Market:** Targets home gardeners and hobbyists with small, attractively packaged seed packets.
   - **Wholesale Market:** Caters to nurseries, landscapers, and commercial growers, providing seeds in bulk at competitive prices.
   - **Export Market:** Focuses on high-quality, well-packaged seeds that meet international standards and are certified for export.

4. **Challenges in Marketing Ornamental Seeds**
   - Competition from imported seeds and established brands in the market.
   - Maintaining seed viability and quality during storage and transportation.
   - Educating consumers on proper sowing, care, and maintenance to ensure successful germination and plant growth.

5. **Strategies for Effective Marketing**
   - Providing a wide range of seed varieties, including rare and exotic ornamental plants.
   - Offering value-added services, such as instructional booklets or online tutorials.
   - Leveraging digital marketing tools like social media, email campaigns, and online stores to reach a broader audience.
   - Ensuring timely delivery and availability of seeds during peak planting seasons.

Proper packaging and effective marketing are critical for the success of

ornamental seed businesses. Packaging ensures the protection and viability of seeds, while marketing strategies increase their visibility and demand. Together, these practices support the floriculture industry's growth by meeting the needs of a diverse customer base, from individual gardeners to commercial growers.

Exercise

Choose the correct answer from the given alternatives.

1. What is the main advantage of seed propagation in plants?

   a. Uniform growth

   b. Cost-effective reproduction

   c. No requirement for maintenance

   d. High level of genetic similarity

2. Which method is most suitable for breaking seed dormancy in hard-coated seeds?

   a. Stratification b. Scarification

   c. Chemical treatment d. Both b and c

3. What is the purpose of solarization in seedbed preparation?

   a. Enhance soil fertility b. Eliminate soil-borne pathogens

   c. Improve soil texture d. Facilitate water retention

4. Which factor does not affect seed germination?

   a.Water b. Light

   c. Soil type d. Temperature

5. Seed viability refers to.....

   a. The ability of seeds to germinate under suitable conditions

   b. The weight of seeds in storage

   c. The chemical composition of seeds

   d. The time taken for seeds to germinate

6. What is the primary cause of seed dormancy in many plants?

   a. Presence of moisture b. Impermeable seed coat

   c. High temperature d. Availability of light

7. Which seed treatment method uses heat to break dormancy?

a. Stratification
b. Scarification
c. Solarization
d. Hot water treatment

8. In epigeal germination, the cotyledons.....

a. Remain underground
b. Rise above the soil
c. Disintegrate immediately
d. Are absent

9. A major disadvantage of seed propagation is.....

a. High cost
b. Lack of genetic diversity
c. Delayed maturity
d. Complex process

10. Hardening of seedlings is necessary to.....

a. Enhance root development
b. Improve the survival rate after transplantation
c. Accelerate growth
d. Reduce the number of pests

11. What is the ideal pH range for most seedbeds?

a. 4.0–5.0
b. 5.5–7.0
c. 7.5–9.0
d. 9.5–10.0

12. A transparent polythene sheet is used in solarization to.....

a. Increase the soil's nutrient content
b. Trap solar heat to kill pathogens
c. Improve aeration in the soil
d. Retain soil moisture

13. Which method of sowing ensures the best seed spacing?

a. Broadcasting
b. Line sowing
c. Drilling
d. Direct planting

14. Which chemical is commonly used for seedbed sterilization?

a. Potassium nitrate
b. Formalin
c. Urea
d. Sulfuric acid

15. Seedlings are typically ready for transplanting when.....

a. The cotyledons emerge
b. The radicle appears
c. 3–5 true leaves develop
d. The plumule grows 10 cm tall

16. What is the primary objective of mulching a seedbed?

a. Increase soil pH
b. Conserve moisture and regulate temperature
c. Eliminate pests and diseases
d. Enhance soil aeration

17. Which seed viability test uses a chemical solution to stain living tissues?

a.Germination test
b. Float test
c. Cut test
d. Tetrazolium test

18. Hard-coated seeds are best treated by.....

a. Boiling
b. Cold water soaking
c. Mechanical scarification
d. Exposure to light

19. Which factor is most critical for the successful germination of light-sensitive seeds?

a. Temperature
b. pH level
c. Light exposure
d. Nutrient availability

20. The term "thinning" in seedling care refers to.....

a. Removing weeds
b. Reducing overcrowded seedlings
c. Applying fertilizers
d. Enhancing irrigation

Write short answer to the following questions.

1. Define seed viability and explain one method to test it.
2. What are the primary causes of seed dormancy?
3. List the steps involved in preparing a seedbed.
4. Mention three advantages of seed propagation over vegetative propagation.
5. Describe the process of hardening seedlings and its importance.

Write long answer to the following questions.

1. Explain the causes and methods for breaking seed dormancy with examples.
2. Discuss the factors affecting seed germination and their importance in floriculture.
3. Describe the steps and precautions involved in seed collection for ornamental plants.
4. Write a detailed note on seedbed preparation and its role in successful seed propagation.
5. Explain the care and maintenance of seedlings with special emphasis on pest management and hardening.

Project Work

1. **Seed Viability and Germination Testing**
   - Perform germination tests on different seed batches. Observe and record germination rates and compare the results with tetrazolium testing to understand viability.
2. **Seedbed Preparation and Sowing**
   - Prepare a seedbed using sterilization techniques like solarization or chemical treatment and Sow seeds using both broadcasting and line sowing methods, and evaluate the results.
3. **Hardening and Transplanting Seedlings**
   - Harden seedlings by gradually exposing them to outdoor conditions and Monitor their survival and adaptation after transplantation.

Unit 9

Vegetative Propagation

9. Vegetative Propagation

Vegetative propagation, also known as asexual reproduction in plants, is a method of propagation that involves the use of vegetative parts such as stems, leaves, roots, and buds to produce new plants. This process does not involve the formation of seeds or spores, making it independent of sexual reproduction. Vegetative propagation is widely practiced in horticulture, forestry, and agriculture due to its ability to produce uniform and true-to-type plants. Various techniques such as cutting, layering, grafting, and budding are employed depending on the plant species and propagation goals.

9.1 Reasons for Using Vegetative Propagation

Vegetative propagation is preferred over sexual propagation in many situations due to its specific advantages. It relies on mitotic division to create genetically identical offspring, ensuring that desirable traits of the parent plant are preserved. Below are the detailed reasons for its usage:

1. **Propagation of True-to-Type Plants:** Asexually propagated plants are genetically identical to their mother plants, ensuring the preservation of desirable traits such as flower color, fruit quality, or disease resistance.
2. **Short Juvenile Phase:** Vegetatively propagated plants often bypass the lengthy juvenile phase associated with seed propagation, allowing them to produce flowers and fruits within a shorter time frame (typically 3-4 years).
3. **Propagation of Seedless Plants:** Many plants, such as orchids and bananas, do not produce viable seeds or may be sterile. Vegetative propagation is the only viable method for reproducing such species.

4. **Preservation of Desirable Characteristics:** Desirable traits such as high yield, disease resistance, or specific aesthetic qualities can be perpetuated without the genetic variability introduced by seed propagation.
5. **Utilization of Rootstocks:** Rootstocks are used in grafting and budding to confer beneficial traits to the scion, such as increased disease resistance, tolerance to adverse soil conditions, or improved vigor.
6. **Repair and Modification of Plants:** Techniques such as bridge grafting are used to repair damaged plants, while top-working can convert less productive trees into improved cultivars or allow multiple varieties to be grown on a single plant.
7. **Efficient Use of Space:** Asexual propagation allows for the production of multiple plants within a smaller area compared to seed propagation, maximizing space usage in nurseries and greenhouses.
8. **Production of Uniform Plants:** Plants propagated vegetatively exhibit uniform growth, size, and flowering, which is particularly important in commercial horticulture for maintaining consistent quality.
9. **Ability to Overcome Seed Dormancy and Viability Issues:** Some seeds have long dormancy periods or lose viability quickly, making vegetative propagation a more reliable alternative.
10. **Facilitation of Novel Plant Arrangements:** Techniques like grafting enable the creation of unique plants, such as multi-variety trees or decorative ornamentals with specific growth patterns.
11. **Preservation of Rare or Endangered Species:** Vegetative propagation is used to preserve and multiply rare or endangered plants that may have difficulty reproducing naturally.

By using vegetative propagation, horticulturists and growers can achieve efficient, reliable, and large-scale production of high-quality plants while maintaining their genetic integrity.

9.1.1 Propagation of Seedless Plants

One of the primary reasons for adopting vegetative propagation is the ability to propagate plants that do not produce viable seeds or are completely seedless. Many ornamental plants, such as orchids and some hybrid flowers, and agricultural crops like bananas, pineapples, and certain types of citrus, are either sterile or have seeds that are non-viable. These plants rely on vegetative propagation for their reproduction.

For seedless plants, vegetative propagation ensures the continuation of their genetic lineage. Techniques such as cutting, grafting, or tissue culture are employed to multiply such plants efficiently. This method also allows the grower to bypass the challenges of poor seed viability, long germination times, or unfavorable seed storage conditions.

9.1.2 Avoidance of Long Juvenile Phase

Seed propagation often requires plants to undergo a juvenile phase, during which they are incapable of flowering or fruiting. This phase can last several years, as seen in many woody perennials and fruit crops, delaying economic returns for growers. Vegetative propagation helps to avoid this lengthy juvenile phase by producing plants that are physiologically mature and ready to flower or fruit in a shorter time.

For example, fruit crops like mango, guava, and citrus propagated by grafting or budding often start bearing fruit within 2-3 years, compared to 6-8 years for seed-propagated plants. This significantly reduces the time required for the plant to reach full productivity, making vegetative propagation an attractive option for commercial and ornamental horticulture.

9.2. Methods of Vegetative Propagation

Vegetative propagation is a method of plant reproduction where new plants are grown from vegetative parts of the parent plant, such as stems, leaves, roots, or buds. This technique bypasses seed production and utilizes mitotic cell division

to ensure that the new plants are genetically identical to the parent plant. It is widely used in horticulture, agriculture, and floriculture to propagate desired plant varieties, especially those that are difficult to propagate through seeds or have a long juvenile phase. The main methods of vegetative propagation include cutting, layering, grafting, budding, division, and specialized structures like tubers, bulbs, corms, and rhizomes.

9.2.1 Cutting

A cutting is a piece of vegetative material—stem, root, leaf, or bud—taken from a plant to grow a new individual. When placed in favorable conditions, cuttings develop roots, shoots, and eventually become an independent plant. Cutting is a simple, economical, and commonly used method of vegetative propagation, especially in ornamental plants.

9.2.1.1 Advantages and Disadvantages of Cutting

Advantages of Cutting

1. **Simplicity:** The method is easy to practice and does not require specialized equipment.
2. **Genetic Uniformity:** Plants propagated through cuttings are true to type, maintaining the desirable traits of the parent plant.
3. **Faster Growth:** Plants grown from cuttings skip the juvenile phase and reach maturity faster than seedlings.
4. **Cost-Effective:** It is inexpensive as it does not require seeds or complex propagation materials.
5. **Wide Application:** Suitable for a large number of plant species, especially ornamentals and shrubs.

Disadvantages of Cutting

1. **Limited Applicability:** Not all plants root readily from cuttings; some require additional treatments like hormones.
2. **Weaker Root System:** Plants grown from cuttings often have weaker root

systems compared to seed-grown plants.

3. **Vulnerability:** Cuttings are susceptible to diseases, pests, and environmental stress.
4. **Skilled Handling Required:** Proper technique and care are necessary for successful rooting.

9.2.1.2 Different Techniques of Cutting

Cuttings are a widely used method of vegetative propagation that involves taking parts of a plant and inducing them to form roots and shoots, resulting in the growth of a new plant. The techniques of cutting can be categorized based on the part of the plant used. The main types include stem cuttings, root cuttings, leaf cuttings, and leaf-bud cuttings. Each technique has specific applications, advantages, and procedures.

a. Stem Cuttings

Stem cuttings are the most commonly used method in vegetative propagation. These cuttings are derived from the stem of a plant and include nodes and internodes. Stem cuttings can be further classified into four types: hardwood, softwood, semi-hardwood, and herbaceous cuttings.

1. Hardwood Cuttings

Hardwood cuttings are taken from mature, dormant, and woody stems during late fall, winter, or early spring.

Procedure

1. Select healthy and mature stems from the plant.
2. Cut the stem into 20–25 cm segments, each with at least 3–4 nodes.
3. Ensure the basal cut is slanted for easy identification during planting.
4. Dip the basal end in a rooting hormone to encourage root development.
5. Plant the cuttings vertically in a well-draining medium, such as sand or a mixture of sand and soil.

6. Water the cuttings lightly and place them in a protected area with indirect sunlight.

Examples: Grapes, figs, pomegranate, currants, and roses.

2. Softwood Cuttings

Softwood cuttings are taken from young, actively growing stems of woody plants during late spring or early summer when the wood is still tender.

Procedure

1. Choose vigorous and disease-free shoots with a length of 8–12 cm.
2. Remove the lower leaves, leaving only 2–3 leaves at the top to reduce water loss.
3. Dip the basal end in rooting hormone powder.
4. Insert the cuttings into a moist, well-draining medium such as peat, perlite, or vermiculite.
5. Maintain high humidity by covering the cuttings with a transparent plastic cover or placing them in a mist chamber.
6. Place the cuttings in bright, indirect sunlight and ensure consistent moisture in the medium.

Examples: Roses, hydrangeas, forsythia, and hibiscus.

3. Semi-Hardwood Cuttings

Semi-hardwood cuttings are taken from partially mature wood of current-season growth during mid-summer to early fall.

Procedure

1. Select semi-hardwood stems that are firm but still flexible.
2. Prepare 10–15 cm cuttings with at least one or two nodes.
3. Remove the lower leaves to expose the nodes and dip the basal end in rooting hormone.
4. Insert the cuttings into a well-draining medium, such as a mixture of sand

and peat.

5. Keep the cuttings under a misting system or cover them with plastic to maintain high humidity.
6. Place in a shaded area with indirect sunlight.

Examples: Citrus, camellia, and gardenia.

4. Herbaceous Cuttings

Herbaceous cuttings are taken from soft, succulent, and non-woody plants, often during the growing season.

Procedure

1. Cut 8–10 cm long segments from the terminal portions of herbaceous stems.
2. Remove the lower leaves and any flowers or buds to reduce water loss.
3. Dip the basal end in rooting hormone for faster root initiation.
4. Plant the cuttings in a moist medium like peat moss or vermiculite.
5. Maintain high humidity by covering with a plastic dome or misting regularly.
6. Place in a bright, warm location with indirect sunlight.

Examples: Chrysanthemums, coleus, carnations, and sweet potatoes.

b. Root Cuttings

Root cuttings are taken from the roots of plants that naturally produce adventitious shoots. This technique is suitable for woody and herbaceous plants.

Procedure

1. Select mature roots with a diameter of 1–2 cm.
2. Cut the roots into 8–12 cm segments during the dormant season.
3. Plant the cuttings horizontally or vertically in a rooting medium like sand or soil.

4. Cover the roots lightly with soil and water thoroughly.
5. Place in a cool, shaded location until shoots emerge.

Examples: Blackberry, raspberry, guava, and horseradish.

c. Leaf Cuttings

Leaf cuttings involve using leaves or sections of leaves to propagate new plants. This method is commonly used for plants with thick, fleshy leaves capable of forming both roots and shoots.

Procedure

1. Select healthy and mature leaves.
2. Cut the leaves into sections, ensuring each section has a vein.
3. Dip the cut edge in rooting hormone to promote root formation.
4. Place the leaf sections on the surface of a moist medium, such as peat or vermiculite, with the cut edge slightly buried.
5. Maintain high humidity by covering with a plastic dome or placing in a greenhouse.
6. Provide bright, indirect sunlight and consistent moisture.

Examples: Sansevieria (snake plant), begonia, African violet, and jade plant.

d. Leaf-Bud Cuttings

Leaf-bud cuttings consist of a leaf blade, petiole, and an attached axillary bud. This method is highly efficient and ensures the rapid growth of a new plant.

Procedure

1. Take cuttings with a single leaf and an attached bud from the parent plant.
2. Remove the lower part of the petiole to expose the bud.
3. Dip the basal end in rooting hormone.
4. Plant the cutting in the rooting medium with the bud just above the soil surface.

5. Keep the cuttings under high humidity with indirect sunlight.

Examples: Camellia, rhododendron, lemon, and blackberry.

9.2.2 Layering

Layering is a vegetative propagation technique where roots are induced to develop on a stem while it remains attached to the parent plant. After successful rooting, the stem (layer) is detached from the parent plant and transplanted as an independent plant. Layering is especially useful for plants that are difficult to propagate by other methods like cuttings.

9.2.2.1 Advantages and Disadvantages of Layering

Advantages

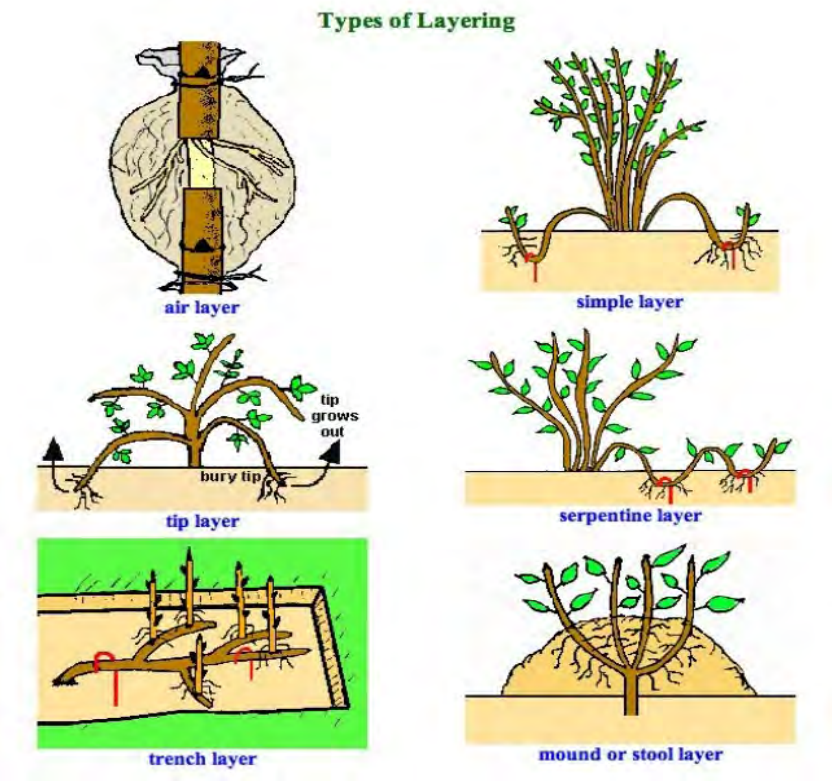
1. The parent plant provides continuous nourishment and water to the layer until it establishes roots, increasing its survival rate.
2. Layering allows the production of comparatively larger plants in a shorter period.
3. It is a suitable technique for propagating difficult-to-root plants, ensuring successful reproduction.
4. This method reduces genetic variation as the new plant is genetically identical to the parent.
5. It is ideal for propagating plants in home gardens or for small-scale use without the need for specialized equipment.

Disadvantages

1. Layering is labor-intensive and time-consuming compared to other propagation methods.
2. It is not feasible for large-scale propagation as only a few layers can be produced at a time.
3. The process may be cumbersome, especially for plants with tall or woody stems.

4. Some plants may not respond well to layering, limiting its applicability.
5. It can be expensive when used on a commercial scale due to the labor and time involved.

9.2.2.2 Different Techniques of Layering



Layering techniques are chosen based on the growth habits and characteristics of the plant. The commonly used techniques include:

a. Simple Layering

Simple layering involves bending a low-growing branch to the ground and burying a portion of it while keeping the tip exposed.

Procedure

1. Select a healthy, flexible branch close to the ground.

2. Bend the branch downward, ensuring a portion of it touches the soil.
3. Wound the underside of the branch at the point where it will be buried to encourage rooting.
4. Cover the wounded section with soil, leaving 6–12 inches of the tip exposed.
5. Secure the branch in place with a U-shaped pin or small rock.
6. Water the area regularly to keep the soil moist.
7. Check for root development after 2–3 months. Once roots are well-formed, sever the branch from the parent plant and transplant it.

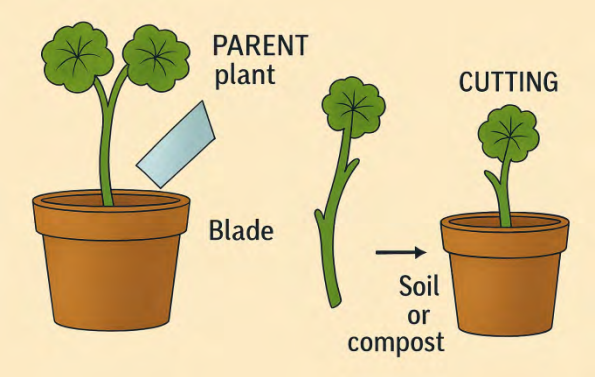
Examples: Honeysuckle, forsythia, rhododendron, and azalea.

b. Tip Layering

Tip layering involves burying the tip of a branch to induce rooting.

Procedure

1. Choose a young, flexible branch with a healthy tip.
2. Dig a small hole (2–3 inches deep) in the soil near the branch.
3. Bend the tip of the branch into the hole and bury it with soil, leaving the rest of the branch exposed.



4. Secure the buried tip with a pin or rock to prevent it from moving.
5. Water the area consistently to maintain soil moisture.
6. After 2–3 months, check for root formation. Once roots develop, sever the branch from the parent plant and transplant it.

Examples: Blackberries, raspberries, and trailing blackberries.

c. Compound (Serpentine) Layering

Compound layering involves burying multiple sections of a single branch alternately in the soil, leaving buds exposed between buried sections.

Procedure

1. Select a long, flexible branch from the parent plant.
2. Dig a shallow trench near the branch.
3. Bend the branch into the trench and alternately bury and expose sections of it.
4. Wound the underside of the buried sections to stimulate rooting.
5. Secure the buried portions with pins or small rocks.
6. Keep the trench moist and monitor for root development.
7. Once roots have formed at multiple points, cut the rooted sections into individual plants and transplant them.

Examples: Clematis, wisteria, and grapes.

d. Mound (Stool) Layering

Mound layering involves encouraging roots to form at the base of shoots by mounding soil around them.

Procedure:

1. During the dormant season, prune the plant back to 1–2 inches above the ground.
2. In spring, allow new shoots to grow from the base of the plant.
3. As the shoots grow to 6–10 inches, mound soil around their bases to cover the lower portions.
4. Continue adding soil as the shoots grow, ensuring their tips remain exposed.
5. Water the mound regularly to keep the soil moist.
6. In late fall or early winter, carefully remove the soil and cut the rooted shoots from the parent plant.
7. Transplant the rooted shoots as new plants.

Examples: Apple rootstocks, quince, spirea, and daphne.

e. Trench Layering

Trench layering involves burying a long branch horizontally in a trench to encourage rooting at multiple points.

Procedure

1. Select a healthy, flexible branch.
2. Dig a trench about 2–3 inches deep near the parent plant.
3. Lay the branch horizontally in the trench, ensuring it is in contact with the soil.
4. Wound the underside of the branch at intervals to promote rooting.
5. Cover the branch with soil, leaving the buds or growing tips exposed.
6. Water the trench regularly and maintain soil moisture.
7. After root development, cut the branch into sections with roots and transplant them.

Examples: Apples, cherries, and nut trees.

f. Natural Forms of Layering

Natural layering occurs when certain plants propagate themselves through specialized structures like runners or offsets.

Procedure

- For runners: Allow the runner to touch the soil and root naturally. Once rooted, detach the new plant from the parent and transplant it.
- For offsets: Detach the offsets from the parent plant when they have a few roots and transplant them directly.

Examples

- Runners: Strawberries and spider plants.
- Offsets: Bromeliads, cacti, and date palms.

g. Air Layering

Air layering is a technique where roots are induced on a branch while it remains attached to the parent plant, without burying it in soil.

Procedure:

1. Selection of Branch

- Choose a healthy, mature branch about pencil thickness.
- Avoid overly young or weak branches.

2. Preparation

- For dicots: Remove a 1-inch ring of bark (girdling) from the branch.
- For monocots: Make an upward 1–1.5-inch cut and insert a toothpick to keep it open.

3. Application of Rooting Hormone

- Apply a rooting hormone to the exposed area to stimulate root development.

4. Wrapping

- Surround the wounded area with moist sphagnum moss, coco coir, or compost.
- Cover the moss with a plastic sheet or aluminum foil to retain moisture.
- Secure both ends with tape or ties.

5. Monitoring

- Check the wrapping every 2–3 weeks to ensure the moss remains moist.
- After 2–4 months, check for root formation.

6. Separation and Transplantation

- Once roots are visible, cut the branch below the rooted area.
- Remove the wrapping carefully and transplant the rooted branch into a pot or field.

Advantages of Air Layering

- Ideal for large or woody plants.
- Effective for plants that do not root easily by other methods.

Examples: Rubber plants, crotons, magnolias, and camellias.

9.2.3 Grafting and Budding

Grafting is the art and science of joining two plant parts—a scion (upper part) and a rootstock (lower part)—in such a way that they grow as a single plant. The scion contributes the shoot system, including flowers and fruits, while the rootstock provides the root system.

Budding is a specialized type of grafting in which a single bud is used instead of a scion. Both techniques are widely used for propagating plants that do not root easily or to enhance desirable characteristics like disease resistance, vigor, or productivity.

9.2.3.1 Advantages and Disadvantages of Grafting and Budding

Advantages

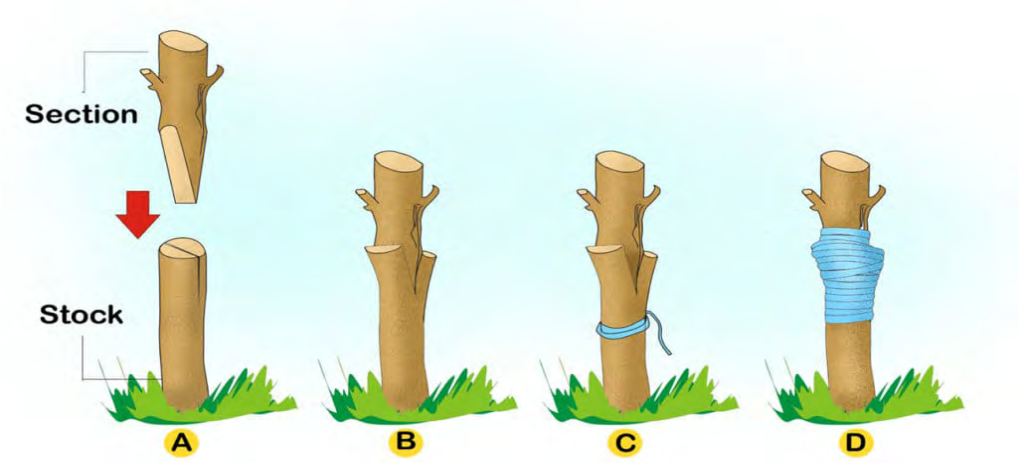
1. **Propagation of Difficult Plants:** Plants that cannot be propagated through other methods, such as cuttings or layering, can be successfully multiplied.
2. **Quality Improvement:** Inferior established trees can be converted into superior varieties through top-working.
3. **Disease Resistance:** Rootstocks impart disease resistance to the grafted plant, helping it survive in challenging environments.
4. **Tolerance to Soil Conditions:** Some rootstocks are tolerant to saline or alkaline soils and excessive moisture.
5. **Novelty and Multiple Varieties:** Grafting allows for the production of novelty plants with multiple flowers or fruit types on a single stock.
6. **Quick Results:** Grafted or budded plants typically flower and fruit earlier compared to seed-propagated plants.

7. **Repair Mechanism:** Damaged trunks or roots of plants can be repaired through bridge or buttress grafting.
8. **Indexing for Viruses:** Grafting can be used to detect viruses in plants, where susceptible rootstocks serve as indicator plants.

Disadvantages

1. **Specialized Skills Required:** Both grafting and budding require technical expertise and practice for successful execution.
2. **Shorter Lifespan:** Grafted or budded plants often have a shorter lifespan compared to seed-propagated plants.
3. **Viral Spread:** Diseases, especially viruses, can be transmitted through grafting.
4. **Extensive Process:** These methods are labor-intensive and more expensive than other propagation methods.
5. **No New Varieties:** Grafting and budding do not result in the creation of new plant varieties.

9.2.3.2 Different Techniques of Grafting



Grafting is a vegetative propagation technique that involves joining parts of two plants so that they grow as one. Below are the different techniques of grafting, along with their procedures:

1. Cleft Grafting

Cleft grafting involves inserting a scion into a cleft or split made in the stock to establish a union between the two.

Procedure

1. Select a healthy and mature rootstock about 3-5 years old.
2. Cut the rootstock horizontally to create a smooth, flat surface at the desired grafting height.
3. Split the stock vertically down the center to create a cleft approximately 5-7 cm deep using a grafting knife.
4. Prepare the scion by cutting it into a wedge shape, ensuring both sides have exposed cambium layers.
5. Insert the scion into the cleft of the rootstock, ensuring the cambium layers of both the scion and rootstock align.
6. Secure the union tightly using grafting tape or raffia.
7. Apply grafting wax to all exposed surfaces to prevent desiccation and infection.
8. Monitor the graft for 2-3 weeks for signs of successful union.

Suitable Season: Late winter to early spring when the rootstock is dormant. **Scion Age**: 6-12 months old. **Rootstock Age**: 3-5 years old. **Time for Success**: 3-6 weeks. **Examples**: Commonly used for apples, mangoes, and citrus trees.

2. Veneer Grafting

Veneer grafting is performed by joining a scion to a rootstock with a slanted notch to maximize cambium contact.

Procedure

1. Select a healthy rootstock aged 1-2 years.
2. Make a downward slanting cut (about 4 cm long) on the rootstock.
3. Prepare the scion with a similar cut to match the rootstock's cambium

exposure.

4. Place the scion onto the rootstock, ensuring proper alignment of cambium layers.
5. Secure the graft with grafting tape to ensure stability.
6. Apply grafting wax over the union to prevent moisture loss.
7. Place the graft in a humid, shaded area to promote healing.

Suitable Season: Late spring to early summer during active growth. **Scion Age:** 6-12 months old, **Rootstock Age:** 1-2 years old, **Time for Success:** 4-6 weeks. **Examples:** Avocado, guava, and ornamental plants..

3. Side Grafting

Side grafting involves inserting a scion into a slanted cut made on the side of the rootstock.

Procedure:

1. Choose a rootstock aged 2-3 years.
2. Make a slanting cut on the side of the rootstock, ensuring the cut reaches the cambium layer.
3. Prepare a scion with a wedge-shaped base.
4. Insert the scion into the slanted cut, ensuring proper alignment of cambium layers.
5. Secure the graft with grafting tape.
6. Cover the union with grafting wax to prevent dehydration.
7. Place the grafted plant in a sheltered environment to facilitate healing.

Suitable Season: Spring to early summer when the rootstock is actively growing. **Scion Age:** 1 year old. **Rootstock Age**: 2-3 years old. **Time for Success:** 3-5 weeks. **Examples:** Mango, litchi, and sapota.

4. Bark Grafting

Bark grafting is a method used when the rootstock is actively growing, allowing

the bark to separate easily from the wood.

Procedure

1. Select a rootstock with a diameter of 5-10 cm and aged 3-5 years.
2. Cut the rootstock horizontally and make vertical slits in the bark.
3. Peel back the bark slightly to expose the cambium layer.
4. Prepare the scion by cutting its base into a wedge shape.
5. Insert the scion under the bark, aligning the cambium layers.
6. Secure the graft with grafting tape and cover with grafting wax.
7. Ensure the grafted plant is kept in a shaded and humid area for recovery.

Suitable Season: Late spring to early summer during active growth. **Scion Age:** 1 year old. **Rootstock Age:** 3-5 years old. **Time for Success:** 6-8 weeks. **Examples:** Walnut, pecan, and cherry.

5. Whip and Tongue Grafting

This method involves making interlocking cuts on the scion and rootstock to ensure maximum cambium contact and stability.

Procedure

1. Select a rootstock aged 1-2 years and a scion aged 6-12 months.
2. Make a slanted cut on both the scion and rootstock of the same length.
3. Make a secondary cut (a tongue) on both the scion and rootstock.
4. Interlock the scion and rootstock by fitting the tongues together.
5. Secure the graft with grafting tape or rubber bands.
6. Apply grafting wax to the union to prevent dehydration.
7. Keep the grafted plant in a shaded area with high humidity.

Suitable Season: Late winter to early spring before bud break. **Scion Age:**

6-12 months old. **Rootstock Age:** 1-2 years old. **Time for Success:** 3-4 weeks. **Examples:** Apple, pear, and rose.

6. Approach Grafting (Inarching)

A technique where both the rootstock and scion remain attached to their parent plants during the process.

Procedure

1. Bring the rootstock and scion plants close together.
2. Remove a small section of bark from both the stock and scion to expose the cambium layers.
3. Bind the exposed areas together with grafting tape.
4. Maintain the grafted area under high humidity and shaded conditions.
5. Once the graft union has healed, sever the scion from its parent plant and the rootstock above the graft.

Suitable Season: Spring to early summer during active growth. **Scion Age:** 1 year old. **Rootstock Age:** 1-2 years old. **Time for Success:** 6-8 weeks. **Examples:** Mango, guava, and jackfruit.

7. Epicotyl (Stone) Grafting

Definition: A grafting technique performed on young seedlings with soft epicotyls.

Procedure

1. Select seedlings about 7-10 days old.
2. Make a longitudinal slit on the epicotyl of the rootstock.
3. Prepare a scion with a wedge-shaped base.
4. Insert the scion into the slit, ensuring the cambium layers align.
5. Secure the graft with grafting tape.
6. Place the grafted seedlings in a humid and shaded environment for recovery.

Suitable Season: Late spring to early summer. **Scion Age:** 6-12 months old. **Rootstock Age:** 7-10 days old. **Time for Success:** 4-6 weeks. **Examples:** Mango, walnut, and tamarind.

Double Working

Double working is a grafting technique where two different scions are grafted onto a single rootstock to combine desirable traits. This method is often used to overcome compatibility issues or to introduce additional characteristics such as disease resistance and high fruit or flower quality. It is particularly useful in fruit trees like apples, where a dwarfing interstock may be used to control the tree size while another scion ensures superior fruit production. For example, in citrus trees, a disease-resistant scion may be combined with one producing high-quality fruits. Double working is ideal for creating multifunctional plants, especially in limited space gardening.

Topworking

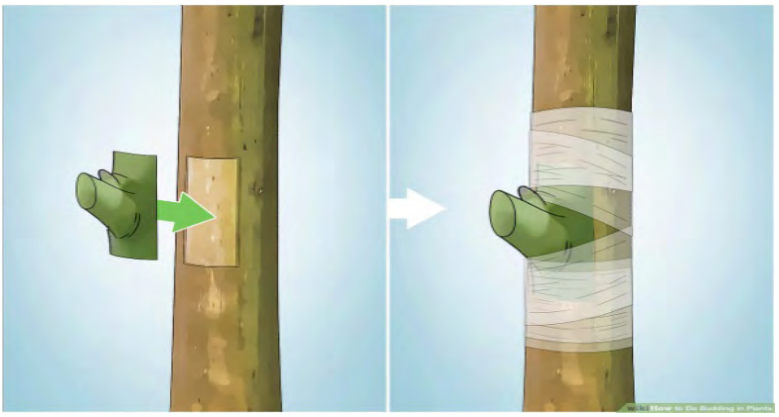
Topworking involves replacing the canopy of an existing mature tree with a new variety through grafting. It is used to improve productivity, change less desirable varieties, or upgrade old trees to newer, high-yielding cultivars. Typically, cleft or bark grafting is used on the tree's branches, and care is taken to protect and nurture the new scions. This technique is commonly applied in mango, citrus, and apple trees to replace outdated varieties with superior ones. For example, a low-demand mango variety can be topworked with a commercial variety like 'Alphonso,' extending the tree’s productive life.

Interstock

Interstock grafting involves placing an intermediary stem segment (interstock) between the rootstock and scion. This technique is useful for overcoming incompatibility issues, imparting dwarfing effects, or introducing specific traits such as tolerance to salinity or frost. For instance, dwarfing interstocks are commonly used in apple trees to produce compact trees suitable for high-density planting. Similarly, in citrus, an interstock can help improve compatibility

between a rootstock and a scion, ensuring successful graft union and enhanced performance under challenging conditions. This method allows combining the best traits of the rootstock, interstock, and scion for optimized growth and yield.

9.2.3.3 Different Techniques of Budding



Budding is a specialized grafting technique where a single bud from the desired plant (scion) is inserted onto the rootstock. Budding is widely used for propagating fruit trees, ornamental plants, and roses. Below are the different techniques of budding, explained with steps and examples:

1. T-Budding (Shield Budding)

T-budding involves inserting a bud into a "T"-shaped incision on the rootstock. It is one of the most commonly used methods for propagating roses, citrus, and stone fruits.

Procedure

1. Select a healthy rootstock with a smooth bark and prepare it by removing any branches near the grafting site.
2. Make a “T”-shaped incision on the rootstock. The vertical cut should be 2.5–3 cm long, and the horizontal cut about 1 cm wide.
3. Carefully lift the bark flaps created by the "T"-cut using a budding knife.
4. Cut a bud shield (a bud with a small portion of bark) from the scion plant.

5. Insert the bud shield under the flaps of the "T"-cut, ensuring the cambium layers of the scion and rootstock align.
6. Wrap the union tightly with budding tape, leaving the bud exposed.
7. After 2–3 weeks, check if the bud is alive, and cut off the rootstock above the bud to encourage growth.

Example: Used for propagating roses, citrus, and stone fruits like peach and plum.

2. Patch Budding

In patch budding, a rectangular patch of bark is removed from both the rootstock and scion, and the bud patch is inserted.

Procedure

1. Select a rootstock with smooth bark and make a rectangular incision (2.5–3 cm) to remove a patch of bark.
2. Remove a similar-sized rectangular patch containing a bud from the scion.
3. Fit the scion patch onto the rootstock, ensuring proper cambium alignment.
4. Wrap the graft tightly with budding tape or a rubber band, leaving the bud exposed.
5. Monitor the bud for 2–3 weeks to check for successful union and growth.

Example: Commonly used for walnut, pecan, and some ornamental plants.

3. Chip Budding

Chip budding involves removing a chip of bark with a bud and replacing it with a similar-sized chip on the rootstock.

Procedure

1. Cut a small chip (about 2.5 cm) from the rootstock at a slight angle.
2. Remove a matching chip with a bud from the scion.
3. Fit the scion chip onto the rootstock, aligning the cambium layers.

4. Secure the union with budding tape, ensuring the bud is exposed.
5. After 2–3 weeks, prune the rootstock above the graft to encourage bud growth.

Example: Suitable for apple, pear, and cherry trees.

4. Ring Budding

In this method, a ring of bark containing a bud is inserted into a matching ring cut on the rootstock.

Procedure

1. Remove a ring of bark (1–2 cm wide) from the rootstock.
2. Cut a ring of bark with a bud from the scion, matching the size of the rootstock cut.
3. Place the scion ring onto the rootstock, ensuring proper cambium alignment.
4. Secure the union with tape or string.
5. Monitor the graft for growth after 2–3 weeks.

Example: Commonly used in rubber plants and some ornamental species.

5. Inverted T-Budding

This is similar to T-budding but with an inverted "T" cut on the rootstock.

Procedure:

1. Make an inverted “T”-shaped cut on the rootstock.
2. Prepare the bud shield from the scion.
3. Insert the bud shield into the inverted “T” cut, ensuring cambium alignment.
4. Wrap the union with tape, leaving the bud exposed.

Example: Used for roses, citrus, and stone fruits.

General Notes

- **Scion Age:** Buds should be mature but not too old, usually 6–8 weeks old.
- **Rootstock Age:** Typically, rootstock should be 1–2 years old with active

cambial growth.

- **Season:** Budding is usually performed during active growth periods when the bark slips easily, typically in spring or early summer.
- **Time for Success:** Buds typically establish in 2–4 weeks, depending on environmental conditions and plant species.

Exercise

Choose the correct answer from the given alternatives.

1. What is the primary advantage of vegetative propagation over seed propagation?
   a. Longer juvenile phase
   b. Genetic uniformity
   c. Increased variability
   d. Faster germination

2. Which plant is commonly propagated using air layering?
   a. Rubber plant
   b. Wheat
   c. Rice
   d. Maize

3. What is the main purpose of using rootstocks in grafting?
   a. Flower production
   b. To impart desirable traits like disease resistance
   c. To increase plant height
   d. To reduce propagation cost

4. What is the disadvantage of using cuttings for propagation?
   a. High genetic variation
   b. Labor-intensive
   c. Weak root system
   d. Delayed flowering

5. Which method involves placing the tip of a branch into the soil to induce rooting?
   a. Cleft grafting
   b. Air layering
   c. Tip layering
   d. Patch budding

6. Which type of cutting is taken from mature and woody stems?
   a. Softwood cutting
   b. Semi-hardwood cutting
   c. Herbaceous cutting
   d. Hardwood cutting

7. What is the primary use of budding in propagation?

   a. To create new plant species

   b. To produce a large number of seeds

   c. To propagate plants with specific traits

   d. To improve soil quality

8. Which grafting technique involves inserting a wedge-shaped scion into a split rootstock?

   a. Cleft grafting b. Veneer grafting

   c. Side grafting d. Bark grafting

9. What is the main disadvantage of layering?

   a. Labor-intensive process b. High genetic variation

   c. Long juvenile phase d. Requires specialized tools

10. Which technique involves inserting a bud under a "T"-shaped incision?

    a. Chip budding b. T-budding

    c. Patch budding d. Inverted T-budding

Write short answer to the following questions.

1. Define vegetative propagation and its importance in horticulture.
2. List three reasons for using vegetative propagation over seed propagation.
3. Differentiate between hardwood and softwood cuttings.
4. What are the advantages of grafting compared to layering?
5. Explain the process of air layering with key steps.

Write long answer to the following questions.

1. Discuss the reasons for using vegetative propagation, providing examples.
2. Explain the advantages and disadvantages of cuttings as a propagation method.

3. Describe different techniques of layering with examples of plants where they are applied.
4. Explain the methods, advantages, and disadvantages of grafting in vegetative propagation.
5. Illustrate the process and benefits of T-budding, including its applications in commercial horticulture.

Project Work

1. Air Layering Practice

a. Choose a woody plant like a rubber plant or guava.
b. Perform air layering using sphagnum moss and plastic wrap.
c. Monitor the development of roots and prepare a report.

2. Cutting Techniques

a. Prepare hardwood, softwood, and semi-hardwood cuttings.
b. Root them in appropriate media and observe differences in rooting success.

3. Grafting and Budding Workshop

a. Perform cleft grafting and T-budding on selected rootstocks.
b. Monitor the success rate and analyze the advantages of each technique.

References

Adams, C., Early, M., Brook, J., & Bamford, K. (2019). Principles of horticulture (6th ed.). Routledge.

Arora, D. R. (2015). Floriculture and landscaping. Kalyani Publishers.

Arora, J. S. (2019). Fundamentals of horticulture. Kalyani Publishers.

Ashman, M. R., & Puri, G. (2020). Essential soil science. Wiley-Blackwell.

Bewley, J. D., Bradford, K. J., Hilhorst, H. W., & Nonogaki, H. (2013). Seeds: Physiology of development, germination, and dormancy. Springer.

Bhattacharjee, S. K., & De, L. C. (2010). Advanced commercial floriculture. Pointer Publishers.

Beyl, C. A., & Trigiano, R. N. (2017). Plant propagation concepts and laboratory exercises. CRC Press.

Copeland, L. O., & McDonald, M. B. (2001). Seed science and technology. Springer.

Datta, S. P. (2013). The tropical garden manual. Agrotech Publishing Academy.

Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. (2011). Plant propagation: Principles and practices. Pearson Education.

Khan, A. A. (1977). The physiology and biochemistry of seed dormancy and germination. Elsevier.

Landis, T. D., & Haase, D. L. (2012). Nursery manual for native plants: Volume 2. USDA Forest Service.

McDonald, M. B., & Kwong, F. Y. (2005). Flower seeds: Biology and technology. CABI Publishing.

Preece, J. E., & Read, P. E. (2005). The biology of horticulture: An introductory textbook. Wiley.